

IT Sharkie – Modern Approach to Teaching Informatics at Secondary Technical Schools

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Abstract— This paper focuses on transferring the knowledge from current research into the education of pupils and adults. Educational models that shift radically from the traditional approach focused on the teacher and the amount of transmitted information, to a student-centered approach and students' ability to apply the issues discussed will be put into practice. We focus on how to prepare the future generation of pupils for the needs of industry 4.0 and the needs of the digital economy.

Keywords— informatics, industry 4.0, framework education program, key competences

I. INTRODUCTION

The Municipality of Prague seeks to strengthen the interest of scientific-research institutions in the City of Prague in commercializing the outputs of their work. Therefore, the Municipality supports the preparation of the transfer of technology and knowledge from research organizations to areas and topics that are essential and topical for the city.

The main objective of this project is to support the preparation of technology and knowledge transfer, activities leading to commercialization of research results, from CTU (research organization) to areas and topics dealt with by the Municipality of Prague and its operations and services. Support will be provided based on the feasibility and potential commercial verification and its implementation.

The project aims to respond adequately to the growing need for quality education and training of pupils in technical disciplines that are developing very dynamically. The project's activities focus on transferring the knowledge from

current research into education of adult and pupil. We will implement the proposed models of learning that are radically shifting from the traditional approach, that has directed to the teacher and the content of the education (the amount of information transmitted), to the pupil / student-oriented plan (which he/she manages after completing the course).

We focus on how to prepare the future generation of pupils for the needs of industry 4.0 and how to prepare the next generation of pupils for the needs of the cyber world protection and the digital economy. It is related not only to the emphasis on the specific technical knowledge of graduates but also to the changing demands for their psychological resistance in the environment of the cyber and robotized world.

The transfer of science and research results into practice also supports by the preparation of commercialization of an economically efficient SW / HW educational platform, which is sufficiently modular, configurable and easy to upgrade SW for future requirements. This platform will use during the preparation of commercialization for experimental verification of educational concepts and study materials.

II. THEORETICAL PART

The presented project IT Sharkie addresses the issue of insufficient preparation of pupils for new labor market needs in the digital economy. As an integral part of this problem, we also see the need to support teaching staff and their home institutions, i.e., helping with the professional development of teachers and transforming existing learning

processes into new ones better-reflecting trends and knowledge in the field.

The trends in the education of pupils are shifting. From the traditional approach, that has directed to the teacher and the content of the training (the amount of information transmitted), to the student-centered approaches and students' ability to practically apply the acquired knowledge (which students can manage independently after the end of the learning process). In addition to professional competencies, it is essential to be able to develop critical skills. In the modern world, people are not paid for what they know, but for what they can do with what they know. The pivotal role is in moving towards a problematic orientation in a full data world and selecting relevant information. Our findings show that many secondary schools or primary schools would like to implement modern approaches to education, but they do not know how to control the transformation comprehensively.

Further education of educators or adults in general, is an essential yet underestimated component of lifelong learning. Effective transfer of new knowledge in this area and modernization of the approach to learning is also one of the national priorities of the Czech Republic. Finally, the application of modern teaching methods and their mastery is essential for maintaining the prestige and economic stability of schools.

The target group of the project consists of primary and secondary schools, who are interested in preparing or at least modifying modern teaching aids for their educational needs. In the current state, schools have a problem with the fact that they have to use ready-made applications, which for example do not precisely fit their curriculum, are not in Czech or do not exist at all for the given topic. With our system, it will be possible to create teaching materials and share them with other teachers and schools, which will bring benefits in the gradually growing basis of educational materials, allow for revision and improvement of background materials and thus faster adaptation of themes to other schools in the City of Prague.

A large number of secondary schools in Prague have expressed great interest in using the project outputs.

Although secondary and primary schools are becoming more and more equipped with material resources, they cannot overlook that teachers often do not use this equipment effectively. Worse still, relying on themselves, they invest a lot of their valuable time in learning to control this equipment at the expense of their professional development and teaching work with students.

In the field of technical education, and especially in ICT disciplines, as well as others that are developing dynamically, teachers also face with several disruptive innovations that make it very difficult for them to teach and prepare students for future labor market requirements. The market, under the pressure of these innovations, is undergoing a radical change. Disruptive technologies and approaches in principle change the ways and attitudes they

experience and adapt them to problems that are active in the market segment into which disruptive innovation comes.

Another problem is the emphasis on individual approach to student education, which places exceptionally high demands on teaching capacities, not only in terms of time but also in terms of mental ability, stress tolerance, and hardiness. Modern learning environments should allow teachers to further personalize their work with students, but they face the ignorance of these environments.

At the beginning, it is also very difficult or costly for new technologies to acquire appropriate teaching aids, which students could "touch" and develop practical skills with.

These and the facts mentioned above inspired the research team to create a platform that will help secondary and primary schools in the areas as mentioned earlier so that they can adapt faster and easier to new market conditions and requirements.

Our market analysis focused on determining whether there are suitable educational aids in this area, designed for secondary or primary schools, to help with the problems as mentioned above and to facilitate their work. For the selected thematic segment Industry 4.0 and Cyber Security, it found that such aids are not available in the Czech Republic.

They are not available in the Czech language or with the support that would make appropriate adaptation to the Czech environment possible. Alternative educational aids are available abroad. However, they provide a prepaid service (implemented using a cloud approach) and design according to educational paths and plans that do not meet the needs of Czech schools. From this point of view, a different offer is not relevant because its acquisition and adaptation to Czech needs would be costly and with an uncertain outcome.

Some competitors could be products that are on the Czech market and are offered for the professional training of employees from companies such as Cisco, Juniper, and Microsoft. These products relatively frequently use in secondary schools. However, because they are, in principle, developed for another target group, it is instead a supplement and, worse, a supplement that is often tied to hardware by a particular manufacturer. The massive deployment of these platforms in teaching then degrades the school somewhat to a firm's training center and certainly does not benefit the role that the school should fulfill.

III. METHODOLOGY

Our innovation and solution are to eliminate the shortcomings mentioned above and to prepare a suitable learning platform that is open (product independent) and easy to adapt to teaching needs. In connection with this platform, the creation of appropriate methodological and didactic procedures, which apply the latest knowledge in the field of education and modern approach to the student, are

related. In this context, we emphasize not the technical and material elements of teaching, but especially the procedures, and abilities of the teacher, which will help to achieve the educational goals of individual students.

Within the project IT Sharkie outputs, we expect:

- Reducing the adaptation time of teaching staff and schools to the educational requirements of the market in the context of the Industrial Revolution 4.0 and the need to educate cybersecurity professionals.
- Applying a multidimensional view of a changing society (with the Industrial Revolution 4.0) and integrating these aspects into educational processes.
- Strengthening the cooperation of CTU with secondary schools and their teachers with the aim of further professional education of secondary school teachers and motivation of students to further study of technical fields.
- Significantly reducing the cost of acquiring teaching aids for secondary schools and maintaining their usability even in the case of future changes in the industry.
- Further developing the expertise of the team, which deals with this issue and strengthening research activities in this area.

In terms of impacts on individual actors in the education process, we expect the following benefits.

Benefits for students.

- Possibility of learning at their speed, improving students' motivation and self-efficacy skills.
- Focus on the possible acquisition of the discussed issue by the student and motivation for further education. As proposed by experience-based learning theories, experiences, including cognition, environmental factors, and emotions, vastly influence the learning process. Knowledge is created through the transformation of experience and results from the combinations of grasping and transforming the experience. Both the cognitive and behavioral aspect of learning allows the student to not only remember information but also to be able to apply it to real-life problems.
- Increased mental resilience in a changing cyber world. Experience-based learning empowers students to overcome fear and transform their learning identity from the anxious inferiority of "I don't" or "I can't" to one of confidence and self-efficacy.
- The emphasis is on mastering both professional and critical skills, which increases the competitiveness of graduates in the labor market. There is a growing body of evidence [4, 6] showing that skills formed relatively early in the life cycle have long-lasting effects on a variety of essential outcomes. Early

human capital interventions, taking into account the multi-dimensional and dynamic nature of skill formation, are proven to be an effective strategy to combat unemployment and other behaviors and outcomes.

Advantages for Educators.

- Help with the introduction of modern education concepts, rapid adoption of learning and teaching practices.
- An individualized approach to teaching (including work with talented students).
- Measurability and ability to effectively change the pedagogical process for both individual and group learning.

Advantages of the solution for schools.

- For those who want, there will be external support that can assist the institution with a significant change in the conception of learning.
- The commercialization model establishes a further close collaboration between the university and the development of pedagogical staff and educational materials.
- Solution scalability and easy adaptation to areas other than those covered by IT Sharkie project.

IV. PRACTICAL PART – IT SHARKIE SPECIFICATIONS

IT Sharkie suite is designed for teaching and studying network technologies at a defined school level (2nd level of primary school, secondary school, specialized secondary school, and high school). It is designed to develop the knowledge and skills of students at a given level of education and methodologically help educators to prepare exciting lessons. Based on a set of exercises, the module presents work with network devices, introduces students to the study of network protocols and the principles of organizing network services.

IT Sharkie is offered for defined levels of schools and in the context of educational goals and level needs.

- IT Sharkie Set of HW/SW devices.
- A set of tutorials - a guide to a specific lesson, basic and advanced exercises including solutions and tutorials, homework assignments, test tasks.
- Training for the teacher within the accredited course of further education of pedagogical staff - presentation and understanding of the IT Sharkie suite, preparation of the teacher for teaching and use of aids, presentation of modern trends in the given area and involvement of new technologies.



Fig. 1. IT Sharkie workstation

Skills and knowledge acquired by students.

- Working with Mikrotik and CLI Linux routers;
- Configuring network interfaces, assigning IP addresses and calculating network masks.
- Understanding the principles of TCP and UDP transport protocols and the differences between them.
- Understanding network distribution principles using DHCP protocols
- Understanding the organization of domain system names.
- Configuring HTTP, FTP, TFTP network servers.
- Understanding operating principles.

IT Sharkie suite consists of two workstations and a server. The workstation includes a Mikrotik router and a small client computer that boot the OS Linux. The module contains a set of pre-installed applications allowing the user to use the learning module effectively. The router has a wide range of functionality and allows working with the TCP / IP protocol stack in the context of defined tasks.

IT Sharkie suite benefits.

- Students have full access to the server and workstation they control.

- Students can work in both the graphical interface and the command line (CLI).
- The command line allows students to make changes and work creatively under the supervision of a teacher.
- The computer's default settings can be restored using special software by pressing a button.

IT Sharkie, as a teaching aid, makes a significant contribution to the development of key and professional competencies. Education leads graduates to work with a personal computer and its basic and application software, as well as other ICT resources, and to use adequate sources of information and work effectively with information.

In general, graduates should [7]

- a) design, assemble and maintain HW, i.e. they should be able to:
 - choose a balanced HW solution with a regard to its function, parameters and suitability for the intended use;
 - assemble and animate assemblies, including peripheral devices;
 - identify and correct HW faults and perform upgrades.
- b) work with basic software, i.e. they should be able to:
 - choose the appropriate operating system for its intended deployment;
 - install, configure and manage the operating system including its advanced settings according to the user's objective needs;
 - support users to work with basic software;
 - design and apply an appropriate data security system to prevent misuse and data protection from destruction.
- c) work with application software, i.e. they should be able to:
 - choose appropriate software with a regard to its deployment;
 - install, configure and manage application software;
 - use common application software, especially so-called office applications;
 - support users when working with application software.
- d) design, implement and administer computer networks, i.e. they should be able to:
 - design and implement computer networks with a regard to their intended use;

- set-up network elements;
- administer computer networks.

IT Sharkie makes a significant contribution to the development of computer networking expertise given in the last professional competence in letter d).

V. CONCLUSION

IT Sharkie is a product that covers up-to-date educational needs of industry 4.0 in the area of computer networks with a primary focus on secondary technical schools. Innovation lies not only in the HW and SW solutions, but also in other complementary parts, such as further education of teaching staff (IT teachers) as well as collections of tasks in the form of methodological sheets elaborated in the form of eBook.

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