Applying technologies in vocational education in Bulgaria

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Abstract. Information and communication technologies (ICT) give many benefits to every learning stage – from primary school to university and even life-long learning. Vocational education uses the base of the previous stages and aims at preparing students for their future jobs. The present paper focuses on vocational education in Bulgarian high secondary schools and universities (colleges). A short overview of the most used WEB-based educational information systems is presented. The paper also describes an extensive survey among teachers and students on the use of ICT in Bulgarian schools. The profile of responded vocational teachers is briefly presented. Here are presented and analysed their opinions about the available conditions and obstacles for using ICT in the teaching process. The usefulness and the frequency of using the most popular e-resources in the vocational subjects are compared. The paper presents a portfolio optimization approach for the usage of different e-resources. Next, the authors give an overview of the application of new technologies in higher education in Bulgaria. The paper provides information about specific educational systems, created for their own needs of the Universities, according to the specifics of the disciplines.

Keywords: vocational education, e-learning, educational information systems, portfolio optimization

1. Introduction

New technologies change almost all social areas, and education is not an exception. Information and communication technologies (ICT) give many benefits to every learning stage [1] – from primary school to the university and the life-long learning. Vocational education uses the base of the previous stages and aims to prepare students for their future jobs. ICTs can be applied in different activities to achieve different goals, such as interdisciplinarity [2], project-based learning [3], and specific purposes. They are greatly applicable in all subject areas like engineering, medicine, and public administration [4, 2, 5]. Providing the necessary conditions for implementing new technologies in the learning process for the vocational subjects is of vital importance for the efficiency of education.

The present paper focuses on vocational education in Bulgarian high secondary schools and universities (colleges). The next section gives an overview of the role of web-based information education technologies, enabling the e-learning to be implemented and increasing the effectiveness of the educational process. Section 3 presents the methodology of conducting a survey among Bulgarian teachers and the profile of professional ones. Section 4 describes the survey findings for vocational teachers – conditions and obstacles for using ICT in their teaching practice, their opinion about the usefulness, and the frequency of using e-resources. Section 5 describes the need to create their own e-learning systems at universities in Bulgaria. It gives an example of several well-developed and implemented in higher education e-learning platforms - own development. The paper ends with a discussion on the presented issues and a conclusion.
2. WEB-based educational information systems

E-Learning has gained widespread popularity in recent years and is in itself interactive learning that uses various communication technologies as a teaching tool. It provides the learner with easy access to teaching materials at a convenient time and place, thus the trainee receives a quick qualification with minimal costs. E-Learning is both an easy-to-adopt environment that is flexible and high-quality when used in combination with traditional teaching methods to increase the efficiency of the educational process in general.

Along with e-learning, widely used concepts these days are Web-based learning, online training, and distance learning.

Web-based learning can be defined as a collection of specialized resources available via the Internet or Intranet, which allows learners to gain knowledge and skills through self-study. Not only does it provide the necessary teaching material, but in practice, it requires learners to demonstrate the level of mastered knowledge.

The fact is that interest in software products, enabling e-learning to be realized, is growing rapidly. There is a wide range of software products available to provide distance learning [6, 12] which can be classified as:

- **Authoring Tools** (Authoring Packages) – These tools enable educators to develop and publish self-contained learning content. In general, products in this class do not provide opportunities related to the control over the learning process and the success rate, nor do they provide real-time communication.

- **Learning Management Systems (LMS)** – They are designed for the organization of a learning process involving a large number of learners. LMS systems provide opportunities for management, administration, documentation, tracking, and reporting of training programs, classes and online events, e-learning programs, and training content.

- **Content Management Systems (CMS)** – These systems are organized for publishing a large volume of all content-texts, pictures, and multimedia. CMS systems are especially effective in cases where a large number of teachers are working on the creation of the curriculum content, which must use the same fragments of learning materials in different courses.

- **Learning content Management Systems (LCMS)** – A system that creates, stores, assembles, and provides customized learning content in the form of learning objects. LCMS provides the means to create learning materials, to track the training of a large number of people, to store and search for individual elements of the educational content.

Some of the most commonly used systems in education are Content Management Systems. These systems are multifunctional and continually evolve and complicate. The problem of how to structure the Web-based course and present it according to a selected model, how to store it in a properly structured Web-integrated database is particularly important.

Although almost all authors point to the universal nature of the systems they have submitted, there are, in practice, specific differences. The practice shows that individual Universities use information systems entirely tailored to their specifics, justifying, and imposing the need to develop their own systems according to a selected pedagogical model.

3. Methodology

A widespread online survey among Bulgarian teachers form all stages and subjects was conducted in 2017/2018. Questionnaire for teachers consisted of 21 questions on several topics: profile, conditions, experience with ICTs and free comments. Survey was held in Bulgarian language, and the hyperlink can be found in the project website [7].

The total number of the responded teachers is 1652 from different settlement sizes and all regions in Bulgaria. The present article focuses on the opinion of vocation teachers, which number is 58, and most of them teach in STEM subjects (Science, Technology, Engineering, and Mathematics). Figure 1
presents their distribution according to their experience in school education. The numbers of responded vocational teachers are almost equal for three of the total four experience groups. The smallest part of them is the teachers with 5 to 15 years of practice in the classroom.

![Figure 1. Experience of responded vocational teachers](image)

**Figure 1.** Experience of responded vocational teachers

Figure 2 presents the teachers’ distribution according to the size of the settlement they teach in. Most of them work in big cities (38%), followed by teachers from the capital city – about 33%. The rest of them teach in smaller settlements. The most probable reason is that usually high schools, including vocational ones, are situated in the bigger cities, and teachers and students who live in smaller settlements have to travel every day.

![Figure 2. Profile of vocational teachers according to the size of settlement they teach in](image)

**Figure 2.** Profile of vocational teachers according to the size of settlement they teach in

4. **ICT in professional high secondary school education**

Here are presented some outcomes from the above described survey concerning vocational teachers. Authors emphasize on the available conditions in schools and the usability and frequency of using the most popular e-resources.

4.1. **Conditions and obstacles for using ICT in the teaching process**

This section presents the opinion of Bulgarian vocational teachers about the conditions and obstacles for applying new technologies in the learning process. The most important conditions that the authors took into account are institutional support, and the availability of training courses, technical equipment, appropriate software, and reliable Internet connection. Additionally, teachers commented on the issue in free text.

According to 81% of surveyed vocational teachers, the support from institutions for implementing ICT in the classroom is available. Unfortunately, this is not enough to provide some of the necessary conditions. A relatively small proportion of teachers say that they lack courses, equipment, or software (between 7% and 12%). For a slightly larger proportion, these conditions are only partially available (between 21% and 30%). The survey shows that only 24% of teachers have a good quality Internet connection. 47% of them state that their connection is unreliable, and 24% do not have the Internet in the school at all.
Figure 3 presents the most frequently mentioned obstacles for implementing information technologies in Bulgarian vocational education. Almost 30% of teachers state that there are no obstacles. According to half of the respondents, the e-resources are insufficient. The lack of technical equipment is an obstacle for 47% of them.

About 28% of the vocational teachers point to lack of time in the schedule for including e-resources and the same part of them – the insufficient competence of teachers to use ICT in the learning process. About 20% of the respondents mention a lack of time for preparation and information about appropriate e-resources. Less checked obstacles are not presented on the figure and are as follow: an attitude of teachers (12%), students (9%), and parents (5%); ICTs distract students from the subject (7%) and lack of specialist of educational technologies (7%). Only 2% of the respondents state that ICTs are not appropriate for learning purposes.

4.2. Usefulness and the frequency of using e-resources
 Teachers had to evaluate the usefulness of the most used e-resources (Figure 4) and how frequently they apply them in the classroom (Figure 5). The most useful e-resources, according to vocational teachers, are learning videos, presentations, and specialized software (respectively, 40%, 38%, and 34% answer with “Extremely useful”). According to respondents, the least useful are educational games and virtual laboratories. Vocational teachers use most frequently presentations (31% for “very often” and 33% - “often”), specialized software (26% for “Very often” and 9% - “often”), and learning videos (19% for “Very often” and 29% - “Often”). The least used resources are virtual labs, educational games, and process simulations. A significant part of teachers did not answer for both issues of e-resources, and the most probable reasons are the lack of such resources for vocational subjects (Figure 4) and the lack of teachers’ experience with them.
5. Portfolio approach for optimization the usage of e-resources

The idea for an increase of the e-learning performance is the appropriate combination of the e-resources in the educational process. The main e-resources, which are considered in the paper are educational games \(x_1\), additional resources \(x_2\), specialized software \(x_3\), virtual labs \(x_4\), process simulation \(x_5\), learning videos \(x_6\), presentations \(x_7\), e-tests \(x_8\), E-textbooks \(x_9\). These nine tools, \(x_i, i=1,\ldots,9\). The idea for an increase of the e-learning performance is the appropriate combination of the e-resources in the educational process. The main e-resources, which are considered in the paper are educational games \(w_1=4\), “often” \((w_2=3)\), “rarely” \((w_3=2)\), and “never” \((w_4=1)\).

Following the given data for e-tool “presentation” the mean value of its usage will be

\[ E_{\text{presentation}} = \sum_{i=1}^{4} w_i f_i, \quad i=1,\ldots,4, \]

where \(f_i\) is the frequency parts of the presentations \((f_1=31\%, f_2=33\%, f_3=\ldots)\).

The portfolio problem for optimal usage of the e-tools will be defined as

\[ \max \sum E_{i} x_i, \quad x_i \geq 0, \quad \sum x_i = 1. \]

The solution of this problem \(x_i\) will give the relative amount of the corresponding e-tool, which is recommended for usage in the e-learning process.

This portfolio model for optimization of the educational process is in the development stage. The paper presents here only the potential usage of such a portfolio optimization procedure.

6. ICT in professional university education

In today's society, computers have established themselves as an indispensable assistant in all spheres of human activity. Enormously has greatly grown the importance of information which already being treated as a business resource. This was made possible thanks to the computer information systems that provide the main environment for the application of information technologies in practice.

Through good knowledge of the possibilities and trends in the development of computer information systems can increase the efficiency of work at all levels and in all spheres of action.

Development trends in e-learning and greater accessibility of education generally reinforce the need to deploy the ICT at all levels of the educational process and encourage institutions to work in this direction. The development of information systems integrating into itself components for administrative services, communication, e-learning, career development, etc. can significantly improve the quality of educational services offered at all levels [8].

Instead of large application programs with multiple and increasingly difficult opportunities, there are a number of small, efficient, and easily interconnected applications that realize clear unique features [13, 14, 15].
6.1. E-learning platforms - Own development
The rapid development of ICT on the hardware-software-hardware spiral is an advantage for the introduction of new training methods, but also a major challenge for universities, especially when they do not have their own informatics units and teams.

There are a number of reasons justifying the need to create an own e-learning system, such as the high prices of foreign systems for organising and managing training, which is not comparable to our conditions; Language barrier, due to the fact that the systems are oriented mainly to the English-speaking countries; Lack of possibility for the flexible renovation of the system used with the development of new information technologies. The systems purchased or obtained through license may not be altered; Despite the universal nature of most systems, there are, in practice, distinctive differences between engineering, humanitarian, medical and other disciplines, justifying and imposing the development of their own systems, according to the specifics of the disciplines. For example, in medical disciplines, it is important to solve situational tasks (clinical cases).

As an example of some of the best developed and applied in higher education platforms – own development, can be identified:

eLSe (e-Learning Shell) – The system was developed in the Department of Information Technologies of Rousse University. It is based on open-source products. E-Learning Shell is a platform that allows educators to publish their own WEB-based courses without the need to possess computer knowledge and skills [9].

DeLC (Distributed eLearning Center) – In the Faculty of Mathematics and Informatics of the University of Plovdiv was developed infrastructure called distributed e-Learning Centre (DeLC). This centre is designed to deliver in a context-dependent, adaptive, and personalised way e-learning services and e-learning content located on servers that can be physically separated. DeLC is a dynamic network structure that consists of nodes and relationships. One of the nodes of the DeLC is an educational portal designed to educate both students in higher education and also to be adapted to educate students in secondary education [10].

Virtual educational Environment of Medical University-Sofia – An information system for WEB-based training in medical disciplines has been developed. The system allows the delivery of Web-based courses as a source of basic knowledge. It gives the students a possibility of (self) evaluation of the theoretical knowledge and a possibility of creation and improvement of their professional skills to solve clinical cases. The administrative module allows teachers easily to organize the database necessary to create and edit Web-based courses composed of lectures, interactive tests, and virtual patients [11].

The Courses created currently by using the university Web-based system are a good example of the integration of the latest achievements in the specific discipline (modern content), ICT (Web-environment), Pedagogy (flexible learning), and Medicine (problem-based learning using virtual patients).

6.2. Comparison of eLSe and Web-based system of MU-Sofia with other Bulgarian and foreign systems in the field of e-learning
A comparison of the possibilities between several popular universal e-learning systems and the E-learning platforms - Own development is presented. The purpose of the comparison is not to point out that the systems are better than the above-mentioned universal e-learning systems. The aim is to show that they are commensurate and close to a large extent on their basic qualities of some of the best solutions in the field of e-learning. The comparison was made on criteria based on independent expert studies [9]. The results are visualized through a radar chart in Figure 6. It is evident that the systems possess the necessary means to conduct an effective e-learning.

For years, information technology has had a significant impact on the development of the education system. This is because the curriculum process is a set of participants, means, and methods for conveying the necessary knowledge so that its improvement according to the new technological possibilities is absolutely essential.
7. Conclusion

ICT technologies are an inseparable part of the life of our society and thus become indispensable in modern training at all levels – from primary education to university education. The proper use of modern educational technologies enhances the effectiveness of teaching and learning. To this end, it is necessary to use new pedagogical models and approaches that enable collaboration, communication, and mobility. Such learning technologies include virtual educational environments such as content management systems, interactive multimedia technologies, mobile device usage, and wireless technologies. The paper makes an attempt to formalize the usage of e-resources, by the definition of the portfolio optimization problem. The solution to such a problem will give recommendations on how frequently the different types of e-resources have to be used in an optimal way in the educational process.

ICT technologies and resources give a lot of possibilities for diversifying and improving the educational process. Thus, new technologies penetrate in Bulgarian vocational teaching as well. In Bulgarian schools, technical equipment and e-resources are available to various degrees. A positive trend is an increase in the percentage of teachers who claim that they do not encounter obstacles to the use of ICT in education. Unfortunately, in many schools, these conditions are still missing or partially available. Above all, vocational training lacks adequate resources and up-to-date cabinet equipment, as well as a fast and stable Internet connection.

Vocational subjects are considerably diverse, both in the high school and university levels. For this reason, it is difficult to provide the necessary e-resources in all specialized subjects. A good solution to creating a large set of e-resources is to encourage teachers to become actively involved in their development. For this purpose, the educational authorities should ease the curricula and pay the time for generating e-resources.

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