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Open education resources in enhancing education of biotechnology engineers[1]

Milevica Bojović[2] and Snežana Tanasković[2]
[2] University of Kragujevac, Faculty of Agronomy in Čačak, Čačak, Serbia
e-mail milevicabojovic@gmail.com

Abstract: *The paper explores the concept of Open Education Resources emphasizing its importance in education of biotechnology engineers in Serbian education context. In order to fill the gap which exists in agricultural education of various target groups such as teaching staff at agriculture universities, teachers in high vocational schools teaching agricultural courses, and agricultural advisors in agricultural extension service considering the development of their professional competences the attempt is made to create the open resources in the field of agriculture. A result of such attempts is the creation of National Repository for Agricultural Education in Serbia. The National Repository for Agricultural Education in Serbia as an open education resource for biotechnology engineering is presented in the paper. Another result refers to the contents created for the repository - face-to-face, blended and online courses created by the agricultural university teaching staff for all stakeholders in biotechnology engineering education in Serbia.*

Keywords: *biotechnology engineering; open education resources; repository for agricultural education*

1. INTRODUCTION

The development of the information and communication technologies (ICT) not only set the path for new opportunities for learning but also questioned established teaching and learning organization patterns. Since the beginning of the 21st century, the digital technologies have been used in higher education to develop and distribute education. Until recently, much of the learning resources developed in such a new teaching and learning setting were protected by propriety rights, not being reachable without passwords. However, more and more institutions and individuals share digital learning materials via the Internet openly and for free. The open educational resource (OER) movement aims to encourage and enable freely sharing content.

At the same time, the education of biotechnology technicians and engineers at secondary and tertiary education levels in Serbian educational context has shown some insufficiencies

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considering their professional competences. These insufficiencies generally refer to their educational, content and communication competences, and ICT competences in acquiring and transferring knowledge in biotechnology engineering. The creation of OER in the field of biotechnology in Serbia is assumed to be the way to fill the existing gap.

2. THE CONCEPT OF OPEN EDUCATION RESOURCES

The term OER was first used at UNESCO conference "Forum on the Impact of Open Courseware for Higher Education in Developing Countries" held in Paris, France in July 2002, where the OER were conceptualized as "the open provision of educational resources, enabled by information and communication technologies, for consultation, use and adaptation by a community of users for noncommercial purposes" (UNESCO, 2002, p. 24). Today, OER are defined as digitalized materials offered freely and openly for educators, students and self-learners to use and reuse for teaching, learning and research (OECD, 2007, p. 30). To put it simply, the concept of OER describes any educational resources, e.g. curriculum maps, course materials, textbooks, streaming videos, multimedia applications, podcasts, and any other materials, that have been designed for use in teaching and learning, that are openly available for use by educators and students, without any need to pay licenses fees (Butcher, 2015, p. 5).

There is a need to emphasize that there is one key difference between OER and any other education resource – its license that facilitates reuse without first requesting permission from the copyright holder (Butcher, 2015, p. 5). Also, it is necessary to point out that OER does not mean the same as the term online learning or e-learning as the openly licensed content can exist in any form such as paper-based text, audio, video, or computer-based multimedia. Many open resources are simultaneously printable and shareable in digital form.

OER is said to include learning content, software tools, and implementation resources such as open licenses (OECD, 2007, pp. 30-31):

- learning content involves courses, content modules, learning objects, collections and journals;
- tools refer to software to support the development, use, reuse and delivery of learning contents, including searching and organization of content, content and learning management systems, content development tools, and online learning communities; and
- implementation resources include intellectual property licenses to promote open publishing of materials, design principles of best practice and localize content.

3. EDUCATION OF BIOTECHNOLOGY ENGINEERS: THE GAP TO BE FILLED

Education system has been remarkably changed since the beginning of the 21st century in Serbia. Earlier, the emphasis was on initial education; now professional development has become important. In the education in biotechnology field in Serbia three target groups are important: university teaching staff at the agriculture faculties, teachers in high agricultural schools teaching courses in the field of biotechnology and related fields, and agricultural advisors in agriculture extension service. Professional development of these three groups, of which two groups belong to teaching profession at tertiary and secondary education levels,

implies acquiring and improving fundamental professional competences of both teachers and biotechnology engineers.

Teachers' professional competence includes: 1) educational competence referring to the system of knowledge, skills, abilities and motivation dispositions needed to realize professional roles, 2) course content competence meaning the system of knowledge and skills derived from the course content and developed abilities necessary to transfer this knowledge, and 3) communication competence referring to the system of the knowledge, skills, abilities, and motivation dispositions needed to realize the goals of communication and social interaction (Bjekić & Zlatić, 2006). Additionally, teachers' professional competence involves general teachers' competence in application of ICT (knowledge of basic computer operations, using ICT to facilitate his/her own professional development, for communication, collaboration and research, and to support teaching/learning process) and specific e-competences in shaping e-teaching/e-learning (using ICT as productive tool to integrate it into learning/teaching context, to research and present developed products, and to evaluate and use information in order to improve teaching/learning process) (Technology standards for all Illinois teachers, cited in Bjekić, 2013, p. 251).

Professional engineering competence, according to 5-tier engineering competency model (Engineering competency model, 2015), includes: foundational competencies involving personal effectiveness competencies, academic competencies, and workplace competencies; and industry-specific competencies involving industry-wide competencies, and industry-sector competencies, allowing an engineer to move easily across industry sub-sectors. Personal effectiveness competencies are personal attributes, often referred as "soft skills", vital for all life roles and learned in the home and community. Academic competencies include reading, writing, mathematics, science and technology, communication, critical and analytical thinking, and computer skills – they are generally learned in school settings and are applicable to all occupations; here, it is important to highlight that ICT competences, also called digital competences (Key competences for lifelong learning, 2007), and communication competences belong to generic competences, i.e. abilities and skills that people could learn in different ways in various learning environments and that are transferable to new situations (Young & Chapman, 2010). Workplace competencies refer to motives, traits, interpersonal and self-management styles also applicable to large number of occupations. On the other hand, industry-wide competencies cover the knowledge and skills and abilities from which workers across the industry can benefit, e.g. design, manufacturing and construction, operations and maintenance, etc. And lastly, industry-sector competencies are specific to any industry sector.

Nowadays, in Serbian education system all three target groups in the field of biotechnology lack some of professional competences. The university teaching staff have been trained to acquire course content competence during their undergraduate and postgraduate studies as well as through various forms of research so they have become the experts in the content; however, their education lacks educational and communication competences, and generally ICT competences for creating the material and using the software of open education resources. The high vocational school teachers teaching courses in biotechnology and related fields have also been educated in course content during their pre-service education (undergraduate studies) and have acquired educational competence to some extent in in-service education; however, they lack the latest knowledge in the field of biotechnology as well as ICT competences to use learning management systems in the attempt to acquire necessary content competence and possibly to develop teaching material for their high school

students. Agricultural advisors in agriculture extension service have gained content competence in the biotechnology field both during their pre-service education (undergraduate agricultural university education) and in-service education (professional development training organized by the Serbian Institute of Application of Science in Agriculture); however, they lack communication competence in their everyday work with the farmers and ICT competences to find, use, and acquire current knowledge in the field of biotechnology.

The attempts to bridge the gap considering professional competence of biotechnology engineers in Serbia were put under one roof – National Repository of Agricultural Education (NaRA). NaRA was created in 2014 as an open resource in education of biotechnology engineers to offer the opportunity for more efficient education to all the stakeholders. It was created within TEMPUS project "Building Capacity of Serbian Agricultural Education to link with the Society" (CaSA).

4. METHODS – FILLING THE GAP

The aims of the CaSA project are to contribute to the improvement of biotechnology education to meet the needs of Serbian society, to improve the quality and availability of vocational biotechnology education, to strengthen professional competences of both university and high school teachers as well as agricultural extension service advisors, and to create open source repository to offer the possibility of lifelong learning in the field of biotechnology (CaSA).

The sample consists of the university teaching staff (63 teachers) of all the faculties of agriculture in Serbia (Faculty of Agriculture University of Belgrade, Faculty of Agriculture University of Novi Sad, Faculty of Agronomy University of Kragujevac, State University of Novi Pazar, and EDUCONS university), high school teachers in the field of biotechnology (60 teachers), agriculture extension service advisors (60 advisors), and IT administrators (7 administrators) at all five faculties and Serbian Institute of Application of Science in Agriculture. The university teachers were selected on the basis of the need analysis carried out among biotechnology high school teachers and agricultural advisors (Šćepanović et al., 2015) – which content areas these two target groups need.

All groups went through the process of in-service training programmes during 2014:

- The university teachers experienced active teaching/learning program (ATL) to improve their educational competence, communication skill training program, and ICT training program in order to be capable of creating the various types of courses such as face-to-face, blended and online courses using Moodle as Learning Management Systems (LMS) to be used in biotechnology high school teacher in-service programs and advisors in-service programs;
- The high school teachers in the field of biotechnology went through ATL training program to develop their educational competence and ICT training program to improve their digital competences to be able to transfer the content knowledge to students through ATL high school classes and use ICT skills to attend in-service blended and online programs and prepare online working material for high school students;
- The advisors in extension service went through communication skill program and ICT training program to strengthen their abilities to communicate with and transfer the current knowledge in the field of biotechnology to the farmers and food

processors as well as to be capable of using and critically thinking over open resource materials in order to learn the newest methods and processes relevant to producers; and

- the IT administrators were trained to assure infrastructural support to the functioning of the open source repository and software support for the created blended and online courses.

5. RESULTS

The first result of the efforts engaged through CaSA project was the development and improvement of: educational competence, communication competence and ICT competences of university teaching staff; educational competence and ICT competences of high agricultural school teachers; communication competence and ICT competences of agricultural advisors in extension service. The teachers at tertiary and secondary education level gained the knowledge and skills which they will transfer in their classrooms to the university and high school students while agricultural advisors are to apply their newly gained communication skills and ICT skills in direct contact with the farmers and food processors and in searching for valid resources in the filed of biotechnology.

Furthermore, the university teachers at five faculties of agriculture in Serbia created 63 courses in various sub-fields of biotechnology, i.e. plant production and protection (e.g. Alien invasive species, Plant breeding in food production), animal production and veterinary medicine (e.g. Organic animal husbandry), food technology (e.g. Fruit drying), agricultural engineering (e.g. Drip irrigation system, Application of the spreadsheet calculations in agriculture), soil sciences, agricultural economics (e.g. Project management in agriculture). The last sub-group of courses includes a course for developing a key competence for lifelong learning - communication in foreign languages (Key competences for lifelong learning, 2007); it refers to reading skills as the basic academic competence (e.g. Developing reading skills in English language for agriculture). This competence may be neglected in Serbian engineering education setting. The number of courses according to the learning environment, target group, and institution at which the courses are created is illustrated in Table 1 (modified according to Topisirović, 2015).

Table 1. *Structure of the courses created by university teaching staff*

Types of courses (N)	**Institutions**					**Overall per type**
	UB	**UNS**	**UNIKG**	**SUNP**	**EDUCONS**	
Learning environment						
Face-to-face	12	3	1	0	9	**25**
Online	3	1	4	0	0	**8**
Blended	3	13	6	8	0	**30**
Target group						
High school teachers	12	5	2	8	5	**32**
Advisors	6	2	5	0	0	**13**
Teachers & advisors	0	10	4	0	4	**18**
Overall per institution	**18**	**17**	**11**	**8**	**9**	**63**

N – number of courses, UB – University of Belgrade, UNS – University of Novi Sad, UNIKG – University of Kragujevac, SUNP – State University of Novi Pazar

These courses have been created to be applied primarily with high school teachers in the field of biotechnology and agricultural advisors in extension service or both; also, the potential users may be the university students, high school learners, farmers, food processors, stockmen, etc. The courses can be grouped further according to the type of learning environment the users are to be exposed to into face-to-face, online, and blended courses (Topisirović, 2015). As it can be seen from Table 1, almost two thirds of all the created courses (more precisely, 60.32%) are online and blended courses. The university teachers applied newly acquired skills to create courses using LMS. Moreover, a half of all the courses have been created for the agricultural high school teachers; if we take into account 18 courses applicable with both target groups, the number of courses offered to agricultural high school teachers increases to 50, which is approximately 80% of all created courses. If we bear in mind that in-service education of biotechnology high school teachers lack specialized courses in the field of biotechnology in their in-service education, this result has even a greater value.

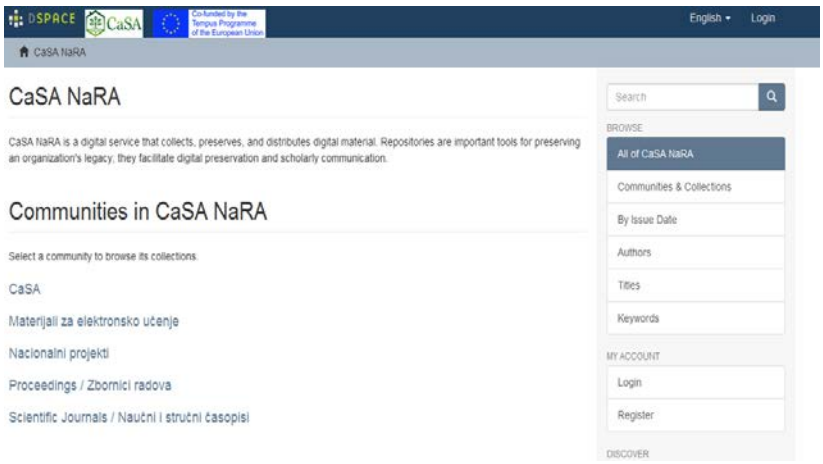

Figure 1. *The front page of NaRA*

Finally, the creation of the National Repository for Agricultural Education in Serbia (NaRA) is also the result of the CaSA project. The domain was registered in 2014 and supported by Computer Centre, University of Belgrade. NaRA is the digital open resource platform, which is also a library containing instruction materials in the field of biotechnology engineering and repository of the courses created by university teaching staff employed at agricultural faculties in Serbia, which could and should be accessed by both agricultural high school teachers and students, advisors in agricultural extension service, students of agricultural faculties-future biotechnology engineers, and broader academic and expert community with the purpose of lifelong learning. The structure of NaRA implies the integration of Moodle as an open source learning platform and DSpace as an open repository software package used for creating open access repositories. A plug-in was created to connect Moodle as Learning Management System (LMS) and a Document Management System (DMS) already used within DSpace platform. The front page of the repository is illustrated in Figure 1.

NaRA is currently being filled up with the contents such as: various materials for e-learning; the courses (face-to-face, online, and blended) in the field of biotechnology and related disciplines created by university teaching staff-participants in the project; the presentations

of projects in the biotechnology field funded by Serbian Ministry of agriculture and environmental protection; books of proceedings from national and international conferences in the field of biotechnology held in Serbia; agricultural journals published by the biotechnology university institutions participating in the project.

6. CONCLUSION

The creation of open education resources in the field of biotechnology in Serbia is the process which is being carried out at two levels. The first level has been the design of the face-to-face, online, and blended courses in the field of biotechnology, created by the agricultural higher education teaching staff by applying the acquired and improved competences in ATL and using Moodle as LMS. The second level has been the creation of open access repository NaRA to which all the created courses are being uploaded. The National repository for agricultural education in Serbia is the unique education resource which, for the first time, offers relevant and updated knowledge in the field of biotechnology collected in one "place". This repository is under open access regime meaning that it is reachable without passwords and for free by its final users – high school teachers, agricultural advisors, students-future biotechnology engineers, farmers, food processors, stockmen.

Taking into account that the courses created for in-service education of agricultural high school teachers and advisors in agricultural extension service are planned to be implemented during 2016, the effects of these face-to-face, blended and online courses as open education resources on high school teacher' and agricultural extension service advisors' professional competences are to be evaluated in the future. OER are among the potential enablers of the shift toward competency-based and learner-centered education if educational policies and organizational frameworks empower teachers and learners to make good use of such resources (Geser, 2007). The potential impact of NaRA as an open access repository on the development of professional competence of biotechnology engineers is another issue for future research.

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