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THE ROLE OF STAKEHOLDERS IN MODERNIZING EDUCATION CURRICULA IN THE FIELD OF GEODESY

Božić, B., Cvijetinović, Ž, Brodić, N.

ABSTRACT

This article deals with the process of modernization the geodesy study program at the Faculty of Civil Engineering University of Belgrade (FCEUB), Department of geodesy and geoinformatics, under the ERASMUS+ European program, which initiate the survey of stakeholders in three partner countries and in accordance to their opinions, BSc and MSc core curriculum were proposed. So far at the Geodesy and geoinformatics program at the FCEUB Department, several new courses and teaching materials were prepared. Additionally, e-learning methodology, has been introduced by installing MOODLE platform which is used as a new learning management system that will initiate more other changes toward this new learning methodology. Also, a problem-based learning (PBL) methodology has been introduced in some of the courses.

Key words: Geodesy and geoinformatics, Study program improvement

1. INTRODUCTION

The University of Belgrade - Faculty of Civil Engineering - FCEUB is a partner institution in a new Erasmus+ program which started in 2015 and lasts till October 2018. The project title is "*Modernizing geodesy education in Western Balkan with focus on competences and learning outcomes***"**. The leading institution is the Royal Institute of Technology (KTH, Stockholm, Sweden). The other partner institutions are: Vienna University of Technology – Department of Geodesy and Geoinformation (TUW, Vienna, Austria), University of Leon (ULE, Leon, Spain) and seven non–EU partners: two from Serbia (University of Belgrade, Faculty of Civil Engineering, Department of Geodesy and Geoinformatics – FCEUB and University of Novi Sad – Department of Computing and Control Engineering – UNS), two from Albania (University of Tirana, Department of Geography – UT and Polytechnic University of Tirana, Department of Geodesy – UPT) and five partners from Bosnia and Herzegovina (University of Sarajevo, Department of Geodesy – UNSA, University of Mostar, Faculty of Civil Engineering – UNMO and University of Tuzla – Department of Geography – UNTZ, Institute of Development Planning – IDPSA, and BNPro d.o.o. – private co.). The official GEOWEB project web site is: http://gidec.abe.kth.se/GEOWEB.

2. PROJECT OBJECTIVES

The wide project objectives are to: 1) modernize higher education in geodesy and geography in partner's countries, 2) facilitate integration of partner countries with EU and 3) strengthen regional cooperation within Western Balkan countries.

The project will last three years and has several activities that contribute the project aims. Planned activities of the project are: 1) Creation of a Balkan geodesy educational database, 2) Establishment of a regional cooperation network, 3) New Laboratories, 4) Four two–weeks courses related to the image processing, GNSS, Geoid and Earth gravity fields and GIS, 5) Core BSc curricula 6) Two new master programs, 7) New teaching materials, 8) New e–learning platform, 9) Problem Based Learning philosophy Introduction.

3. CONCEPT OF SURVEY QUESTIONNAIRE

Under the working package five, University of Belgrade – Faculty of Civil Engineering (FCEUB) with other partners and the project coordinator developed an Internet based survey questionnaire.

The objective and the concept of the questionnaire are:

- to collect information from geodesy stakeholders operating in Western Balkan countries,
- to provide better insight into activities of geodesy stakeholders and their needs regarding surveying and geodesy professionals skills and knowledge, and
- to establish web site and database that will live and be operational during the project lifetime and allow afterwards, so additional input is expected and desired.

The questionnaire (and database) is designed to be as simple as possible, requiring minimal effort to provide requested information; predefined answers offered whenever possible. Project members were asked to invite as many as possible geodesy stakeholders from their countries to take part in the survey. The idea behind internet based questionnaire was to have a live database containing the results of the survey. Each stakeholder is invited to update his questionnaire as needed. Also, it is expected that more and more geodesy stakeholders will participate in the survey in the future, since other events are planned within the project. Therefore, it is realistic to expect significant increase in number of stakeholders participating in the survey. The results of the questionnaire available are analysed and described, as follow.

Draft version of the questionnaire was provided to all project participants for the review and comments. Comments were analysed and implemented, accordingly. The final version of the questionnaire is provided to all stakeholders at the FCEUB website http://osgl.grf.bg.ac.rs/survey/accounts/login/ (Figure 1).

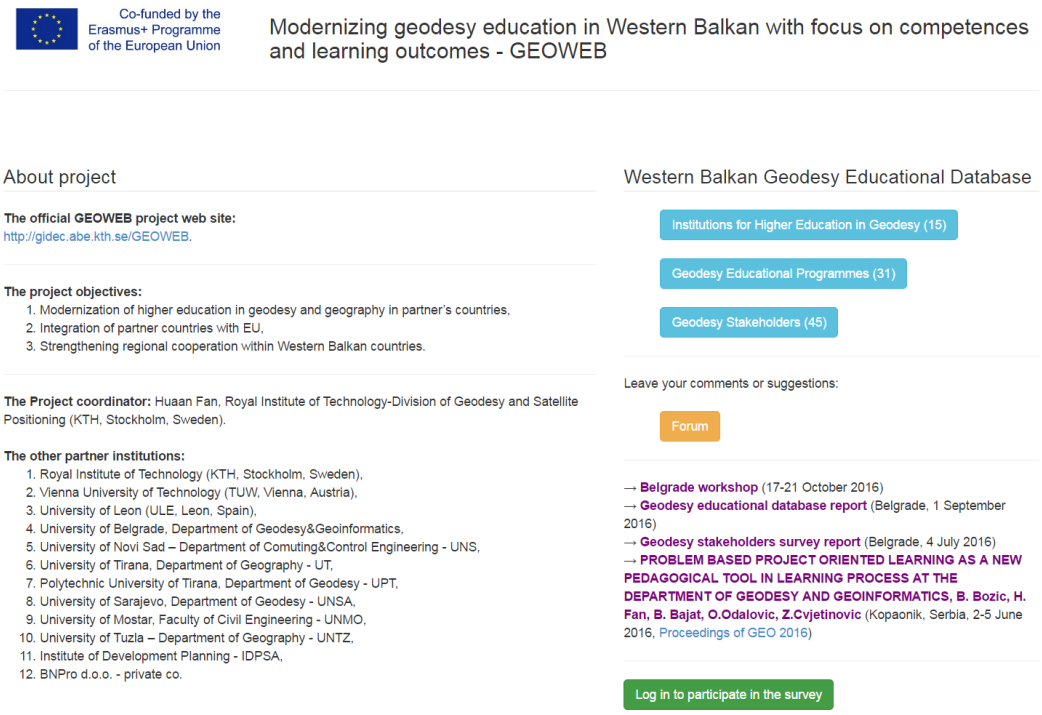

Figure 1. Login page for the questionnaire for the geodesy stakeholders and survey regarding higher education institutions and programmes in geodesy

3.1. Questionnaire content

As it has been already stated, the questionnaire is designed to be as simple as possible, requiring minimal effort to provide requested information. Basic information on geodesy stakeholders have to be filled in using provided web form such as the following (Figure 2):

- name,
- address data,
- information on contact person,
- the type of organization,
- number of geodetic/GIS employees and
- main activities of organization.

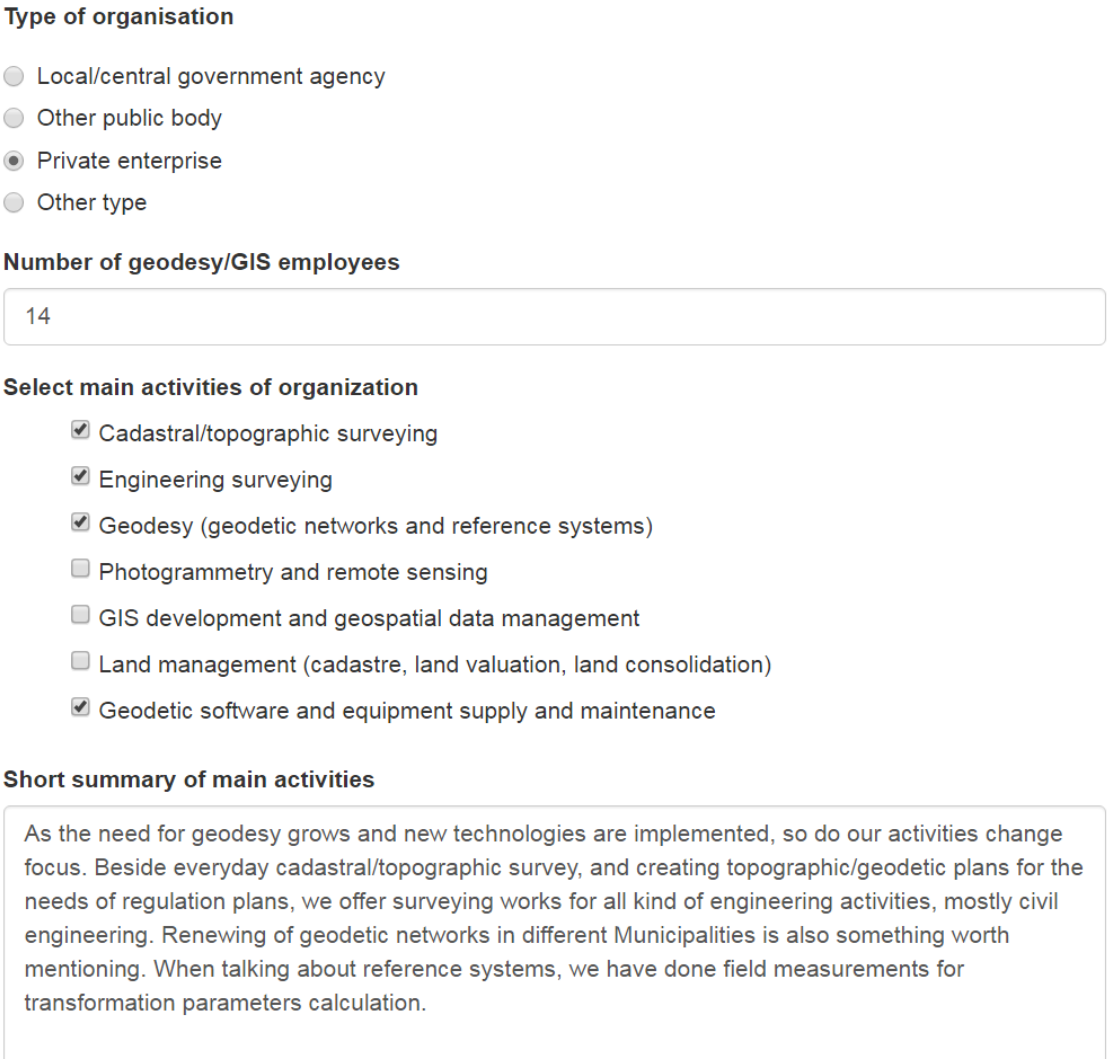

Figure 2. Web form for entering basic information on geodesy stakeholders

Whenever possible, representative of the stakeholder is offered to select predefined answers. The option for describing main activities of the stakeholder is provided as well. The second part of the questionnaire was designed to provide desired information on geodesy stakeholders' needs regarding surveying and geodesy professionals' skills and knowledge. The stakeholder is offered to select the type of specialists that are most needed in his organisation and also to specify if retraining of his

existing staff is required in some field of geodesy. Also, stakeholder is asked about the possibility to receive geodesy students for visits, practice and/or employment. Finally, the stakeholder is offered an opportunity to give his comments on geodesy education. Section of the questionnaire containing the most significant questions is given in the Figure 3.

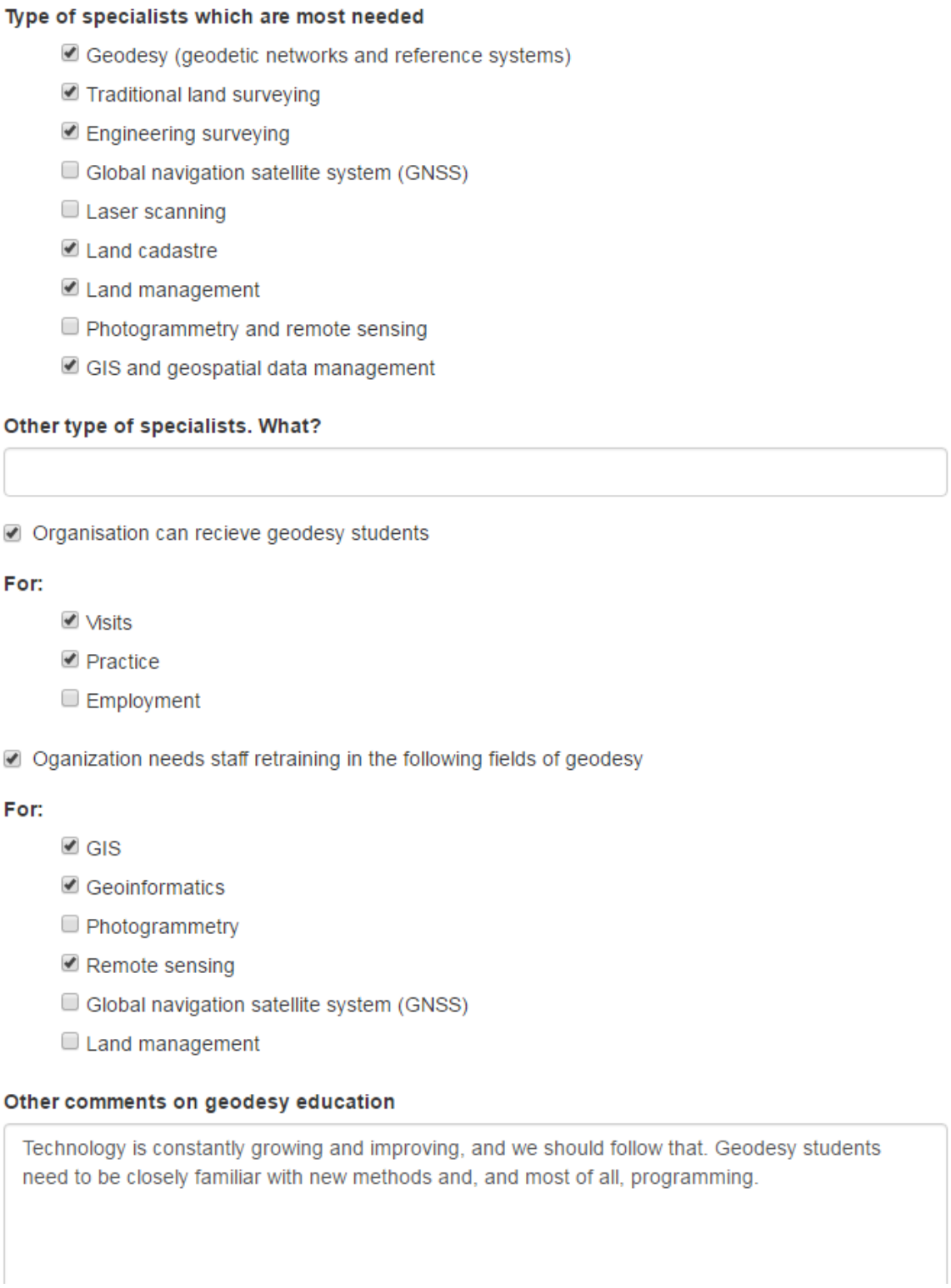

Figure 3. Section of the questionnaire for the geodesy stakeholder's survey – Information regarding education and competences of future professionals

3.2. The Results of questionnaire survey

At the time of writing this article the number of stakeholders that participated in the survey was 42 (Table 1).

Country	
Albania	10
Bosnia and Herzegovina	20
Serbia	12
Total	42

Table 1: Number of stakeholders per country participating in the survey

Having in mind that, according to official sites of the National Geodetic Authorities in partner countries, there are more than several hundreds geodetic organisations having some kind of licence for practising geodesy/surveying, it is clear that the number of survey participants is rather low. Therefore, it would be irresponsible to state that the results of the survey should be statistically significant. Nevertheless, there are some interesting indications regarding stakeholders' needs and their opinions on geodetic education, so these will be given here briefly.

The summary results of the geodesy stakeholder's survey are given in Table 5. The stakeholders are sorted according the country they are located in. It can be noticed that all three types of organizations are present: private enterprises, local/central government agencies and other public bodies. However, as expected, the largest number of participants is private enterprises (Table 2).

Stakeholders according to their type	
Private enterprises	31
Local/central government agencies	8
Public bodies	3
Total	42

Table 2: Number of stakeholders participating in the survey

It can be easily concluded from the Table 5 that stakeholders are mostly engaged in standard geodetic activities such as: cadastral/topographic surveying, engineering surveying, geodesy (geodetic networks and reference systems) and GIS development and geospatial data management (Table 3). Organisations dealing with photogrammetry and remote sensing as well as those providing geodetic software and equipment supply and maintenance services are, as expected, in minority.

Activity	No.	%
Cadastral/topographic surveying	27	64
Engineering surveying	27	64
Geodesy (geodetic networks and reference systems)	25	60
GIS development and geospatial data management	23	50
Land management	21	50
Photogrammetry and remote sensing	12	29
Geodetic software and equipment supply and maintenance services	11	26

Table 3: Activities of stakeholders

Regarding the type of specialists that are most needed by the stakeholders, it is quite indicative that GIS and geospatial data management specialisation is the most needed one. About 74% of stakeholders stated that they need this type of specialisation. This is quite understandable, having in mind that geospatial data management and processing is compulsory activity within almost every

geodetic project. Also, standard geodetic specialisations such as: geodesy (geodetic networks and reference systems), engineering surveying and knowledge and skills from global navigation satellite system (GNSS) are also highly required (50–64%). Laser scanning, as a new technology, requiring still very expensive equipment is, again, as expected, not so required (17%). The needs for other types of specialisations are in the range of 33–43% (Table 4).

Activity	No.	%
GIS and geospatial data management	31	74
Engineering surveying	27	64
Geodesy (geodetic networks and reference systems)	24	57
GNSS	21	50
Land management	18	43
Land cadastre	17	40
Traditional surveying	15	36
Photogrammetry and remote sensing	14	33
Laser scanning	7	17

Table 4: Competences needed

Most of the stakeholders are ready to accept geodesy students for visits and practice, and some of stakeholders are also open for new employees.

It is quite interesting to analyse the information provided by stakeholders regarding their needs in staff retraining:

- Almost all stakeholders from Albany stated that they need staff retraining in almost all offered fields in geodesy;
- Needs of stakeholders from Bosnia and Herzegovina in this respect were quite limited,
- Stakeholders from Serbia showed no interested at all for staff retraining.

Due to rather limited sample, this may not be the real situation regarding this matter. However, the results are quite interesting and they certainly deserve further attention.

Although there is a rather limited input provided by stakeholders, we are giving here a summary of comments provided by stakeholders:

- more practical knowledge and skills is required,
- better cooperation between geodesy stakeholders and educational institutions is required,
- education should be focused on modern technologies, especially geoinformatics (GIS, programming),
- other knowledge and skills required (standards, economy, legislation, etc.).

A complete list of relevant comments is given in Table 5.

Stakeholder	Cadastral/topographic surveying	Engineering surveying	Geodesy (geodetic networks and reference systems)	Photogrammetry and remote sensing	GIS development and geospatial data management	Land management (cadastre, land valuation, land consoli	Geodetic software and equipment supply and maintenanc	Geodesy	Traditional land surveying	Engineering surveying	Global navigation satellite system (GNSS)	Laser scanning	Land cadastre	Land management	Photogrammetry and remote sensing	GIS and geospatial data management	Visits	Practice	Employment	GIS	Geoinformatics	Photogrammetry	Remote sensing	Global navigation satellite system (GNSS)	Land management	Country	Type of organization	Number of empoyees
1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ALB	PE	12
2	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ALB	PE	13
3	1	1	1	1	1			1		1	1		1	1		1	1	1	1	1	1	1	1	1	1	ALB	PE	8
4	1		1	1	1	1		1			1		1	1	1	1	1	1	1	1	1	1	1	1	1	ALB	GA	4
5		1	1		1			1		1	1		1	1		1	1	1	1	1	1	1	1	1	1	ALB	PE	15
6	1	1	1	1	1			1		1	1		1	1		1	1	1	1	1	1			1	1	ALB	PE	3
7	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	ALB	PE	2
8			1	1	1	1		1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	ALB	GA	35
9		1	1					1		1	1		1	1	1	1	1		1	1	1	1	1	1	1	ALB	GA	5
10			1	1	1			1			1	1	1		1	1	1	1	1	1	1	1	1	1	1	ALB	GA	22
11	1	1				1		1	1	1	1						1									BiH	PE	3
12		1						1		1	1					1	1	1	1					1	1	BiH	PE	3
13	1	1	1			1		1	1	1				1						1	1	1				BiH	PE	6
14	1	1	1				1	1	1	1			1	1		1	1	1		1	1		1			BiH	PE	14
15							1									1	1	1								BiH	PE	4
16	1	1	1		1	1		1	1	1	1					1	1	1		1	1			1	1	BiH	GA	4
17					1											1		1	1							BiH	PE	5
18	1	1	1			1				1	1					1	1	1								BiH	PE	8
19	1	1	1	1	1	1	1	1								1		1		1						BiH	PE	5
20																										BiH	GA	5
21	1	1	1		1	1	1	1		1				1		1				1	1				1	BiH	PE	16
22		1			1					1						1										BiH	PE	1
23					1	1	1							1	1	1	1	1	1	1	1					BiH	PE	13
24									1							1										BiH	PB	1
25		1	1		1			1		1						1	1									BiH	GA	3
26	1	1	1					1	1	1						1		1		1				1		BiH	PE	3
27					1			1	1	1					1	1	1	1		1	1		1			BiH	PB	8
28	1	1	1		1	1			1	1	1		1													BiH	PE	4
29	1					2							1			1										BiH	GA	3
30	1	1	1			1		1	1	1				1			1	1								BiH	PE	3
31	1	1																								SER	PE	4
32	1	1	1					1	1	1	1		1		1			1	1							SER	PE	10
33		1	1				1				1					1										SER	PE	1
34	1		1	1	1	1	1		1				1	1	1	1	1	1	1							SER	PE	15
35	1				1	1		1	1	1	1		1	1		1		1	1							SER	PE	10
36	1	1	1		1	1	1	1	1	1	1		1	1		1	1	1	1				1			SER	PE	25
37				1	1										1											SER	PE	5
38	1	1										1			1	1		1								SER	PE	3
39	1	1	1			1				1	1			1												SER	PE	2
40	1			1	1				1	1					1	1	1									SER	PB	30
41	1	1				1				1	1	1														SER	PE	2
42	1								1																	SER	PE	1
Total	27	27	25	12	23	21	11	24	15	27	21	7	17	18	14	31	22	25	17	18	16	10	12	13	13			
%	64	64	60	29	55	50	26	57	36	64	50	17	40	43	33	74	52	60	40	43	38	24	29	31	31			

ALB	Albania
BiH	Bosnia and Herzegovina
SER	Serbia

GA	Local/central government agency
PE	Private enterprise
PB	Other public body

Table 5: A complete list of relevant comments

3.3. The response to the results of questionnaires

As a result of survey in **Error! Reference source not found.** and **Error! Reference source not found.** and in Figure 4 and Figure 5 the structure of BSc and MSc core study program were proposed.

	General	Surveying	GIS	LM	Final
Mathematics	21				
Physics	8				
Construction Engineering	5				
Theory of Errors	10				
Language	3				
Informatics	5				
Introduction to Programming	5				
Surveying		15			
Geodetic Reference Systems		7.5			
Geodetic Plans		3			
GNSS		7.5			
Satellite Geodesy		3			
Engineering Surveying		5			
Practice (surveying)		5			
Geoscience			5		
Spatial Planning			5		
Geospatial Databases			5		
GIS			10		
Photogrammetry			7.5		
Cartography and Mapping			7.5		
DTM			5		
Remote Sensing			5		
Digital Image Processing			5		
Geosensors			5		
Law and Economy				6	
Cadastre				10	
Land Management - LM				5	
Final Work					12
ECTS	**57**	**46**	**60**	**21**	**12**

Table 6: ECTS per specific group of courses at BSc level

Figure 4 contains the graphical view of the course structure where it is quite clear that stakeholder request for more GIS was respected. Except GIS modern technology inside the Surveying part of the program was hold as the fundamental part of the surveying profession. The similar conclusion and impact could be concluded in MSc program (**Error! Reference source not found.** and Figure 5).

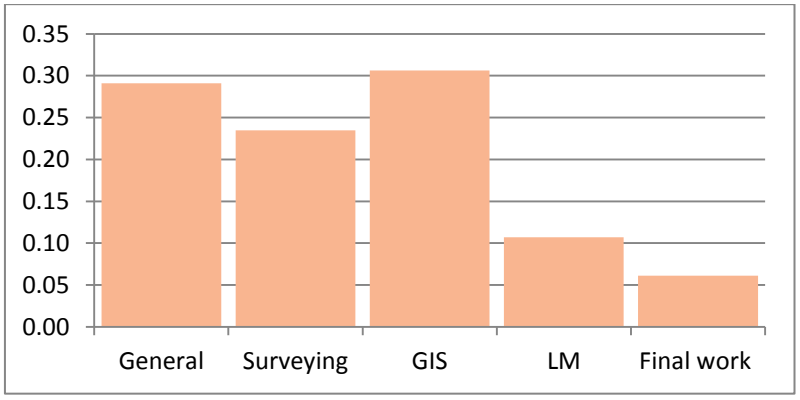

Figure 4. BSc core study curricula

	General	Surveying	GIS	LM	Final	
Advanced programming	5					
Advanced Theory of Adjustment	5					
Applied Mathematics	5					
Project Management	5					
Research Methodology	5					
Physical Geodesy		5				
Laser Scanning		5				
Geodetic Optimization		5				
Reference Systems		5				
Integrated Sensors		5				
Geodynamics		5				
Precise Industrial Measurements		5				
Precise Positioning and Navigation		5				
Geodetic Space Techniques		5				
Spatial Data Infrastructures			5			
Spatial Analysis			5			
Digital Photogrammetry			5			
Geostatistics			5			
Advanced Remote Sensing			5			
Geovisualization			5			
Web GIS			5			
Location based services			5			
GIS in Spatial Planning			5			
Real Estate Investment Analysis				5		
Land Consolidation				5		
Final Work					30	
ECTS	**25**	**45**	**45**	**10**	**30**	**155**

Table 8: ECTS per specific group of courses at MSc level

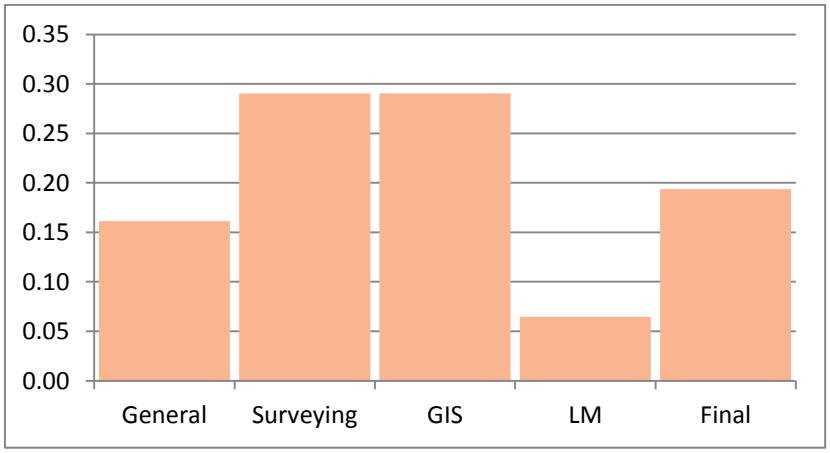

Figure 5. MSc core study curricula

3.4. The MOODLE platform for e–learning – eGeo

For many of the existing courses on Department for Geodesy and Geoinformatics (DGG) of FCEUB that are related to geoinformatics, a large portion of the materials for students (lecture slides, tutorials, assignments, etc.) was already available for download from the courses' web pages. For some courses, (for example, courses in geoinformatics such as: Geoinformatics 1, Geoinformatics 2, Fundamentals of Digital Image Processing, Digital Terrain Modelling), students already had an option

to upload all finished work (exercises) for the review by academic staff. The same applies for practical exams, where exams were organized in a computer classroom. Students were downloading assignment in electronic form and uploading results in electronic form also, but much of this different software tools were not so well integrated as it is the case with MOODLE platform for online learning.

Some of the mentioned courses are transferred to the newly established MOODLE platform for e–learning of students of DGG that is called eGeo (website: http://egeo.grf.bg.ac.rs). Now, having Moodle platform installed all of the courses' content are better organized, especially from the basis of integration of students' personal information, exam results, prerequisites of other passed courses on this program etc. Eventually, this will be done for most of the courses at DGG. However, the whole process run gradually depending on the teaching staff involved.

Figure 6. MOODLE platform website for e–learning

Two courses on BSc program: Geoinformatics 1 and Digital Terrain Modelling, and one course from MSc program of Geoinformatics: Digital Photogrammetry, are possible to enrol from eGeo MOODLE website and all of the teaching materials for exercises and lectures are accessible and ready for download (Figure 7, Figure 8 and Figure 9). Certain assignments for each exercise are placed on eGeo, so that students may upload their results for each topic in the designated time. All teaching materials are updated and improved, and in near future quizzes will be created and some examples of practical exams will be posted. Student must earn a proper grade for an assignment within each topic in order to fulfil requirements for passing the courses. Practical exams for mentioned courses will be organized in computer classrooms with upload option of exam results to server for each student. Students that are attending course Digital Terrain Modeling in this semester have their own accounts and are already enrolled while students who take course Geoinformatics 1 will be enrolled in the next semester.

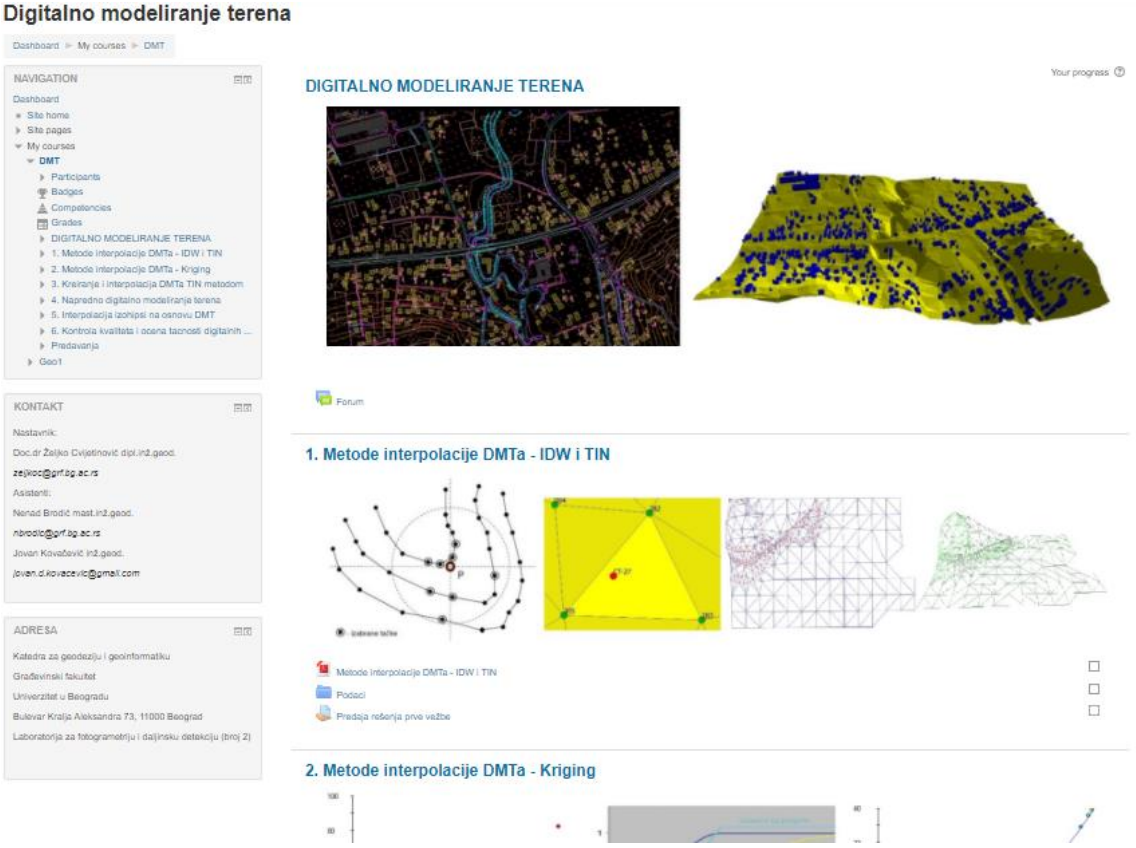

Figure 7. Course of Digital Terrain Modelling

Figure 8. Course of Geoinformatics 1

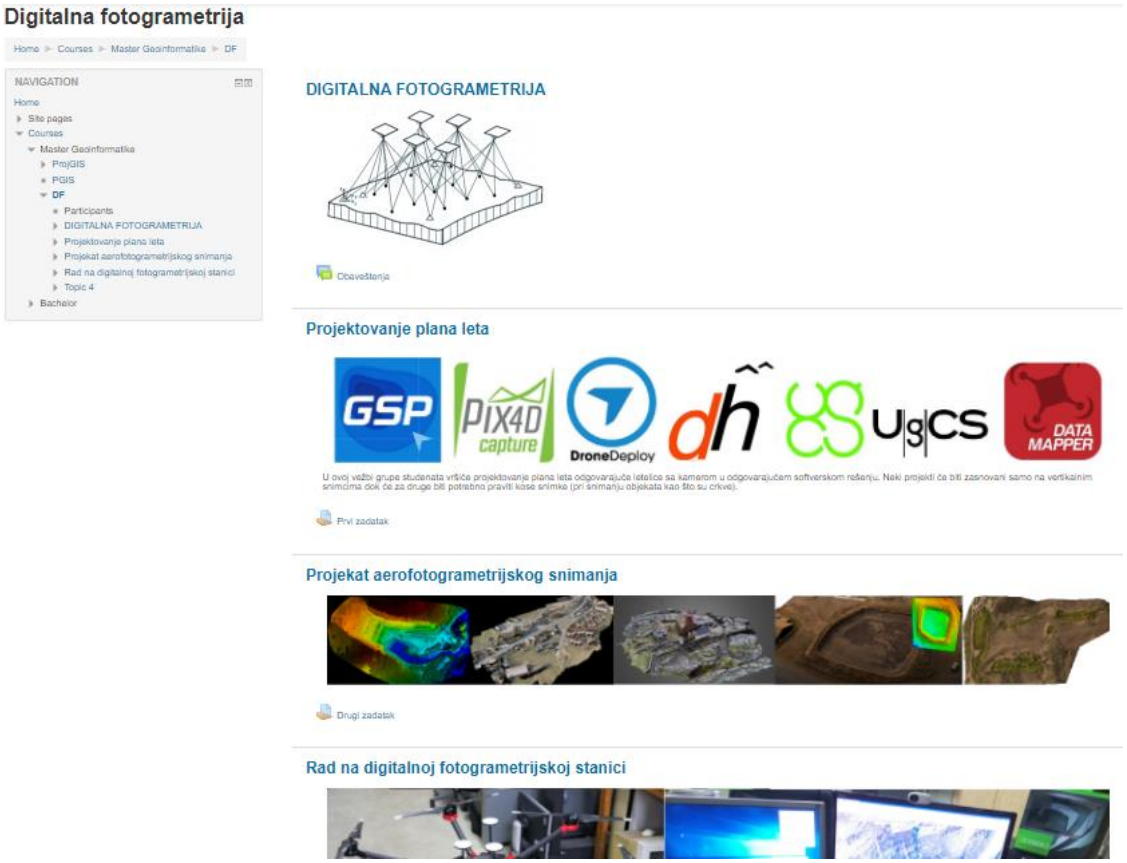

Figure 9. Course of Digital Photogrammetry

As it was planned on this project, Problem–based Learning methodology (PBL) will be introduced within two courses of the Geoinformatics module of the MSc program that are posted on eGeo website. First of these courses is a course Design and Implementation of Geoinformation Systems. Students will get a suitable literature and software (CASE tools, DBMS and GIS software) for the implementation of the project assignment. They will have meetings with teachers where they will have opportunity to clarify some issues from the selected literature and to discuss some problems and solutions related to their assignment. Project assignment will be designed with sufficient complexity so that student has to acquire all the knowledge and skills specified by course objective and content. The second course with PBL methodology is a course of GIS Programming. It was quite reasonable to assume that actual programming for solving some GIS task is a good way for students to acquire knowledge and skills listed in the course content. Everything said for the previous course is also valid for this one. This PBL courses are created on MOODLE platform and appropriate materials are transferred. Students are enrolled in this courses and student working groups are formed for solving different problems.

4. CONCLUSIONS

Taking into account the answers collected from the surveying companies in three partner countries, summary of the results is:

- Mostly students need more practice, more economical topics, industry standards and ethic code;

- Modernizing in geodesy should go through education in modern technology, GIS, Web GIS, Remote Sensing, land management and legislation;
- New teaching methods should be developed and implemented in geodesy study programs with more stakeholders involved and continuous training process practiced;
- The students should be in the focus of curricula development, theory and practice should be integrated, better and Labs need be equipped in a proper way to satisfy all market needs.
- Geodetic engineers should have better skills and knowledge in geoinformatics, especially in terms of solving various problems by programming, i.e. using scripting languages in GIS software or standard programming languages and software development tools, such as Visual Basic, C# and Visual Studio.

The response have been obtained from different stakeholders related to the geodesy education development was of a great importance to the project content and new core curricula. Special attention is paid on PBL philosophy and it's impact on better knowledge transfer and skills development. In connection with that MOODLE learning management system was used as a platform for e–learning implementing everywhere where is suitable to do so.

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