

How New and Evolving Biomedical Engineering Programs Benefit from EVICAB project

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Abstract— Problems of new and evolving Biomedical Engineering (BME) programs in European universities are collated with the opportunities and benefits offered by the EVICAB project. Benefits of European Virtual Campus for Biomedical Engineering (EVICAB) for new course developers, administrators, teachers and students are presented and illustrated by examples.

Keywords—Biomedical engineering; programs; teaching; learning; virtual environment.

I. INTRODUCTION

Although biomedical engineering educational systems have been under development for 40 years, interest in and the pace of development of these programs has accelerated in recent years [1]. This acceleration is a natural consequence of the rapid evolvement of biomedical engineering science, technologies and rising sophistication of the equipment used today in medicine and biology. The pace of development causes specific challenges both for new programs which are starting (especially actively in new European Union (EU) member states) and already established and long running programs which are seeking for better quality, modernization and international harmonization within EU. Today more than 100 universities and colleges offer education programs on BME in EU. Wide scope of education goals and multidisciplinary of BME as a field of science and technology makes it difficult to consolidate and harmonize education programs under certain international criteria. Therefore activities towards EU accreditation of BME programs has been taken [2,11]. Additional challenge for the education programs is high requirements of research and education unity outlined in a form of national science education standards (for example in USA [3]). Universities experience significant problems in keeping the appropriate level of multidisciplinary BME programs, especially at new program establishment and in initial stages of program running.

Since one of the missions of EVICAB project is to create a favorable virtual environment for program startup and modernization, the aim of present paper deals first - with the problems which new and evolving BME programs are facing, second – with means and tools which EVICAB project offers for the problem solving, and third - with benefits of

virtual environment which EVICAB project is offering, illustrated by case examples. Those three parts define a presentation structure below.

II. PROBLEMS OF NEW AND EVOLVING BME PROGRAMS

Problems of new BME education programs begin with the choice of proper course composition, curricula and content of courses. Program from one side preferably should meet high quality criteria for EU accreditation [2] and from another – should include good courses delivered by high level specialists. Since BME education is multidisciplinary and high technology based at the same time, a difficult problem arises to cover the program with sufficiently high level courses from all necessary disciplines. Small countries also those newly entered EU usually haven't good experience in BME field, also there is lack of long term traditions and industries developed. Therefore programs usually suffer from the top-down fitting of program courses to the limited possibilities of teachers and teaching environment. This usually causes a creation of big variety of one-sided or too specialized programs of limited quality defined by local qualifications and facilities. Problems with good teaching materials including demos, interactive practical work, textbooks, and software are very essential for new programs as well. Facilities of libraries don't cover the needs, specific problem is in post-soviet countries where books in Russian are present in libraries but are not practically readable for new-generation students. Therefore collaboration, mobility, virtual environment for program development are problems of vital importance.

Apart of technological problems in a new program development a conceptual teaching and learning problems arise [9, 10]. BME is a field where special teaching and learning methods are necessity, since it covers complicated issues of physiology, anatomy, tissue engineering, bioelectromagnetism, biophysics, sensors and transducers, signal and image processing, visualization, modeling of complex systems, direct and inverse problems of 3D systems and so on. Constructionism and constructivism, social constructionism concepts promoting a self-construction of knowledge, sharing and brushing knowledge obtained within appropriate environment are conceptual problems to cope with [4, 7, and 8].

Table 1. Classification and ranking of main problems for new and evolving BME education programs

No.	Problem	New program	Evolving program
1.	Curricula composition in accordance with EU criteria for BME programs	5	3
2.	Re-engineering of programs in accordance with Bologna process	2	2
3.	Covering of wide, multidisciplinary scope of BME program in sufficiently high level	4	3
4.	Lack of teaching materials, textbooks, demos, interactive labs	5	3
5.	Lagging behind rapid development of BME technologies in the world	4	4
6.	Requirements for entrance to BME master program: need for an appropriate flexible equalization courses	4	2
7.	Keeping research and education unity: translation emerging technologies to the studies	3	3
8.	Sharing efforts and resources in preparation of courses, especially advanced ones	5	3
9.	Balancing the core/fundamental courses with application and emerging technologies oriented ones	3	2
10.	Internationalization and mobility of students and teachers, recognition of credits	5	3
11.	Adaptation of program for life long learning and part time studies	4	2
12.	Introduction of modern teaching and learning paradigms – constructionism, problem orientation, self-evaluation etc.	3	2
13.	Need for advise, discussion and collaboration in course and program development	5	2
14.	Involvement of the best lecturers worldwide	4	3

Problem rating used in the table 1.

- 1 – practically no importance
- 2 - little importance
- 3 – significant importance
- 4 – high importance
- 5 – very high importance

In big extent problems typical for new programs are also valid for not new programs which are seeking for update, modernization and accreditation in EU (shortly – evolving programs). Among them one can point on the transition to the Bologna process and leading decisions by Sorbonne Declaration (inclusive objectives and statements), Salamanca resolution and Prague follow-up meeting from 2001 defined the two-cycle program [5]. This problem is

particularly important for well established BME programs in German speaking countries.

The list of main problems is presented in Table 1. together with approximate ranking of problem importance for new and evolving programs.

Evidently, new programs experience main difficulties since in addition to the problems listed practical questions of management, rooms and other facilities, legal frame of program, motivation and involvement of staff should be solved simultaneously. Entirety of problems needs for appropriate environment for successful solution.

III. METHODS AND TECHNOLOGIES FOR NEW PROGRAM SUPPORT BY EVICAB

The contribution possibilities of EVICAB project for new and evolving BME programs lies deep in the mission and philosophy of the project. Openness and inheriting evolvement of the project itself respond to the evolvement of dynamic BME discipline and to the corresponding study programs, especially new ones. Project suggests an open coordination method used widely in EU (one evident example is EU Lisbon strategy implementation) together with concrete assistance.

Main methods and technologies used for support of new and evolving BME programs by EVICAB project are as follows (in brackets the corresponding problems from the Table 1 are listed):

EVICAB project keeps in account the accreditation criteria for EU BME programs developed by BIOMEDEA project [2] concerning program course composition, curriculum and course content. New programs are oriented towards those criteria from the beginning and further path of evolvement towards future EU accreditation is supported. (Response to problems No. 1, 2, 10, 13).

Project integrates multidisciplinary BME courses creating virtual environment enabling choice of necessary high level, especially advanced courses which are usually not affordable for new program organizers due to lack of specialists, experience and facilities and other practical reasons. In many cases this is a chance to fill painful gaps in program influencing overall quality of the program. (Response to problems No. 3, 4, 7, 14).

Advanced teaching and learning concepts and technologies available in MOODLE environment [4,6] and beyond [7] including problem orientation, self creation of knowledge structures, interactivity, self - assessment, internet examination are offered together with implementation examples in particular EVICAB courses. (Response to problems No. 5, 7, 12).

Teaching and learning materials including e-Books, interactive models, demos, textbooks and other information is offered thus covering the painful lack of teaching resources for new BME programs and for programs seeking for update. (Response to problems No. 4, 5, 8).

Flexibility of the virtual learning environment (VLE) used by EVICAB makes translation of research advancements and emerging technologies in the teaching and learning process easier, due to the openness, effective technologies for course update and involvement of best competences both in research and education. (Response to problems No. 3, 7, 9).

Creating an environment for sharing efforts in development programs and courses. Since advanced course development is expensive and in many cases not affordable by national universities, especially for new members of EU, sharing of efforts and competences offered by EVICAB is of vital importance. The environment creates possibility to contribute for all participants and use the best competences wherever they are in EU. (Response to problems No. 3, 7, 10, 13).

Virtual European campus for BME is a favorable environment for internationalization both of program and course development as well as teaching and learning. Open discussions, encouragement of contributions in course development for teachers, as well as mobility and course choice possibilities for students, environment of communication are supported by EVICAB. New programs especially in small countries are accepting little number of students (10-20), therefore communication is vital. (Response to problems No. 10, 13, 14).

Generally speaking new program developers and students are supported by EVICAB in several ways simultaneously: conceptual, methodical, technological, and teaching material supply. Complexity and openness makes EVICAB an evolving environment favorable for absorption of new findings and developments whenever they occur.

IV. RESULTS, BENEFITS AND CASE EXAMPLES

Results and benefits of EVICAB project could be classified for developers, lecturers/teachers, students and administrators. A benefit gradually becomes more evident with the development of the project. Below will be presented those of benefits, which could be already illustrated by the case examples.

Benefits for developers: Harmonization of the program and curriculum with EU accreditation criteria, Bologna process direction; filling the gaps caused by the lack of national competences with best internationally recognized courses provided by outstanding lecturers; improving local

course content by collaboration within the project framework, getting support in terms of teaching materials, methodical and conceptual advises, good practice examples. Project promotes the use of modern technologies and tools of course development.

New BME master program has been started in Kaunas University of Technology (KTU) in 2003 and it was the first BME program in Lithuania. Developers experienced a lot of difficulties and problems, because specific experience in BME field was very limited in the country. EVICAB support here was essential. Project enabled to gain an experience in program shaping and modernization, application of modern teaching and learning methods, also made available valuable teaching materials – e-Book on Bioelectromagnetism opened for free use by prof. Jaakko Malmivuo, valuable support and supervising Lithuanian students by prof. Goran Salerud, and other participants of the project. Without this support of EVICAB the successful start and running of the program hardly would be possible.

Benefits for teachers/lecturers: Gaining experience from colleagues and good examples; use of open teaching materials; possibility to concentrate and improve own competence in the favorite field of BME and relying on EVICAB courses when needed other competence; possibility to contribute to EVICAB by own course and materials; sharing efforts in update and development of new courses; participation in discussions; self-evaluation of course quality; gradual adaptation of course to BME accreditation criteria.

Teachers in KTU started to use MOODLE virtual learning environment, aligned new courses on adaptive biosignal processing, biomedical engineering methodology, clinical engineering with accreditation requirements, prepared computer - aided interactive laboratory works and practices, developed virtual instrument laboratory. New teaching concepts – problem based approach, encouraging of self-construction of knowledge system by students are under implementation. In 2006 a self-evaluation report on the KTU BME master program was submitted to the national quality evaluation committee.

Benefits for students: Increased possibility for best course choice; participation in distant lectures and webinars; access to the advanced learning materials, textbooks, demos, illustrations, models and interactive practices; possibility to take course and pass exam remotely thus saving money for travel; more easy contacts with foreign colleagues-students and teachers; better conditions for mobility; better knowledge and better adaptation of European labor market in BME; possible recognition of qualifications in EU.

Quiz organized in KTU for BME master students had shown that students are in general for the use of virtual European campus offered by EVICAB, they like new teach-

ing and learning materials delivered remotely. Interactivity and friendliness learning of environment was welcomed and better career opportunities stressed. Students participated in remote pilot intense courses and lectures delivered by Finnish and Swedish lecturers and enjoyed good technical quality (sound, image, demos, slides) of lectures and seminars.

Benefits for administrators: Saving financial and other resources in organizing and running BME program; ability to motivate staff to raise qualification and to self-assess quality of courses and delivery methods; more objective evaluation of programs using international context; approaching a possibility to accredit program in EU; possibility to involve best EU competences with minimal expenditures.

KTU administration welcomes project support and encourages Biomedical Engineering Institute to start a new bachelor program on BME using the opportunity to gain benefit from EVICAB project.

V. CONCLUSION

Project EVICAB responds well to the needs and problems of new and developing BME programs. Openness for access and contribution and open coordination concept of the project, use of modern teaching and learning technologies makes it useful for BME education in Europe.

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