BIOMEDICAL ENGINEERING AND MEDICAL INFORMATICS EDUCATION IN GEORGIA: EXPERIENCE AND CHALLENGES

Gotsiridze Irine *– Professor, Head of Department, Department of Biomedical Engineering, Georgian Technical University, Tbilisi, Georgia*

Gigilashvili Giorgi *– Assistant Professor, Department of Biomedical Engineering, Georgian Technical University, Tbilisi, Georgia*

Abstract

Introduction and aim: In the paper Study Program in Biomedical Engineering (BME) and Medical Informatics (MI) in Georgia is described. This program are realized in Georgian Technical University, at Biomedical Engineering Department. Implementation and sustainability activities are presented. The broad fields of Biomedical Engineering (BME) and Medical Informatics (MI) are among the most prominent and fastest developing scientific areas. These are considered as key, out of a few, challenges within crucial research and innovation strategies worldwide. Almost every university wanting to be in accordance with a technological progress offers a curricula in BME&MI at master and doctoral levels, and numerous offer bachelor level degrees, as well. Where it is not the case, state and universities authorities are making efforts to open dedicated study programs. Following the evident needs European Commission promotes such actions through its educational strategies and corresponding projects, Tempus being one of these. Department of GTU is one of the participant of BME-ENA – Biomedical Engineering Education Tempus Initiative in Eastern Neighbouring Area, Project Number: 543904-TEMPUS-1-2013-1-GR-TEMPUS-JPCR, is a Joint Project within the TEMPUS IV program and is 90% financed by the Commission of the European Communities. The following short study highlights the main guidelines of BME&MI study programs development, respecting European good practice.

Research methodology: The broad fields of Biomedical Engineering (BME) and Medical Informatics (MI) are among the most prominent and fastest developing scientific areas. These are considered as key, out of a few, challenges within crucial research and innovation strategies worldwide. In the paper Study Program in Biomedical Engineering (BME) and Medical Informatics (MI) in Georgia is described.

Results and implications: This programs are realized in Georgian Technical University, at Biomedical Engineering Department. Implementation and sustainability activities are presented. Georgian Technical University is in accordance with a technological progress offers a curricula in BME&MI at bachelor, master and doctoral degrees levels. Programs are implemented at Georgian and English Language study. Where it is not the case, state and universities authorities are making efforts to open dedicated study programs.

Conclusion: Systemic approach must be taken for increasing local capacity for BME and MI, both in terms of education and practice of the discipline. Greater endogenous BME and MI has the potential to narrow the medical device chasm between developed and developing countries.

Keywords: Higher Education, biomedical engineering, medical informatics, educational program.

Biomedical Engineering Department was established at Georgian Technical University in 1983. Biomedical Engineering Department has produced more than 500 professionals who were successfully employed in the Georgia Health Care Organizations. Georgia's health care reforms in the implementation of the necessary preparation of biomedical engineering specialists, higher education at all levels, who are able to biomedical engineering and Health Information Technologies, also all management and control-related problems. Graduates of this Department provide the country's total health care engineering and information systems functioning and, therefore, the fields economic development. Biomedical Engineering Department of Georgian Technical University promoted an initiative based on which the Medical Systems and Technologies Department was established in the Ministry of Healthcare of Georgia. According the LAW OF GEORGIA ON HIGHER EDUCATION higher education shall be comprised of three cycles. The first cycle (Bachelor's Program) – an educational program covering at least 240 ECTS creditsThe second cycle (Master's Program) – an educational program covering at least 180 ECTS credits (except for the

case, envisaged by Paragraph 22 of this Article) ; The third cycle (Doctoral Program) – an educational program covering at least 180 ECTS credits. At a higher education institution an educational program shall cover average 60 ECTS credits per year. Upon completion of each educational cycle a relevant diploma shall be awarded together with a standard supplement. Any person who did not/could not complete any of the above cycles shall be given an appropriate certificate. At his time at the Department Of Biomedical Engineering students are apply for admission for Bachelor Degree, Master Degree and Doctoral Degree programs. Students are offered to be trained on various accredited programs on Georgian and English languagesFrom the beginning of its foundation, Biomedical Engineering Department has had exchange programs with various European. Universities like Friedrich Schiller Jena University, Warsaw Biomedical Research Centre in Warsaw, Almena Technical University. Administration And

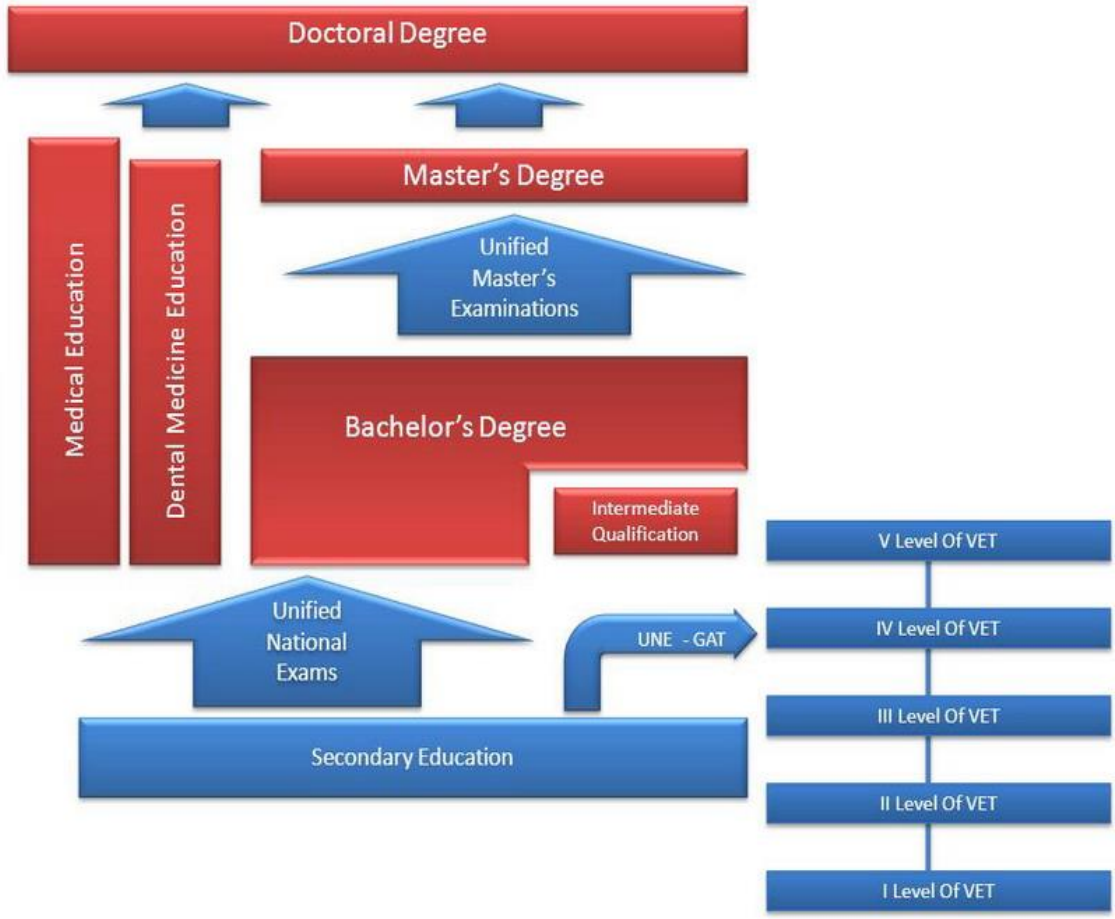

Fig.1 Educational System Of Georgia

Management Artificial Organs Medical Information Systems In 2012-2013 years memorandum was signed by the Georgian Technical University and Alabama University, United States to promote collaboration in the field of Biomedical Engineering. Above mentioned memorandum involves possibilities of exchange programs between two Universities.

The program educational objectives Of Biomedical Engineering Program is giving students knowledge how to apply their fundamental engineering skills to solving problems in medicine and biology. Program covered include, medical instrumentation and design, physiology, biomaterials, mass transport, application of computers in medicine, artificial implants, and medical imaging. Anatomy and physiology as they relate to specific to bioengineering will be reviewed. It is intended to facilitate the student's understanding in all

areas of Biomedical Engineering so that they can appreciate the collaborative nature of the field.Provide an empowering professional degree for students who intend to become practicing engineering]

The main aims of the biomedical engineering education in Georgia are:

- To provide interdisciplinary education based mostly on engineering disciplines, information technologies and life sciences; and
- To integrate engineering and medical knowledge with principles of computing technologies for the understanding and control of the processes in human organism.

Forms and Methods of achieving of the learning outcomes of all levels of study are Lecture, Seminar (working in the group) Practical classes Laboratory classes Practice Course Work/Project Independent Work, Consultation.For Bachelors the period of theoretical study and practical work takes 4 years. The students who became Bachelors can be admitted to Master of Sciences degree programs.

Bachelor degree program: 240 CP. The program educational objectives of biomedical engineering program is to integrate engineering and life science principles into a comprehensive curriculum, that prepares students for entry into the doctoral program, biomedical industry, or professional school. Primary research areas are biomedical imaging, biomedical implants and devices, cardiac electrophysiology, multi scale computational modelling, tissue engineering and regenerative medicine. Program provide graduates with a rigorous, broad-based advanced education in engineering coupled with applied biology that will prepare graduates for the many diverse career opportunities of biomedical engineering.

Provide an empowering professional degree for students who intend to become practicing engineers Core courses of the short-cycle are: Mathematics, Physics Biophysics, Electrical Measurements Fundamentals of Medical Electronics, Elements and Nodes of Medical Technics, Algorithmization Fundamentals and Programming Elements, Electrophysiology, Human Physiology etc. Core courses of the Module I: Biomechanics, , Biomedical Instrumentation, Computing, Fundamentals of Biomedical Electronics, Microprocessors in Medical Systems, Mathematical Modeling, Physiological Signal Processing, Designing of Medical Biomedical Systems etc. Core courses of the Module II : Programming, Biomedical Signal Processing, Control on Biomedical Systems, Biomedical Informatics.Core courses of the Free Module: Biostatistics Medical Expert Systems Hospital Administration And Management Artificial Organs Medical Information Systems.

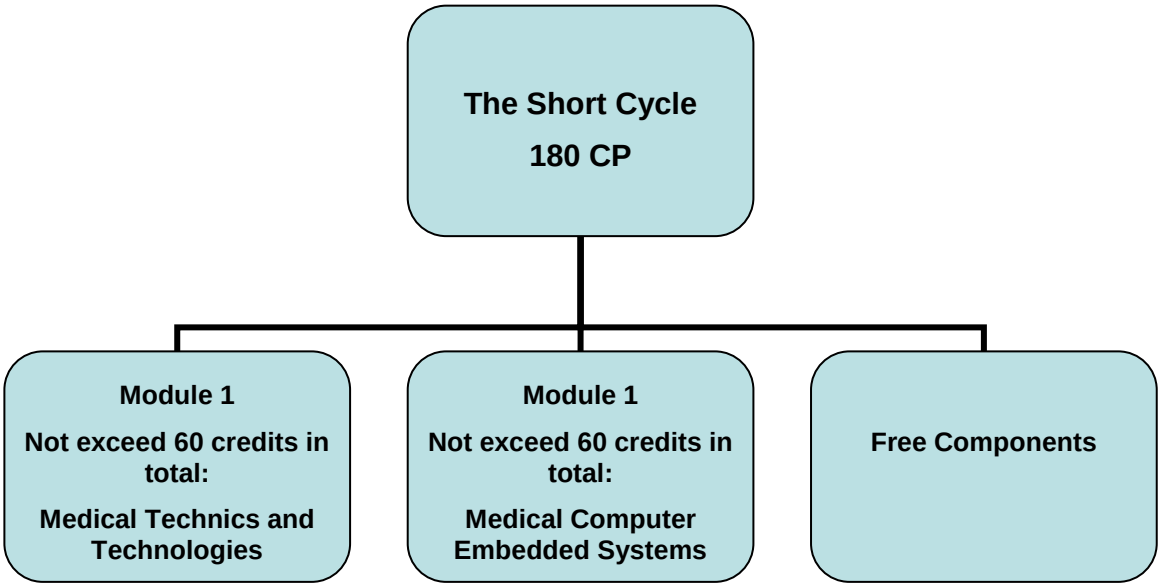

Fig. 2 Structure Of Bachelor Degree Program OF BME

Intermediary will be awarded in case of passing a of 180 credits of educational program (among them free module minimum 60 credits).Bachelor Degree Qualification will be awarded in case of passing of 180 credits of educational program (among them free module minimum 60 credits) and combination of the current courses of University. Minimum240 credits.

Master of Science degree program - 240 CP.

For Masters of Sciences the period of study is 2 years. The study program is directed towards the delivering of the education for subsequent activities as biomedical engineers and medical informatics specialists at hospitals, clinics, research institutions, public health organizations, etc. The persons who became Masters of Sciences can apply for further education for getting Doctor of Sciences degree.

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Table 1

General Structure of Master Educational Program

Core Courses: Microprocessor Medical Systems, Mathematical Modelling of Biomedical Systems, Health Information Systems, Mobile Health, Interfaces of Medical Systems, Clinical Diagnostic Laboratory Devices, Radiological Equipments. Doctor of Science Degree program - 480 CPSpecial course in Biomedical Engineering, Modelling of Physiological Processes, Control Systems in Medicine.

For Today Biomedical Engineering Department Of GTU is one ofe the participant of BME-ENA – Biomedical Engineering Education Tempus Initiative in Eastern Neighbouring Area, Project Number: 543904-TEMPUS-1-2013-1-GR-TEMPUS-JPCR, is a Joint Project within the TEMPUS IV program and is 90% financed by the Commission of the European Communities.

Program Biomedical Engineering: Master of Biomedical Engineering / Master Sc in Biomedical Engineering Educational program will be given at least 120 credits.

. The Master's program is carried out jointly by three institutions of higher education: Akaki Tsereteli State University (ATSU), Tbilisi State Medical University (TSMU) and the Georgian Technical University (GTU). At ATSU one credit equals 25 academic hours, at TSMU - one credit equals 30 academic hours of students, at GTU one credit equals 27 academic hours. The MSc Joint Program in Biomedical Engineering resides equally within the Faculties of Health Sciences and the Faculties of Engineering at the collaborating Universities.

Educational program duration is 2 academic years and it includes 4 semesters.

- The first semester (30 ECTS) is carried out at the Akaki Tsereteli State University and is devoted to human organ systems in order to study their structure and normal operation.

- The second semester (30 ECTS) is carried out at the Tbilisi State Medical University

№	Learning and Scientifical Components		I Year		II Year		Credits
			Semester I	Semester II	Semester III	Semester IV	
	Learning Componenrs;						
1	Learning Courses		30	25	20		75
	Scientifical Component:						
2	Master Project Thesis /Prospectuse			5			5
3	TheoreticalPractical Research/Coolloguim				10		10
4	Master Thesis					30	30
ECTS Credits		Per Semesters	30	30	30	30	120
		Per Courses	60		60		120

Educational programs in the area medical informatics are covering topics from the field of medical informatics, health informatics and bioinformatics. The conceptual roots of such programs lead back more than thirty years and the programs are well established in many countries. The leading role in promoting activities concerning education in biomedical informatics has been given by the International Medical Informatics Association (IMIA) at MEDINFO congresses, special topics conferences and activities of the IMIA working group on Health and Medical Informatics Education.

In Georgia under this program preparation of young experts is spent last two years. We study all experience of preparation on this discipline of various European universities and the program for computing training and testing systems (TTS) is developed for this field. We present TTS and other interactive tools for evaluation of a targeted knowledge have been developed. The idea of the system is based on generalized multiple-choice questions, with no prior restrictions on the number of given answers. The only restriction is that at least one answer is correct and at least one wrong. This new idea has led to new concepts of standardization of test results and also to new research problems in statistics. Evaluation by the TTS is performed using fixed or automated test.

A fixed test is appropriate for evaluation of the group of students in computer classroom connected to Internet. Students can pass evaluations by automated tests by themselves and the final results of the tests are displayed immediately. The displayed results also give explanation to students why some answers were not correct. Using this matrix and initial data, obtained by the recognized international organizations we have developed the mathematical model that gives the opportunity to calculate the components of human life quality and safety as the components of sustainable development index and harmonization level of this development for every country. The system of indexes and indicators has been developed and gauging matrix for sustainable development processes (SDGM) in 3 dimensions: economic, ecological and socio-institutional has been offered. The global modeling of sustainable development processes for the large group of the countries in terms of human life quality and safety has been

performed. The results of modeling have been explained in details by every dimension of the sustainable development.

We based on recent advances in biomedical research and the developments of new equipment and techniques, the field of Biomedical Engineering and Health Care Telematics are currently undergoing a rapid evolution characterized by an increasing degree of specialization. This, in turns, imposes new requirements in advanced education, while the changing scene at European level, introduces a major challenge for harmonization and standardization of education with a focus on meeting the emerging needs. At the same time information technologies provide new means and tools supporting the educational and training activities. An initiative for the development of a multinational advanced course in Biomedical Engineering, is implemented in Georgia with extended collaboration of European Universities, providing a unique case for achievement of excellency. In order to take full advantage of this potential, new programs implemented over the past years, aiming to provide the appropriate framework for mutual recognition amongst the participating institutions.

In order to confront the numerous factors that have led to the current lack of medical devices and innovative capacity in BME in the developing world, a truly systemic approach must be taken. The cornerstone of this approach needs to be increasing local capacity for BME, both in terms of education and practice of the discipline.

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