

Work in Progress: Competence Building in Engineering Education in Mongolia

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Abstract—The paper presents the work in progress within the on-going Erasmus+ “Competence Building in Higher Education project” EU-Mong for development and implementation of innovative curricula in electrical engineering. The last years Mongolia is at the stage of expanded industrialization and the areas of electrical engineering, communication and energy efficiency will drive innovation and economic growth. The most fundamental driver is modernization of education in these areas. The presented project aims at transferring knowledge between European higher engineering education institutions and the higher education institutions in Mongolia to modernize their university curricula in electrical engineering. Its objective is to adapt, innovate and modernize existing curricula in the three universities; to develop new e-learning courses, to test innovated curricula and to disseminate the results.

Keywords—higher education; electrical engineering; electronics; internationalization of higher education; modernization of curricula

I. INTRODUCTION

This project aims at transferring knowledge between European higher education institutions (HEIs) and the HEIs in Mongolia to modernize university curricula in electrical engineering. Its objective is to adapt, innovate and modernize existing curricula; to develop new e-learning courses, to test innovated curricula and to disseminate the results. With this, it fits into the development strategies of the country in both curriculum modernization and industrialization stimulation.

II. THE MOTIVATION BEHIND THE PROJECT

The project addresses the regional priorities of the Asian country for development of learning and teaching tools, applying the approach with learning outcomes and ICT-based practices, including virtual mobility of students and staff.

A. Needs and Problems the Project Intends to Solve

The specific problems identified by the survey made by the Higher Educational Authority of Ministry of Education, Culture and Science in the report “Current Situation of Higher Education”: “Training quality of Higher education can’t meet needs of learners, employers and public demand.”, “There is lack of partnership between educational, research, industrial and business organizations”. In this project we started with analysis of needs of learners and educators, of employers and the national labor market and the innovation and modernization of curricula is done to meet these needs.

B. National Priorities

The resolution of Mongolian Great Khural from 29 January 2015, No 12 about approval of Government policy for Education until 2024 states: “Curriculums of Higher and Vocational education will be improved through constantly integrating the development policies, labor market needs, scientific and technological progress, citizens’ educational needs and requirements of working places.”... “Higher and Vocational Education will be developed with orientation to international models.” The section “Cooperation in education, policy implementation, evaluation” plans: “Taking an active part in international and regional educational organizational activities, implementing collaborative programs and projects and exchanging alternate information will be coordinated.”

To respond to the national priorities in higher education to meet labor market needs of the Partner country we involved two enterprises (one is a partner and the other - associate partner) in the electro-energetic sector which are consulting in need analysis, contents development and implementation of innovated curricula. To the internationalization of the HEIs contributes not only the collaboration with the EU universities during the project lifetime and the training of Mongolian teachers in EU HEIs but the introduction of the approach with learning outcomes definition as a step towards credit systems which will allow for increased mobility of students and teachers.

Specific national priorities with regard to the development of the country and labor market needs are the following. Nowadays town and settled areas in Mongolia have been developing because of it new substations and additional power stations for production energy have been established providing stable activity in settled areas, for that reason many electrical engineers are required. In recent years in the country the production such as mineral industries, road construction, metal –mining and processing raw materials have been developing rapidly. Large industries have started their activity that is why in those industries power supply experienced engineers who to install industrial technique and equipment with high capacity and know about the usage of them. Also industries of all another sectors are been installing techniques and equipment which were made in high developed western countries and are automating industrial and technological process.

This project targets the sector of electrical engineering which is of highest priority in Mongolia.



Fig. 1. “Euro-Mongolian cooperation for modernization of engineering education” project’s logo

III. THE CONSORTIUM

The project is based on a multilateral partnership between higher education institutions and enterprises in the sector of electrical engineering in Europe and Mongolia. It involves three higher education institutions and two enterprises from the sector of electrical engineering and ICT from Mongolia as a full partner and associate partner and three higher education institutions with expertise and experience in electrical engineering, communications and in curriculum development from France, Germany and Bulgaria, and one institute with high expertise in energy efficiency from France.

The Mongolian universities are developing the new courses in collaboration with the representatives from the industry and the EU partners and new e-learning materials in the different fields of electrical engineering according to the needs of the labor market.

IV. PROJECT’S OBJECTIVES

The project aim is modernization and internationalization of the HE in engineering sciences in the targeted Universities in Mongolia through innovation of MSc curricula in line with the new development in the area, the labor market demand and the opportunities for virtual mobility through e-learning provided by the ICT. The objectives are:

- To analyze the educational needs in electrical engineering, communications and energy efficiency through problem and job analysis, and to define the necessary knowledge, skills and competencies of engineers in the sector in terms of learning outcomes.

This objective addresses the need of definition of new skills for new engineering jobs in Mongolia and the needs of improvement of transparency of qualifications.

- To design syllabi and course content and assessment for compulsory and elective courses in electrical engineering, communications and energy efficiency to meet the user needs.

This objective addresses the needs of skills and competences for ‘high-performance work practices’ in the new work organization in Mongolia.

- To adapt/develop new e-learning courses with modular structure for the innovated curricula of partner universities and to establish a platform and procedures for knowledge sharing inside Mongolian and European academy and students.

This objective addresses the need of sharing knowledge and skills of experts in all fields for effective education in engineering.

- To perform a pilot test and to start the implementation of the joint modules/courses delivery during the last project year.

This objective addresses the necessity of striking a balance between what is offered in the educational system and what is needed in the sector.

V. WORK IN PROGRESS

First activity within the project was a more precise educational need analysis in electrical engineering, communications and energy efficiency through problem and job analysis, and definition of necessary knowledge, skills and competencies of engineers in the sector in terms of learning outcomes. A survey was done with questionnaire and interviews with teachers and students, managers of big and small enterprises in the sector, graduated students, analysis of the statistics of the labor market and of the university formal engineering education.

Through analysis of the domains (electrical engineering, communications and energy efficiency) the necessary skills and knowledge in terms of learning outcomes were defined for the necessary knowledge and skills. The job analysis resulted in definition of learning outcomes for the necessary competences.

The following courses are developed for the three innovated curricula at the three universities:

- “Engineering CAD” and “Microelectronics for Information and Communication technologies” [7]
- “Improvements of multi-disciplinary engineering study by exploiting design-centric approach, supported by remote and virtual labs”, “Integrated Concept for embedded system study”, “Comprehensive Blended Learning Concept for Teaching Micro Controller Technology”
- “Bio-Micro&Nano Systems” and “CAD for microsystems”;
- “Energy efficiency in building construction”, “Solar Photovoltaics” and “Solar Thermal Systems”;
- “Power Supply Calculation Algorithm”, “Utilizing New Energy Sources for Power Supply”, “Special Course of Power Supply”, “Quality of Electrical Energy and its usage regimen”, “Special Course for an Electrical Machine”, “Determining Methods of Energy Loss of Electrical system” [8], “Calculation automation of Electrical Lighting”;
- “Power system automation”, “Relay protection”, “Interfacing technique” and “Industrial automation”;
- “Introduction to Electronics”, “Digital Signal Processing” [10], “Semiconductor Devices and Microelectronics” and “Modern Control System”[11].

The engineering education involves the use and application of skills for finding solutions, making decisions, and thinking effectively, i.e. problem-solving skills. The instructional strategies and tactics for higher-level skills were used in the course design. In this project discovery inductive strategy was implemented (when it was possible from pedagogical point of view) in an interactive Web-based instruction (related most to problem-solving).

Specific tasks were designed for competences training, e.g. group work and tasks to manage a team or plan a new work organization for implementation of new technology.

In the course development, a prototyping approach is used: developing, testing, improving. So, users are involved from the first prototypes development and in all stages, until the pilot test. This approach has two advantages: it allows meeting user needs from the first stages of the course design and helping developers to remove errors and improve their products at the earlier stages to save time, staff load, money. To facilitate the use of the course materials, they were translated in Mongolian depending on the user needs.

Three new laboratories were created at the Mongolian HEIs, equipped with modern apparatus and equipment for both, practical work of students and development and delivery of ICT-based materials. Fig. 1 shows the inauguration of the first laboratory.



Fig. 2. Inauguration of a new laboratory at the National Technical University of Mongolia, shown by five national televisions

Teachers were trained on new methodologies and pedagogical approaches with the use of learning outcomes and on the development of e-learning materials.

The three curricula at the National University of Mongolia, at the Mongolian University of Science and Technology and at the National Technical University were accredited and from October 2019 starts their implementation.

VI. THE IMPLEMENTATION OF NEW CURRICULA

Part of the second and the whole third project year are devoted to the testing and implementation of courses. After successful assessment students will be awarded certificates for courses.

The pilot test will be conducted with different groups of learners from the universities. Specific evaluation methods will be used and corresponding tools designed for assessment of knowledge (e.g. multidisciplinary tests); of skills (e.g. tasks for finding solutions for new problems, or, how to find procedures to solve new problems); of competences (e.g. tasks to manage a team or plan a new work organization for implementation of new technology).

Because of the different academic curricula, not all courses will be implemented in each university but only those corresponding to the scientific area of the corresponding curriculum.

The courses developed in this project that are not in the compulsory curriculum will enter as elective courses in the

curricula of the MSc degrees in the partner university. So, not all students will study all courses but minimum 25 students per partner institution will be involved.

After successful assessment, the student will obtain a certificate with the corresponding credits and the local grade of the host institution system with corresponding grade of the student's home institution system. The European Credit Transfer System (ECTS) is not priority of Mongolia but we will test the credit system in this project. The purpose will be to prepare the partner universities for further collaboration with student mobility. In addition of some Mongolian universities the credits are already used in the curriculum definition.

Questionnaires and interviews will be used to measure the students and teachers attitudes, satisfaction, to reveal problems if any and to improve the courses.

VII. THE BENEFITS FOR THE MONGOLIAN HIGHER ENGINEERING EDUCATION

In this section, we present the impact of the project as it is seen by the representatives of the Mongolian Ministry of education and of the teachers involved in the development of innovative curricula

In recent few years, the Ministry of Education, Culture, Science, and Sport, Government of Mongolia, has worked very actively to reduce the gap between the changing labor market and skills that are obtained by students when they are students at university. The goal of this project exactly targets this ambitious purpose of Mongolia's government to reduce the gap between changing labor market and skills.

According to the international good practice, the most desired way of curriculum development is to make a curriculum in a market-oriented way on the basis of data of need analysis and real demands of changing labor market. However, the most popular scenario of curriculum development in Mongolia is that professors or teachers make a curriculum based on their professional knowledge, experience, and belief by ignoring the labor market demands in the real nature without the survey of need analysis.

A curriculum should meet the changing demands of labor, so that it will let students obtain future ready skills to successfully market themselves into both local and global market. Today employers demand world class skills from their perspective workers beyond the local education level, because every day their business competes with world class products and services in a local market. Therefore, the most important benefit of this project is to let Mongolian professors to understand the importance of market-oriented curriculum development culture and learn from European best practices to make a world class curriculum that meets the changing labor market.

“Due to this project, we are working to update and change the existing curriculum in a rational way or a market-oriented way by learning from the best practices of European program countries. Thus, we are doing our best to build the best practice for other Mongolian universities to learn how to make an excellent curriculum that best reflect the needs of changing labor market of new century. We believe that we can improve quality of higher education and teaching practice in Mongolia due to this great opportunity of the Euro-Mong Cooperation for Engineering Education Modernization project.”

VIII. SUMMARY AND CONCLUSIONS

In this manuscript we presented briefly the work in progress within the Erasmus+ Competence Building in Higher Education project “Euro-Mongolian cooperation for modernization of engineering education”. Until now, the new laboratories were created at the three partners’ universities, the twenty two courses in electrical engineering and three courses for transferable skills are ready, the training of teachers was done and now the project is on the stage of implementation – the pilot test and field trial.

The last years Mongolia is at the stage of expanded industrialization and the areas of electrical engineering, communication and energy efficiency will drive innovation and economic growth. The most fundamental driver is modernization of education in these areas. The EU-Mong project is contributing through:

- Internationalization of HE in engineering education through collaborative development/update of MSc curricula;
- Innovated contents in line with the new development in the area;
- Upgraded facilities necessary to the implementation of ICT-based learning materials, practical work of students in innovated laboratories;
- Staff trained for the development and delivery of innovated curricula;
- HE responding to the labor market demand.

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