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Software Engineering Competence Evaluation Portal

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Abstract

This paper presents the results of the initial research phase of Software Engineering Competence Evaluation Portal design and implementation. The web portal will be dedicated to joint master program training content and supervision synchronization between several Baltic universities. The functionality of the portal will provide a common support service for learning outcomes information exchange, referring to a graduate’s knowledge, skills and competence upon completion of the Master of Science in Software Engineering (Information Technology) Programs.

Keywords: Competence evaluation; Web portal; Knowledge mapping; Testing; SWEBOK

1. Introduction

The rationale for undertaking this project is set out under the following key themes:

- Recognising the importance of developing and applying common standards for higher education qualifications across Europe in the framework of creating the European Higher Education Area (EHEA);
- Recognising the significance of identifying key competences that are the basis for the employability of university graduates in the area of Software Engineering (SE);
- Recognizing the importance of developing and implementing an efficient web-based system that will be used for identifying key competences of the graduates of the Master of Science in Software Engineering & Software Technologies (MS SE&ST) Program;

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Recognising the significance of making competence-related information more accessible in the framework of the development of OER-based educational materials (documents and media that are useful for educational, assessment and research purposes), which will contribute towards the development of the European Union as an advanced knowledge society in accordance with the objectives of the Lisbon strategy. So the project aims to foster interchange and cooperation between education and training systems within the EU.

Consequently, the project addresses the following issues and needs:

- This project will provide analysis of some core issues related to the development of common standards for higher education qualifications, which is needed for establishing a common way of measuring educational outcomes in the EU member countries. In the context of increased workforce mobility and lifelong learning, the management and interoperability of data about learning outcomes (LOs) in outcome-based learning are of high importance for both education and employment sectors;
- This project will specifically benefit educators and students by providing them with a research-based online tool that will support the exchange of information on learning outcomes, referring to a graduate’s knowledge, skills and competence upon completion of the Master of Science in Software Engineering Program;
- Using a common online format for describing, referencing and sharing the graduate learning outcome definitions defined in the Program will make it easier for educators to assess the compatibility of educational systems and sectors across national borders in the framework of creating the EHEA. By managing and sharing this data, students will be able to better plan their careers and enhance their employability potential;
- Internet-based information flows play an important role in the development of modern society. The implementation of a unified metadata and service IT system for promoting the OER-based educational materials will help making key educational resources sharable, storable, findable and interoperable on a global scale;
- The project will introduce new on-line technologies supported mobile devices and tablet PCs to make the competence evaluation solution accessible for wide European Software Engineering society.

2. The background of the SEEMAP project

The background of the SEEMAP project is the following:

- Importance recognition of developing and applying common standards for higher education qualifications across Europe in the framework of creating the European Higher Education Area (EHEA);
- Significance recognition of identifying key competences that are the basis for the employability of university graduates in the area of Software Engineering (SE);
- Importance recognition of developing and implementing an efficient web-based system that will be used for identifying key competences of the graduates of the Master of Science in Software Engineering & Software Technologies (MS SE&ST) Program;
- Significance recognition of making competence-related information more accessible in the framework of the development of OER-based educational materials.

The project aims to foster interchange and cooperation between education and training systems within the EU. The SEEMAP project will reinforce and accelerate the process of innovation in higher education by enhancing the universities' capabilities by granting better access to the educational know-how as OER, setting an effective experimental framework for defining and measurement Educational Outcome for the selected Master Programmes in SE&ST at European and Baltic regional level.

There are three Partner universities as members of SEEMAP project: Transport and Telecommunication Institute (Latvia), Kaunas Technological University (Lithuania) and University of Murcia (Spain). All project Partners successfully run their own Master Programs in SE&ST for years. Informatics Faculty of University of Murcia offers the innovative Master Program in Modern Software Technologies, which can be used as a pattern for competence model development and evaluation implementation, as well as for localization at Baltic universities. TTI and UM already have strong ERASMUS mobility flow and a special partner's cooperation agreement. Informatics Faculty of
Kaunas University of Technology is one of the regional leaders in Software Engineering Research and Education. TTI and KTU have fruitful relations in academic program accreditation, multimedia and e-Learning implementation areas. All project partners have successful previous EC project experience.

The SEEMAP project will reinforce and accelerate the process of innovation in HE by enhancing the universities' capabilities by granting better access to the educational know-how as OER, setting an effective experimental framework for defining and measurement Educational Outcome for the selected Master Programmes in SE&ST at European and Baltic regional level. The SEEMAP project is the complementation to the TTI current project “Communication and Information Technology for Improvement Safety and Efficiency of Traffic flows: EU-RU-UA Master and PhD Programs in Intelligent Transport Systems” (TEMPUS No. 517374-TEMPUS-1-2011-1-RU-TEMPUS-JPCR) - CITISET and successfully completed in 2009-2011 the project FP7: Baltic–to–Balkan Network for Logistics Competence (B2B LOCO) - Project reference: 234106.

The SEEMAP project will extend the previously developed formal model of competence description and will utilize tested design decisions for new Master Program graduates' competence evaluation portal development:

- Project Partners already have long time cooperation in education and research area;
- All project Partners successfully run their own Master Programs in SE&ST for years. Informatics Faculty of University of Murcia offers the innovative Master Program in Modern Software Technologies, which can be used as a pattern for competence model development and evaluation implementation, as well as for localization at Baltic universities. TTI and UM already have strong ERASMUS mobility flow and a special partner's cooperation agreement. Informatics Faculty of Kaunas University of Technology is one of the regional leaders in Software Engineering Research and Education. TTI and KTU have fruitful relations in academic program accreditation, multimedia and e-Learning implementation areas;
- All project partners have successful previous EC project experience.

3. The main activities the project

The main activities the project will organize are the followings:

- Research of European experience in SE&ST Master Programs implementation for common measurable Educational Output (competence) requirements suggestion (as a Template for Joint Master Program in SE&ST);
- Development and documenting of the Methodology for evaluation of competence in Software Engineering and Software Technologies;
- Descriptions of measurable competences’ characteristics of the Master of Science for Software Engineering Program’s graduates;
- Development of testing material for the Master Program Educational Outcome evaluation;
- Creation of the Engineering Competence Evaluation Internet Portal (SECEIP);
- Development of on-line training course “How to use SECEIP” for academic personnel and master program graduates.

During the preparation phase of the project the following activities will be done:

- Agreements arrangement and signing;
- Project staffing in accordance to required skills and competence;
- WBS performance and work assignment development (allocation of tasks amongst partners including lead on specific tasks);
- Outputs (Deliverables) acceptance and quality control checklists development;
- Project Communication system establishment;
- Project Kick-Off meeting preparation;
- Detailed project schedule and individual assignments and responsibilities development for partner's review;
- Publishing information about the project beginning at partners' universities web pages;
- Project logo design;
Logistical arrangements.

The project manager is in charge of the day-to-day running of the project. The project manager shall coordinate project activities across the participating parties, keep the project on track, and thus ensure that everybody works towards a common goal as a team.

The project manager is responsible for:

- Keeping the steering committee informed about progress in the project;
- Working with the steering committee to ensure that project resources are used in the best way possible;
- Ensuring that everybody in the project endorses decisions taken in the project;
- Arranging a kick-off meeting for everybody working on the project within two months from project start;
- Compiling well-structured reports including appendices;
- Compiling and submitting in due time requests for payment of funds;
- Compiling and submitting in due time annual accounts for the project;
- Contributing to VIAA with a description of the project;
- Ensuring that information about the project is communicated between VIAA and the project as a whole.

The Project plan has milestones (one per each Output delivered) for progress tracking and deadlines for activities implementation.

Each activity is connected to an accounted deliverable.

4. The descriptive model of competence as education outcome

One of the main problems for the research is the problem of actual professional SE knowledge representation for the program graduate’s competence testing purposes. As the main source of the professional knowledge for this research were used SWEBOK (3.0 version) document as well as the description of TTI (Transport and Telecommunication Institute) master program in Computer Science.

As the model for the professional area description was selected so called knowledge mapping model. Knowledge maps are node-link representations in which ideas are located in nodes and connected to other related ideas through a series of labelled links.

Three main categories of links were used:

- Dynamic links that denote a changing relationship between the linked ideas;
- Static links that describe structural relationships between ideas and elaborative links that extends information.

Knowledge maps differ from other similar representations such as mind maps, concept maps, and graphic organizers in the deliberate use of a common set of labelled links that connect ideas.

The document SWEBOK v.3.0 has three levels hierarchy: 17 chapters, topics and subtopics. Each name of a chapter, topic or subtopic was considered as an idea and was represented as a separate knowledge map with its name borrowed from the document. The list of these main knowledge representation nodes (chunks) for the SWEBOK Chapter 4: Software Testing is presented in the Table 1 only as an example of the representation. Attribute “Coverage” reflects inclusion (or not) of the particular knowledge chunk into the master program education outcome.

| Chapter | Topic | Subtopic | Knowledge Chunk                  | Relations | Coverage |
|---------|-------|----------|----------------------------------|-----------|----------|
| 4       | 0     | 0        | Software Testing                 | 1.1.1     | Yes      |
| 4       | 1     | 0        | Software Testing Fundamentals    |           | No       |
| 4       | 1     | 1        | Testing-Related Terminology      |           | No       |
Initial findings on the use of knowledge maps as navigational guides and competence testing strategy roadmap in web-based environments are promising\(^1,4\).

5. Development methodology

Web applications are subject to changing requirements more frequently than other systems. The development cycle of Web applications is also shorter and more volatile than others. Methodology is needed for maintainability, scalability, and upgrading Web applications, especially for large-scale and mission critical projects\(^5\).

The ideal methodology is the one that can guide when to switch to another tool during the development cycle, which generates a hybrid approach consisting of the most appropriate tools and techniques from different methodologies. As methodologies, tools, and techniques are changing and volatile, it is more important for
developers to understand their function and objectives than to learn all of them. As there can be multiple ways to achieve an objective, understanding of the objective can provide flexibility to development methodologies and tools.

The general trend of more recent methodologies is to broaden the approach to cover more of the lifecycle and address wider issues. Many early approaches to designing web based applications tended to be based on E-R (Entity-Relationship) modelling. Later approaches have tended to focus on automatic generation of pages directly from a database using various notations. Many of the key current approaches for producing a development overview of a website are based on UML.

The final recommendations for the required design methodology selection were formulated as following:

- All the pages in the website/web application must be visible;
- Links between the individual web pages are mapped;
- Transitions cause the user to move from one page to another is defined;
- The major external systems are identified;
- Server-side components are identified;
- Indication of what data is sent between the web pages and the server-side components.

To avoid the problems posed by the “Page-by-Page” authoring systems it is recommended to use a kind of Content Management System (CMS). This system will allow webmasters to “program” the layout of the Website into the CMS and then allow users to add content by filling the content into appropriate fields of a form. So all content gets stored in a database and the web pages are created using the CMS.

The CMS provides several benefits: separate “Content” from “Layout”, automatically generates the formatting and navigation menus, provide enhanced services (Contact Us Form, Site Search Form, Online Ordering, Email Subscription etc.)

Once the project proposal is approved, the process by identifying the project implementation teams begins. In this phase, all team members and their roles are identified and documented.

The main steps of the selected development methodology are the following:

- Step 1: Discover;
- Step 2: Design;
- Step 3: Develop;
- Step 4: Deploy;
- Step 5: Monitor.

Empirical research is currently taking place to explore the methodology strengths and weaknesses in a real situation of university web site re-engineering.

6. Expected results

The expected results of the project implementation will be the following:

- Multilingual example of SE&ST Master Program's Education Outcome (competence) definition freely accessible for European educational community as OER;
- Operational Internet Portal (SECEIP) for multilingual SE&ST Master Program's graduates competence evaluation and certification;
- The Basic ECTS oriented Framework for Joint Master Programs in SE&ST design and implementation.

All the projects results will be described by Intermediate Report and Final Report.

The desired impact of the project at the local level:

- More attractive SE&ST education and training programmes, in line with individuals' needs and expectations.
- A more modern, dynamic, committed and professional environment inside the education organizations.
• Improved levels of skills for employability through on-line self-assessment.

The desired impact of the project at regional and national level:

• Increased workforce mobility and lifelong learning, students will be able to better plan their careers and enhance their employability potential;
• Easier for educators to assess the compatibility of educational systems and sectors across national borders in the framework of creating the EHEA.

The desired impact of the project at European and/or international level:

• Educational resources sharable, storable, findable and interoperable on a global scale (OER);
• SE&ST competence evaluation solution accessible for wide European Software Engineering society;
• Promote the use of learning outcomes when describing and defining qualifications, parts of qualifications and curricula, in support to teaching and learning and in assessment.

7. Conclusion

Project results will create a powerful platform for implementation of Joint Master Programs in SE&ST for European and international universities. The Internet Portal (SECEIP) existing in several localized copies at Partner universities as OER may be considered as an innovation centre of new IT technology implementation for on-line Software Engineering Education and as a stimulus for master students and academic staff mobility facilitation.

These Portal copies will be maintained completely by partners’ universities’ resources together with their home e-Learning support systems on the bases of free LMS Moodle. Technical support will be delivered by partners’ universities' IT departments at regular bases. Yearly improvement of Portal testing material will be done by Computer Science and Informatics faculties' staff at partners’ universities as a regular activity of their Master Program in SE&ST implementation.

Developed, published and implemented description of SE&ST Master programs Education Outcome including test material for graduates' competence evaluation will be used by partners’ universities for future Joint Master Program in SE&ST design and implementation. Design and accreditation of such a joint program could be voluntary done by any university and on its own responsibility.

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