CURRICULUM FRAMEWORK FOR PROJECT MANAGEMENT COMPETENCES – CASE TUAS

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ABSTRACT

The universities of applied sciences educate practically oriented experts for working life. The skills and competences needed in the future can be categorized for example as information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The learning environments and the curricula should be designed to support the development of these skills. In this paper we present the curriculum framework developed and implemented for project-based learning in Turku University of Applied Sciences (TUAS) faculty of Engineering and Business. By integrating project management skills into the academic curriculum, we support our students' success in the modern working life. The project learning environments used in the implementation are introduced as well. The professional project management competences have been identified and the curriculum has been developed to ensure that students are provided with the necessary skills. By describing the learning process and the learning objectives, we enable a logic and coherent learning path starting from the first year of bachelor studies and continuing to the master studies. The CDIO standards have strongly influenced on the development of the curriculum framework together with the IPMA (International Project Management Association) project management competences. IPMA's Individual Competence Baseline® is utilized in the curriculum development. The students of TUAS have a possibility to take a certification test. Achieving the certification is an international recognition of project management competence described in the Individual Competence Baseline®. For the institution students achieving the certificate is evidence that the learning outcomes are valid, and the students obtain high enough proficiency level. The presented framework has given a backbone for overall curriculum development to our faculty. The project activities (Project Hatchery, Innovation Project Capstone) have strengthened university-industry relationship and have created positive visibility to faculty. The framework has created natural multidisciplinary learning environments and offers an excellent platform for the pedagogical research and development work.

KEYWORDS

Curriculum development, project competence, IPMA, Standards: 4, 5, 6

INTRODUCTION

The students of today face turbulent and ever-changing world with the known and unknown challenges. The OECD (The Organisation for Economic Co-operation and Development Learning) Framework 2030 offers a vision for the future and sets educational goals. In addition to disciplinary skills students need a broad range of other skills such as cognitive and metacognitive skills (critical thinking, creative thinking, learning-to-learn and self-regulation), social and emotional skills (empathy, self-efficacy, responsibility, and collaboration) and practical and physical skills (using new information and communication technology devices). (OECD 2018.) The learning environments and the curricula should be designed to support the development of these skills. The CDIO standards offer fundamental principles for building curricula and learning environments. In case of project management competences, the IPMA's (International Project Management Association) Individual Competence Baseline® supports and complements the CDIO standards.

This paper describes the development and implementation of the curriculum framework for project management in the Faculty of Engineering and Business in Turku University of Applied Sciences. The Faculty of Engineering and Business has seven schools providing bachelor and master degrees to over 7000 students. The education covers basically all fields of engineering and business. The list of engineering programs is following:

- Mechanical Engineering
- Chemical Engineering
- Automotive and Transportation Engineering
- Civil and Community Engineering
- Construction Management
- Environmental and Energy Engineering
- Industrial Management and Engineering
- Information and Communications Technology
- Electrical and Automation engineering.

The presented curriculum framework is aimed at our bachelor programs. In addition to the general framework, the conceptual frameworks, and practical tools, such as applicable CDIO standards, Innovation Competencies and IPMA Competence Baseline® are presented. The background of the curriculum development and design elements for project learning environment are described as well.

CURRICULUM DEVELOPMENT

In the Faculty of Engineering and Business, Turku University of Applied Sciences (TUAS) the CDIO approach has been used as an educational framework since 2006. However, the organization of TUAS has changed remarkably since then. The engineering faculties have had two mergers where three separate faculties covering engineering and business programs have merged to new Faculty of Engineering and Business in 2018. The latest merger put together a faculty that had implemented CDIO several years and a faculty that haven't used CDIO in their pedagogical development, but which had largely involved in development of the university's common pedagogical model (Innovation Pedagogy). At the beginning common elements and structures for the curricula were defined. The CDIO approach was defined as a general guiding principle in the development together with the Innovation Pedagogy. These two approaches support each other and are not in conflict rather they share similar goals and objectives as described in (Penttilä, Kontio, Kairisto-Mertanen, & Mertanen, 2013; Penttilä &

Kontio, 2014; Penttilä & Kontio, 2016). The CDIO approach focuses mainly on engineering education providing concrete support for teaching and learning while Innovation Pedagogy has broader viewpoint of the entire economy and valid competences for future society (Penttilä, Kontio, Kairisto-Mertanen, & Mertanen, 2013). During the years the curricula has been in constant review and development focus as we have tried to improve our performance in teaching and learning (Kontio, 2014).

The key principles and guidelines defined in 2018 were following:

- All bachelor programs have an Introductory course for their degree in the beginning of the studies (CDIO Standard 4)
- All bachelor programs join to faculty wide multidisciplinary Project Hatchery course
- Studies are organized around modules (typically 15 ECTS)
- RDI projects are embedded in degree programs (CDIO standard 5)
- All bachelor programs join faculty wide multidisciplinary industry driven Innovation Project Capstone - course in third year of studies
- Project competences are supported and developed throughout studies.

In addition to these, we have actively implemented the ideas and guidelines of CDIO and Innovation Pedagogy to our teaching and learning activities throughout the years. For example, our degree programs have clear learning outcomes, learning outcomes are aligned with teaching and assessment, active and experimental learning methods are widely used, learning environments and workspaces are modern, sophisticated and in active use.

Curriculum framework for project management

The curricula in the Schools at the Faculty of Engineering and Business are designed to include project courses throughout the studies (Fig. 1). There is a combination of field specific and multidisciplinary courses, and they all are linked to working life through research, development, and innovation (RDI) projects or company assignments. The learning objectives and contents of common project courses are planned and agreed in faculty level to ensure that the project management cornerstones form a logical and coherent path throughout the studies leading to high quality and up-to-date education and relevant competencies for the students. The program specific project courses and activities fulfill and support these faculty wide project competences.

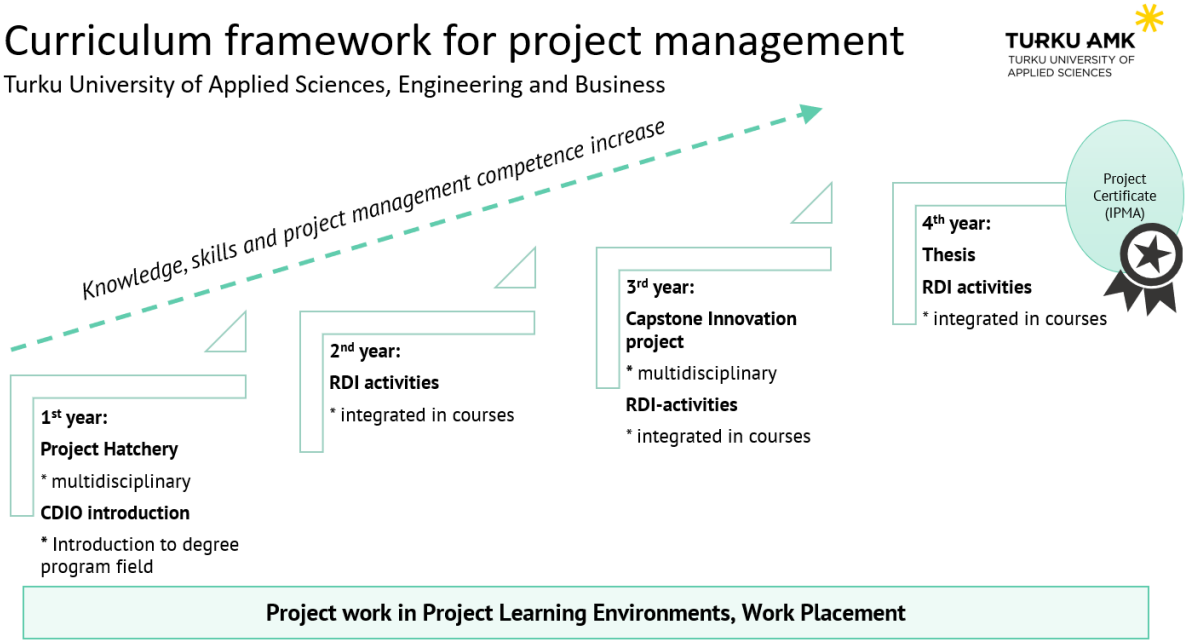

Figure 1. Curriculum framework for project management

Project Hatchery –course (5 ECTS) is scheduled in the beginning of the studies. First year students form multidisciplinary teams, and they work with real-life project assignments. The course aims at getting familiar with studying at the Turku University of Applied Sciences as well as acquiring the basic skills and knowledge in project management. The project assignments are quite general and suitable for very multidisciplinary teams. The CDIO Introduction course taking place during the first study year as well is the first study field specific design-implement experience.

The CDIO standard 4 defines Introduction to Engineering as an introductory course that provides the framework for engineering practice in product, process, and system building, and introduces essential personal and interpersonal skills. The idea of an introductory course is to provide a framework and broad idea of the profession students are starting to study. Usually this is a one of the first courses and places students in real engineering activities through problem solving and simple design exercises, individually and in teams. The introductory courses planned in our university in Faculty of Engineering and Business were supposed to start in all Bachelor programs in autumn 2019. As the faculty covers business programs too, the Introduction to Engineering was named in the guiding documents as Introduction to degree program field. The schools of the faculty designed different Introduction to modules such as Pump design in Mechanical Engineering, Introduction to Chemical Engineering by making soap, Product development in ICT and Basics in Business Administration.

Both courses (Project Hatchery and Introduction to degree field) are run as projects where learning project principles and activities are one part of the learning outcomes. The difference is that Project Hatchery is operated in multidisciplinary teams and Introduction to course is run within a specific degree program. Approximately 1400 students attend to these project courses yearly. There are over 100 projects during one Project Hatchery round.

During the next years students work with more and more demanding project assignments as the RDI-projects are integrated in the courses. Again, in the third year of studies, students are

gathered in multidisciplinary project groups in Capstone Innovation Project (10 ECTS). The course is executed in co-operation with company partners and the project assignments are genuine projects in the companies. The projects' goals are set high by the companies. Students have a possibility to create networks, and there are several examples of the Capstone Innovation Project being the gateway to employment after graduation. Capstone Innovation Project course runs both in the Autumn and in the Spring and the total number of projects is around 90 projects.

The thesis is the biggest personal project for a student. The experience of project work and design-implement experiences support the students in succeeding. The students of TUAS have a possibility to achieve recognition of their project management competence by taking an IPMA's (International Project Management Association) certification test.

PROJECT MANAGEMENT COMPETENCES

In the TUAS Faculty of Engineering and Business the CDIO approach is the fundamental educational framework. Innovation Pedagogy is TUAS's learning approach based on experimenting, sharing of knowledge and expertise, and combining different viewpoints leading to enhancing innovation competences of individuals and groups. Working life orientation, flexible curricula and multidisciplinary learning environments are the corner stones of Innovation Pedagogy. Together with the principles of the CDIO approach, Integrated Curricula (standard 3), Introduction to Engineering (standard 4), Design-Implement Experience (standard 5) and Engineering Learning Workspaces (standard 6) students gain generic skills in addition to disciplinary skills.

Project management competences have been identified to be in central role in modern working life and project-based learning as well as developing project management competences support the development of generic skills.

IPMA Competence Baseline and Certificate

The International Project Management Association (IPMA) has created Individual Competence Baseline® (ICB) for project management competences. IPMA ICB defines the competences that are needed in project work, project management and project portfolio management (IPMA 2015). IPMA defines competence as the application of knowledge, skills, and abilities to achieve desired results (IPMA 2015). The IPMA Individual Competence Baseline® includes three competence areas: people, practice, and perspective competencies (Fig. 2). People competencies consist of personal and interpersonal competencies that are needed to successfully work or lead a project. Practice competencies are the specific tools and methods used in a successful project. Perspective competencies include methods, tools, and techniques to interact with the environment. (IPMA 2015.)

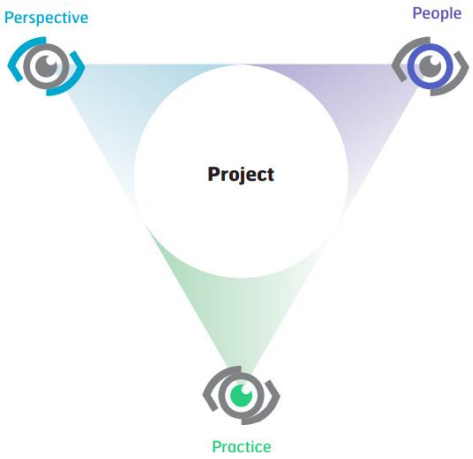

Figure 2. IPMA ICB Competence areas (IPMA 2015).

The IPMA ICB competence areas and their competence elements have been studied and analyzed. The contents of the multidisciplinary project courses, Project Hatchery and Innovation Project Capstone, have been examined to identify the competence elements that are covered in the tasks and learning outcomes of the course. Based on this information a content matrix was formed.

People competences are emphasized in Project Hatchery. The competence elements cover self-reflection and self-management, personal integrity, and reliability as well as personal communication, teamwork, and results orientation. All these competence areas are further developed in Innovation Project Capstone and in addition leadership, and managing conflicts and crisis are taken in account. Practice competences become part of Project Hatchery by using project management tools, such as project plan and gantt-chart as scheduling method. Resourcing and quality are part of the project plan. At the end of the project reflection and lessons learned are utilized. Again, Innovation Project Capstone gets deeper in these competence areas. For example, Kanban charts are used along with gantt, phasing and milestones become familiar. Perspective competences are handled by defining the basic concepts and in Innovation Project stakeholders are defined and considered more carefully than in Project Hatchery.

The content matrix of Projects Hatchery and Innovation Project Capstone is available to be utilized in other courses. The content matrix makes visible the learning outcomes in each competence area that are covered in the mentioned courses. In the other courses, learning objectives and course content can be built on this basis. It can be used as tool to identify possible gaps or redundancies in the students' learning path. It's worth noticing that quite often same competence areas are developed further as an individual gains more experience in project work and project management.

The students of TUAS have a possibility to take a certification test to achieve a certification to verify their skills in project work. The International Project Management Association (IPMA) has a competence-based certification level. The certification is uniform with IPMA Level D® certificate. The Level D® certificate is aimed for starting professionals. (IPMA 2022). For the institution students achieving the certificate is evidence that the learning outcomes are valid, and the students obtain high enough proficiency level.

CDIO Syllabus and Innovation Competencies

The CDIO Syllabus is recognized and utilized is the engineering education in TUAS. There are similarities between CDIO Syllabus and IPMA Individual Competence Baseline®, interpersonal skills for example. The IPMA ICB is applied to complement the CDIO Syllabus with skills specific to project management. In CDIO Syllabus the project management competences are widely involved in 4.3.4 called Development Project Management and in the extended CDIO Syllabus in section 4.7. Leading Engineering Endeavors.

Innovation competencies are categorized into individual, interpersonal and networking competencies. By developing skills in these competence areas, we will have professionals that are creative and initiative, critical thinkers who are able to co-operate and network. Innovation competencies, and especially students' ability to recognize and self-evaluate the development of these competencies, lead to competent and innovative professionals in working life (Keinänen 2019).

As educators we have the tools, such as CDIO Syllabus, IPMA Individual Competence Baseline® and Innovation Competences. Our job is to use these tools to enable our students to evolve into innovative and skilled professionals, capable to creative work in team- and project-based working environments.

DESIGN ELEMENTS FOR PROJECT LEARNING ENVIRONMENT

The CDIO Syllabus statement: "Graduating engineers should be able to conceive-design-implement-operate complex value-added engineering systems in a modern team-based environment" (Crawley 2011) is supported in project learning environments. In TUAS the learning environments are designed to enable learning by doing and experimenting in a problem-based manner in working life context (Hänti et al. 2021).

An essential element in projects is learning workspaces (Standard 6). The learning workspaces and laboratories support learning as they emphasize hands-on learning and engage students in their own learning. TUAS has followed a coherent and pragmatic plan to update and remodel our physical and digital workspaces. Autumn 2020 all engineering education moved to one integrated campus with renewed research teaching and research laboratories as well as other learning resources.

As an example of a learning environment Project Hatchery has been analyzed and developed based on epistemic, spatial, and instrumental, social, and temporal design elements (Table 1).

Table 1. Design Elements of a Learning Environment (Hänti et al. 2021).

Design Element	Description of the Element
Epistemic	The task characteristics and task arrangement
Spatial and Instrumental	Physical features, e.g. location, spaces, and tools
Social	Actors and their roles
Temporal	Timespan, intensity, schedule

In Project Hatchery social and epistemic elements are emphasized. Social elements include for example heterogenic and multidisciplinary groups, changes in group members and new roles in a group. Epistemic elements become visible in course assignments where both, the subject, and the working process, are new to a student. The expected outcomes are not always defined by the educators and there is not only one way to do the work. Students must evaluate their work and the results themselves. Spatial and instrumental elements include e.g. the use of several communication channels and platforms. Project Hatchery groups work mainly on campus at certain time and place but working online is occasionally used. Temporal elements include planning and scheduling the project work. There is a general schedule based on the CDIO-model. But each group creates their own schedule based on their project assignment and the general outline. The groups are instructed to plan and document their work on weekly basis. (Hänti et al. 2021.) As a learning environment, Project Hatchery supports the students' personal development in several competence areas mentioned in IPMA competence elements and in CDIO Syllabus.

CONCLUSIONS AND FUTURE DEVELOPMENT WORK

The Curriculum framework for project management competences was introduced and implemented in 2019. The first group of students that have gone through this path are to graduate in 2021-2022. There is a long history of collecting survey data of the student experience in the Project Hatchery. Since the curriculum framework introduction, the survey data has been collected from the same students after completing Project Hatchery as well as after completing Innovation Project Capstone. In addition, project clients and educators have evaluated the success of each implementation. The comprehensive data analysis is to be done and the effectiveness of the curriculum framework will be studied.

The framework for project management enables students to certificate their competences with standardized IPMA test. Every year part of the students utilize this opportunity, but still, it is less than 5 % of the engineering and business graduates.

From faculty perspective the common framework has worked well. It has given a backbone for overall curriculum development, and it has still given freedom for the degree programs to create degree specific solutions. The project activities (Project Hatchery, Innovation Project Capstone) have strengthened university-industry relationship and they have created a lot of positive visibility to the Faculty of Engineering and Business as well as to our university. In addition, they have provided us platforms where both our personnel and students work naturally in multidisciplinary environment with people representing various fields in engineering and business. These learning environments also offer an excellent platform for the pedagogical research and development work.

Turku University of Applied Sciences offers a Master's degree program in Project Management. Our Bachelor's and Master's degree programs are working closely together, and the curriculum framework has a continuity to the Master's thesis level. In the upcoming years, the effectiveness of the curriculum framework may be seen in the competence level of the new Master's students. Originally the Master's degree program in Project Management started based on the need to provide even more deeper project management competences for the industry around us as well as to our alumnis. Nowadays it is connected to the framework and the path from the first year Bachelor's studies to Master degree are better aligned regarding the project management competences.

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