Integrating Innovation Driving Activities in a Master Level Project Course

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Abstract

The computer engineering and computer science curriculums at Åbo Akademi University have had for more than 10 years a capstone course, called Project Course, where the students in groups implement larger software or combine software/hardware systems. A major change in the environment for the students was in year 2006, when information systems students, a business curriculum, was integrated in the department. At that point, activities for integrating innovation were added to the course development. The aim of the innovation activities is to try to make the students aware of their possibilities, as well as encourage them to form start-ups based on either ideas in the project course or further development of their ideas. To this point, year 2012, we have at least two companies based on the basic technical work done during the project course. In parallel, a student entrepreneurship organization has been formed in the university campus area, which today is a major, student based, co-operator to the project course.

This paper brings forward the development of the Project Course and the supporting activities around it. We explain the cooperative work and how it affects the students in the project work during the course. We analyse how different strategies for innovation have turned out in practice, and provide suggestions and tools for how student innovation can be encouraged and facilitated.

Keywords: entrepreneurship, course curriculum, IT education, student projects

1. Introduction

For a long time, innovation has been a buzzword in the western world, and especially in Finland and its economy. With the decline of traditional large industries in Finland, such as forest industry, shipyards and even relatively new telecommunication industry, there is political demand for new innovation-driven industries, expected to contribute to the growth needed for the society. Already ten years ago, in the book by Castells and Himanen [1], innovation and the need for building entrepreneurialism among the young are stressed as key challenges in the Finnish society. Since then, this need has only grown.

One of the players required to take part in this activity is the educational system, which is expected to also contribute to the innovation activities. Innovation is traditionally not the outcome of the educational part of the university, where the main focus is to provide theoretical background, skills, and to various extent practical knowledge of existing solution methods. Instead the other main task of universities, the research, is expected to be the basis for innovations. But also here, the basic scientific method, especially in the field of natural sciences, is to observe, build models that explain existing phenomena and prove that the models are explaining the observations well enough. So can an innovation be based of scientific research, if we assume that natural sciences only deal with observations of the environment? Can a model of the world around be an innovation?

This leads us to the need defining what an innovation is. Firstly, an innovation is something that is *not directly (logically) derivable* from the well known knowledge around us. An innovation must be an artifact that in that sense breaks the normal way of thinking. Secondly, an innovation must be something that *generates value*, i.e. it brings value to the users or the environment around it. This value might not always be something that people are willing to pay for, but it should provide a change to its surroundings.

For instance, a new physical model explaining some phenomena, based on vast amounts of basic research is not necessarily an innovation; the innovation is only when we find a way to use the model to provide value to the society.

This also forms some basic learning outcomes for education that should support innovation. We must in the education explore what innovation is, how to achieve it and how to measure it.

There is today a general trend in technical education to promote innovation. The most visible example in Finland is the joining of the three separate universities in capital Helsinki area to form the Aalto University. Three different disciplines of education were joined for one main reason: to be the cradle for innovation. But as such, only doing an administrative join of universities does not help: corresponding activities are needed. Just as an example for such an activity is the forming of a new educational program called Service Design and Engineering (SDE), which is discussed in [2]. On European level, the European Institute of Innovation & Technology (EIT) which recently started its operation has innovation as its key element.

We, as a rather small university, cannot of course by our own change so much. But we can for sure do small changes at grass root level, and let that change slowly grow. In this paper, we are explaining how activities supporting innovation have been included, through a Project course, in the curriculum of the study programs at the Department of Information Technologies at Åbo Akademi University. We show what can of activities have been included, at which stage, and we analyze how well they support the goal that

our students will be innovative now and in their future careers. We also analyze, what can of growing these activities so far have contributed to.

The Project Course is not unique as a capstone course in other universities, for instance at Aalto University [3] and at Tampere University [4]. We however promote a certain structure in our Project Course and address the need for student motivation; these key features have made this course a favorite among students.

2. Background – setting the scene

The Project Course at the Department of Information Technologies, Åbo Akademi University is a graduate-level course, recommended among the last courses a student attends in a Master-level curriculum. The goal of the Project Course is for the students to develop a software-intensive system by working in a team. There is a very limited amount of teaching in this course; instead, the students are provided with the opportunity of applying earlier gained knowledge in developing a product that is more complex than a typical academic assignment. This type of course existed at our department for at least 15 years; however, a major change occurred six years ago, when the department was reorganized.

In 2006 the former Department of Computer Science was replaced by the actual Department of Information Technologies that has three disciplines: Computer Technology (CE), Computer Science (CS), and Information Systems (IS). Computer Technology is an engineering programme focusing on software engineering and embedded computing. The Computer Science programme consists of computing and programming methodologies with a focus on abstract reasoning as well as interdisciplinarity. The Information Systems programme offers a strong business component in addition to various studies on managing software-intensive systems development.

Once the department was reorganized, the focus of the Project Course also extended correspondingly to the change. While earlier the Project Course students were required to demonstrate (only) programming and documenting skills, currently the students need to also develop a business/exploitation plan. Each team is encouraged to have students from all three disciplines.

Most importantly, the course culminates with the so-called "ICT Showroom", a public competition held at the ground floor of our university building; all the projects need to be completed by then and are demonstrated; the public and a carefully selected jury vote to select the best product; the members of the winning project each get a significant prize (in 2012 each winning student team received a brand new Nokia Lumia phone).

For the sake of the example on the size of the event, 56 projects have been presented in the 2012 edition of the Showroom, of which 9 research projects and 47 seven student projects. The student teams belonged to the 3 universities in the Turku area: Åbo Akademi, University of Turku, and Turku University of Applied Sciences. Eleven of the

student projects were projects developed during the Project course. In total, over 200 participants have been present in the event. As mentioned earlier, such an event provides both a positive pressure and a motivation for the students during the course.

Figure 1 ICT Showroom 2012

The objective of the Project Course is to plan, design, implement and deliver a software product in a team. The team creates a specification of the product, often with the help of an external customer; creates a project plan, designs a solution, and implements the solution. The project should be carried out within the strict time limit of seven months. Students are evaluated during the execution of the project based on several deliverables and presentations they produce. A team consists of four to six students. The idea of the project is either provided by the course lecturers or by the team members. There are two main requirements to pass the course:

  1. There should be a working product/demonstrator at the end of the project. That is, the team has to deliver a running system, not only a plan nor a vision of a system:

     a. It should be delivered with documentation, source code, and a test suite.

     b. The demonstrator should be crafted professionally and work as expected without obvious defects.

  2. There should be a business/exploitation plan detailing why and how the solution is useful and/or how it can be turned into a viable business.

Each team is assigned a team mentor, which is one of the lecturers in the course. The team should have about four meetings (or more if needed) with the mentor as the chairperson. The mentor is a support person for the team related to managerial issues, such as helping setting up the organization of the project, help on prioritizing and finding the right activities needed for going forward. The mentor is also the direct support person of the Project Manager, who should contact the mentor if s/he feels any need for support in organizing the work of the team.

Each project has an external customer, i.e. a person not part of the development team. In most cases, the customer will be a professional working in the software industry. The team will interview the customer to create a product vision, define the main product requirements and validate these requirements with the customer. The students own the work they perform in this course.

This course corresponds to 10 ECTS points and has no written examination. Instead, the team should create and deliver on time a number of deliverables. The students are graded from 1 to 5, based on active participation in lectures, presentations, project implementation and project deliverables.

The course includes 3 evaluations:

- First evaluation upon the first meeting after setting up the team, worth 10% of the grade
- Second evaluation upon presenting a prototype, worth 30% of the grade
- Third evaluation at the end of the course, worth 60% of the grade

There are several aspects with respect to the impact of this course on students, their innovation potential and the Finnish society. We describe these aspects in more detail in the following section. One obvious characteristic of this course is that it provides an environment for working life experience: each group has a project leader, a client (external stakeholder), and a mentor (one of the teachers). In fact, this is the most often provided feedback from the students: "this was the first and only course where I felt I was doing something real".

3. The innovation process

The Project Course provides an innovation framework in which is intended to foster the innovation capabilities of the students in a constraint free (yet guided) environment. The "guided" environment basically imposes a strict format for the course *phases*, *milestones*, and *deliverables* so that the students do not have to focus on practical details but just be creative. The latter implies that the students are encouraged to decide for themselves how each phase is approached, and how the deliverables are produced and shared within the team. At the end of each phase the students will present during the lecture some aspects related to the project, such as status, idea, plan, etc. In addition, each milestone has a list of deliverables that should be provided by each project team.
The milestones provide both a target for the students and a checkpoint for the lecturers.
In fact, previous research [] has shown that running similar project courses without a guided framework results in practical courses in learning project management by mistakes.

Our approach is different from the "typical" university course in which the course lecturer "dictates" the in detail the activities of the students throughout the course. Another difference resides in the fact that compared to traditional courses in which students are basically accumulating theoretical knowledge, in the Project Course the students have the opportunity to combine and apply in practice the theoretical knowledge in the previous courses.

During the Project Course, students have the opportunity to learn practical project management. They have themselves to create, organize, and work in teams. Also they are responsible for planning and executing the projects, for taking decisions and allocating resources accordingly. In fact, in this course is also intended to familiarize

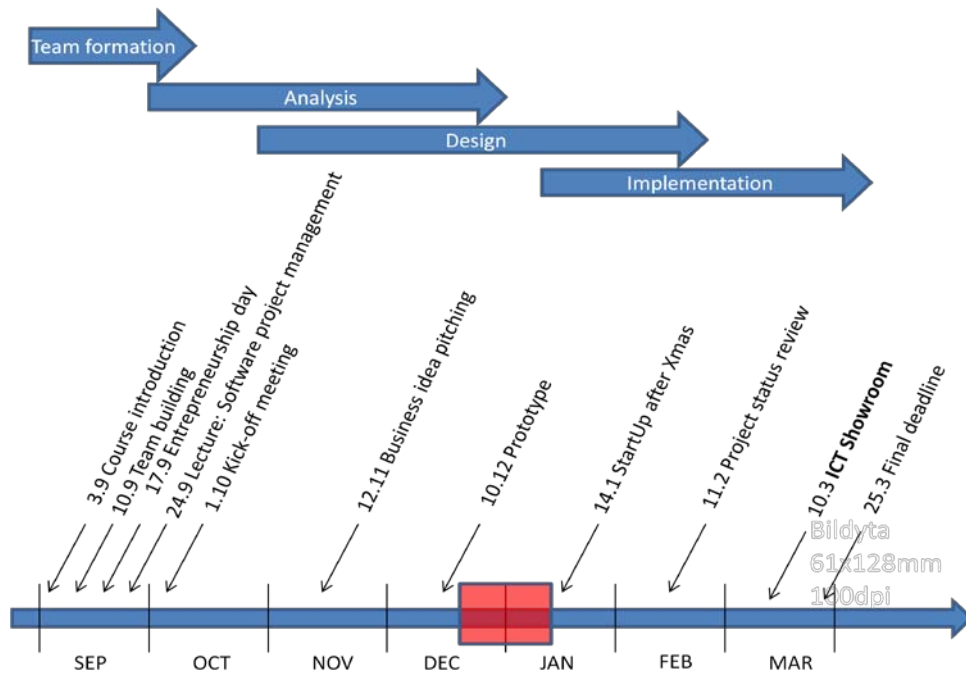students with real-life situations which they will face once they graduate from the university.

Figure 2 Example schedule of the Project Course, edition 2011-2012

The phases of the project course are based on the milestones depicted in Figure 2. For each milestone the student team has to present in a lecture the current status of the project, milestone specific information, and deliver the corresponding deliverables. In the following, we will briefly go through the main phases of the project course.

3.1.1. Course introduction

The rules and settings of the course are introduced to students, followed by the presentation of project ideas by the external customers. Students have the liberty of suggesting their own project idea, and later on to try to attract other students interested in working in the project. The only requirements from lecturers side is that the final product will be related to the information technology field and that the effort required is compatible with the duration of the project course and the size of project team. Being able to select a project of their choice and on their favorite topic increases the motivation and dedication of the students. For projects suggested by students, one of the lecturers will act as a customer.

3.1.2. Team formation

In this phase, project teams of 4-6 students are being formed. The students are responsible themselves for forming a team by eliciting either their own project idea (previously discussed with and approved by the lecturers) or their skills (developer,

designer, project manager, analyst, business analyst, etc.). As the students participating in the course belong to the three somewhat complementary directions at the department, CE, CS and IS, we encourage the teams to have members from all three directions.

The students in this course are at master level (years 4 and 5 of study) and they are both local and foreign students from countries inside and outside EU. For instance, in the previous version of the course around 40% of the participants have been foreign students coming from 9 different countries. During the team formation phase we also encourage the students to form multicultural teams, with members from at least two countries. The students have 2 weeks for forming the teams and agreeing on their project idea, team members and the duties of each member.

3.1.3. Analysis Phase

In the analysis phase each project team analyzes and decides the features of their product based on the discussions with the customer, on estimations regarding the effort required to implement the product. A project plan is also created in which the team details the team members, roles, tasks of the project, schedule and allocation of effort.

In addition, each team has to prepare a business pitch presentation in which they pitch the idea of their product in four slides – four minutes. The point of the business idea pitching is to make the team think about the core idea of the project and how to commercialize it. The pitch is evaluated by an external panel. The panel includes business-oriented professionals, as well as members from Boost Turku, a student entrepreneurship organization whose mission is to provide guidance on creating new start-up companies among university students. The analysis phase ends with the presentation of a product prototype by each project team.

3.1.4. Design and Implementation Phases

During this phase the project team has to decide the architectural design of their product, by making an internal review of different design options.
The implementation phase is mostly about implementing the design decisions taken in the previous phase. At the end of the implementation phase a functional product should be demonstrated in the ICT Showroom event. During both phases, the project teams are encouraged to choose their favourite or to explore new technological solutions, especially solutions that they consider that will give their product a competitive advantage.

3.1.5. ICT Showroom

The ICT Showroom (Section 2) represents the main milestone of each project. In addition, it has been observed to be the main motivating factor for our students. During this showroom, each team will have to demonstrate their final product to a wide audience, including students, lecturers and public. Each project team will get a stand, a

poster panel and the necessary equipment for their presentation. They are free to decide on how to market and advertise their product to the public via posters and marketing materials. An external jury is evaluating all projects at the event; the evaluation criteria are for instance, degree of innovation, technical content, and overall presentation.

3.1.6. Wrap up phase

After the project presentations in the ICT showroom, in the wrap-up phase, each project team delivers the technical documentation, user manual, and the source code of the product. In addition, a post mortem analysis presentation is given, in which each student team present to the other teams and to the lecturers, a post mortem analysis of their project. This analysis includes things that went well during the project, things that went wrong, as well as lessons learnt by each team. This activity rounds up the purpose of the project course, that is teaching the students to learn from their own mistakes.

3.2. Skills and competences acquired

The course is not only a practical course in software project work, but also a means to develop skills relevant for innovation. Among this we mention: interaction with the customer, communication requirements and design decisions, planning and developing a software project. The students also learn how to review the plan during the execution of the project, reflect over their initial expectations and estimations, how to work in a team and how to present their project, product, plans and documents to their colleagues, stakeholders and the general public.

4. Retrospective

As mentioned above the students participating in the course come from different curricular background. In addition to the engineering, computer science and business background some students study in the international Master Programs offered at the IT department or are exchange students from different countries and cultural backgrounds. The students have different personal goals for the course. Some students or student groups already have an idea or a dream that they want to fulfill. This makes the team formation process challenging.

In order to facilitate the team formation we ask the students to prepare themselves for the second lecture. The students are asked to list their technical and human-interaction skills, and how they could contribute to a software-intensive development project. In addition, the students are asked to evaluate themselves in which role they could perform best in the team. After an in-class exercise where the students are forced/guided to informally present themselves and their skills and potential roles for each other the teams are basically self-formed.

The studies by Bruce W. Tuckman [2] presents group development model. The model suggests that a working group or team develops in four stages, forming, storming,

norming and performing. The *forming* stage is a comfortable stage in which the group gets to know each other and agrees on goals and tasks. *Storming* is the next stage, where different opinions are expressed and conflicts between team members occur. This is a critical and important stage to pass in order to move on with the task. The *norming* stage is when the team is solving their interpersonal issues and the members make personal sacrifices in order for the team to work towards a common goal. When the team reaches the *performing* the team structure and roles are clear and the work is done smoothly and members are motivated. Our experience is that the teams in our course also (more or less) pass through these four stages.

The team dynamics in our course are very different due to the different cultural and technical backgrounds of the students from one year to another. In many occasions, some students in a team already know each other from previous courses and have already gone through the stages of group development. Some teams are built from scratch from students with different backgrounds and some subgroups need to form new teams with new students of various backgrounds.

Over the years we have worked out a course structure that will guide the teams in their development process. Having a clear course structure, as detailed in the previous section, with clear steps in forming the teams and producing deliverables, forces the students to learn how work together and how to collaborate for achieving the final goal. All the presentations in class and the definite deadlines force the teams to work and perform. In addition a mentor (lecturer) is assigned to each team. The role of the mentor is to be there in case the team runs in to difficulties and to make sure that the project is making progress.

Supporting entrepreneurial activities in the university teaching is encouraged in Finland. As explained above our aim in the course is to lower the barriers for starting a company and to think about the business potential of the developed solution. We are proud to say that we today at least have two interesting companies that started out from an idea developed during the course. These former students of ours are invited to the course to give a short speak about how the coursework have contributed to their success. In the feedback given from the students we can also see that the work done to actually develop a product that someone would find useful is much appreciated.

5. Conclusion

In this paper, we put forward the Project Course at the Department of Information Technologies at Åbo Akademi University, with emphasis on activities driving innovation. The main observation is that having a well structured course format helps the student on working on the contents, instead of dealing with practical issues. Activities that force them to be able to formulate their vision and ideas, understandable to other persons, drive innovation. For the overall motivation, a final presentation, visible for the public and the jury, is essential. The complete package gives a good basis for student innovation, which is proved by very interesting and challenging projects, into which the students put a lot of effort.

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