Experiences from Teaching Enterprise Modelling to Students of Information Systems

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Abstract. In this paper, we describe how Masters students at a university studying Information Systems adapt to Enterprise Modelling. The paper describes an overview of the course and its design and the feedback from the students based on a questionnaire at the end of the course. The feedback indicates that the students found it helpful to be able to select their own cases for their modelling assignment, that they were able to relate their modelling assignment to the real world and the theory taught in the course and that their confidence in modelling improved during the course.

Keywords: Enterprise Modelling, Model Evaluation, Modelling Theory, Modelling Practice, Aspects of modelling.

1 Introduction

The goal of an enterprise model is to support analysis of an enterprise and to model the relevant business processes and how they relate to the rest of the enterprise such as how the work is organized and resource utilisation. Enterprise models and modelling have been defined by several authors; e.g. Fox and Gruninger describes an enterprise model as a computational representation of the structure, activities, processes, information, resources, people, behaviour, goals and constraints of a business, government, or other enterprise [1]; Bernus defines Enterprise Modelling as a collective name for the use of models in Enterprise Engineering and Enterprise Integration [2]; and Vernadat defines Enterprise Modelling as a consistent set of special purpose and complementary models describing various facets of an enterprise to satisfy some purpose of some business users [3]. All these definitions suggest that Enterprise Modelling involves modelling several aspects of an enterprise and how they relate to one another. In particular bringing in the business perspective together with the IT perspective is an important role of Enterprise Models.

This paper considers the practice of Enterprise Modelling where theory and knowledge are applied in a practical manner to make sense for an enterprise. This is important to ensure that the knowledge is applied in an appropriate way to gain optimal results from the modelling.

As part of our teaching and research, we take an Action Research [4] approach to investigate the best way to teach Enterprise Modelling to Information Systems students. A traditional cycle of planning, action and reflection has been considered. Our aim has been to improve the curriculum and teaching approach and practice by reflecting upon the previous years' courses and making improvements for the next year. Our focus has been on how the students applied the theory that they had learned to create Enterprise Models and how they ensured that their models served their intended purposes. We believe that in order to teach modelling to university students, they have to practice modelling as a part of their education.

In this paper, we describe how Masters students at a university studying Information Systems (IS) adapt to Enterprise Modelling. The paper will present our experience from three years of teaching Enterprise Modelling. We discuss the design of a course for teaching Masters students studying Information Systems to gain knowledge and acquire the competences necessary to do Enterprise Modelling in business situations. In particular, we discuss the design of the course which is based on theory and practical aspects and engaging students by encouraging them to model their own cases. The main aim of this paper is to validate our teaching approach and to obtain feedback from the students to improve our teaching practice and to identify best practices for teaching Enterprise Modelling.

Feedback from the students has been obtained using a questionnaire at the end of the course. The results of the questionnaire are presented and discussed in this paper. (The paper [5] presented results from 2011 and 2012. Note that a preliminary analysis of the data from 2013 was presented at EMMSAD 2013, but is not provided in the paper.) The rest of this paper is organized as follows: Section 2 provides a background of teaching Enterprise Modelling; Section 3 describes the Enterprise Modelling course on which the paper is based upon; Section 4 describes the observations from earlier years of teaching; Section 5 describe some examples of models created by the students, Section 6 presents and discusses the feedback from the questionnaire and Section 7 summarises the paper.

2 Background

Enterprise modelling requires an understanding of the enterprise or business situation that is modelled. Thus the course aims to bridge the students' understanding of how IT supports business and other situations and the role that IT plays in organizations. The enterprise perspective takes into account the business requirements that will determine the investments to be made by the enterprises to deliver their products and services. This may require IS support for the enterprise to be able to perform their processes effectively and to meet their customers' needs. These may pose requirements on the IS support, thus driving the IS needs for an enterprise. This is illustrated in Fig. 1.
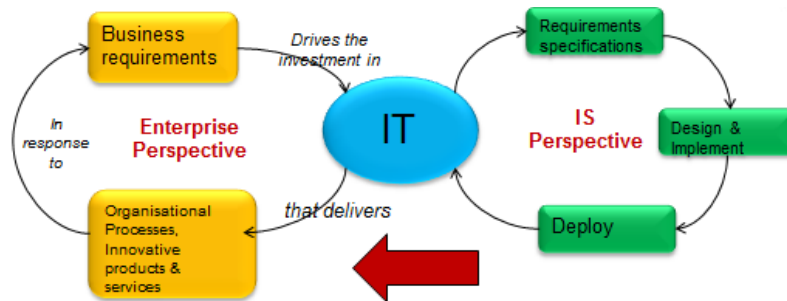
Fig. 1. Enterprise and IS perspectives

Enterprise modelling courses are offered at a few other universities too. For example, at University of Duisberg-Essen in Germany[1], the course on Enterprise Modelling teaches specific modelling methods such as ER and UML and includes presentation by students. A course offered at Jonkoping University[2] in Sweden includes practical hands-on modelling seminars in groups, group modelling sessions, and review seminars of the group assignment. The course reported in this paper is a Masters and PhD course in the Dept. of Computer and Information Science at NTNU. At this stage of their studies, the students have had courses in programming, computer science topics, databases, software engineering, potentially including model-driven software engineering, and information systems, and have experience in modeling with UML and BPMN.

3   Course Design

The main aim of the course is to prepare our IS students to be ready to do Enterprise Modelling when they finish their Masters course. It is a Masters course attended by both Masters and PhD students for one semester. During 2011 and 2012, the course had 15 participants per year. In 2013, 21 students took the course, 3 of whom were PhD students. The students are mainly from the Dept. of Computer and Information Science who had already taken courses in IS-related subjects, which focused on several modelling techniques such as UML and BPMN. A few students are international Masters students and a few are from other faculties such as Mechanical Engineering. The course consists of lectures spread over 11 weeks, and a mandatory modelling assignment. Attending the lectures was optional.

The course aimed at bridging the theory and practice of Enterprise Modelling and the design of the course are influenced by this. Some of the modelling techniques that

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[1] (http://www.wi-inf.uni-duisburg-essen.de/FGFrank/index.php?lang=en&groupId=1& contentType=Course&generalModuleNumber=test2)

[2] https://hj.se/sitevision/proxy/jth/student/...html/.../TVMD28.pdf

were taught in the course include i* [6] and IDEF0[3]. The course is based on two main activities:

1. The theory part of the course which consisted of traditional lectures. The curriculum is based on a collection of articles. The main topic included modelling methods for stakeholder and the early phases on requirements modelling, Product Modelling, Process Modelling, Enterprise Modelling and Enterprise Architecture. The lectures were given by the course teacher and two guest lectures were given by others.
2. The practical part of the course which consisted of an individual modelling assignment where the students had to analyse a situation, create a model, present it to the class and write a report.

In this paper we focus on the practical part of the course consisting of the modelling assignment. The approach taken was that students learn Enterprise Modelling by applying the theory to practice. The practical part of the course is designed to support learning by doing [7] and reflection [8]. Following Kolb's experiential learning cycle, the students have a concrete experience by creating their models.

Enterprise modelling requires an understanding of the enterprise or business situation that is modelled. In practice, Enterprise modelling is conducted as a team including the modelling expert, who conducts the modelling and the domain expert, who has in-depth knowledge and experience on the situation or the modelling domain [9]. Enterprise modelling involves externalisation of knowledge, sometime knowledge that is tacit. Therefore, modelling experts and facilitators require experience supporting the externalisation of tacit knowledge [10] from the domain experts. In the course, we didn't have any domain experts. Since the students worked individually on their assignments, they had to act as the domain experts. The students were asked to select their own case for the modelling assignment for a number of reasons; they needed a case for which they could act as the domain expert as well as the modelling expert, to ensure a close affiliation between the modeller and the knowledge and ownership of the knowledge to support their learning. To find a realistic case for the students, it was decided that it is best for the students to find their own case that was meaningful for them.

The students were required to present their models to the class 3 weeks before they had to submit the final model and the report. This part of the assignment supports the reflection part of Kolb's experiential learning cycle [7] where the students reflect on what they have modeled as well as make an attempt to articulate their models in a manner that is understandable for the audience. The students then receive feedback from their peers as well as the teacher. Through this, the students also learn providing constructive criticism.

The students were required to use the Metis Enterprise Modelling environment[4], which provides a visual space and metamodels for creating Enterprise Models. Metis was introduced at the beginning of the course and time was allocated during every lecture to provide modelling support to the students as required. Specific requirements were set for the assignment; they were required to describe their cases in detail, to

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[3] http://www.idef.com/IDEF0.htm
[4] A product of Troux Technologies.

identify the users and stakeholders of the model, to describe the purpose of the model and to use this to define how they will evaluate their model to ensure that the model fulfilled its purpose, to create a model that included at least five aspects of an enterprise (e.g. processes, organisation, applications), use the functionalities provided by Metis to selectively view the contents of the model (e.g. user-specific views of the model), to evaluate their model and to describe the lessons learned from the modelling experience. Metis allows users full-fledged meta-modeling to introduce new modelling concepts and notation to the metamodel, i.e. enhance the modelling language; thus the students were asked to describe how they had enhanced their metamodel wherever appropriate. This was to assess if they were actually capable of appropriately represent a real-world situation as an enterprise model.

The students were graded based on the combination of the modelling assignment and a written exam, where the modelling assignment counted 35% and the written exam counted 65%.

4 An Example Model

In 2013, two thirds of the students chose their own case, while the others chose the suggested case of developing a mobile app for language learning. Although the latter case was suggested by the teacher, all the students had adapted their cases according to their own understanding. The students who had chosen their own case brought ideas from their own experiences and had identified a need for modeling the case. One student modeled the roles and responsibilities for Abakus Linjeforening, the organization set up by Computer Science students to arrange various activities for themselves. This organisation is structured as eight committees, each with their roles and responsibilities. One of the challenges experienced by them is ensuring that their new members, several each year, are able to quickly get to know how Abakus works and their roles and responsibilities and who they should contact for whatever they need. Thus, a model was created to show these explicitly and one that could be use to educate the new members of Abakus. The model shows the different committees, their leaders and goals and the processes that are connected to them. The complete model is shown in Fig. 2.

Another student modelled an online booking system for a physical therapy clinic to design one to simplify the booking process for the patients and to decrease the secretary's workload, while another modelled the processes in a retail chain of stores that he used to work in to see where the problems are and in the hope to raise the awareness of the management. All the students found their models useful for their situations and sometimes identified issues that they had not foreseen prior to the modelling exercise. Almost all the models were of sufficient complexity, addressing at least five domains of the enterprise (e.g. process, goals, organisation, people and documents) and how they related to one another. The students displayed good knowledge of the domain and had clear purposes for their models. They were able to use various viewing capabilities such as selected views and relationship matrices to use their models. An automatically generated relationship matrix from selected contents in the model,

of the committees in the Abakus organisation and the people that lead each committee is shown in Fig. 3.
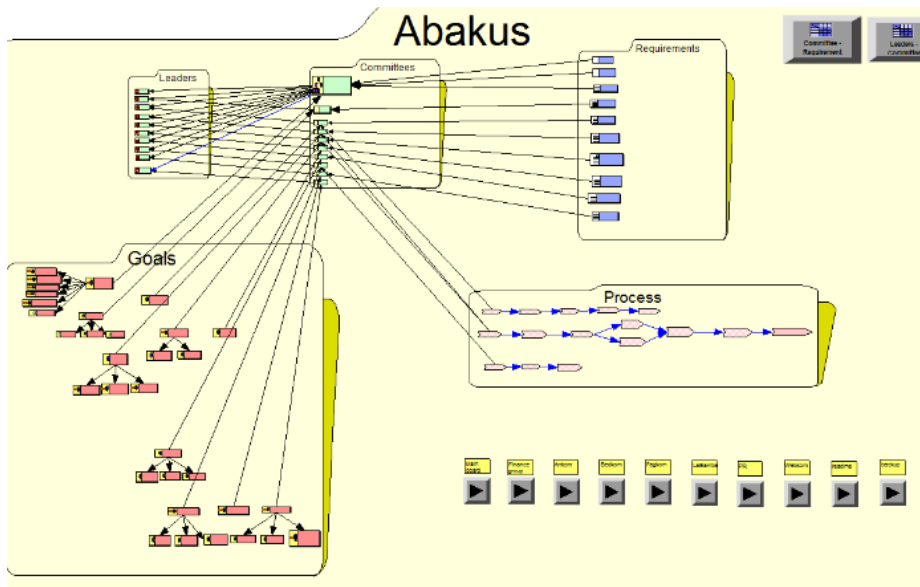

Fig. 2. Example model: Overview of Abakus

Fig. 3. Example model - a relationship matrix for the Abakus model

5 Feedback from Students

In 2013, we have focused on validating our approach to the design of the course, in particular, the practical part of the course which includes the modelling assignment. Feedback from students was obtained through a questionnaire presented to them at the

end of the course. 20 students submitted assignments, 18 took exams, 13 responded to the questionnaire (72% of students that took the exam).

The questionnaire was developed using the SurveyMonkey tool and made available to the students online. The questionnaire was developed to obtain students' feedback on the following:

- General view of the assignment.
- Assignment design and presentation.
- Ability to relate the practical work with theory and the real world.
- Confidence in modelling.

6.1 General view of the assignment

The students were asked: Did you find this course useful? On a scale of 1-3, where 1 is "Not useful at all", 2 is "useful" and 3 is "Very useful", 8 (62%) responded that was useful and 5 (38% responded that it was very useful. Some of the comments provided by the students in the open part of the questionnaire are: "*The course gave me insight in the world of modelling. There were a bit more to it than I first thought, so this course has kind of "opened my eyes"*", "*Gave me more insight in how to model enterprises*" and "*The course considers "the bigger picture", and you learn to think about how (initiality) seperate domains are related. I found this very useful*".

6.2 Assignment design and presentation

The design of the assignment was validated by asking the following questions:
- Did you find the composition of practical work and lectures suitable?
- Did you find it helpful that you were able to select your own case for the modelling assignment?

When asked: Did you find the composition of practical work and lectures suitable?, on a scale of 1-3, where 1 is "Not suitable at all", 2 is "Suitable" and 3 is "Very suitable", 10 (77%) responded that it was suitable and 3 (23%) responded that is was very suitable. The students found it helpful that they could select their own case to model; 6 students (46%) responded that it was helpful and very helpful while only 1 student (8%) responded that it was not helpful at all.

The students provided their views in the open part of the question: some were very positive, e.g. "*Selecting my own case, let me select something I was motivated to model*", "*This made the assignment awesome in my opinion:) I could select something that I was already a domain expert in. Then I could just keep focus on the modelling task*". There were some students that found it a bit challenging or various reasons, e.g. "*It was hard to come up with good ideas about the case, when I did not have anything from the real world I felt I could use*" and "*I think this has both advantages and drawbacks. I felt that selecting my own case ensures that it's a case I find interesting and feel motivated to model. But at the same time it was hard to make sure that it applied to what we learnt and understand....*".

The presentation was validated by asking the following questions:

- Did the presentation clarify things for you?
- Did you receive useful feedback from the class that helped you improve your model?
- Did you receive useful feedback from the teacher that helped you improve your model?
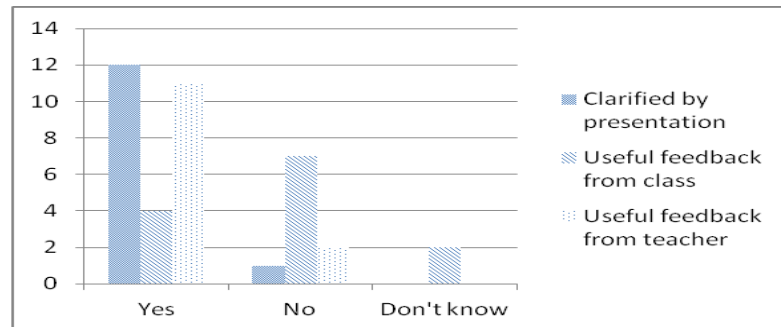
Fig. 4. Clarification through presentation

An overview of the responses to the above questions is presented in Fig. 4. 92% of the students responded yes when they were asked if the presentation clarified things for them. 84.6% of the student agreed that the feedback they received from the teacher was helpful while 15.4% disagreed with that. 30.77% agreed that the feedback they received from their peer students was helpful while 53.84% disagreed with that and 15.4% said that they did not know. One of the aims of the presentations were also to encourage peer reviews among students and to learn to understand others' models as well as to be able to present one's own models. However, there was very little feedback provided by the students during the presentations.

6.3 Relating the practical work with theory and the real world

Validation of the relation between the practical work and the real world and theory were done by asking the following questions:
- How well do you think you were able to relate your case to the real world?
- How well do you think you were able to relate your case to the theory taught during the course?

An overview of the results when asked how well they were able to relate the case that they had chosen to model to the real world and the theory that was taught in the course is shown in Fig. 5. 9 students (69%) responded that they were able to relate their cases to the real world while 4 students (31%) responded that they were able to relate their cases to the real world very well. In the open part of the question, one of the students responded with the following comment: "*It is highly related to the real world such that I am thinking of trying out my model in my work later on :)*".
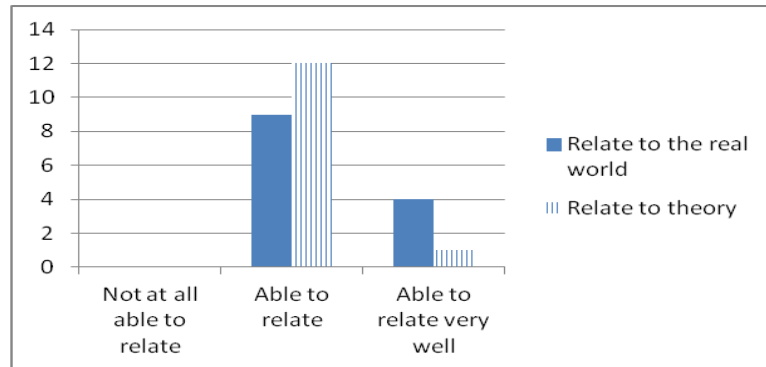
Fig. 5. Ability to relate modelling cases to the real world and theory

When asked how well they were able to relate their cases to the theory that was taught in the course, 12 students (92%) responded that they were able to relate while 1 student (8%) responded that s/he was able to relate the case to the theory very well. None of the students responded that they were not at all able to relate their cases to the real world or the theory. Some of the students comments in the open part of the question are: "*Quite a few of the theory lacks the fundamental "why" question. In other words, why do we need this modeling language is not answered…..*" and "*As often is the case, the real world has many more "grey" areas than the theory teaches, but absolutely saw the link between theory and practice*".

6.4 Confidence in modelling

The students were asked the following question with an open response:
- How confident do you feel in using modelling as an approach in your future work related to software design and development?

Three of the students explicitly stated that they were "very" and "pretty" confident of modeling and three stated explicitly that they will continue modeling and would use it in their future work. Five of the students expressed that they had learnt from the modelling assignment and would know how to create an enterprise model. Three students expressed explicitly that they were not confident in modeling after this course. Some of the comments from the students include: "*I think It was good to learn and I am searching for the next field to apply this knowledge rather than storing this knowledge as garbage in brain*", "*I would continue this work in my future work*", "*Not too confident, but I do believe with more experience that I should be able to create good models*" and "*Not very much more confident than before the course*".

6 Summary

In this paper, we describe how Masters students at a university studying Information Systems adapt to Enterprise Modelling. The paper describes an overview of the

course and the rationale for the design of the course. A questionnaire was used to obtain feedback from the students and the results of the questionnaire are presented. The course was designed to ensure that the students gained practice in Enterprise Modelling and to act as a bridge between the IS courses and the business perspectives of enterprise modeling.

The results of the questionnaire show that the students found the course useful and the ratio of theory and practical parts of the course was suitable. The course included a presentation of the modeling assignment which the students found helped them clarify their cases and how to model an enterprise. In particular, almost all the students found that it was helpful that they had the possibility to choose their own cases for modeling. The students also responded that they were able to relate the practical part of the course to the real world as well as the theory taught. The students responded that they had gained confidence in modeling and some indicated that they would do modeling in the future.

Based on this feedback from the students, we aim to continue improving our course design and teaching approach. In particular, we aim to conduct further studies to understand the process the students follow during their modelling work and explore modelling in a team.

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