Experiences and insights into tutoring and assessment on interdisciplinary project-based learning

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INTRODUCTION

This paper introduces experiences from several interdisciplinary project courses at different schools of Aalto University. The courses were Mechatronics Exercises, Experimental methods, Mechatronics Project, Fibre Product Development - Project Course, Integrated Interior Wooden Surfaces and Astronomical View of the World (Part B). They vary in extent both in terms of duration and credits. Some courses are run in one period (seven weeks) and some last the whole academic year (four periods). The smallest course is three ECTS (82h) and the largest twelve ECTS (328h). The number of students varies from 10 to 60.

The focus in this paper is on tutoring and assessing students in project courses. Adjusting the various approaches to learning of students from different fields is a challenge for teachers, but also an opportunity to bring new energy and ideas to a project course. According to the authors' experiences, tutoring of interdisciplinary

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projects changes the role of the teacher from the traditional lecturer towards a coach or a trainer. The teacher supports the students in the learning process while students need to be active and take responsibility for their learning. Both teachers' and students' perspectives are considered with the aid of a web-based survey and feedback collected from courses taught by the authors.

1 TEACHING AND LEARNING AT AALTO UNIVERSITY

1.1 Pedagogical goals

According to its strategy [1], Aalto University was established to strengthen the Finnish innovation system by way of integrating expertise in science and technology, business and economics as well as art and design. The university will build its operations on top-quality research and research-based education. In a learning-centred culture students are guided towards a strong commitment to their studies and to taking responsibility for their own learning.

1.2 Bringing together different disciplines

Development of an interdisciplinary curriculum is one way of taking advantage of the different disciplines (engineering, business, and design) at Aalto University. Interdisciplinary project-based learning has been used already at the former Helsinki University of Technology, Helsinki School of Economics, and University of Art and Design Helsinki. Three years ago these universities were merged into one: Aalto University. Now Aalto's strategy encourages Schools to create even more courses that will bring students from different fields and study programmes together.

For example, wood construction education at Aalto University has employed workshop type teamwork for a long time. It requires good supervising skills and commitment from the teachers. The task is even more demanding when students from different departments are put into the same group and are expected to work together towards a common goal. Both the students and the teachers in different departments have been accustomed to different teaching and learning methods, which needs to be considered in interdisciplinary teaching and learning activities. [2]

1.3 Teaching and learning in projects

The context in which skills and concepts are learned is crucial for the implementation [3]. Project works resemble real working life situations, and give the students better understanding of the practice of engineering and strategies for problem solving. This applies also to their ability to work in a multicultural or interdisciplinary group.

Blumenfeld et al. [4] have studied motivation and learning in project-based learning. Projects are relatively long-term, problem-focused and meaningful units of instruction that integrate concepts from a number of disciplines or fields of study. Projects have two essential components: a question or a problem that drives activities and results in a series of artefacts or products. While seeking solutions to problems the students acquire knowledge and understanding of the subject. To fully benefit from project-based learning, students need to be cognitively engaged with the subject matter, and the teacher must support the students in this by motivating and instructing. Teachers need to create opportunities for learning and an environment conducive to constructive inquiry.

Problem-based learning is widely used in engineering education along with project-based learning. According to Tynjälä and Gibbels [3], problems in project-based learning are more complex and closer to real-life situations because students need to create a real solution, not only to show that they have learnt about the topic.

1.4 Assessment of learning in projects

Many project courses at Aalto University use both self and peer reviews for student assessment. According to Stefani [5], students have a realistic understanding of their own capabilities, and they are able to assess other students' performance in a consistent and reliable manner. They also concluded that self and peer assessment motivate the students considerably. In fact the students put more effort into their work if they know it will be assessed by themselves and also by other students. It is also noteworthy that the sooner the students are introduced to self and peer reviews, the easier they get comfortable with them and will be able to use them in a more effective way [6]. One of the most important skills the students learn at university is indeed the ability to assess one's own work and learning [5 and the references therein].

2 CASES (COURSES) IN THIS STUDY

2.1 Project courses

Basic information of the courses in this case study is presented in Table 1. Chapters 2.2.-2.5 describe the courses in more detail. Academic year in Aalto University is divided into two semesters. One semester has two six or seven week periods. Assessment weeks follow the periods.

Table 1. Information of the courses in this case study

Course name	ECTS	Duration	Number of students	Years in the curriculum
Mechatronics exercises	4	one semester (2 periods)	30	6
Mechatronics project	8	one academic year	30	6
Experimental methods	5	one semester (2 periods)	50-60	6
Integrated Interior Wooden Surfaces	4	1 period	20-40	6
Fibre Product Development – Project course	12	one semester (2 periods)	10	1
Astronomical View of the World (Part B)	3	1 period	10	1

2.2 Wood related project courses at Aalto University

The units responsible for the education of wood construction at Aalto University have established a shared strategy called Aalto Wood. The pedagogical aim of the strategy is to educate cooperative experts, who comprehend the whole wood construction sector in depth. In practice this means bringing students from different areas (wood architecture, wood products technology, wood construction) to work in a project together. In the department of Forest Products Technology the language of instruction in all Master level courses has been English since 2005.

One of these projects is a course called Integrated Interior Wooden Surfaces. It is a 4 credit one period course where students from different disciplines explore the material properties of wood and try to find new ways to utilise the functional properties of wood in varied wooden interior products. Studying together helps the students to understand other perspectives to problems related to wood construction

than just their own. After the course student is able to plan and schedule a short project in a group and knows how to search information related to a research topic, make a project plan based on a given framework, analyse the results, and present the results of the project. To pass the course, students have to document the project work and present the results, and write a learning diary for every course week. All these elements were assessed and affected the final grade.

Other project courses in the department of Forest Products Technology belong to the relatively new degree programme of Bioproduct Technology. One of the programme's majors (Fibre Product Technology) concludes with a project which tries to simulate a typical engineering work situation where one needs to find a proper solution to a problem in a limited time. This course is called Fibre Products Development Project and it is a 12 credit, two period course. The aim is to get the project ideas from industry partners and invite working life experts to give comments to the students during the project. The course grade is based on the final project report.

2.3 Mechatronics education at Aalto University

Mechatronics is an interdisciplinary field, which requires non-traditional approach to education. Mechatronics encompasses the disciplines of mechanical and electrical engineering. Mechatronics engineer needs multidisciplinary knowledge and must be able to work successfully in projects with multicultural teams.

Mechatronics exercises is a 4 credit, one semester course offering a first opportunity for undergraduate students to build a device that reacts to the environment and executes its task in a controlled way. For most of the students it is the first time they can see their own design coming into operation.

Mechatronics project is a 8 credit, one academic year course for graduate students. A hands-on project has always been the core content of the course. Since 2011 the task has been to build working research equipment and use it for research. The project ideas have been derived from on-going research projects in the department. Instead of writing a final report of the project, documentation is done in the form of a scientific paper which is presented in an international conference.

In the assessment the project outcome is naturally taken into account, but failure to achieve the target does not mean failure of the course. The project teams give a peer evaluation of other teams, and each team also reflects its own learning process and learning outcomes during the project.

2.4 Experimental methods

Experimental methods is a 5 credit course that introduces students to planning and execution of an experimental study. Learning outcomes include also scientific writing and presentation of research results. Major part of the course consists of a research project which is supported by lectures. The project is done in small groups. Students are allowed to choose a research subject of their own interest as long as it includes experimental elements and is realizable. The course is included in the study module Methodological Principles, and is available for all Aalto students. The assessment is based on peer review of the project plan and two presentations that the teams give during the course. The final report is assessed by the teacher. The weighting of these components in the evaluation is decided together with the students at the beginning of the course. The exam was dropped this spring in agreement with the students.

2.5 Astronomical View of the World

Astronomical View of the World is a new, interdisciplinary course that was held for the first time in spring 2013. It is a so called Aalto course, organized by the

School of Electrical Engineering, that is open to all students at the university regardless of their field of study, aimed mainly at Bachelor students. The course begins with the current scientific worldview and discusses the effects astronomy has had on the human civilizations throughout history (Part A, 3 ECTS, approx. 60 students). In the second part (Part B, 3 ECTS, approx. 10 students) this knowledge is put to use: the students work on projects that focus on astronomically relevant themes from the perspective of their own major subject, either individually or in small groups or pairs.

In Part B the students completed the project work and presented it, and also wrote a learning diary, but these were not graded mainly because the course is new and the teachers did not know what to expect from such an interdisciplinary course. Indeed the range of topics was wide and multidisciplinary (for details see https://wiki.aalto.fi/display/AVotW/Student+projects). However, the project work part of the course served as a test-bed for similar challenges in the future.

3 STUDENT SURVEY

3.1 Motivation for the study

The authors participated in a large pedagogical course (20 ECTS), *Teacher as a developer*, in Aalto University in 2012. It lasted one year and the participants represented different disciplines. Many discussions during the course concerned the assessment, motivation, and tutoring of students. Assessment and tutoring are teacher-led activities, but developing them requires understanding of the students' perspectives on them. Thus the main research question was how students experience assessment and tutoring in the authors' project courses. An anonymous web-survey was done in April 2013. Invitation to fill in the survey was sent to 135 students who participated in the authors' project courses in the academic year 2012-2103. 32 students filled the form. The answer rates in different courses varied from 15 to 50%.

3.2 Background information

As background information, respondents were asked which project courses they participated in, where they had completed their Bachelor's degree, how many credits they had (Fig. 1), gender, and previous experience from project courses (Fig. 2).

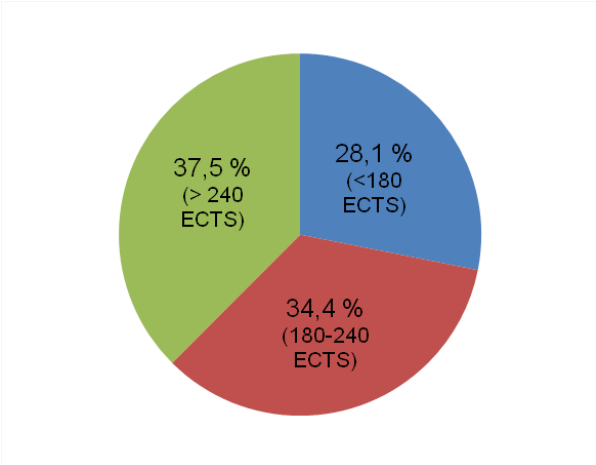

Fig. 1. Students credits

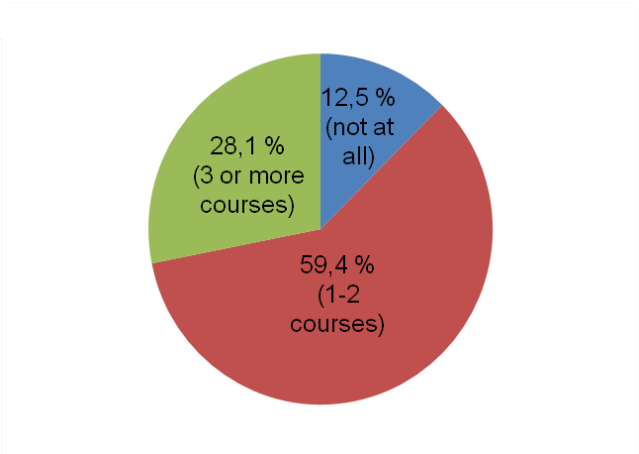

Fig. 2. Students' previous project-course experience

Most female respondents and foreign students represented the same course, so this information was not used in the comparisons made from the results. The responses from different courses were consistent, and therefore the results are presented based on the whole respondent group, not on different courses. In a couple of questions some differences between groups were found, and these differences are presented.

3.3 Assessment

Several questions (Fig.3-5) concerned the assessment of project work and how students considered the assessment of the course.

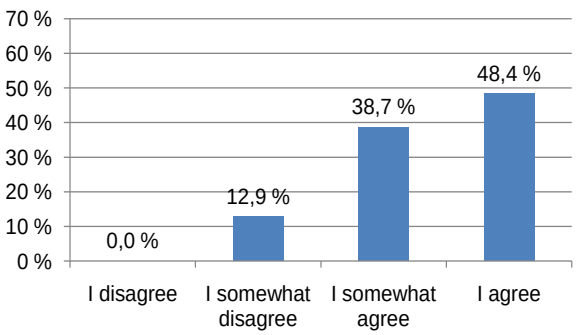

Fig. 3. Was the assessment criteria clear?

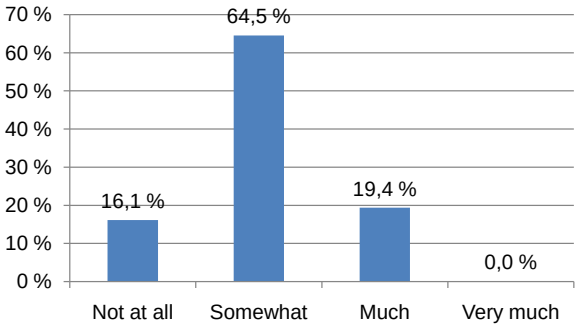

Fig. 4. How did the assessment criteria affect student work?

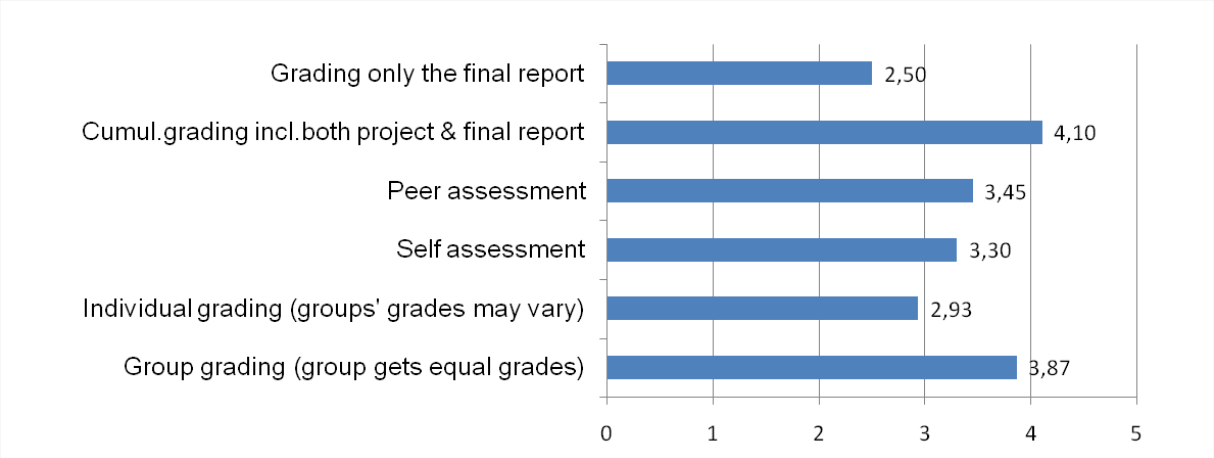

Fig. 5. How students' considered different assessment methods. 1 is not suitable, 2 suits poorly, 3 suits somewhat, 4 suits well and 5 suits very well.

None of the students with the least credits (< 180 ECTS) said that assessment criteria had no effect at all on their work. The same applies to respondents with no previous project course experience. Students with no previous project course experience and students with most experience from project courses (3 or more courses) ranked group grading higher than students with some experience (1-2 courses). Accordingly, they ranked individual grading higher than two other groups.

3.4 Tutoring

Students' experiences of tutoring were also explored in the survey. Nearly 50% of the respondents fully agreed with the statement *Tutoring in the course has been sufficient* and 45% agreed. None disagreed. The scale was from 1 (I fully disagree) to

4 (I fully agree). The course instructor or tutor has helped the students most (Fig. 6), but other faculty members have been important tutors as well as the project group. Tutoring is needed most in defining the project and in specific technical matters.

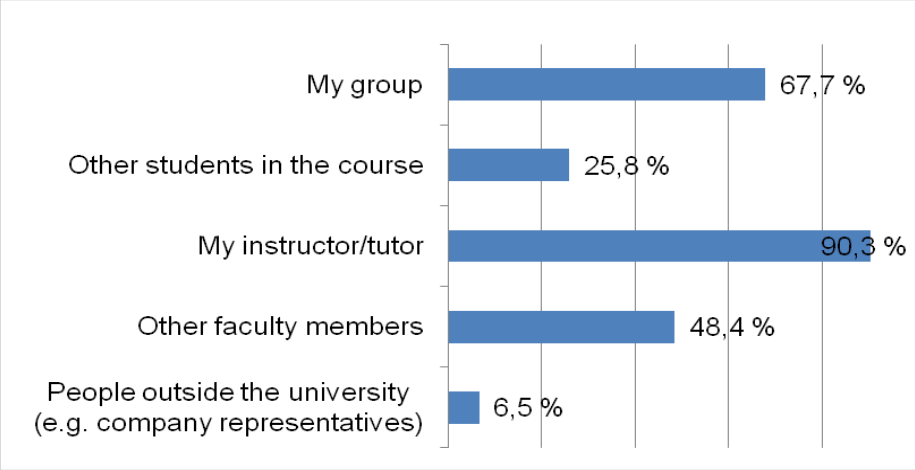

Fig. 6. Who have participated in tutoring the students in the project courses.

3.5 Skills

One of the most interesting aspects in teaching is what students learn during the course (Fig. 7).

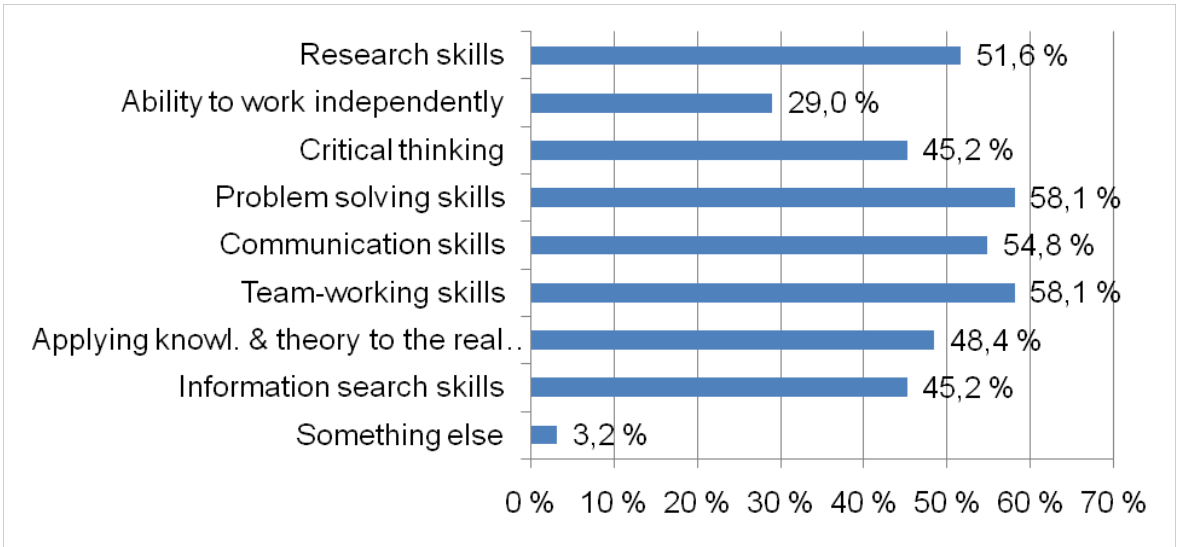

Fig. 7. What kind of skills have students developed?

According to written feedback from students in mechatronics courses, hands-on approach and project work are seen as good methods to learn. The possibility to actually manufacture your own product is a good change to traditional courses because it may bring out problems that cannot be seen in theoretical design. Students have learnt the structure and different phases of the design project. Having a real budget adds reality to working.

4 DISCUSSION AND CONCLUSIONS

In general the survey results were positive. For example, the clarity of assessment criteria was somewhat a surprise. It is possible that respondents belong to those students who were most satisfied with the course, but on the other hand responses

from all courses were similar and thus increase the reliability of the result. Hunaiti et al. [7] have interestingly pointed out that although teaching strategies have developed away from the behaviourist model, the assessment is often fairly close to the traditional way of assessing only one piece of work from a student, and giving a grade with a short comment or no comment at all. If the only (assessed) deliverable by students is the project outcome, it may be difficult to see how the learning is evaluated. The effect of assessment criteria on the students' work was smaller than we expected. This is definitely something that should be further studied and discussed. Ongoing forms of assessment, as Hunaiti et al. [7] describe, might have a stronger effect on students work. Another aspect is that the assessment criteria are better understood in the courses where the assessed elements are clearly informed and students have participated in the assessment and the definition of the criteria [7].

The project team seems to have an important role in tutoring. Even though tutoring was considered sufficient, the role of students in other project groups as commentators and advisers could be more significant. Another thing that needs development is the guidance of students in problem situations. The tutors should be able to recognize the situations where guidance is needed. Students should not waste too much time with challenges that have a recognized solution. This is naturally a question of teaching resources as well. Real world problems and possibility to choose own project ideas result in higher motivation. Students take the challenge when given freedom, resources, and responsibility to manage their projects. However, it is the responsibility of the teacher to take care that the workloads in projects stay on a reasonable level.

REFERENCES

[1] The Strategy of Aalto University. Available at http://www.aalto.fi/fi/about/strategy/. [Accessed on June 13th 2013]

[2] Vahtikari, K, Mauno, A, Kairi, M, Absetz, I and Heikkinen, P (2006) Interactive Development of Wood Construction Education. Proc. of the 9th World Conference on Timber Engineering. Portland, Oregon, USA.

[3] Tynjälä, P and Gijbels, D (2012) Changing World: Changing Pedagoogy in Transitions and Transformations in Learning and Education, pp. 205-222.

[4] Blumenfeld, PC, Soloway, E, Marx, RW, Krajcik, JS, Guzdial, M and Palincsar, A (2006) Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning, *Educ. Psychologist*, Vol. 26, No. 3&4, pp. 369-398.

[5] Stefani, L (1994) Peer, self and tutor assessment: Relative reliabilities, *Studies in Higher Education*, Vol.19, No. 1, pp. 69-75

[6] Ballantyne, R, Hughes, K and Mylonas, A (2002) Developing Procedures for Implementing Peer Assessment in Large Classes Using an Action Research Process. *Assess. & eval.in higher education*, Vol.27, No. 5, pp. 427-441.

[7] Hunaiti, Z, Grimaldi, S, Goven, D, Mootanah, R and Martin, L (2010) Principles of assessment for project and research *based learning. International Journal of Educational Management*, Vol.24, No. 3, pp. 189-203.