DESIGNING PROCESS ENABLERS TO STRENGTHEN PROFESSIONAL SKILLS IN PROJECT WORK

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ABSTRACT

The phrase "Personal and Interpersonal Skills" is mentioned in six out of 12 standards in the CDIO Syllabus , but these skills are hard to asses and grade. Personal and interpersonal skills are a tacit knowledge, learned and performed by the student through social and professional relations.

Grades are easily given to professional and technological knowledge and technological results, but harder to recognize in working processes and development of personal skills.

We present in this paper our experience with a dual focus in the project work: technical and process performance and we introduce some tools that we have found useful for stimulating project work and group working processes.

KEYWORDS

Personal, Interpersonal, skills, process, team, project

INTRODUCTION

Aarhus University School of Engineering is dedicated to educating students in engineering skills, so that future employers are provided with a professional engineering workforce, performing at a highly skilled level.

From the outside world we experience a growing demand for engineers that are able to work at a holistic level. The industry supports the education of professional engineers with a solid technical knowledge and good personal skills, so that professional engineers through working processes can achieve efficient problem solving in a professional team context. Danish employers asks for engineers with developed personal and interpersonal competencies in combination with a high professional level of engineering qualifications in contributing to the process required for successful project work and teamwork. Our experience is that engineers with these social and professional skills are highly attractive for the industry and that they often get better jobs and interesting career paths.

We realize that the CDIO concept in particular includes the aspect about working processes, but in our daily lives we meet it as a challenge. Our students don't recognize personal and interpersonal skills as a crucial competence, if they can't get a grade in it.

From the inside of the Engineering School we experience that the teams the students are joined in during the project work in the course program at the engineering studies differs very much in level of performance. Some students and teams perform at a very high qualitative level and others unfortunately do not. This is of course a consequence of the students' ability to learn and of their academic performance skills, but also and not least, as we have noticed a consequence of their inadequate personal and interpersonal skills.

These observations have led us to work with the CDIO standards in order to find a working method that will connect the professional engineering skills and the personal and interpersonal competencies, and be desirable for students to adopt.

This method is based on the group processes, and we have in the past two years investigated process tools to support this concept of social skills. The tool supports the professional supervision of the teams in order to develop students that are very self-managing and more independent of tutorial supervision in their work with the project.

We often notice that students demand feedback from their tutors and that they stop their work progress until their supervisors have checked their work out. In our opinion we see this attitude as an immaturity which is incompatible with the intentions of the CDIO vision of educating highly skilled engineers. We have found that by introducing these process tools space is left for the supervisors to work in depth with didactical and professional issues in cooperation with the student team.

We don't estimate the supervisor as the crucial key factor for the learning and performance of the student team as is mentioned in the article by Johan Bankel and Lennart Persson [1]. We have seen that by developing the personal and interpersonal skills it is the team performance itself which is the key factor of the learning and engineering performance at a high qualitative level.

The main questions approached in this paper is

> How do we engage students in learning personal and interpersonal competencies?

> How do we enable students to work with the fundamental issue that ensures high performing project teams?

> How can we in an excellent way measure the level of competencies in a project work process?

CDIO STANDARDS

Since 2010 the Engineering School has systematized the professional progression and methodology at all programs according to the CDIO standards [2]. During this work we have observed that while it is relatively easy to make this standardization in the professional engineering area it is very difficult to define the personal and interpersonal tools, efforts and evaluation even though these competencies are highly stressed in the standards.

In the CDIO Syllabus Report (p.8) by Professor Edward Crawley this model shows the relationship between professional and personal skills [3].
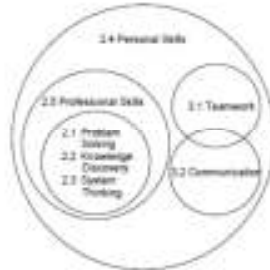

Figure 1: Venn Diagram of Personal and Professional and Interpersonal skills

The figure 1 shows in our opinion that personal skills are an immanent competence for professional skills, teamwork skills and communication skills. But while the area of professional skills is well described in the model we assess that it is insufficient to define personal skills by just mentioning the other features. We think that the thinking underneath this model lacks specific terms of how to train the students' personal skills. According to this issue we read the following in Professor Crawley's report, where he summarizes the rationale behind the 12 CDIO standards:

> "Graduating engineers should appreciate *process*, be able to contribute to the development of engineering *products*, and do so while working in engineering *organizations*. Implicit is the additional expectation that, as university graduates and young adults, engineering graduates should be developing as whole, mature, and thoughtful individuals."[3]

The keywords in Professor Crawley's quote are: process, products, engineering organizations and mature and thoughtful individuals. This paper focuses on the relationship between these keywords. The goal of the paper is to point out what we see as crucial tools for a high performing team to deliver products of high quality.

HYPOTHESIS

Our hypothesis is that good working processes, good team works and a strengthening of the students' personal and interpersonal competencies is a basic condition for the result and quality of the projects. The hypothesis is well-founded in theory of team processes and group theory as it is treated more detailed below.

SYNERGY BETWEEN COURSE WORK AND PROJECT WORK AT THE MECHANICAL STUDY

The Mechanical study curriculum is organized in 7 semesters, and the process tools we have worked with till now are known and used by 1st and 2nd semester students.

In the Mechanical studies every semester consists of mandatory courses and project work. The 5th semester consists of an engineering internship in a company, where the students work in an engineering context. This is their first experience as professional engineers, and for some students this is a demanding meeting at a personal level.

Figure 2 shows the connection between the two fundamental study activities: the courses and project work. These are connected through an integrated curriculum, where the learning objectives of the courses are to be applied in the project work. The assessment and grading of each course and project work is based on how well the students fulfill the specific learning objectives.
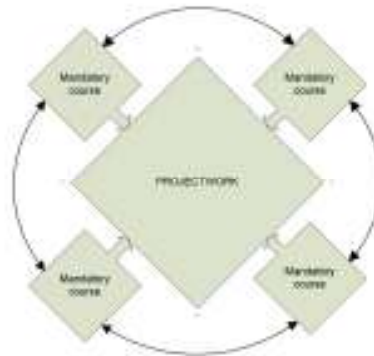

Figure 2: Overview of the building blocks of a semester

During a semester the students attend courses to achieve technical knowledge and reasoning. In the project work the students are divided into teams, and in collaboration with industrial companies they find solutions to an engineering problem encountered by the industrial partner. The project work trains the students' personal and professional skills (CDIO Syllabus section 2) [2]. However the students focus is "getting the job done", using engineering reasoning and problem solving , experimentation and knowledge discovery, and system thinking, and not so much on "how to do the job", here meaning: personal skills and attitudes, professional skills and attitudes and interpersonal skills.

In the different semesters there is a progression (figure 3) in the approach to how the forming and supervising of the project teams are conducted.

Project teams are formatted as

- Predefined by the supervisor team
- Freely chosen by the students

Interpersonel competencies

- Taught in specific lessons
- Assessed

Supervisor focus (an individual supervisor for each focus)

- Technical focus, on solving the problem
- Process focus, on managing the project in an excellent way

Term	Project group formation.		Interpersonel competencies		Supervisor focus	
	Predefined	**F**reely chosen	Taught	Assessed	Technical	Process
Semester 1	X		x	x	x	x
Semester 2	X		x	x	x	x
Semester 3		x			x	
Semester 4		x			x	
Internship	X				x	
Semester 6		x			x	
Semester 7		x		x	x	

Figure 3: Overview of the project work represented in the Mechanical studies

TOOLS

In order to train the students' personal and interpersonal processes in the project work, we have used two tools:

- a background theory about group psychological processes and performance
- a Jungian based personality testing tool

The group psychological processes are crucial in understanding the project's final result. How has this result ended up like this and who is the major force behind this result? Which person in the team attracts the role as the informal leader, who starts up the working process, who gets the ideas, who ensures the quality of the result and who takes care of deadlines? How does the team agree on norms, crises, working processes and other issues? Our basic understanding of group processes is taken from Tuckmann's understanding of the four stages in a groups' working process on its way to being a high performing team [4]:

- forming (a group),
- storming (different characters fight in order to find a common platform),
- norming (finding common norms),
- performing (hopefully high performing) and
- adjourning (splitting up the group after finishing the job

This theory is well-known, but what we have found out is that many of our student groups never entered the stage of high performing. In other words: the successful groups evaluated their work as highperforming based on some vague personal and interpersonal processes that they could not really describe.

On the one hand they described the feeling of equality in intellectual capacity, values, norms and attitudes. On the other hand they also pointed out that some kind of heterogeneity is necessary in order to get all aspects into the working process and to avoid e.g. social loafing. Katzenbach and Smith have pointed out that the progress from being a group to a high performance team is a question of finding synergy i.e. distribution of leader roles according to the task, individual and collective responsibility, clear goal and vision with the work, solutions are the result of a collective effort, open meetings and open discussion forums and finally: recognition, confidence and well-being [5].

Our tool to support the students' need for equality and diversity is to test their personality. We admit that a test tool like this is only a guiding line and that it cannot be the truth about a person's character. So far we have estimated that we can get a very inspiring starting point to form high

performance teams and not what many of our students feel: group work is based on pseudo teams and for some of them it feels like a waste of time.

Belbin team roles is a well-known tool for many of us who work with teams – and we agree with the quotation from the Belbin-website that "A team is not a bunch of people with job titles, but a congregation of individuals, each of whom has a role which is understood by other members. Members of a team seek out certain roles and they perform most effectively in the ones that are most natural to them." [6] However, we have chosen another Jungian based tool, which gives our students a double insight of their personality and their mates in a team. This test tool, Insights Discovery, divides people into four personality types (comparable with Myers-Briggs Type Indicator, DISC and others) according to their introverted, extroverted, innovative, entrepreneurial, communicative and other preferences [7].

The Insight Discovery system is a quadrangle of types which is divided into four colors (blue, red, yellow and green) corresponding to the students' answers to 25 questions. The colors form a wheel like this– each color corresponds to a specific personality:

Figure 4: The personality indicator wheel

This test is just a random choice, and we might find another more suitable test tool over the years. The crucial point for us is that this testing tool – or any other testing tools – gives the student a picture of his and her strengths, blind spots, communication manners, the shadow side of the personality (i.e. The opposite color), leadership manners and focus points for a personal development.

What we have noticed is that the students, by given this report about their personality followed by an individual conversation with a coach about important issues in the report, establish a solid tolerance and respect for the diversity of other people. This forms a basis for the group, and by supporting the group during the project work with coaching on difficult issues, we see that the group feels safe and confident towards the work and to each other. In the long run we will evaluate on grades to see if we can see any coincidence with high performance teams and high grades – and the opposite.

WHAT WE HAVE DONE

In order to develop the students' ability to integrate better into team work processes we have found it necessary to start out at the beginning of the 1st semester to focus on personal and interpersonal competencies. In the 1st semester we introduce skills that train the students to focus on their personal issues. In the 2nd semesters we focus on the group and team work processes. In the 3rd

and 4th semester we intend to continue this process by focusing on the team, ending up by evaluating the whole thing after the 5th semester. In the last two semesters we presupposes that the teams and the individuals in the teams are trained to handle personal and interpersonal issues from their team work such as: conflicts, progress of work, speed, focus and goal setting, innovation, communication, leadership etc.

In short, we have done the following:

1st semester: Focusing on the student's personal competencies
   a. Introduction to a recognized Jungian personal type testing tool (2 hours lecture)
   b. Each student receives a personal report about his or her personality based on this testing tool
   c. Each student is offered an individual session with a coach in order to help them achieve an insight into personal strengths, comfort zones and development areas.

2nd semester: Focusing on the team's interpersonal competencies
   a. Introduction to group theory and high performance team theory according to the personal type testing tool, now focusing on the team's different person types (2 hour lecture)
   b. Each team receives group coaching at least once per quarter
   c. Each team agrees on a common expectation report on the team work, including a communication plan, a crisis plan and a risk plan for the group's social conditions, a goal setting including ambitions of the level of grades
   d. Parallel to the courses the teams write a process report, which includes subjects from their team work process and their expectation report. This report is not evaluated with grades but is read by the coach and discussed with the team

A future issue in this progression is to train the trainers i.e. to train the teachers to guide and supervise the students at two levels: at the professional engineering level and at the process level. So far we agree with Bankel and Persson [1] that the supervisor can attract some key functions of the team work. However we disagree with Bankel and Persson that the supervisor's function is the crucial key to the group dynamics.
In our view it is the team itself that is responsible for the processes and dynamics. The group, however, needs a helping hand from the personality test and the supervisor or a coach to reflect on the process and communication techniques.

WHAT STUDENT EXPERIENCE

In an educational context we are focused on delivering value to student's education, and thereby to the society. In order to show that the students succeed in achieving the right competencies, we grade every part of their educational progress. It is fairly easy to grade closed problems, involving calculating, optimization and constructing, but grading processes involving uncertain factors such as collaboration with fellow students, handling different personal approaches to conflict solving, levels of communicating and so on, is so far very difficult or, in our view, impossible.

In the project process, the students experience a completely new professionalism towards their future career as a professional engineer. They act in their project work on the basis of their knowledge about personal and interpersonal competencies, and their reflections about these aspects form what we think is "whole, mature, and thoughtful individuals." [3].

Figure 5 illustrates that by looking into the performance level of the project groups formed, and comparing the grades they have achieved in the theoretical courses, with their engagement in adapting project work processes, we can divide the project groups into four categories. By doing this we hoped that we could see a strong connection between the groups' academic level, grades and their competencies or interest in engaging in project processes.
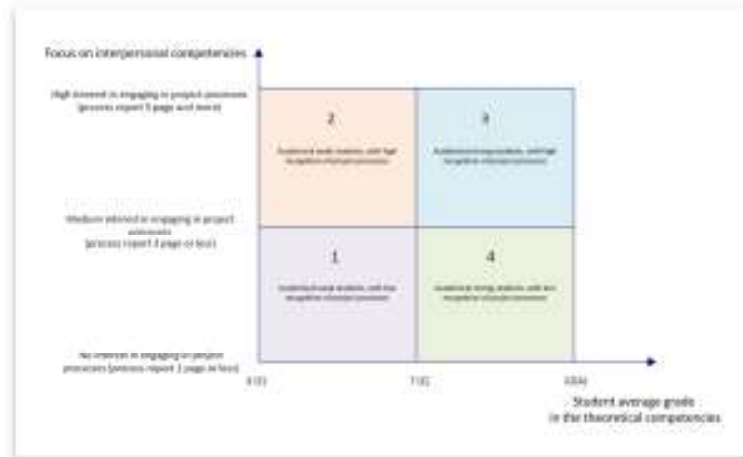
Figur 5: Categorized project teams

This was not the case. However we found something else which is very interesting according to our hypothesis: If a group learns how to act within the process thinking, it surprises the group members how well it works for them, how well they feel about working together and how well they mature in the project working skills.

Below are four examples of group level combined with the group's comments on its process. The examples are taken from each of the four quadrants in figure 5:

	Average grade	Engagement	Project grade
Project groups in quadrant 1:	3,2	low	10
Comments: The team has been interacting very well. We didn´t agree on everything, and sometimes the discussion were very lively. In the project we learned that structure is important for the team to work effective. It has been interesting to learn about other personalities, and understand my own. Knowing about strong and weak sides in myself and others, has made me a better team player. The process has made me aware of how I, in a constructive way, can cope with disagreements in the team.			
Groups in quadrant 2:	6,5	high	7
Comment: The whole process has been very valuable, in the context of working in teams. I have gained competencies in effective, constructive project work, where disagreements there used to hold us			

back, now were used to focus the team work.			
Groups in quadrant 3:	7	high	12
Comments: In the beginning I thought it would be hard to make the team function, since we were all different profiles, and therefore viewed working processes differently. But it turned out that the team dynamic was great. I always have a hard time finishing my task, and I knew that this would be a personal issue of improvement. I now recognize and uses new approaches in this field. It is still not something I enjoy; I am an initiator more than a closer. In future project works; I will avoid working with students like me. I will look for diversity, we have really enjoyed our differences, and as a group we are much more than just individuals contributing to the project. The structure with a project leader keeping us on track, and a process leader making us aware of how we worked together, has been brilliant in our team.			
Project groups in quadrant 4:	7,9	low	10
Comments: The project resulted in a good solution, and a finished report. Personally I have learned a lot about how projects are managed, not because of the teaching in processes, but because we have worked thoroughly with a large industrial project, in a professional way.			

Our preliminary observation is that there is no connection between high grades in the project work, and high performance in the team processes. Interpersonal competencies is required from our students by the industrial partners, however this cannot be seen listed specific in the student's transcript, or reflected in their grades. The knowledge is learned through experience, and is a part of the students coping style, and personality.

CONCLUSION

This paper aims to open a discussion of the following questions:

How do we engage students in learning personal and interpersonal competencies?

How do we enable students to work with the fundamental issues that ensure high performing project teams?

How can we in an excellent way measure the level of competencies in a project work process?

We have tried to answer these three questions by introducing a process tool according to the six CDIO standards that treat personal and interpersonal competencies.

Our conclusion is – even though we have just started the process – that there is very promising aspects in introducing interpersonal competencies in the context of structured coaching and team work processes.

The students engage in applying group processes, when they experience that the diversity of each group members' personality, positively contributes to group dynamics and team processes.

We have also introduced the issue that the key function in engineering team work at the Engineering School is NOT the supervisor but the team itself, in order to develop mature individuals. However we also point out that the supervisors need to understand the coaching processes and importance of personalities that can be inspected in e.g. personality testing tools.

Finally we conclude that the grading system used to assess student competencies, is insufficient when trying to address the use of constructive alignment within section 2.4 – 2.5, and section 3 of the CDIO syllabus. This theme would be interesting to investigate further in upcoming CDIO events.

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