DESIGNING PROCESS ENABLERS TO STRENGTHEN PROFESSIONAL SKILLS IN PROJECT WORK 2.0

Jane Flarup

Associate Professor, MA, GDBA, Head of the Business Engineering Studies,
Department of Business Development and Technology, Aarhus BSS, Aarhus University.

Helle Wivel

Associate Professor, M.Sc.Mech.Eng., e-MBA, Head of the Mechanical Engineering Studies,
Aarhus School of Engineering, Science and Technology, Aarhus University.

Christina Munk

Associate Professor, M.Sc.Mech.Eng, EBA,
Aarhus School of Engineering, Science and Technology, Aarhus University.

ABSTRACT

This paper aims to complement a previous paper by two of the authors (Flarup & Wivel, 2013) about how to design process enablers to strengthen project work. This article contains examples from eight first semester student teams (fall 2016 survey) and the staff surrounding these teams. The purpose is to illustrate how a few simple tools are able to strengthen the students, their professional mastery of teamwork and their general sense of well-being. What we also recognized – as a surprising finding – is that this feeling of general well-being seems to dramatically prevent the first semester students from dropping out of their studies and caused a higher student retention rate in the first and the second semester, which in general are critical periods for the students' socialization. The article adopts the theory of self-efficacy and well-being (Bandura), and the conclusion is that mechanical engineering students feel much better professionally and socially in their project work when they have been trained in the program of general well-being. The article is related to the CDIO standards 2, 3, 4, 6, 7, 9, and 11 concerning personal and interpersonal competencies and social learning.

KEYWORDS

Well-being, self-efficacy, project work, process enablers, personality test, coaching, dropout, retention, mechanical engineering, personal and interpersonal competencies, standards: 2, 3, 4, 6, 7, 9, 11.

INTRODUCTION

The phrase "personal and interpersonal skills" is mentioned in six out of twelve standards in the CDIO Syllabus, and in a seventh standard, the phrase "social learning" is mentioned. This indicates that, not only in Denmark, but worldwide, there is a call for engineers with sophisticated personal and interpersonal competencies combined with a high level of

professional engineering qualifications; competencies and qualifications that contribute to the process required for project work and teamwork to be successful.

At the Aarhus School of Engineering, we are dedicated to training students in engineering skills in order to provide future employers with a professional, highly skilled engineering workforce. Joining the CDIO Initiative in 2010 resulted in the development of training activities in January 2012 designed to advance our mechanical engineering students' personal competencies. We experience a growing demand for engineers that can work – with a quotation from Professor Edward Crawley – as "whole, mature, and sensible individuals" (Crawley, 2001).

As we have demonstrated in our first paper concerning this issue (Flarup & Wivel, 2013), the students feel good about these personal and interpersonal training programs, but we cannot assess it by simply looking at the grades (or rather, we have not tried). However, what we have found is, surprisingly, that the well-being of the students both positively affects their experience of the project work and their fellow team members and has had a positive influence on the general retention rate in the first and the second semester; semesters that are critical for the students' decision to drop out or continue their studies. From January 2010 to August 2012, the number of dropouts (first semester) was reduced from 25% to 10.5%. One of the associate professors (first semester coordinator) has said: "Something works - but we don't know why".

The intention of this paper is to elicit the following issue: How can the well-being of the students in their project work strengthen their professional engineering skills and at the same time cause retention especially at the first and the second semester. Through quotations from the students, we demonstrate that the well-being implies a higher level of professional skills in doing project work and, as a positive side effect, a higher student retention rate.

Well-being

The concept of well-being is based on the social cognitive psychological behavior theory of self-efficacy (Bandura, 1994). Self-efficacy is the feeling of mastery. There are four sources for developing personal self-efficacy: 1) Mastery and self-efficacy in general – feeling that you are able to master your life and a challenge, 2) the influence from a role model – teacher or someone you feel alike and admire, 3) influence from social persuasions, meaning that the role model or other sources convince you that you are able to master a situation, and 4) how you handle your positive and negative emotions about yourself and the situation. Negative emotions are telling you that you are a failure, whereas positive emotions make you believe in yourself in every respect. The more you master your life in general, the more you believe positively in yourself, the higher level of well-being you feel. Role models convince you to do your best i.e. by coaching or other tools of persuasion. Research (DeWitz et al., 2009) has shown that university students with a high level of general efficacy and positive emotions about them selves and a high well-being have a lower risk of dropping out – even though they might meet overwhelming challenges - because their feeling of general self-efficacy is linked to a greater sense of purpose in life; whereas students with a lower general self-efficacy but a high sense of social efficacy and/or a high sense of academic efficacy surprisingly have a higher risk of dropping out even though they are doing well in a social context or receive high grades because they miss an overall purpose in life. The conclusion is that we have to train our students in developing a general self-efficacy, positive thinking, purpose in life, and well-being to make them "whole and sensible" (Crawley's quote) and

better engineers and to prevent them from quitting their studies, which is a shattering, personal defeat.

When writing our first paper in 2013 about process enablers for strengthening project work, we were unaware that our question about how to assess these efforts by grades was unimportant. What we didn't realize then was that good grades don't lead to a strong personality and they don't necessarily make you a better engineer. In our daily life we meet students for whom it is very stimulating to do these personal and interpersonal activities, and who enthusiastic adopt the skills in their professional life. We also experience students who on the contrary focus on engineering skills and find personal development boring and not relevant to their careers. Despite their different attitudes to these personal activities, we see an increase in the overall well-being of the students, and in general, they proactively tackle any collaboration issues of the teams and exhibit a higher motivation for engaging in social activities. Since then, we have worked intensively to organize a program which motivates all kinds of students despite their attitudes to personal development to participate more comprehensively. In this context, we base our insights on theories of inner motivation, meaning that you have to feel autonomy, self-determination, positivity about the task you are doing and relatedness to other people, e.g. in teamwork situations (Deci & Ryan, 2000). As we wrote in the first article, the important thing here is that: "Personal and interpersonal skills are a tacit knowledge, learned and performed by the student through social and professional relations" (Flarup & Wivel, 2013, p. 1). In the following, we will explore this more thoroughly.

The program

The table below outlines different elements of the interpersonal program. Each of the semesters of the mechanical engineering study program is different in terms of course program activities.

Table 1. Personal and Interpersonal Competencies course program

| 1st semester | Psychometric test: Insights Discovery (a random choice, see www.insights.com). | Team coaching. The personality test is used in team coaching. Introduction to project management tools (e.g. Gantt Chart, Scrum Board). Communication tools are, e.g:
• Talking stick (if you have the stick, you talk, if you do not, you listen)
• Collaboration contract (see appendix)
• Team poster
• Team Effectiveness Wheel (see appendix) | Teaching in class (two lessons): Introduction to personality test + communication and perception | Process report: Two pages per person included in the project report. See keywords in appendix. |

2nd semester	Reuse of personal profile test.	Team coaching. The original personality test is reused in team coaching. Work with project management tools (e.g. Gantt Chart, Scrum Board) and the above-mentioned communication tools.	Teaching in class (two lessons): Conflict management, team theory, social intelligence, including the personality test.	No report.
4th semester	Reuse of personal profile test.	No team coaching. If there are any problems in the team, it is possible to contact the team coach.	Teaching in class (two lessons): Organizational theory and professional behavior, including reuse of the original the personality test.	No report.
6th semester	Reuse of personal profile test.	No team coaching. If any problems arise in the team, it is possible to contact the team coach for at conversation.	Teaching in class (two lessons): Career planning based on the personality test.	No report.

As is evident from the table, the program consists of a mixture of teaching in different non-engineering subjects and the completion of a personal profile test forming the basis of team coaching and further teaching, which all in all is in accordance with the influential factors of the self-efficacy theory: mastery, role model, social persuasion, and positive emotions. Since the program was introduced in January 2012, ten semesters ago, we have witnessed a growing sense of well-being, a much stronger ability to work in teams, significantly increased tolerance and acceptance of each other, and an increased insight into personal and interpersonal competencies among the student population.

SELF-EFFICACY IN PRACTICE AT THE MECHANICAL ENGINEERING STUDY PROGRAM

As stated above, we will substantiate our findings by means of examples from the students' process reports (fall of 2016) and statements from the staff. The examples are organized according to the self-efficacy theory, upon which our work is based, as its applicability has proven very robust.

Examples

The examples are based on quotations from interviews and process reports.

Purpose of team coaching, personal profile, and process report

Some students are very negative before they take the personality profile test and enter the team coaching room. They think it is a waste of time and, as a student writes in the process report:

"Humanistic nonsense? Maybe, but nevertheless, we were all a bit surprised at how much actually fit."

"When I heard that we were to take a personality test that would divide us into different colors that symbolize our personalities, I thought, 'what is this pedagogical bullshit!'"

"[…] Then when we got our Insights profile back, I was extremely surprised at how well it fit my personality. I could see myself completely in the description of my strengths and weaknesses. And when I read other people's Insights profiles, it struck me how different we really are."

"[…] I thought about it for a while, and it was not until we had our group meeting with [team coach] that it dawned on me, and I understood how each team member worked and expressed opinions differently. It was really an eye-opener for me; it was as if many things just fell into place, my view of other people changed. I do not claim that I understand all people now, but it gave me a greater appreciation as well as food for thought."

As they work with the process report, the team members reflect on their own personal and professional development as well as the team's development. One team writes in its report:

"The Process Report is a tool. It is a way to gain knowledge and an ideal opportunity to reflect on the project. A product development phase is always a new journey, and you will constantly bump into unexpected problems, personal conflicts, and time constraints. But how does the team tackle these problems? To what extent does the team manage to make room for the group members' strengths and weaknesses? That is exactly where a project like this strengthens and develops all its participants; you learn to be aware of your colleagues, you learn to help each other, and together, you gain detailed insights into how you, as a group, are able to develop and create a product that the world has not seen before."

In the team coaching sessions, we work with the four above-mentioned parameters: Self-efficacy, role model, social and verbal persuasion, and mastery of positive and negative emotions.

Self-efficacy

"I feel that this project workshop has given me a better understanding of the techniques that make up excellent teamwork. I've learned many tools and gained a lot of knowledge about not only my way of working/expressing myself but also other team members' way of responding. So, I've learned to react and communicate differently with my fellow team members, depending on their individual profiles and personality traits."

"We believe that we all, to varying degrees, have gone through a personal development in course of the project, and we have challenged ourselves in areas that are not necessarily our strongest fields of competence. We've been good at providing scope for each other's

personal development and for working on the goals we each had set for ourselves. Also, we structured the project work so that we worked with tasks that accommodated our strengths and weaknesses. In particular, the various roles in the team served as a development tool for the weak points, whereas in the different sub-projects, we worked with our fields of competence. [...] We are convinced that we leave this project and enter into the next with the knowledge that we have grown, both on a personal level and as a group. We have gotten to know ourselves and each other better by taking on unfamiliar roles, while giving each other the space to work in the way that best suited the individual team member."

"We realize now that we, as a team consisting of a bunch of diverse individuals – both privately and professionally – can work amazingly well. Sometimes you get stuck in your attempt to solve a task, we even ended up a couple of times in situations where the whole group sat in silence, and nobody got anything done. And not until after a little while did you realize that your teammates were in the same situation as you. We realized that the best way to proceed was to review the status of the project and discuss what still needed to be done. Summaries and status meetings. Often it could provide some inspiration to hear what the others in the group had been working on."

"We have developed as a team in this process; initially, we didn't even know each other's names, now we continuously strengthen our cooperation and social relations, although our personal profiles do not necessarily match. Even if we sometimes are very different in terms of how we work and what our particular focus is as far as the project is concerned, we have managed to find a balance, making everyone in the group feel safe and cooperate energetically on the chosen project."

Role model

The team coach plays a vital role in the program, as it is exceedingly important that the students can identify with and trust the person. At ASE, the first semester team coach is a female mechanical engineer. She says about her role:

"They meet me both as a teacher and as a team coach. I am therefore able to draw on my education as a mechanical engineer as well as my experience as a development engineer and as a teacher. I also tell them that I am the internship coordinator, which means that I will meet them again later on in their studies in connection with their engineering internship as well as a supervisor and teacher. They appreciate when I tell them that team work is important for an engineer. I am able to convey to them the importance of working in a team. The fact that I am an engineer and that I consider my students to be my future professional colleagues entail that I am able to approach them on an equal footing; or as equal as it can be considering that I am their teacher and at their parents' age."

"At the team coach meeting itself, we of course started out by going over the roles, the cooperation agreement and our headlines. Afterwards, we started talking about things, asking the coach and each other questions, which turned out to be really productive. The conversation, moderated by the coach, especially revolved around our Insights profiles. That meant that we were guided into addressing a lot of issues that might have seemed pathetic to address outside the meeting. Consequently, the team coaching session meant that we got to know each other better, but it primarily meant that we got to know ourselves. It gave us some great ideas for how to have a fruitful working relationship and friendship moving forward."

Social and verbal persuasion

One of the team coach's tools is to persuade the student to develop new skills using arguments from the profile test. A student writes in the process report:

"During the meeting with [team coach], she said that the test showed that I was in an area that also defines a leader. And that is something that I would like to explore further to see if I can find the inner leader in me. Other than that, I have been working on opening up; for instance, I visited Rema 1000 [a Danish supermarket] and interviewed one of the employees."

Another tool is the Team Effectiveness Wheel (see appendix), which functions as key words for what works in the team and what does not (an issue for the coaching session). One of the teams states in the report:

"Preparatory to the team coaching session, we appointed a process manager and a project manager; we really didn't put that much thought into our choice, as we figured that we would take turns, allowing everybody the chance to take on the roles. Then we defined the roles together. Shortly before our team coaching session, we prepared three headlines (key words) that the team was good at along with three headlines that we would like to be coached on."

Another student writes about being challenged socially and verbally by the teammates:

"I am well aware that I can be inflexible. I am not confident about simply taking the plunge without thinking things through beforehand. That is why it is important that we have people in the team that are of the opposite type; people who are able to take me out of my comfort zone once in a while."

Positive emotions

When looking at the students' ability to handle negative and positive emotions (a resilient attitude to challenges and personal weaknesses gives a higher feeling of efficacy no matter what), we ask them to study the paragraphs in their personal profiles about strengths, weaknesses, and blind spots and to share this with the team. The following is a process report quotation from a student:

"My strengths are to encourage structure and order, maintain established rules and procedures, and I am stable and reliable. My weaknesses are that I lack confidence in my own judgement, even though I am most often right. I can be stubborn when I'm under pressure, and I sometimes avoid solutions that entail high risk. My contribution to the team is that I will follow the project through, that I support the team devotedly, and that I am able to focus on both task- and person-related subjects where the team is involved."

Another student writes about how to handle feelings of not being not heard in a communication:

"[…] as I had failed to use the suggestions for communicating with my opposite [personality-wise]. I forgot to make use of my advantages and think things through before commenting, which triggered my opposite who has a problem with vague and inexact communication. I was out of my depth and wasn't able to think my arguments through, as I was pressured for

an answer. This made me weak, and all of a sudden, I lost track of my logical viewpoints, which meant that I somehow just had to give in and let my opposite 'win'."

Finally, the personality profile test tool and the process report provide the students with the opportunity to reflect on their way of handling feelings, aggressions, and positive and negative emotions. One student indicates:

"I don't respond positively to viewpoints that are different from my own, which produces premature conclusions because I lack the benefits that might spring from having a second opinion. My capacity thus lies in gathering people to negotiate a solution, if this is necessary for the project. Other people's mistakes make me angry. Neither do I appreciate critical comments about my personal qualities, and I interpret these as an attack on my personal integrity. I am an extreme realist and rely heavily on my common sense."

Summary and concluding remarks

As the quotations above demonstrate, the personality profile test tool, the team coaching sessions, including project management tools and communication tools, and the process report all indicate a very high level of self-reflection on part of the students as to their personal and professional development. This corresponds with the self-efficacy theory, which defines well-being as a feeling of mastering the situation professionally and personally. The theory shows that a guiding process by a role model aiming to strengthen efficacy is necessary for students with a more or less positive view of their own skills. This is exactly the purpose of the team coaching sessions headed by an engineer taking on the role as coach. Albert Bandura, the father of the theory of self-efficacy, points out that the levels of feeling mastery and personal positive emotions are of crucial importance for enduring challenges, and that those two, mastery and positive emotions, are more important than role models and verbal persuasion, which are just means to acquire these competencies.

The Head of the Mechanical Engineering study program observes a new engineering culture at ASE, which is aimed at in the CDIO standards as well. She summarizes:

"Slowly, a new culture has emerged. It is different than six years ago. The students are met at eye level; we see them, we listen to them, and we try to understand them. They have become much more open – it's ok for them to say that something isn't working and that their feelings matter. They are better equipped at handling social anxiety, and they have great empathy for each other. Their behavior seems more personally and professionally competent."

She continues:

"Retention of students by means of personal and professional competencies is very difficult to define seen in relationship to the whole course of study. In general, we see a dramatically low dropout rate during the first two semesters as well as a lower dropout rate at the later semesters compared with before we introduced these activities. We think that we have eliminated the unqualified dropout in the initial phase of the study by training young people to cope with fear and negative feelings and to behave much more capable and mature towards studying at an engineering university."

Summarizing on the aspect of retention, the dropout rate of the mechanical engineering study program has been dramatically reduced at the first two semesters as a consequence of the program to enhance the students' personal and interpersonal competencies, as described in the CDIO syllabus. In the succeeding semesters, the dropout rate is also lower than it was before 2012. The students deciding to embark on another professional career or failing to pass their exams are typical reasons for dropping out on the second or third year of the study. This kind of dropout is a much more qualified decision for the individual, although dropping out is still a personal defeat.

The team coach concludes:

"We believe that the students' high level of self-efficacy and the fact that they work with their understanding of themselves and their teammates result in a lower dropout rate in general. We see retention in close relationship with an insight into personal and interpersonal competencies. We haven't investigated whether other activities have had any influence on the retention rate, but we haven't changed the study program or the curriculum during this period, so we have reasons to believe that the personality test tool, team coaching, and the focus on collaboration in the teams are of major importance for the students' wellbeing and retention and that a role model is a safe backup for each student. All the teachers have taken this personality test, and they know about the rationale of the test. This creates a common, cultural framework for both students and staff that also has an effect on the students' general capacity to engage more actively in the teaching and in the learning processes."

One of the teams has reflected on what would be worth bringing into the next semester (into new teams). They write in the process report:

"What we would bring:
- *Planning tools: morning meetings, logbook, after-work meetings, calendar, daily schedules, process poster.*
- *Division into manageable intermediate aims.*
- *Putting as much energy in the process as in the product.*
- *Calm and professional conflict resolution.*
- *Changing roles in the team.*
- *Talking stick.*
- *Use of Google Drive to ensure that everybody is involved in everything.*
- *Early decision on fixed structure.*

Good advice for next year's students:
1. *It is worthwhile to use time and energy on considered planning.*
2. *Maintain focus on the users and the process.*
3. *Start working on the report early on in the process."*

What we see above is a new culture at the Mechanical Engineering study program at ASE. It has been a great success, as the tools have been disseminated to the whole Engineering School. What we see is that the students proactively contact the team coach if they expect challenges in their team work. They know where to get help and they know the tools. One of the seventh semester teams writes (in an email to the team coach):

"As it is right now, only two thirds of the team is aware of the issue. It is not a problem as such, merely something that should be addressed in order to make sure that it doesn't become one. I am planning on bringing it up, and in that connection, I would like to explore

the options available. So, what I would like for now is a quick talk with you in order to find out if it falls under your area of expertise."

Further work

We intend to continue to work with these personal and interpersonal tools together with the professional training of our engineering students. What we see is that the industry asks for these qualifications and competences. Therefore, in order to further support our findings to date, we plan on introducing a test of the students' individual character strengths and virtues in order to stimulate self-control and grit. This is based on Martin Seligman's research (Seligman, 2004, 2011) on why and how some people endure and keep on track – and others do not. This is intended to stimulate the engineering students' feeling of an overall general purpose of life, which is as demonstrated above a significant factor for keeping students from dropping out of their studies (Koch, 2013).

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APPENDIX

Team Effectiveness Wheel
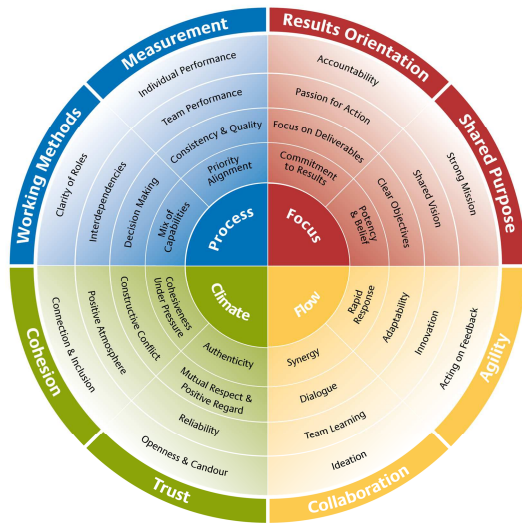
As a part of the preparation prior to the team coaching session, the team is asked to prepare:

- Three key words for what works in the team collaboration processes.
- Three key words for what the team finds challenging and would like to be coached on.

The Team Effectiveness Wheel is a tool that corresponds to the Insights Discovery personality profile.

See www.insights.com.

Process Report

The content of the process report is structured according to the following headlines. This report is an addition to the project report and forms part of the overall grade for the project.

1) Introduction and purpose of the report as the team sees it.

2) The personal development in the team – for the individual student and for the team.

3) The professional development – management of the project.

4) Learning – which topics and aspects, tools and themes will the team bring to next semester's team work? The team must gather the experiences from the lectures, the process report, and the project report and take a position on the following:

- Which good experiences in terms of the processes and the tools will the team bring to the second semester and continue to develop (the second semester teams will – as one of the first things – be asked to evaluate on the basis of their experiences from the first semester) in accordance with the phrase: WHAT SHOULD WE DO MORE OF?
- Which less than good experiences will the team refrain from bringing to the second semester in accordance with the phrase: WHAT SHOULD WE DO LESS OF?
- Which three good experiences and which three less than good experiences will the team pass on to a future first semester team?

BIOGRAPHICAL INFORMATION

Jane Flarup, MA, GDBA (jfl@btech.au.dk). She is an Associate Professor and the Head of the Business Engineering Studies at Aarhus University, Denmark. She is a member of the MBIT research group at the Department of Business Development and Technology. Together with Helle Wivel, she is the author of a CDIO conference paper on the process enablers in project work (2013), and together with Helle Wivel and Christina Munk, she is the author of this CDIO conference paper (2017). She continues to conduct research on this topic together with Helle Wivel and Christina Munk. She is team coach and coordinator of the personal and interpersonal activities at the Aarhus School of Engineering.

Helle Wivel is an Associate Professor, M.Sc.Mech.Eng (hwi@ase.au.dk). She holds an e-MBA and is the Head of the Mechanical Engineering Studies at Aarhus University, Denmark. Together with Jane Flarup, she is the author of a CDIO conference paper on the process enablers in project work (2013), and together with Jane Flarup and Christina Munk, she is the author of this CDIO conference paper (2017). She continues to conduct research on this topic together with Jane Flarup and Christina Munk.

Christina Munk is an Associate Professor, M.Sc.Mech.Eng (cmu@ase.au.dk). Besides teaching Thermodynamics and being a project supervisor, she is an internship coordinator and team coach. Together with Jane Flarup and Helle Wivel, she is the author of this CDIO conference paper on the process enablers in project work (2017). She continues to conduct research on this topic together with Jane Flarup and Helle Wivel.

Corresponding author

Associate Professor, Head of the Mechanical
Engineering Studies
Helle Wivel
Aarhus School of Engineering, ASE
10, Inge Lehmanns gade
8000 Aarhus C
Denmark
hwi@ase.au.dk