

Integrating Soft Skills into Engineering Education for Increased Student Throughput and more Professional Engineers

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Abstract—Soft skills are recognized as crucial for engineers as technical work is becoming more and more collaborative and interdisciplinary. Today many engineering educations fail to give appropriate training in soft skills. Linköping University has therefore developed a completely new course “Professionalism for Engineers” for two of its 5-year engineering programs in the area of computer science. The course stretches over the first 3 years with students from all three years taking it together. The purpose of the course is to give engineering students training in soft skills that are of importance during the engineering education as well as during their professional career. The examination is based on the Dialogue Seminar Method developed for learning from experience and through reflection. The organization of the course is innovative in many ways such as we use dialogue seminar method for reflective practice, have mixed groups with students from year 1, 2, and 3 where each group has a teacher mentor. The indications so far show that fewer students drop out from the program.

In this paper we share our experience from introducing the course and the results so far.

Index Terms—Personal development, personal efficiency, social competences, engineering profession, motivation, reflection, soft skills, team work, feedback, self-awareness

I. INTRODUCTION

THE importance of soft skills in engineering and teaching these has been raised by faculty and industry.

Backlund and Sjunnesson argue that engineers’ technical ability is just a small part of the skills needed in order to be successful in practice and engineering students are not trained for professional cooperation that require e.g. colleagues understanding, empathy, and self-criticism [3]. Tong uncovered that employers prefer to hire new engineering graduates that posses both technical and non-technical skills such as interpersonal communication, planning, and people as well as team management [13]. Woratschek and Lenox found that in some instances the non-technical skills such as communication, motivation, problem solving, time management, professional ethics, and the ability to learn are considered more important than the technical skills [15]. Gruba and Al-Mahmood found that computer science engineering students, teaching staff, and

industry representative agreed that development of communication skills is critical to professional success [7].

Many universities are working on integrating soft skills in engineering educations ([8], [10], [13], and [11]). According to the student involvement theory, the greater the students’ involvement in the college the greater will the students’ personal development and learning be, and one of the involvement forms is interaction with faculty and other institutional personnel ([1] and [2]).

Smith et al. emphasize the importance of cooperative learning that increase the engineering students’ involvement in learning [12]. They indicate that if faculty provides students with training and practice in social skills required to work cooperatively with others, the students are prepared for their future jobs that require coordination with others and skillfully balance personal relationships [12].

II. OVERVIEW OF THE COURSE

The course *Professionalism for Engineers* stretches over 3 years with students from year 1, 2, and 3 taking it together. The essentials of the course are a) reflective practices b) mixed groups and c) teacher mentor.

A. Reflective Practices through the Dialogue Seminar

To maximize the students’ learning we use the Dialogue Seminar Method developed by the Royal Institute of Technology in cooperation with a Swedish high-tech consultant company Combitech [6]. It is a method for learning from experience through reflection and discussion. The method has been used in many Talent Programs for young engineers as well as for Experience Development Programs for project managers in the industry in Sweden Backlund [3]. The method’s main purposes are:

- Establish a common language
- Develop reflective and analogical thinking
- Develop experience-based knowledge

The *Professionalism for Engineers* course has 12 dialog seminars and each seminar has a specific soft skill topic. Before the seminar some preparations are done by the students including: 1) tasks that each student should do to gain experience with the topic 2) appropriate reading material and/or online talks to stimulate individual reflection 3) writing an individual reflection essay in 1-2 A4 pages based on their experiences with the topic. Thus, the students first reflect on the topic on their own relative to the tasks and the material. The students and their mentor then meet in

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small groups where they spend about 15 minutes per student in a dialogue around that student's experience. Each dialogue starts by the student reading his/her own reflection out loud followed by the dialogue where the group through questions and by sharing their own experiences further explores the experience and reflections made by the student.

B. Mixed Groups

The students are organized in small groups of 8-11 students. To increase and diversify the experience exchange between the students, each group has students from year 1, 2 and 3 of their study programs. The student group meets during the dialog seminars, which last about 4 hours.

C. Teacher Mentor

Each student group has a teacher mentor who is an experienced teacher interested in soft skill aspects, the students' situation, developing the engineering education, and trained in the methodology. The teacher's role is to be a mentor that the students can turn to when needed. The mentor stays with the group over time. The mentors are teachers in the program and/or members of the program faculty to signal the importance of the course. In order to be a mentor in the course the teacher has to take a two day course introducing the dialog seminar method:

- Day 1: Introduction to the dialog seminar method in general and the course itself. For this occasion the mentors write a reflection essay after reading some relevant texts. The mentors get introduced to the method by having a dialog seminar. The theme for the dialog seminar is *Professionalism for Engineers*.
- Day 2: In order to practice the dialog seminar method each mentor holds a dialog seminar session. As day 1 the mentors write a reflection essay after reading some relevant texts. This time they also take turns leading the seminar. The theme for the dialog seminar is *Personal development or Personal efficiency*.

So far two mentor courses have been held with support from industry. At the first dialog seminar with the students a new mentor has support from an experienced dialog seminar leader.

III. THE COURSE CONTENT

The course focuses on four main areas: personal

	1 Personal effectiveness	2 Personal development	3 Social competence	4 The engineering profession
Year 1	Personal management	Self Awareness & Presentation skills	Team work	Engineering roles
Year 2	Personal leadership	Selfmotivation	Interpersonal leadership	Ethics
Year 3	Coaching	Mentorship	Communication	Life-Long career

Fig. 1. The course *Professionalism for Engineers 2013-2016* structure.

effectiveness, personal development, social competence, and the engineering profession. During the course many tools are presented for the students and some of them are used during the tasks. These tools help students during their

academic studies and make them more prepared for their engineering careers.

A. Personal Effectiveness

Personal management, personal leadership, and coaching are three skills that lead to increased personal effectiveness.

- Personal management – This topic is taught during the first semester in order to give the students the tools they need to be more effective in their studies by practicing planning, prioritization, and monitoring of their own tasks/studies as well as working with long and short term planning. Study skills are also introduced here. For example, one task for the students is first to plan the semester (long-term planning), make a detailed plan for a week (weekly planning and "day by day" planning), and then write a diary for 1 week capturing their own activities, analyzing the captured data, and then reflecting upon them in a dialogue seminar.
- Personal leadership – This topic is taught during the beginning of year 2 where the importance of being focused and having a vision that is broken down into short-term and longer-term goals is emphasized. This ability is essential for successful organizations, projects or activities. For examples, the students have a task to set weekly SMART goals related to their studies broken down into sub-goals.
- Coaching – Is about having a coaching approach which is about focusing on finding solutions rather than identifying problems. Self-coaching keeps individual motivated, reduces the risk of failure and increases the chance of achieving a desired position. To coach others is about challenging and picking out the best in individuals and ensure that they are heading in the direction that they want. The students train in coaching themselves and year 3 students coaches year 1 students.

B. Personal Development

Self-awareness, self-motivation, presentation skills, and mentorship are all related to personal development.

- Self-awareness - The first step for a human to evolve is to become aware of her/his thoughts, feelings and behaviors. The specific themes raised here are mindfulness and stress.
- Self-motivation – The students get introduced to the ability to motivate themselves to achieve what they want without the need for external influences, the role of motivation within the engineering profession, and the consequences of motivated and unmotivated employees. The specific topics we work with are positive thinking, mental attitude, reward, and procrastination.
- Presentations skills - Conveying a message to others is central to the engineer's professional role and therefore we focus on body language, oral salience, and visual presentation. For example, the students learn how to structure an oral presentation and give a presentation about their project in a parallel course.
- Mentorship - is about two people, a mentor and a mentee, who meet in order for them both to develop themselves. Students train in reflection and the communication ability to understand first and then to be understood.

C. Social Competence

Teamwork, interpersonal leadership, and communication are three skills that develop the students' social competence.

- Teamwork – the students reflect on what leads to effective teamwork and personal effort in interaction with other [14]. For example, the students get introduced to theories and practice different aspects of teamwork by roleplaying and practical exercises.
- Interpersonal leadership – is about capabilities that enable an individual to interact positively and work effectively with others. For example, one factor that influences how well teamwork works is the composition of the team. It is often convenient to work in homogeneous group, but it is most effective to work in heterogeneous groups.
- Communication – involves both non-verbal and verbal communication. The non-verbal communication involves sending and receiving wordless messages conveyed through gestures, body language, facial expressions, and eye contact. The verbal communication involves the ability to listen actively and to give and receive constructive feedback. The students learn various communication tools e.g. the Johari window [9] and the experience cube [5].

D. The Engineering Profession

Engineering roles, ethics, and a life-long career are essential skills for being a professional engineer.

- Engineering roles – Many students do not know much about what they are going to work with in the future. The students reflect on the professional role and think about their own interests. One task they have is to interview established engineers about their daily work and career to get insights into the real life waiting for them, practice listening, and to develop their professional network.
- Ethics – An engineer can be faced with many ethical dilemmas in technological and organizational contexts. For example, what the engineer creates can have a direct and significant impact on the quality of life for many people.
- Life-long career – is about having whole life perspective on where health, professional career, family, personal interests, networking are of importance. It is also about the changes and continuous improvement mindset Kaizen.

IV. EXAMINATION

The course is continuously examined through individually writing reflection essays and actively participating in all 12 mandatory dialog seminars. Some extra assignments are required for higher grades.

V. INDICATIONS

The indications we see after the first year are:

- The students appreciate the dialog seminars since they realize that they are not alone in their struggles, they can discuss study, life, and career issues. Having groups with students from different years is very valuable for the knowledge transfer among students.
- The students are starting to understand the importance

of soft skills and are beginning to become aware of their own behavior.

- We see that the mentors get more insights in the students' situation and their study programs.
- It seems that fewer students decide to drop out. Only about 10-15% of the students dropped out during the first year compared to 20-25% previous years.

VI. CONCLUSIONS

The engineering profession requires soft skills. To fill this need, we have created a new course. The indications are that the students enjoy the course and they have become more positive to soft skills and realize their importance.

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Aseel Berglund is the examiner of the course with a long industry experiences from different roles such as project management, business development, and consultant management. Aseel developed the course and introduced the dialog seminar method that she had experience with. Aseel is responsible for the course and also mentor for two groups.

Fredrik Heintz has been involved in the creation of the course and the mentor training from the start. He is also a mentor for two groups.