STUDENT COMPETENCE PROFILES – A COMPLEMENTARY OR COMPETITIVE APPROACH TO CDIO?

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ABSTRACT

For students to develop independent learning strategies, it is essential to have an understanding of what it is they are aiming for. For this reason, every educational programme in Sweden has learning outcomes as stated by the Swedish Higher Education Authority. However, these are rather formal and sometimes described in a way that is not easy, either for teachers or for students, to implement in teaching and learning activities. A challenge is to both apply CDIO-standards and comply with the Swedish Higher Education Authority's stated learning objectives. At the same time, we should uphold students' motivation to develop their competences and teachers' understanding of which teaching and learning activities are relevant, and how and what to assess in students' learning to contribute to all of these approaches. The aim of this paper is to describe the development of a competence profile. The idea is primarily based on the Vitae Research Development Framework, but with inspiration from several other frameworks and approaches. The competence profile is designed to support students´ individual professional industrial design engineering competences. It allows the students themselves to map their knowledge, skills, experiences and qualities, and also provide support for teachers' feedback and assessment. In other words, the student competence profile is used to describe what students are supposed to be able to do (prior to courses), what the learning activities are supposed to contribute to (during courses) and for formative and summative feedback of how well it has been done (during and after courses). It also allows a visualisation on how different courses contribute to the overall programme objectives.

KEYWORDS

Competence Profile, skill development, self-regulated learning, learning objectives, learning outcomes, Standards: 2, 3, 11

INTRODUCTION

What exactly are the goals of higher education? A summary of the objectives of the CDIO initiative could result in a general goal of independent engineering students who are capable of learning and developing their knowledge and skills in a self-regulated manner.
The overall objective of this paper is to discuss learning objectives and outcomes for Industrial Design Engineering students at Luleå university of Technology (LTU) and how to support them in meeting those criteria. If students are to develop independent learning strategies, it is important that they have an understanding of what they are striving for (Tinto, 2003). In Sweden, the Higher Education Regulation (1993:100) stipulates learning outcomes, which specify the knowledge, skills and judgment capability MSc in engineering students should

demonstrate in order to achieve their final degree. One challenge with these outcomes is that they describe the competences engineering students should have at the end of their education, but does not clarify what competences we as teachers should include in learning activities, provide feedback on or assess in a clear and straightforward manner. The learning objectives refer to the the final level at graduation. Several of our students are finding it difficult to know their level of accomplishment during their studies. To meet the Swedish Higher Education Regulation is a requirement, it is something every higher education body in Sweden has to do. Meanwhile, there are several other frameworks that support skills development and independent learning strategies.

The MSc programme in Industrial Design Engineering (IDE) joined the CDIO initiative in 2015, as one of four test pilots at LTU. The aim was to reform the educational programme with support of the framework offered by CDIO. A challenge with this is however to both exercise and fulfil the CDIO standards, whilst we at the same time are required to meet the Swedish Higher Education Regulation. In parallel, teachers and faculty who work with educational reform want to know what learning activities best accomplish both regulations and CDIO standards and what competences they should assess in courses. At the same time, we also need to maintain students' understanding of, and motivation for, developing their competences as Industrial Design Engineers, i.e. to strive for their particular professional engineering practice capabilities. For that reason, we developed a competence profile, with the purpose of serving as a framework for both students and teachers to discuss, plan, and receive feedback on specific IDE competences and criteria for those. Using the competence profile as an illustration, we in this paper address the following questions:

- How can an independent learning strategy be supported, and what would be gained, through implementing a framework for competence progression?
- How can the three approaches: Swedish Higher Education Regulation, CDIO syllabus, and the IDE competence profile, co-exist, and contribute to students' self-regulated learning?

INDUSTRIAL DESIGN ENGINEERING

Students who apply for Industrial Design Engineering at LTU sometimes have a vague understanding of the professional practice that their education leads to, or what responsibilities they are expected to participate in, in their future professional practice. In our experience, many students are attracted by the artistic design elements, and at the same time consider it reassuring to have an engineering degree. The challenge is to get those different practices, disciplines, and topics that the education and its courses consist of, to actually work together in a constructive and supportive learning path for the students. IDE students can for example take a course in Form studies while they at the same time take a course in Solid Mechanics.

Industrial design engineering is an area that can be broadly described as consisting of industrial design and engineering design, i.e. an area that is on the border between a more design-oriented and a more engineering-oriented practice. An industrial design engineer in professional practice is often involved in facilitating various disciplines in a development process. One way to describe the competences and qualities needed for this is 'T-shaped people', who have deep analytical skills (the vertical bar of the T), while they at the same time have a broad understanding of other skills and disciplines (horizontal line of the T) (Amber, 2000).

As a professional practice, Industrial design engineers, have according to Eder (2008) the purpose of creating future solutions (processes and artefacts), through the development of understanding of use and users, i.e. the interaction between human and the solution. In this perspective, accomplishing this involves identifying the best solution to satisfy the needs of potential stakeholders, users and clients, through thinking which solution best assists human actions,. Eder further describes that this requires competences in understanding form, aesthetics, usability and ergonomics as well as skills in implementing technical functions, manufacturing, safety and reliability and several other factors.

Smets and Overbeeke (1994) describe that practitioners in the field of industrial design engineering need technical knowledge, knowledge of user experience and product expression. It renders an industrial design engineer student needs to develop engineering skills, i.e. competence to develop the product's function and purpose, and industrial design skills, which, according to Ulrich and Eppinger (2012), cover form and user interaction. Ulrich and Eppinger also believe that the design of products that meet customer needs should include expertise in both engineering and industrial design. This can be said to be the essence of Simon's (1969) proposal of the development of a 'science of the artificial', i.e. to achieve a fundamental foundation between the various practitioners who are involved in the creative process of developing future solutions that satisfy human needs. According to Simon, it has not before been possible for these various practices to cooperate, because they have such different languages.

In Brännberg, Gulliksson and Holmgren's (2013) view, engineers should be defined on the basis of their education. Their argument is that there are so many different types of engineering education that it is difficult to identify unifying elements. The origin of the concept 'engineer' is the Latin word 'ingenerare': meaning creating, which can be compared to the origin of design in the Latin word 'designo': i.e. to designate, to create. Although the concepts are very similar, and in some professional practices are used synonymously, some engineering fields do not use the term 'design', but describe it as various forms of 'engineering'. In our experience, the concept of design, particularly in Sweden, is often misused to describe only the aesthetic expression of the final product, while we emphasise it as both constructing and designing (Wikberg Nilsson, Ericson Törlind, 2015). Cross (2006) describes this dilemma as the major challenge for the field, that is, to find means of communication within and between practitioners involved in the creative professional solution development. The basic idea, as Cross sees it, is that there are specific skills that a design engineer should have, regardless of which professional practice they work in. For that reason he suggests focusing on what he describes as designerly ways of knowing, thinking and acting. Brown formulates this as the concept of 'design thinking', which can be described as an approach for using the designer's method of matching human needs with what is technically feasible, and has a viable business strategy (Brown, 2008).

SUPPORT IN HIGHER EDUCATION

The next sections include identified students' needs in higher education, identified both by students themselves and through research on student support.

Student's views of support

The Student Mirror is a survey carried out by the Swedish Higher Education Authority[1], focusing on quality in higher education. The 2007 Student Mirror includes a survey of 11,119 students at Swedish universities. According to this study, students' experiences of support for professional development are disapointing. The categories deal with the relationship between students and teachers, and the results show a rather negative image:

"To discuss and converse with teachers and tutors provides you with a perspective on your education. It is often only in the discussion that the student gets the opportunity to expose their knowledge and thoughts to others." (Student Mirror, 2007 Authors' translation)

The survey includes the question of whether the students have discussed with the teachers or supervisors outside scheduled course activities, discussed future plans with teachers or other persons connected with the university, discussed course requirements or responsibilities or otherwise interacted with the teacher or tutor in contexts other than courses. The results show that 90% of those students perceive that they rarely or very rarely discuss with teachers or supervisors outside scheduled course activities. Likewise, they state that they rarely discuss future plans. It is further revealed that 70% of students report that they rarely or have never discussed the course requirements or responsibilities with a teacher or tutor. Only 12% state that they have discussed future plans with teachers or the equivalent at the university.

The questions included in the survey also deal with the extent to which teachers and supervisors provide the neccecary support for the student to grow and to develop competences, whether teachers have helped students to manage non study-related commitments, have encouraged contacts between students, or motivated students outside the course.

"The teacher's support can be of different types, both intellectually and socially, and can contribute to a good learning experience. The support can also be an important prerequisite for the students to develop and grow as people. " (Student Mirror, 2007 Authors' translation)

According to this survey, it is only on rare occasions that teachers have supported students to deal with non-course-related commitments or have provided support for students to develop their own competences.

RESEARCH ON SUPPORT

Research covering aspects needed for students to pursue their education with good quality identifies five conditions: clear expectations, support, feedback, engagement and learning, which are described in more detail in the coming sections.

Tinto (2003) believes that students are more likely to pursue their studies if teachers and faculty have high expectations of their success. Students are greatly affected by what faculty expect of them individually. According to Tinto, students also need study environments that provide academic, social and individual support. Most students need support at some time during their education, Tinto stresses that this is particularly important during the first year. Support should be offered in a structured form, but it is equally important to have daily support from teachers

[1] http://www.hsv.se (2007-09-04)

and faculty. Astin (1984) similarly argues that support should be given in the form of advice, guidance and support. Astin believes that this support should be individual.

McHugh, Engstrom and Tinto (1997) believe that students are more likely to continue and develop their competences in a learning environment that provides frequent feedback on their individual performance. Different forms of on-going assessment and evaluations should offer the student the necessary information on how their performance can be improved to better meet the requirements. Rendon (1994) also points at the importance of formative feedback to students concerning their competences Biggs and Tang (2011) discuss that formative feedback, i.e. feedback that occurs during the learning process when the student has the opportunity to improve their performance, better supports students' motivation and their will to work more constructively towards certain goals. Ramsden (1993) points out that the feedback situation needs clear criteria and objectives to stimulate students' intellectual challenge, and their dedication and efforts to achieve the goals.

Students' competences grow best in a learning environment that welcomes them as appreciated members of the institution (e.g. Tinto, 2003; Astin, 1984; Rendon, 1994). Commitment, in this perspective, involves both teachers and others being involved in the individual student's education, and also for both teachers and the institution to have a clear objective to motivate students to develop their competences in the field. Rendon (1994) argues that committed students are those who put consistent effort into studying, meaning spending time on campus, actively participating in student organisations, and interacting with teachers and other students outside of course activities. Students with low comittment often neglect their studies, spend little time on campus, do not take part in outside-of-curriculum activities, and have little contact with teachers and other students. The latter, according to Rendon, risk failing their studies, i.e. not achieving the required quality of the learning outcomes. In anticipation of this, students need to be confirmed and to feel that they are capable of learning. With such confirmation, they gain confidence and feel that they are accepted and seen as valuable. When students are not confirmed, they feel frustrated, subordinated, despairing and are become silent. Confirmation outside the classroom, but within the educational framework, can be in the form of conversations with other students, teachers, counselling, coaching or other guidance (Rendon, 1994).

The main condition for students to succeed in their higher education is a learning environment that fosters learning, says Rendon (1994). The more time and energy students devote to their own development and learning, and the more intensely they engage in their own education, the better they perform, and the more satisfied they will be with their education (Rendon, 1994). Commitment seems therefore to be a key to learning: students who are actively committed in their education learn more. To create commitment and persistence in learning, the entire institution needs to actively support students' understanding of learning objectives and how to achive learning outcomes (Wikberg Nilsson & Gedda, 2013).

For this reason, Boekaerts (1999) argue that self-regulated learning has emerged as an important part of education. This involves research on learning styles, metacognition and regulation styles, and theories of the self, including goal-directed behavior. It can be summarized into processing modes, learning processes, and regulation of the self. In this perspective, teachers and researchers would benefit from integrating these three layers into a comprehensive model of self-regulated learning. In support of this is Schoenfeld's (2011) argument that what people choose to do is a result of their resources (knowledge and available materials and other resources), their goals (conscious or unconscious goals they are trying to accomplish), and their attitude (their assumptions, values and abilities). Clear guidelines and

support could for that reason contribute to student skill development and probably thereby also to student success.

EXISTING FRAMEWORKS

There are a variety of legislative and non-legislative frameworks for supporting students in their competence development. Some of these are described in upcoming sections.

Swedish Higher Education Regulation

The Higher Education Regulation is developed by the Swedish Government, and is in turn subordinate to the Swedish Higher Education Law. This stipulates the conditions for managing higher education, for universities governed by the state. The Higher Education Regulation describes the learning objectives for each higher education degree. These objectives are in other words not negotiable, but are goals of the education that must be met in order to attain a certain university degree. It is divided into three sections with different criteria of 1) student's knowledge and understanding, 2) skills and abilities, and 3) judgment and attitude.

The CDIO framework

The CDIO framework is described as an innovative framework for developing future engineers[2]. In summary, it covers development of engineering students' skills, in order to become professional and independent so that they can participate in an engineering practice directly after their education (Crawley, Malmqvist, Lucas & Brodeur, 2011). CDIO's 12 standards serve as a guideline for educational reform and evaluation and provide a framework for continuous improvement. They also provide evidence for each standard, illustrating how the standard can be met.

There is a broad consensus in engineering education that is in accordance with the objectives of the CDIO initiative (Cloutier, Hugo & Sellens, 2010), i.e. that there is a need to develop engineering education and future engineers who have the expertise to apply conceive-design-implement-operate skills in developing future products, processes and systems. Crawley et al. (2011) emphasises that the 12 standards include developing consistency between objectives, learning activities and evaluations, in accordance with Biggs and Tang's (2011) description of 'constructive alignment'.

The 12 standards address major aspects of higher engineering education; aspects which are essential for teachers and faculty to mutually and continually discuss and develop. Crawley et al. (2011) argue that there are different needs that today's engineering courses should contribute to: they must help to develop students' technical skills, while at the same time contribute to a variety of individual and social skills, such as having the skills to work in teams and the skills to meet ethical, corporate and societal needs. An important aspect of this framework is the description of the need for skills in the form of 1) disciplinary knowledge and reasoning (learning to learn), 2) individual and professional competences (learning to be), and 3) social skills: teamwork and communication (learning to be together).

[2] http://www.cdio.org

Alverno's ability-based curriculum

Alverno College in the US has over 30 years' experience of working with ability-based curriculum strategy. Their focus on eight core abilities represent what is described as "the very building blocks needed to create an effective and relevant learning experience."[3]

Riordan and Sharkey (2010) describe the implementation of the ability–based learning strategy as involving the entire college in the question of what is most important that the students learn: what is it that students must not miss in your area? The result is that the whole institution agreed on eight abilities, which were seen as common and fundamental to all disciplines and areas. Each skill is described by a number of criteria. To get a degree from Alverno require all students to have achieved at least level 4, then it is up to each educational programme to identify abilities that are vital, and thus determine the level students must achieve. Hakel (1997) believes that this is due to the focused performance: *"You get what you measure. If you want performance, then you have to measure performance".*

An important ingredient in Alverno's ability-based framework is their focus, primarily, on learning and, secondly, on education. According Hakel (1997), it covers a different mindset from 'how should I teach this' to 'how should students learn this'. Far too often from Hakel's perspective, what students learn is something else than what was actually intended, which is also different from what was actually taught. To detail the abilities that are central for students, and to start a discussion about how students can learn that, and how students can demonstrate that they have learned, is in this perspective central. An important aspect, according to Hakel, is to provide constant, inevitable and formative feedback. At Alverno, this includes self-evaluation, peer-review, teacher assessment, and external evaluation. The framework consists of students documenting evidence of their performance, which is then assessed through self-assessment, peers, faculty and external assessment. The point of this, says Hakel, is to compete against oneself, not against others.

Vitae - Research Development framework

Vitae Research Development Framework RDF) (Vitae 2011) is a framework and career development tool for researchers at all levels, from graduate student to highly qualified research leaders. The RDF was introduced in the UK in 2010 (Bray & Boon, 2011) and was developed to plan, promote and support personal and professional career development of researchers. The idea was that the tool would enable researchers to assess their knowledge, skills, behaviours and personal characteristics against clear criteria.

The RDF comprises a matrix of different attributes with up to five different quality levels. A total of 63 areas (RDF uses the term descriptor) are organised in four main areas and 12 sub-domains. For example, within the sub-domain D3 Commitment and Impact, the area of education is outlined with four different skill levels. To achieve level 1, the researchers are supposed to contribute in teaching and supervision of projects at the basic level. To achieve the highest level of competence, the researcher is required to lead educational programmes and their evaluation and quality assurance, as well as actively promote a culture that links research and education, and act as a mentor for others.

[3] www.alverno.edu/academics/ourability-basedcurriculum/ (2016-04-27)

The framework is implemented in an on-line tool that helps the researcher to self-evaluate the level of competence he or she is at the moment, as well as a desired level to strive for. The choices are recorded and the researcher must provide evidence they have achieved a certain competence level. The process can be described as an iterative deliberative process (Bray & Boon, 2011), where the researcher can return, adjust and change their previous choices. In the tool, the researcher can also set objectives (areas and skill levels) that he or she should achieve, how it should be measured and when it should be implemented.

COMPETENCE PROFILE

In early 2015, during the process of the current CDIO framework implementation and educational reform of Industrial Design Engineering LTU, we identified a need to better govern teaching and learning activities toward learning objectives and outcomes. The reason for this was for both students and teachers to recognise competences that are particulary relevant in this MSc engineering education, without having to search in both the Swedish Higher Education Regulations and CDIO Syllabus. In short, we saw a need for a common framework that could suppport teachers to e.g. plan learning activities, provide formative feedback during courses, and assess learning outcomes, and support for students' self-regulated learning by assessing their knowledge, skills, behaviours and personal characteristics against clear criteria.

A challenge for Industrial Design Engineering is that one department does not give all courses within the programme: instead three institutions provide some of the courses, without insight into specific graduate coucome for IDE. Luleå University of Technology, for example gives the same general basic courses in mathematics, physics, economics and chemistry for all disparate engineering degrees: space engineering, mechanical engineering, architecture, civil engineering, computer engineering, industrial design engineering etc. This represents a difficulty for the students to realise how the course contributes to their individual skills development, and also makes it difficult for teachers to provide examples and learning activities for the individual programmes.

This is the background to the work with developing a framework that supports both teachers' and students' understanding of what competences they need to develop to be able to work in the field of industrial design engineering. In 2015 the implementation of CDIO began. It meant that work with the Competence Profile included both discussions about the Swedish Higher Education Regulations and how they could be filtered down to more straight-forward descriptions of the competences that are specific for industrial design engineering, as well as CDIO's syllabus. To exemplify, we describe one of the Swedish Higher Education Regulation objectives:

"Demonstrate the ability to in both national and international contexts, orally and in writing, and in dialogue with different groups, clearly present and discuss their conclusions and the knowledge and arguments that form the basis for these"

This objective clarifies what the student should be able to demonstrate at the end of their education, but does not illustrate what qualities the student needs to have in order to progress toward the final examination. An interpretation of the competences this objective requires could include oral and written communication, dialogue with different groups, and the ability to express themselves in both Swedish and English. This can be compared with CDIO's Objective 3.2, Communication, which is defined in Table 1.

Table 1. CDIO objective 3.1 Communication (Cloutier, Hugo & Sellens, 2010)

3.1	**COMMUNICATION**
3.1.1	Communication strategy
3.1.2	Communication structure
3.1.3	Written communication
3.1.4	Electronic/Multimedia communication
3.1.5	Graphical communication
3.1.6	Oral presentation
3.1.7	Inquiry, listening and dialogue
3.1.8	Negotiation, compromise and conflict resolution
3.1.9	Advocacy
3.1.10	Establishing diverse connections: networking

The CDIO syllabus covers the Swedish Higher Education Regulation and more. It thus provides a good overview of the communication skills that are valuable for an engineer, while providing education leaders and teachers further indication of important competences to practice in teaching and learning activities. However, it does not provide support for discussing quality or progression. On the other hand, Alverno's ability-based curriculum provides several criteria for self-evaluation for each learning objective, see Table 2. This illustrates the criteria for self-evaluation of oral presentation.

Table 2. Self-evaluation of learning objective for communication (Hellertz, 2004)

COMMUNICATION	
1	Talks without reading from, but with assistance of, notes
2	Seizes attention and clarifies content, in a, for this particular audience, relevant manner, making clear demarcations, and refers to relevant sources
3	Uses verbal expressions that demonstrate clear focus, an understandable terminology etc.
4	Effectively convey information, e.g. through adequate voice strength, varied tone, use of body language, eye contact etc.
5	Uses conventional rules for formulation, pronunciation, sentence structure etc.
6	Uses a meaningful and effective structure and disposition
7	Supports and develops theme, using quotes, examples, personal comparisons etc.
8	Uses relevant media (OH, PowerPoint, video etc.)
9	Conveys an appropriate content

Our idea was to develop a framework that could support students' understandings of important qualities for an industrial design engineer, and a self-regulated learning strategy of progression towards certain objectives. The framework should support both teachers and students in understanding how and with what quality, a certain competence should be developed. The framework consists of eight different competence areas, visualised in Figure 1.

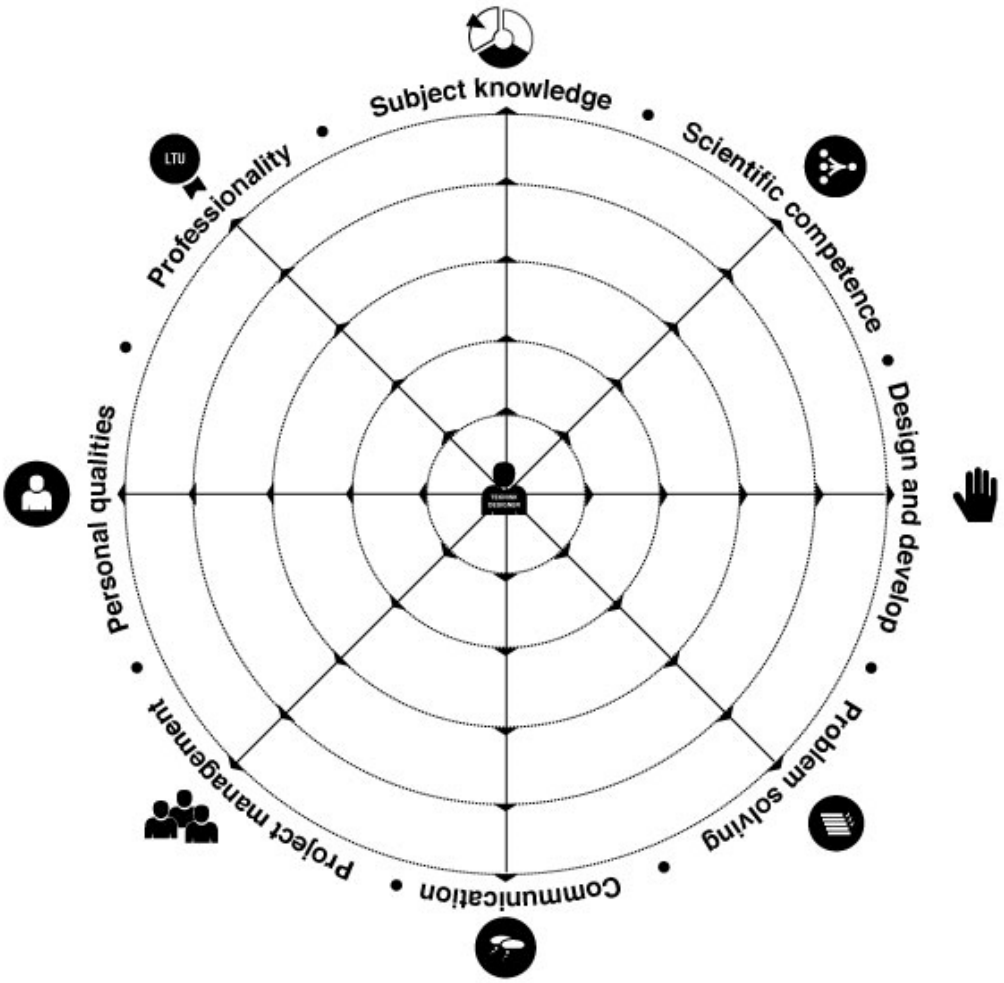

Figure 1. The IDE Competence Profile

The eight areas were developed in discussions with students, teachers, and alumni of what competences that was most important that the student had developed during the education. The Competence profile development has been an iterative process, where the framework was first discussed, introduced and implemented in an introductory course during autumn 2013, and then further developed in several steps and implemented in later courses. Each competence area is in this model divided into several criteriaompetences where student starts as a novice and can progress to an expert. For the competence area Communication skills, the sub areas and the criteria's areis listed in Table 3.

Table 3. Competence Communication for Industrial Design Engineering at LTU.

COMMUNICATION				
Oral communications				
NOVICE	**ADVANCED BEGINNER**	**COMPETENT**	**SKILLED**	**EXPERT**
Execute a presentation in a structured and factual way, keeping track of time, and through the use of appropriate aids.	Motivate and defend basis of ideas and arguments in a confident and convincing manner	Select and apply a range of presentation techniques for different audiences and situations	Convinningly formulate answer to questions and discuss the basis of arguments with different people	Present, defend and argue in English in a credible manner
Written communications				
NOVICE	**ADVANCED BEGINNER**	**COMPETENT**	**SKILLED**	**EXPERT**
Understand use and format a basic template	Apply a variety of reporting methods (lab reports, project reports, workbook, pm etc.)	Evaluate, assemble and convincingly formulate work, results and arguments in a credible manner	Select and develop structure, content and format of written communication for different audiences	Ccommunicate in writing in English
Visual communication				
NOVICE	**ADVANCED BEGINNER**	**COMPETENT**	**SKILLED**	**EXPERT**
Understand basic tools and techniques for visual communication	Apply a broad range of visual communication techniques (sketch, rendering, physical model, simulations, animations, 2D and 3D models)	Analyze and argue for visual communication technique, create a visual communication also of the work process and its results in a convincing manner	Select, argue for and design visual communication for different target groups	Professionally and convincingly, combine different visualisation techniques to communicate process and results

Table 4. Competence Design and develop for Industrial design engineering at LTU.

DESIGN AND DEVELOP				
Think and act innovatively				
NOVICE	**ADVANCED BEGINNER**	**COMPETENT**	**SKILLED**	**EXPERT**
Explain and use basic creative methods	Challenge current solutions, apply creative methods	Apply creative methods and approaches to create novel solutions	Select and customize creative methods and approaches to fit context and problem situation	Facilitate and create creative processes and workshops tailored both to the team and the problem
Prototype and test				
NOVICE	**ADVANCED BEGINNER**	**COMPETENT**	**SKILLED**	**EXPERT**
Understand and use simple prototypes to evaluate features and characteristics	Apply and use different types of prototypes to evaluate the features and characteristics.	Explore the solution space by creating and evaluating prototypes with a user centered approach.	Create prototypes in an iterative process to explore, test, analyze and evaluate the functions and features	Carry out design projects in which prototypes are used throughout the entire process to ensure user experience and usability

The purpose of the matrix is to support students' independent learning strategy, i.e. that they have the opportunity to self-evaluate their competences both with and without teacher intervention. It also provides support for teacher's planning of teaching and learning activities, and in feedback situations. The idea is also to eventually use it to set standards for graduate outcomes, i.e. to get a degree require all students to have achieved at least level 3. The goal is to implement the competence profile throughout industrial design engineering curriculum.

During 2015-16 the Competence profile has been tested in three courses, where the students have used it as a self-assessment guide. Students' comment have been e.g. "it supported to identify my weaknesses"; "it was a pedagogical tool for my own development"; and "it helped me understand what to develop and learn in the education". Future work is to further discuss with both students and teachers which courses should have learning activities that can contribute in developing a specific competence, i.e. teaching and learning activities that contain elements who ensures practice of a particular competence at a certain level. For this to be possible requires learning activities of self-evaluation, peer-review and teacher assessment of competences, sessions in which the student receives formative feedback on their performance, and what they need to do to develop their competences.This should ideally also be reflected in curricula and study guides, so that students themselves can adjust their own competence profile, and visually see how their competences develops in and through teaching and learning activities. At the moment, we are implementing this in a visual representation of the curricula, in which the students can see what the courses' teaching and learning activities can contribute to their individual competence development, see Figure 2.

Figure 2. An example of how the Competence profile is aligned in one of the courses in a visual representation of the curriculum.

In addition, the idea is to use existing workbooks, learning portfolios, and implement a self-evaluating scale of what the students themselves think that they achieved during the teaching and learning activities. Afterwards, this can be used in feedback sessions where teachers and students discuss how they can develop their competences before summative assessment. This would provide a framework for a self-regulated learning strategy, in which the students focus on these competences, which are required for their professional practice, and that also makes it easier to understand how learning activities constructively are aligned toward their final degree.

DISCUSSION

A comparison between the Swedish Higher Education Regulation objective 9, CDIO learning Objective 3.1 and the competence profile Communication Skills illustrates that the competence profile contributes both in fulfilling the Swedish Higher Education Regulation and the CDIO syllabus. An interesting aspect is that visualisation competences are left out in the Swedish Higher Education Regulation degree outcomes, while CDIO expresses the need for graphical communication as an aspect of communication. For industrial design engineering students, visualisation competence is essential for their future professional practice, consequently it is an important skill to develop during education. Otherwise, we believe that the comparison illustrates that both students and faculty are supported by the Competence Profile, both in meeting the Higher Education Ordinance requirements, as well as the CDIO initiative engineering expertise, and that it also provides support for student developing a self-regulated learning strategy of competence in a clear and straight-forward way.

We believe that self-regulated learning strategies can be one important complement in higher education that have potential of contributing to higher quality and student success. It is a framework that supports students' independent learning strategies towards outcomes based on clear criteria. For the various functions and roles involved in implementing higher education, student's independent learning strategies is often an implicit demand that in our experience is rarely discussed with the students. The Competence profile is designed to support an independent learning strategy, and to create a professional framework for developing and planning teaching and learning activities,, as well as promoting students' personal and professional development. An independent learning strategy is supported as it allows the students themselves to map their knowledge, skills, experiences, and qualities, and take action for change. It is also valuable as basis for formative and summative assessment. In other words, the Competence profile is employed to describe what students are supposed to be able to do (prior courses), what the learning activities are supposed to contribute to (during courses) as well as for formative and summative assessment of how well it has been done (during and after courses).

Finally, to conclude the question of what can be gained by introducing a new framework. We believe that the competence profile provides a framework that is easy to understand and implement for both students and teachers. It supports actual implementation through the easy-to-use design. The Competence Profile states the individual characteristics that are required for achieving an MSc degree in Industrial Design Engineering at LTU. It covers the Swedish Higher Education Authority's requirements, but in a more straightforward, way. It also allows an visualisation on how different courses contribute to the overall programme objectives. The second question of issue for this paper was how these different approaches to learning objectives can co-exist. In our experience, overall the student competence profile is a valuable framework that supports both educational development in a CDIO implementation, and students in developing necessary competences for their professional practice. The student competence profile therefore in our view completes, not competes with, the CDIO syllabus.

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