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INTERACTIVE TEACHING IN INTERPERSONAL SKILLS AS INNOVATION IN ENGINEERING EDUCATION

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ABSTRACT

Nowadays the typical engineer has working conditions different from before. They require many competences other than just the hard-core technical ones: personal and professional skills, multidisciplinary teamwork, communication, communication in foreign languages and leadership skills; thus, the personal competences are becoming more important. It is vital that the modern education for engineering students meets the demands of the business life of today, where the engineer has to solve both technical and interpersonal problems. For this reason, it is important to implement practises of interpersonal skills in the engineering education. International communication is one of the issues becoming more important in the globalised world of today. The CDIO Syllabus narrates the needed skills and one way of improving the quality and ideas in the CDIO implementation is through international co-operation. In this case the co-operation was begun through the invitation of Associate Professor Christensen to give an International Communication Course, in February 2010, at **Helsinki Metropolia University of Applied Sciences**. This invitation has been repeated twice a year since then. The International Communication Course is an innovation in engineering education based on the development of teaching methods for learning interpersonal skills in interactive classes – enabling the students to gather their own experiences through active involvement in exercises in groups of two to six persons. In order to improve the course a couple of initiatives were implemented. One is a course booklet, which contains all issues to be approached during the course. The students read the booklet beforehand and thus the course just consists of interactive exercises with interventions of explaining, sharing comments and discussion. Sharing comments and discussions are very important as they both tell the students that others have similar problems and issues as they do; but they also show the differences between young people from different cultures. In a class there are usually participants from 15 different countries and students from 55 countries have taken the course so far. Another initiative is that the students have to do three assignments. One reason for this is to see if they are able to apply what they have learned; but also to avoid students that will not deliver the efforts required. This has elevated the level of learning significantly. Based on students' assignments written during the courses and the course booklet, the content of the course was crystallized, a book was written and published in 2017 by Metropolia. This paper discusses our experiences of the international CDIO co-operation, implementing an International Communication Course at Metropolia.

KEYWORDS

Communication, interactive teaching, integration of international students, Interpersonal skills, teamwork. Standards: 2, 8, 11

INTRODUCTION

The importance of communication is increasingly recognized and acknowledged in engineering education. Successful performance of the engineering profession requires engineers to understand and explore customer needs, negotiate contracts, and collaborate in working teams. Communication in different styles is highly needed in all sectors of engineering fields. Of course, similar requirements concern professionals of other fields, too. Due to the increasingly globalized market, professionals who possess the ability to effectively communicate between cultures are in high demand. International communication studies are often ignored in regular engineering curricula, although any form of communication plays an important role in an engineer's everyday work life. The core of communication is to understand what the information messages are and how they are sent, received and processed. It is essential to learn to pay attention to the content (what) but also to the relational message (how).

Design Build Course – Danish Technical University (DTU), Denmark

At DTU, Department of Civil Engineering the first CDIO course was developed in the autumn 2008 for the first semester students (Krogsbøll et al., 2010), (Krogsbøll et al. (2011). The CDIO course was introduced as a *Design Build course*, where the students had to build a model house in the scale of 1:20 as a model of a realistic house (Christensen et al., 2009), (Rode et al., 2011). Each group of students had to go through all the CDIO processes, starting with the conceive phase with a lot of ideas, designing the house, constructing the house in the implement stage, and finally operating the house outside in the natural environment by measuring the heat loss for one month and comparing these results of heat loss, see Figure 1 – left.

When the students work together as a group in the CDIO process, it is extremely important that they can communicate in a satisfactory and positive way. It does not help them to be a well-educated and skilled engineer if they are unable to communicate with colleagues, partners, customers, etc., (cf. Figure 1 – right). In the development process of the *Design Build course,* it became quite clear that the students needed to improve their communication skills in order to get the full benefit of the CDIO process.

The experience from the CDIO *Design Build course* has inspired us to innovate a course in communication for engineering students. This paper explains the results from this process.

Figure 1. Left: The final model of a house. Right: The students need to communicate in the CDIO process during the course.

BACKGROUND, INTERNATIONAL COMMUNICATION COURSE – ICC

Traditionally the structure of teaching lessons is a 45-minute monologue by a teacher. However, the engineering students of today demand teaching which is both interesting and engaging. The teacher needs to present the subject in a variety of ways with different kinds of teaching activities and should have a wide repertoire of teaching methods and study forms for different occasions and to supplement with a variety of student activities (Biggs, 1999), (Biggs et al., 2007), (Christensen et al., 2007), (Grasha, 1996).

In many technical universities, there is a lack of focus on teaching interpersonal skills such as ethics, communication, co-operation, engagement, leadership and teamwork. It is imperative that space is allowed in the curriculum for courses in the interaction skills. Training the communication skills in engineering specific programmes is a relatively new concept, but it is highlighted and applied in the CDIO approach. The CDIO approach is a model made to develop and ensure comprehensive coverage of the engineering education. The letters indicate the stages or the lifecycle of a process, product or system. Modern engineers are involved in all stages, which are **Conceive**, **Design**, **Implement** and **Operate**. According to Crawley et al. (2007), the *Conceive* stage means to explore customer needs and to develop plans. The *Design* stage focuses on creating the design that describes what product, process, or system will be implemented. The *Implement* stage is to transform the design into the product and the *Operate* stage concerns usage of the product.

According to Crawley et al. (2011), the CDIO Syllabus v2.0 consists of four parts. (cf. Figure 2). They are 1) Technical Knowledge and Reasoning, 2) Personal and Professional Skills, 3) Interpersonal Skills, 4) CDIO.
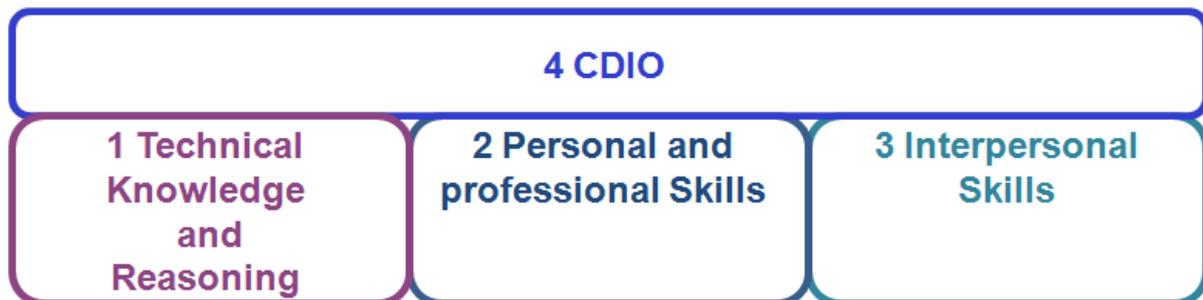

Figure 2. The CDIO Syllabus. Adapted from Crawley et al. (2011)

Figure 3 shows that the working conditions of the typical engineer nowadays include many other competencies than just the hard-core technical skills – sections 2.1, 2.2 and 2.3. They also include personal and professional skills, teamwork, communication and communication in foreign languages – sections 2.4, 3.1, 3.2 and 3.3. For this reason, it is essential that modern education for engineering students meets the demands of today's business life, where the engineer has to solve both technical and interpersonal problems, thus creating good results from an all-round perspective. It is also important to pursue interpersonal skills in engineering education. There is, however, a tendency in engineering educational programmes to give the implementation of this pursuit lower priority. Accordingly, this field therefore really needs innovation, but perhaps something is changing. When looking at the CDIO papers from former years more and more include the words interpersonal skills and especially 2017 had quite a number of papers related to the subject.
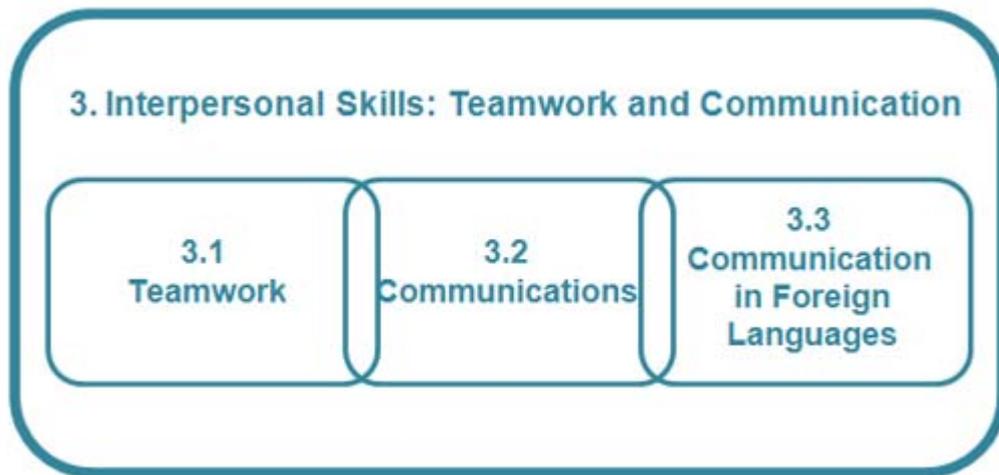
Figure 3. Adapted from Crawley et al. (2011): The second level of the Syllabus

DESCRIPTION OF INTERNATIONAL COMMUNICATION COURSES – ICC

As a teacher at DTU Byg and Metropolia, it is desirable to find an optimal teaching method that gives students the best introduction to and understanding of the engineer's world. According to Meyer (2006): "*There is no teaching in the world that is good in itself*". According to Kruse (2006) one may use different characteristics in order to try to define good teaching. However, educational research shows that it is an advantage to use a wide spectrum of different kinds of learning models so that the students can get a wide approach to the syllabus and what is needed to become an engineer. Connecting with the introduction of CDIO at DTU Byg the development of this course focused on working according to what is described as "Part 3 Interpersonal Skills", see Figure 2. Another reason is that the skill levels of the students in the 21st century varied; as a result, the ability of learning cannot be taken for granted in the same way as before (Jank et al., 2006). According to Jank, the consequence is that: *"Students are more demanding; their most frequent complaint is that teaching is boring. This problem can be resolved only with a renewal of the culture method"*. In this way, CDIO becomes a natural contribution to this renewal of the teaching method and is designed to help meeting the students' needs for meaningful and focused instruction, since they are constantly exposed to a very large flow of information.

Based on the **CDIO** as a model, the stages have been applied and implemented in the International Communication Course in order to better correspond to the needs of the students.

Conceive stage

Before the course the students read a book to make them aware of difficulties in communication by getting ideas, uncover problems and finding the overall perspectives. Through this process they begin to develop awareness about their communication skills, followed by writing a short assignment (*Assignment 1*) in which they analyse these skills, also the students can explore themselves and get awareness of their challenges as a future engineer. By doing this they will be able to conceive an understanding of the problems and work with their personal behaviour for communication.

Design stage

During the course the students do some exercises that focus on creating solutions to problems and they describe the process that is to be implemented. Based on these exercises they work on an individual basis to be able to design their further improvement for communication skills and how to develop these skills. As a part of this they participate in many practical exercises in groups or pairs. After each of these exercises they analyse and talk about their experiences, and possibilities for further improvement are discussed. This stage concerns the CDIO standards 2 and 8 (CDIO, 2018).

Implement stage

In the Implement stage the design is transformed into the process or the realization of the chosen tools/solutions. This means analysing by discussions what happened during the exercise. How they felt, how it worked. Many times, there are some intense debates; it is great for the students to learn that other young people regardless of their origin and upbringing share the same feelings and experiences they do. Also, the students like to listen to the other students telling and finding that something which is important in one country could be utterly useless in another and this creates situations that are great subjects for discussion in our class. This stage is where the students recognize that they may have some challenges that they will be able to work with during the exercises. They transform the design into the process i.e. the realization of the chosen solutions. At the end of the course they implement these skills in practice by taking part in a bigger long-lasting exercise, where most of the elements of the course are being applied. During the course the students write their *Assignment 2* in which they have the opportunity to reflect on their experiences. This stage concerns the CDIO standards 2, 8 and 11 (CDIO, 2018).

Operate stage

The Operate stage has focus on the actual use of the chosen tools/solutions. After the course the students will be able to operate their improved personal communication skills after returning to their class in their own university – they have their focus on the actual use of the things learned. Part of this will be that they write their *Assignment 3* in which they reflect on and analyse what they have learned and how they will be able to use it in their future life. This stage concerns the CDIO standards 2 and 11 (CDIO, 2018).

THE STUDENTS OF INTERNATIONAL COMMUNICATION COURSES – ICC

Finland was one of the few countries in the world where it was possible for students from any country to study in English and for free up to September 2017, when a tuition fee was set for students coming outside EU/ETA countries. In some other countries studies are also free of charge; however, the teaching language is not English. Therefore, we have had students in our course who have travelled straight from their own country to Finland from all the continents meaning that they may arrive without much knowledge of European conditions. Since Finland is so hospitable there are usually students from approximately 15 different countries attending our International Communication Course (ICC). All together, we have had students from 55 countries from all over the world. Because the students are from so many different countries they really do get the opportunity to explore international communication.

In order to make everybody feel fine we first do some ice braking exercises where the students just get the chance to find out where everybody is from and the chance to talk with each other. Later based on the material studied beforehand, we go through some theory and related exercises. Each day the students have to monitor and write what happened. Especially this *Assignment 2* is extremely useful to teachers because it helps to evaluate how much the students really got from the day and the specific exercise. We have applied the results of this evaluation to change our course in several ways. When we read the *Assignment 3* we can really check if the students understand what it is about and how to actually use the learned skills in everyday life. As described below, this assignment also tells whether the students have focused on the course. Comparing assignments 1, 2 and 3 it is possible to get a clear understanding of the students´ development as well as to control that an effort has been made.

INNOVATION IN THE INTERNATIONAL COMMUNICATION COURSE

Since August 2012, the students have had to write three assignments. The main reason for this is to see if they are able to apply what they have learned. During the Conceive stage before the course, the students read the material and write their *Assignment 1*. During the course itself, which covers the Design and Implement stages, the students write their *Assignment 2*. Six weeks after the course the Operate stage takes place where the students use what they have learned but now in their own environment and they finish the course by writing their *Assignment 3.* Since the International Communication Course is all based on doing practical exercises, it is essential that the students read the given material beforehand. Writing assignments is a good way to assess whether the desired level has been achieved but it has also increased the level of learning dramatically.

The International Communication Course is structured in a way that helps preparing the students to take responsibility for their own learning while working actively. This is of great importance since development in society is accelerating, and students must cope with tasks that remain unknown while they are under education (Jank et al., 2006). Jank defines students as follows: *"Students are people who let teachers assist with learning. No outsider can make learning happen. One can only learn for oneself. Teachers are people who will assist students to learn".* When the course first started in February 2010 at Metropolia anyone enrolled were accepted to attend. However, this did not work out well after a couple of times when there were more than 60 students in the class. It is crucial that the students really attend all class sessions, because the most of them consist of exercises in pairs or small groups, see Figure 4. If a student does not work seriously with the given exercise, he/she destroys the effect and this will influence the partners' experience, too. *"Teamwork comprises forming, operating, growing and leading a team, as well as skills specific to technical and multidisciplinary teamwork."* (Crawley at al. 2011), so great emphasis is placed on the exercises being in teams. Some of the students attended to get easy ECTS credits. (ECTS European Credit Transfer System – used all over Europe, a method of measuring study programmes and transfer academic qualifications from one educational institution to another). They arrived late, they talked during the introduction of the subject, or they left for some hours in the middle of the course even though there is 100 % compulsory attendance. This made it necessary to check on those present several times during the day. In addition, it was somewhat difficult and took a day or two to find out who was there to learn and who was not. At one course, there was a bad incident where a Pakistani student hushed some Nepalese students, who bullied him later in the canteen.

Figure 4. Most of the course consists of exercises in pairs or in small groups.

In March 2011, we delivered the course in Alcala, Spain (Nyborg et al., 2011) for a group of students participating in an Erasmus Intensive course on *Developing Open Source System Expertise in Europe (DOSSEE)*. Since they had been forced to take, also some of our classes in communication many of them had a rather negative attitude. One of the students actually wrote in the evaluation:" *Not so much theoretical stuff, if you want to make a Social ICE-Breaking give us a bottle of alcohol and not some stupid exercises with a Danish couple."* One of the students in Spain was a Dane and since we are Danish, we had noticed him right away. He was studying Information Technology and could definitely not see the point in learning communication. Nevertheless, we did the exercises and somehow he suddenly got an epiphany, he got all excited and ended up taking pictures of all the material presented on the blackboard. In another class at Metropolia, we had a young man entering the room, taking the name badges (carefully placed in the alphabetic order) throwing them around, then taking his own and without a word going to sit down. These experiences among others have forced us to be more innovative about how we apply the CDIO model.

Innovation – Writing three assignments

As mentioned above, the students have to write three assignments. One reason for this is to see if they are able to apply what they have learned; but also to avoid students that just expect no efforts needed for participating in the course since the students make an assignment even before they join the course. We have found that 30-35 students at each course is the optimal number, so when we have many students wishing to join the course we can increase the level as to only get the students that will make an effort and who understand that being able to communicate is essential when you are an engineer.

Innovation – Timing of the course, integrated breaks

In the beginning, the course was scheduled for five days and only three hours a day, which was found not to be enough. For some years each day had a five-hour class which used to be from 1PM to 6PM. Finding that the students love the breaks when they get the chance to talk to someone they just found interesting during an exercise, the latest initiative was that our class in May 2017 was from 10AM to 4PM, so the students had a lunch break together.

The course is based on the students being very active and demands that they only take this course during that week. When the course was offered in the afternoon hours some students thought they were smart and took another course in the morning thus getting 6 ECTS points in just one week. When reading the Assignments 2 and 3 it was very easy to see that the students had not been fully concentrating on this course. They were not able to answer the

questions (that is to understand the exercises), also the assignments were much shorter. When the students are doing what is required they each day spend about 45 minutes after class to write their Assignment 2 in order to be able to remember clearly what they experienced. Many times, the students only understand what really happened once they write about it, which is why so much effort is expected to be put into this assignment. It is the innovative process in the course – for the students it is a development that first they read about the theory, then they get their experiences during the exercises in class and then afterwards adapt them during the writing process – this makes the learning process deeper. From the students´ assignments, we can see that they currently get a far greater benefit. When it comes to Assignment 3, which is to be submitted six weeks after returning to their own university, it is also very easy to see that the students are not able to apply what they have learned if they did not focus during the course.

Innovation – Course material

When the course first started the students only needed to read approximately 15 pages of text. The required reading before attending the class increased as the course increased in lessons. Some parts of the booklet have now been written in a format of a book (Christensen et al., 2017) which is obtainable both as a printed book as well as in digital format free of charge. This latter being important since the students come from all over the world and need to be able to download the book and the pre-assignment before arriving in Finland.

Innovation – Presentation of theory and practice of exercises

In the beginning the course was based on a short verbal presentation without any digital presentations, followed by doing exercises and expecting that the students had read the booklet carefully. The students loved that they were doing exercises all the time; but they were not quite able to connect the exercises with the subjects. After having introduced Power Points as part of making a short presentation, the students now get a much better understanding of the subjects and have improved their ability to follow the structure of the course. Since the change the students are much more contended. We have now worked for some years to find an appropriate balance of theory and practice, and we now spend approximately 15 % of time on theory and 85 % on practice.

The different innovations have now made their impact on the International Communication Course and the students behave quite differently during the course compared to earlier.

CONCLUSION

In many technical universities there is a lack of focus on teaching interpersonal skills such as ethics, communication, co-operation, engagement, leadership and teamwork. It is important that space is allowed in the curriculum for courses in interpersonal skills. For some courses it should be a deliberate requirement, stated as a learning objective that the students will be evaluated on their interpersonal skills previously listed. Thus, they would feel urged to focus on their personal development knowing it is a part of the evaluation procedure.
Teaching so called softer skills can take place in strictly non-engineering courses on communication and interpersonal skills or in courses with technical substance. This paper presents the innovative process of a course development in order to use the CDIO concepts adapted to our International Communication Course. The innovation of the course has developed to be a strictly non-engineering course in communication. The duration of the

course is a full week and it consists of various small exercises with personal involvement, whereby the participants can develop their interpersonal communication skills. Experience shows that the students appear to be very positive and delighted to attend the communication course, and they feel they can develop their interpersonal communication skills in interrelation with fellow students

The students having to write three assignments has made the most significant change of the course. It has made it possible to get in the class only the students that will make an effort and who understand that being able to communicate is essential for an engineer.

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BIOGRAPHICAL INFORMATION

Jørgen Erik Christensen is an Associate Professor at the Department of Civil Engineering, Technical University of Denmark (DTU). From 1997 to 2001 he studied gestalt therapy specialising in communication at the Norwegian Institute for Gestalt. In 2009 he studied "Pedagogical and Didactic Theory about University Education and Teaching" at the Danish Pedagogical University, Denmark. He has been involved in national and international research in the field of energy and environment and is a co-developer of an internationally used thermal analysis program known as tsbi3 (now BSim). Christensen has been a member of the CDIO implementation board of the Department of Civil Engineering at DTU.

Markku Karhu was the head of the degree programme in Information Technology at Helsinki Metropolia University of Applied Sciences for 20 years. His academic background is on Computer Science. His professional engineering experience is based on the research work of 20 years while applying software engineering methods to research projects at VTT Technical Research Centre of Finland. As an engineer educator, his interest in enhancing engineering education has taken him to participate in many European-wide engineering education projects as well as in the CDIO collaboration.

Cecillia Christensen received her degree as Interior Decorator in 1975. She has completed various courses in personal development and in 2002 was awarded her degree as NLP Master Practitioner.

Jonita Martelius is a senior lecturer on English and communication, French as a foreign language and cross-cultural communication at Metropolia University of Applied Sciences since 1999. She has also completed a degree in media education.

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