TEACHING PROFESSIONAL ENGINEERING SKILLS
- INDUSTRY PARTICIPATION IN REALISTIC ROLE PLAY SIMULATION

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ABSTRACT

Engineering education aims at providing students with sufficient disciplinary knowledge of science and engineering principles in order for them to become successful engineers. However, to fulfil their roles as professional engineers, students also need to develop personal and interpersonal skills, as well as professional skills, in order to implement and apply their theoretical and technical knowledge in a real context. CDIO constitutes a comprehensive approach to engineering education in which these additional skills represent fundamental principles besides the predominant technical knowledge. The implementation of professional skills as well as personal and interpersonal skills in engineering teaching must be done, however, without reducing the existing curriculum of technical disciplines and still allow for the continuous acquisition of new technical knowledge. The general purpose of this study is to discuss how to facilitate the teaching of professional skills in engineering education in parallel with the technical disciplines. The objective is to test and evaluate extensive role play simulation in which the students interact with professional engineers in a realistic, industrial context. The underlying argument for this approach is to establish a realistic learning environment that will foster the learning of professional skills. The role play simulation has been applied and reviewed in two engineering courses, i.e. at Lund University in Sweden and at the Technical University of Denmark. Course evaluations, a questionnaire, and discussions with students confirm a genuinely positive attitude towards the role play simulation. The students engage in the role play and express an increased understanding of the requirements and the implicit rules of real-life engineering. The interaction between students and the professional engineers act as a prime mover for the students to perform their best, which in turn strengthens the learning of the technical content. The study concludes that role play with participation of representatives from the industry can facilitate the teaching of professional skills in engineering education.

KEYWORDS

Active learning, role play, professional skills, simulation, industry participation.

INTRODUCTION

Engineering education fundamentally aims at preparing students to become professional engineers which requires thorough and specific knowledge in science and engineering principles

and a general understanding of the complex products, processes, and systems that constitute the society of today. Besides the disciplinary knowledge needed, practice of professional engineering also requires the ability to work in teams with people of different professional and cultural backgrounds, to communicate orally and in writing, to understand the basics of markets and business processes, to be creative and innovative, to conduct to professional ethics and social responsibilities, and to understand the nature of engineering products, processes and systems. The continuous development of specialised technical knowledge is challenging engineering education programs and engineering education has been criticised for being too biased in favour of the teaching of theory and technical disciplines while too little attention has been given to the teaching of personal, interpersonal and professional skills [1].

CDIO constitutes a comprehensive pedagogical approach to engineering education that integrates the disciplinary technical knowledge and the personal, interpersonal and professional engineering skills that are required of engineers. According to CDIO, the need for engineering education is "to educate students to understand how to conceive – design – implement – operate complex value-added engineering products, processes and systems in a modern, team-based environment." [2] The teaching context of conceiving, designing, implementing, and operating represents the professional role of engineers and provides hands on actions, integration of different subjects and a realistic setting in which to teach professional engineering skills and attitudes [2].

Problem Statement

The implementation of professional skills as well as personal and interpersonal skills in engineering teaching must be done, however, without reducing the existing curriculum of technical disciplines and still allow for the continuous acquisition of new technical knowledge. One way of approaching this is to consider the implementation of professional skills as a matter of teaching and learning, rather than as an implementation of new subjects in the existing curriculum, i.e. developing professional skills in teaching is a matter of how to teach rather than what to teach. In the case of CDIO, this approach is manifested e.g. by a closer integration of different subjects and active and experiential learning by design-implement projects.

Purpose and Objective

The general purpose of this study is to facilitate the teaching of professional skills in engineering education and the objective is to test and evaluate teaching by an extensive role play simulation, in which students play the role of engineers who interact with professionals from the industry in an industrial environment. The underlying argument for this approach is to establish a realistic learning environment that challenges and motivates the students and, consequently, fosters the learning of professional skills.

FOSTER THE LEARNING OF PROFESSIONAL SKILLS

Teaching professional skills in engineering education involves considerations about learning and the development of competences among students, e.g. how the choice of teaching methods create the context in which the engineering students learn and how the teaching design interrelates and facilitates the learning of professional skills. Other issues to considered are the nature of professional skills and competences in the field of engineering and how these skills develop [3]. Another issue is how to assess and grade the students' professional skills. The

CDIO initiative deals with those issues and particularly accentuates the importance of develop professional skills in engineering education [2].

The development of professional skills among engineering students can have a wider scope than teaching the engineer students the skills they will need in their future lives as professional engineers. To really succeed in develop engineers who can engineer, is also a question of how engineering education can foster the students to identify themselves as engineers during their university studies to meet the expectations from different stakeholders in society, e.g. from industry and institutional actors [3]. As stated by Christensen et. al. [4], development of engineering professional skills is very closely related to the formation of the identity of an engineer.

How to develop professional skills and competencies concurrently with development of a high level of disciplinary knowledge are issues not only for engineering education, but for all study programs in higher education. An education program of this nature must deal with the combination of high performance in both disciplinary knowledge and professional skills. To develop an understanding of how to act within the specific profession, the culture and the ethical rules as well as understanding the consequences of ones actions are important parts of the professional development and understanding as well as the establishment of a professional identity. This will form the base of competences for the students in their field of profession. Bates [5] states that the concept of professionalism requires knowledge, autonomy, and responsibility to be integrated and interrelated in practice.

One consequence of this aim for engineering education and, the CDIO initiative, is the importance of continuous exploration and investigation of how different teaching and assessment methods support and foster the development of professional skills, and thereby also support the students' development to identify themselves as professional engineers. Many teaching and assessment methods used in higher education, e.g. Problem Based Learning, Case Based Method and Project Based Learning etc., have been developed to support efficient learning of disciplinary knowledge in a context of practice with realistic problems and situations.

The development of competencies is a complex mental and personal process that involves many levels of knowledge [6], [7]. A competence can be described as consisting of knowledge, skills, and attitudes, as three interrelated elements [8]. You must know what to do, how to do it, and know the consequences of what you choose to do as well as being able to judge and understand those consequences in a broader perspective. Accordingly, the teaching of professional skills in engineering education must make sure that all those elements are covered and practised during the education, and that these different elements are made explicitly clear and are explained to the students in terms of learning objectives and learning outcomes [9].

Traditionally, in higher education curricula, the teaching of disciplinary knowledge is the principal focus [4]. The professional skills are developed implicitly while the students are solving technical problems, do projects, and observe other experts within the field. In this way, the development of professional skills becomes an unconscious action and the skills and competences developed cannot be explicitly described or assessed. Simply, professional skills are regarded the traditional and prevailing way of doing engineering work. Thus, the engineering students achieve some understanding of professional skills and the requirements they are facing when graduating even though the teaching of professional skills has not been explicitly articulated. However, the drawback of this kind of learning process is that the skills are developed as tactic knowledge [6].

One consequence of professional skills being mentally stored as tactic knowledge is that those skills very often must be learnt in an apprentice and master relationship. Someone who is mastering something needs to show another person how to do it. This is due to the nature of tactic knowledge which implies that the knowledge of something cannot be explicitly described. This kind of implicit learning process can take long time and is dependent on the ability of the involved persons to meet and spend enough time together for the training. This might not always be the most efficient way and there is no control of what is achieved by the learner. Another consequence is that the body of knowledge that is embedded in practices in professions is more difficult to develop and learn. Without a specific language to describe the content in a practice, it is difficult to describe the actions in a way that others in the same profession can embrace and react upon it. This fact implies that it is important that professional skills are considered and trained in an explicit way in engineering education to make the students conscious about the skills they posses and develop. Doing so also helps the students to further develop the skills and practices in their profession as they are aware of their actions [9].

Thus, it is important that learning professional skills is made explicit in teaching in the same way as the disciplinary subjects. Still it is important in the process of learning professional skills and developing an identity as an engineer to work together with professionals in the field who can be regarded as the masters. The social learning theory, as described by Wenger [7], is one of the theories about learning that is useful to apply when to foster professional skills among engineering students. Social learning theory states that we are all a part of communities of practice of different kinds, and one of these communities is our profession [7]. Those communities are social, and we construct our identity according to them in a process of socialisation where we initially act in the periphery of the community. Step by step we enter into the community of practise and finally we become internalised into it. We learn new competences by being active within the framework of this community and interact with other professionals in it. As a new professional in a field, we must be invited into the community of this profession and start to construct our understanding of it and learn how to act within it [7]. Accordingly. a combination of conscious training and development of professional skills and the use of different role models in education are likely to be an efficient way to prepare the students for their professional life.

This assumption about learning as a social process which goes on in a certain context, leads to the next factor with implication on fostering professional skills. Knowledge and understanding is dependent the context where it is learned. In education of professionals, the problem is often to transfer knowledge and skills learned in a university context into an industrial context. This is due to the situated nature of learning [10]. To be truly successful in educating the students, not only the disciplinary knowledge required, but also professional skills and attitudes, it is important to create a learning context which is as realistic as possible [9].

As always when creating effective learning of disciplinary knowledge and professional skills, clearly stated learning objectives are of importance. This stresses the importance, highlighted here, of being explicit to the student about what they are learning and why. The idea of alignment between learning objectives, the teaching methods and the assessment methods used [9] is also a powerful tool when fostering professional skills. Similar to the requirement of explicit teaching activities of the professional skills, the assessment methods should also be explicitly expressed as the assessment methods strongly influence the priorities and actions of the students [11].

In this study, the teaching method of role play simulation is brought out and evaluated. In the role play, the students play the role of engineers who interact with professionals from the

industry in an industrial environment. The underlying argument for this approach is to establish a realistic learning environment that challenges and motivates the students and, consequently, fosters the learning of professional skills.

THE TEACHING CONCEPT OF ROLE PLAY

The concept of role playing as a teaching method has a long tradition and has been widely used in higher education. Druckman and Ebner [12] provide a thorough literature review on the experiences and evaluation of simulation role play learning in which they refer to Cherryholmes [13] as one of the early originators in the field. Literature reports on a variety of different role playing procedures and concepts applied for educational purposes in many different sciences and subject fields, e.g. social sciences [12], supply-chain management and marketing [14], natural resource management [15], [16], and accounting [17], [18].

Role playing for teaching purposes is part of a wider group of teaching and learning methods known as simulation and gaming which provide a learning mechanism that involves and activates the participants embracing their roles, guided only by implicit rules and instructions [12]. Role play constitutes a case-based learning method in which the participants assume the roles of different characters and interact in the contextual settings of a given scenario.

Many cases describe various advantages of role plays. Maier et.al. [19] point out the values of role playing as a teaching method when it comes to developing personal and interpersonal skills by referring to how the students gained an improved understanding and control of emotions and feelings. They also improved their self-knowledge, and understanding of their attitudes and of human interaction in social situations. Craig and Amernic [18] describe role playing as "one particular type of simulation that focuses attention to the interaction of people with one another" and, consequently, they share the view that interpersonal skills are central to role playing.

The general purpose of role playing in teaching is to gain enhanced learning outcomes for the participants, but in wider perspective, role playing has turned out to embody many other distinctive merits. As always in research and scientific studies with human processes as the research object, criticism can be levelled against the validity of the research reviews of role playing as a teaching concept. Despite the criticism of how to evaluate the pros and cons with role play as a teaching method, the advantages of role playing seem to exceed the difficulties. Literature studies and reviews of experiences with role play for teaching purposes are primarily positive in terms of the way in which it helps the students to enhance and retain learning of the subject field. Besides, role playing also facilitates the important development of personal and interpersonal skills, e.g. the skills of communication, behaviour, decision-making, and the ability to manage diverse and unstructured problems [18]. One conclusion can be that role playing does not imply improved learning in the subject field more than many other active learning methods, but it provides an extended learning scope that goes beyond the specific subject field in question. As such, role playing can possibly add the required learning of professional skills, e.g. advertised by the CDIO-concept.

The arguments and the experiences of role playing as an integrated part of teaching are very diverse. The pedagogical concept of role playing as described in this paper rests upon the principle argument of establishing a realistic context, i.e. a realistic learning environment for the students. This argument stresses the importance of establishing a teaching context which is in accordance with the first, out of a total of 12, standards of CDIO. This argument is also supported by Pepper and Clements [20] who identify and describe the need to prepare students

for the ever-changing and dynamic environment of engineering work and, in order to facilitate the teaching and learning of professional skills, they introduce the approach of role playing as a way to establish a realistic learning environment.

The teaching method of role playing also supports the understanding of the underlying context, the functions of the different actors involved and the complex dynamic nature of the given problem [16]. The establishment of realistic environments and scenarios for the role play encourage the participant to become involved in, and commit to, the learning process [21]. Besides the immediate purpose of generally improved learning from role playing, the active involvement required in role play simulation promotes an enhanced enthusiasm, motivation, and a positive attitude to the teaching subject [17], [22], [18].

Even though role play has many documented advantages, literature also reports on challenges using role playing as a teaching method, both from the participants´ and the teachers' point of view. Craig and Amernic [18] bring forward the risk that the roles played by the participants can emphasize stereotypes and maintain prevailing, and inadequate, behaviour and relations. On the other hand, to a certain extent the given roles to be played need to be of a stereotyped nature in order to be distinct and familiar to the participants [23]. The value of enhanced commitment and enthusiasm among the role play participants must also be balanced in order not to turn the role play into a too frivolous and giggly game where the learning process is neglected. If the value and the procedures of the role play concept is properly conveyed and perceived by the participants, the "constructive peer pressure seems likely to operate to prevent role play degenerating into play" [18]. Participants with no previous experience from simulations might express an initial anxiety and apprehension about acting and performing in the role play situation [23], and as a consequence, they may adopt a cautious and non-committal attitude or even withdraw from the course [21].

From the teachers' point of view, role playing requires considerable efforts in the design and conceptualisation of relevant role play simulation and the establishment of a realistic environment that stimulates and activates the participants in the learning process [12]. Despite the efforts and determination of the teacher designing and preparing for the role play, the teacher must allow the role play participants to act and perform within the context of the given scenario only with implicit rules and a minimum of guidance. As the role play situation provides a creative and less predictable process in which the participants are in focus, it will render difficulties for the teacher to apprehend and assess what is learnt among the group of participants [21]. To sum up the described experiences and studies from using role play as a teaching method in higher education, combined with the factors mentioned before, which can have a certain impact, for students developing professional skills the method seems to cover many important aspects of this professional training. Using this method, the learning is taking place in a realistic setting, there is a social interaction, the students must actively use the disciplinary knowledge in the course, apply it on a case and try it out acting as professional engineer. This addresses the context dependences of learning. In the cases described in this paper the students interact with professional engineers from industry which also act as role models. It seems like role play is a teaching method which can be useful fostering professional skills in higher education, at the same time as it supports learning of the disciplinary knowledge.

METHOD

The presentation and review of the extensive role play simulation with industry involvement described in this context rests upon practical experiences from two different cases, i.e. two

different courses, where case 1 took place at Lund University, Faculty of Engineering, in Sweden during the time period of 2003 to 2005, and case 2 refers to The Technical University of Denmark, Department of Management Engineering during the time period of 2009 and 2010. The approach to the role play simulation with industry involvement was basically the same in both cases. Besides, the subject field is construction management in both courses, the teaching is project based, the courses are optional for students in their final year of education, the course credits correspond to about 30% of full-time studies for a semester, there is about 15 to 20 students from different engineering programs in the class, the students work in groups of about four to five students, and the groups are formed by the teacher.

Civil-engineering students constitute the main target group for both courses, but both courses are characterised by a cross-disciplinary selection of students. In case 1, the group of civil-engineering students was supplemented by students from the architectural and land surveying programs. In case 2, the group of students are made up of equal numbers of civil-engineering and architectural-engineering students, and a number of different nationalities were also represented in the group.

The review of the extended role play simulation rests upon, in case 1, course evaluations from 2001 and 2005 (CEQ) and, in case 2, a course evaluation from 2009 and a questionnaire survey carried out at the start of the course in 2010. The collected empirical data is reviewed in light of existing research and literature in the field.

EXTENDED ROLE PLAY WITH INDUSTRY PARTICIPATION – THE CASE STUDY

The extensive role play simulation that is tested and evaluated in this study is applied in two engineering courses in construction management. The pedagogic design of the two courses relies on three interactive processes, i.e. the tutorial process, the project process, and the social process which run in parallel throughout the course, see Figure 1. The project process is designed as a role play simulation in which each group of students carry out a project assignment in the role of construction managers, assigned by a professional client. The project process and the role play provide the corner-stone of the course, facilitated by input from the other two processes. The tutorial process includes traditional lectures and exercises in which relevant theories and methods are introduced on the basis of the discussions and requests that arise from the role play between the students and their professional clients in the project process. The social process includes a conscious and formal assessment and documentation of the students own personal development and progression of social skills in the respective student groups throughout the course [24].
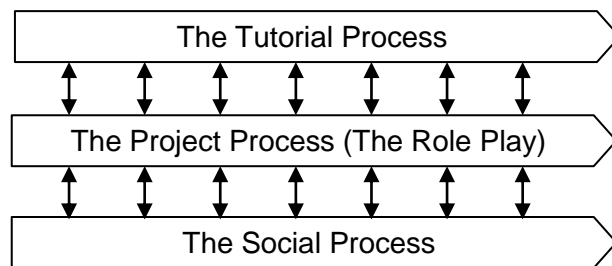

Figure 1: The Tutorial, the Project and the Social Processes of the Course

Creating a Realistic Learning Context

The role play is initiated at the very beginning of the course. On day one, each group of students are invited to a business meeting by their respective professional client. The role of a client is played by a professional engineer, usually employed at a consultancy firm or a contractor. The students organise themselves as a fictitious consultancy company with a company name, a logo and a business plan etc. in order to prepare for the first meeting. This initial work prepares the students in the roles of engineering consultants, it gets them introduced to the general terms and conditions of the subject field and, not least, it gets the teambuilding process in the groups started.

The meetings between the students and their clients take place at the office of the respective industry representatives in order to strongly contribute to the realism of the project assignments. The students are responsible for setting up the meeting appointments with their respective client, to agree on when and where to meet, to prepare a meeting agenda and keep the minutes of the meeting.

The Clients Pull the Project and Teaching Processes Forward

The recurrent project meetings with the clients make up milestones during the course, i.e. as project phases at which the students report and discuss their intermediate results. It is the clients who pull the project process forward in dialogue with the students. Consequently, the clients successively introduce and express the requirements of the project which, in turn, arouses an interest and a need for new disciplinary knowledge among the students. Thus, when the students return to the teaching process of the course, they have an explicit urge to learn the disciplinary subjects in order to deliver an answer and solution to their client at the next meeting. Besides, the recurrent meetings and part deliveries of the project assignment help balancing the workload distribution during the course.

The clients have been given a step-by-step guideline for the project assignment. The guideline provides a framework for the project assignment, defining its scope and principal contents. The guideline has been developed in dialogue with the professional engineers in order to provide a common platform for each client and to make sure that the project assignment is realistic, relevant, and valid.

The Students' Attitudes to and Remarks about the Role Play Simulation

Regardless of the arguments and intensions of the role play and need for professional skills, it is of little value if the students do not respond and adapt to the pedagogic design. Course evaluations, a questionnaire, and informal discussions with students in the two courses confirm, however, a genuinely positive attitude towards the role play simulation with industry representatives. In the most recent course evaluation from 2009, the students were asked to - individually and at their own will - point out positive and negative aspects of the course and, subsequently, agree or disagree with the aspects pointed out by the other students.

The interaction with the industry clients was highlighted as the most positive aspect of the course. Quotes from the DTU evaluation from 2009, presented in the bullet list below, are examples of positive remarks from the students regarding the role play with industry representative. The share and number of students who agree to the respective statements are put in brackets. There were a total of 14 students in the evaluation.

- Direct contact with the industry made it more interesting, 100% (14/14)
- The client contact/case, 100% (14/14)
- Real Clients, 100% (14/14)
- The client contact/case, 100% (14/14)
- Working with an external client, 100% (14/14)
- The correspondence with a real firm, 100% (14/14)
- Getting real cases to work with did it exciting to solve, 93% (13/14)
- The role play adds a good dimension to the project, 71% (10/14)

The evaluation included one single negative aspect about the role play and interaction with industry expressed as "Expectations from clients really high", 7% (1/14). That is a relevant remark as it indicates that the students might experience a higher pressure to deliver well-worked results to their client. However, only a single student agreed to the statement.

The positive remarks about the cooperation with industry in the evaluation from DTU in 2009 were confirmed in a CEQ evaluation of the LTH case in which "the connection with reality" was brought out as the most important positive aspect of the course.

The Need for Professional Skills in Engineering Teaching

There are many pedagogic aspects involved in teaching by role playing, but in this study, professional skills were put forward as the main argument for the role play simulation. A questionnaire from 2010 (with a total of 20 respondents from the Danish case) shows that there is a widespread understanding and positive attitude towards teaching of professional skills among the students in the case. At the start of the course, 95 percent of the students agreed to the statement that "...teaching of professional engineering skills is of importance in an engineering study programme" and the same number expressed a positive attitude towards role playing with industry representatives. Furthermore, 90 percent of the students concur with the statement that "...role playing with industry facilitate the learning of professional engineering skills". In this connection, it is relevant to point out that about 50 percent of the students claimed that they have previously been exposed to role play simulations and teaching of professional skills in their university education. However, despite their previous teaching experiences, 75 percent of the students rated their own current level of professional engineering skills as limited at the start of the course.

The open comments about teaching of professional skills reveal and express the thoughts and considerations of the students on these matters. The following bullet list presents some descriptive examples of positive comments (quotes) about teaching of professional skills:

- "I think it is a very important part of studies, which would help students to understand how it works in real life"
- "Engineering is not only reading books and solving problems in exams, but it's also being a responsible engineer in real life."
- "More realistic, more responsible"
- "Learning about real life industry. You have to communicate with persons with different interests."
- "I hope/expect that role play with real firm will improve professional skills and give experience"
- "You get the understanding of how engineers should act in real life"

There were also some examples of concern among the open comments from students in the questionnaire (quotes):

- "Doubt that our presentation will live up to their requirements/standards"
- "It's a good idea but you are not necessarily a better engineer by learning in this way. Sometimes there is too much focus on learning to communicate instead of gaining other relevant engineering skills"

Experienced Challenges Related to the Role Play Simulation

Besides the general positive remarks about the role play in this case study, there are of course some difficulties identified as well. From the teacher's point of view, it is emotionally difficult to leave part of the teaching in the hands of the clients. When involving external clients in the role play, who meet with their respective group of students at their offices, the teacher loses some of the control of the teaching process. Several reports from the clients to the teacher about the results of the role play sessions is of vital importance for the teacher to keep informed and to prepare the teaching process in order to address the subjects and questions raised in the role play. In the course evaluation from the DTU case, one of the students expressed this concern as follows "- The workload is very much in the hands of the clients - can be good and bad". In order to keep the role play between students and clients in line with the scope of the course, its learning objectives and the teaching process, a clients' guide was developed. Among other things, the guide outlined some common milestones in terms of subjects that should be considered in the role play. Thus, the guide provided a common framework for the role play in which the clients were free to act.

Another challenge experienced in the case study was the need to assess the learning of professional skills which is just as important as assessing the learning of the disciplinary knowledge. The disciplinary learning achievements from the project assignment and teaching process are reported in this study in a traditional oral presentation and a written report. The professional skills, however, are not as tangible and consequently they are difficult for the students to express orally or in a written report. This problem must be taking seriously though it addresses some of the important factors in fostering professional skills. Special the issue of professional skills often become tactic knowledge and the problem this is develop not only during the education, but also for the continues development of professional skills in organisations. Besides, the academic lecturers are likely not to be as capable of assessing the professional skills as the engineers from industry who interact with the students in the role play. In order to deal with the assessment problem in the role play simulation of this study, each project meeting between the group of students and their professional client was concluded with a critical review and feedback of the students' professional performance during the meeting. Thus, the professional clients assessed the professional skills of the students and gave direct feedback to their group of students.

CONCLUSION

This study discusses teaching of professional skills in engineering education by implementing a role play simulation in which industry professionals are strongly involved. As such, the role play simulation goes beyond the limitations of discrete exercises, and instead it constitutes the principal foundation of the course.

In literature it is stated that the learning objectives in general should be explicitly expressed and explained to the students. Thus, it is concluded that the learning objectives of professional skills need to be described and communicated to the students as part of the learning objectives, and consequently, related to teaching activities and assessment methods in accordance with the constructive alignment of the course. The role play simulation constitutes the fundamental teaching activity in this study. On the basis of course evaluations and questionnaires, it is evident that the students express a genuinely positive attitude towards the role play and the interaction with professionals from the industry. The recurrent meetings between students and their respective professional client act as a promoter for the students to perform their best in the project assignment, which, in turn, fosters the learning of the disciplinary knowledge of the course. The students feel committed to the role play simulation and express an increased understanding of the requirements and implicit rules of real-life engineering.

One of the challenges identified with role play and industry participation is to assess the level of professional skills achieved by the students. The difficulties rely on the elusive nature of professional skills, the potential lack of professional experiences among the academic teachers and, in the case of this study, that the role play took place outside of the university and excludes the academic teachers. The study suggests that the assessment of professional skills should be done in collaboration with the professional engineers who are likely to have a better knowledge of professional skills and work close to the students in the role play simulation. In the case study, feedback from the professional engineers after each role play session was given in to the respective group of students in order to promote the learning progression of professional skills. The interaction with professionals from industry also contributes to making the learning of professional skills explicit to the students which is one of the key questions to foster professional skills in engineering education.

The study concludes that role play with industry participation facilitates the teaching and learning of professional skills in engineering teaching and consequently, it supports the process of preparing engineering students to become professional engineers ready to enter the industry.

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