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INTERNATIONAL PROFESSIONAL SKILLS: INTERDISCIPLINARY PROJECT WORK

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ABSTRACT

Higher education should provide learning situations that prepare students for a future profession and make them world-ready. This paper reports insights from an international interdisciplinary collaborative project aiming to create learning experiences that are close to a professional situation. The collaboration setup simulates a setting of a digital agency with a development team in Sweden and a marketing team in Australia working together to solve a task. The collaborative project has been active since 2017, completing its fifth iteration in 2021. Post-course survey results show that the students felt that a real situation was created with a high level of collaboration and commitment, internationalization, well selected digital collaborative tools, and that an interdisciplinary community of practice was created among the students.

KEYWORDS

Internationalization, collaboration, professional experiences, Standards: 1, 3, 4, 5, 7, 8, 10

INTRODUCTION

The fast-paced technological development has drastically influenced and affected society for a long time. At the center of this development is the art of engineering. Since engineering is the "application of science, mathematics, economics and social science which can manifest into creations" (Kumar, 2018), engineering itself is also affected by research and practice within many different areas. Hence, engineering innovations that create value happens in the cross-section between scientific discoveries, technological development, and societal changes. This development has had a profound impact not only on the professional role as an engineer, but also on engineering education throughout the world. Rapid technological changes, which are common within engineering, create a high uncertainty among students of future career paths. Consequently, interdisciplinary skills and being able to work with professionals from other disciplines have become increasingly important over a long period of time (Ertas, Maxwell, Rainey, & Tanik, 2003). This is especially true for even more interdisciplinary areas such as, e.g., interaction technology where today's students are facing complex contemporary problems (Churchill, Bowser, & Preece, 2013). Professional skills such as communication, teamwork, and understanding external and societal context are all desired by the industry (Mechefske, Wyss, Surgenor, & Kubrick, 2005). Therefore, it is important that students in higher education move beyond the pure disciplinary subject and are given opportunities to develop their skills in relevant societal and business-related contexts (Cardozo et al., 2002).

During the last 20 years, the CDIO Initiative has been focusing on bridging the gap between engineering education and the industry's vision for their new employees' skills. According to the CDIO, engineering education should focus on real-world demands in the complete value system and all skills needed to successfully execute the engineering profession - Conceive, Design, Implement and Operate (Crawley, Malmqvist, Östlund, & Brodeur, 2007). Hence, the CDIO approach is largely based on the idea that students should, during their time at the university, face reality-alike contexts and face situations that facilitate learning of professional skills which are very important to prepare students for their future profession. Simulating these settings can increase students' motivation and enhances the learning (DuHadway & Dreyfus, 2017; Mejtoft, 2015). For participating engineering students, interdisciplinary collaboration has a positive impact on, e.g., communication, and provides a solid foundation for future engineering units (Hirsch et al., 2001). Even though the CDIO thinking is designed to give students experiences that are needed for a professional career, collaboration and context are frequently addressed within the CDIO Syllabus 2.0 (Crawley, Malmqvist, Lucas, & Brodeur, 2011), e.g., Teamwork (3.1) and External, societal, and environmental context (4.1). Consequently, project-based learning has become more frequent in engineering education, due to its ability to address both these generic skills as well as developing the students' disciplinary skills within the same setting (Mills & Treagust, 2003).

Globalization with interaction and integration between countries, business, and, foremost, people have accelerated with the development of applications for real-time communication. Globalization and the use of technological innovation in society have made clear that engineering is a profession with global impact. From a work perspective, most students will face situations when working together with international customers and colleagues, either on-site or online. Creating diversified teams with collaborators from other cultures becomes more important to reach specific markets and to understand these users' needs. This development has gradually increased the importance of having international segments during students' education to prepare students for these types of situations (Borri, Guberti, & Melsa, 2007; Guillotin, 2018).

The CDIO emphasizes in the Optional Standard 4: Internationalization and Student Mobility, that education should have "curricula which prepare engineers for a global environment and exposes them to a *rich* [emphasis added] set of international experiences and contexts during their studies" (CDIO Initiative, n.d.). This is truly done mostly by exchange studies or other activities where students spend time abroad and submerge in the international context. However, there is a need to give students who cannot, or do not want, to spend time abroad the opportunity to participate in different kinds of authentic international experiences. During the last two years, this has become increasingly important due to the global pandemic and closed borders, which has affected students' internationalization and mobility negatively.

Since the Covid-19 global pandemic hit the world in 2020, there have been many good practices regarding the possibilities of emergency remote work and collaboration over distance for professionals. Consequently, there has also been a vivid discussion about remote work and more flexible solutions for employees in a post-pandemic world. Even though many still prefer to work on site, there is a huge increase in the number of employees that desire a more flexible solution to their work situation (Alexander, Smet, Langstaff, & Ravid, 2021). In combination with globalization, there is an increasing need for engineers to work in an international hybrid environment for firms to utilize human resources in the best possible way and, thus, create competitive organizational capabilities. According to Berkey (2010), combining international experience with exposure to interdisciplinary situations and collaborative learning creates high quality learning experiences. Furthermore, from a university perspective, students feel that focusing on solving real-world problems in a collaborative and international context increases the perceived quality of their education (Damnjanovic & Novcic, 2011; Srikanthan & Dalrymple, 2002).

This paper discusses how hybrid collaboration in an international interdisciplinary setting as part of the curriculum can create professional situations that prepare students for future challenges. The paper presents results and learnings from the latest iteration of a long-term international interdisciplinary collaborative project. The aim of the project has been to expose students to a range of "real" situations to strengthen their professional skills. This paper extends preliminary results presented at the CDIO Conference in 2020 (Mejtoft, Cripps, Berglund, & Blöcker, 2020) by focusing on creating simulated settings close to what students will face professionally.

During all five iterations of the joint project (2017-2021), surveys have been conducted among the students, both at the beginning and the end of the collaboration. These surveys have been focused mainly on the setup of the collaboration and have been separated from the ordinary course evaluations. Furthermore, discussions with students and group interviews have been conducted during the different iterations. This paper is mainly based on the latest iteration between the two post-graduate units *Advanced quality project work in interaction technology* at Umeå University and *New product development* at Edith Cowan University. The results are based on documentation from entry and exit surveys as well as group interviews and discussions with the students, carried out between August 2021 and January 2022.

COLLABORATION SETUP

This paper presents results from an interdisciplinary project in an international setting between two universities: Edith Cowan University (ECU) in Perth, Australia, and Umeå University (UmU) in Umeå, Sweden. The collaboration is set up between a marketing unit at ECU and an engineering unit at UmU. The idea of the collaboration (Figure 1) is simple, and structured as a potential collaboration between a marketing team (ECU) and a software/UX development team (UmU), located at two different offices of a fictional digital agency. This is close to a real situation where firms often have different competences located in different parts of the world, depending on what and for whom a product is developed. Together, the teams are developing a solution for a wicked problem (Churchman, 1967; Rittel & Webber, 1973), given to them by a hypothetical customer, i.e., the teachers. The problem definition is intentionally kept broad to give the students the opportunity to shape the project, but also to reflect the common real-world situation that rarely all required information for a project is available. Hence, this is close to real

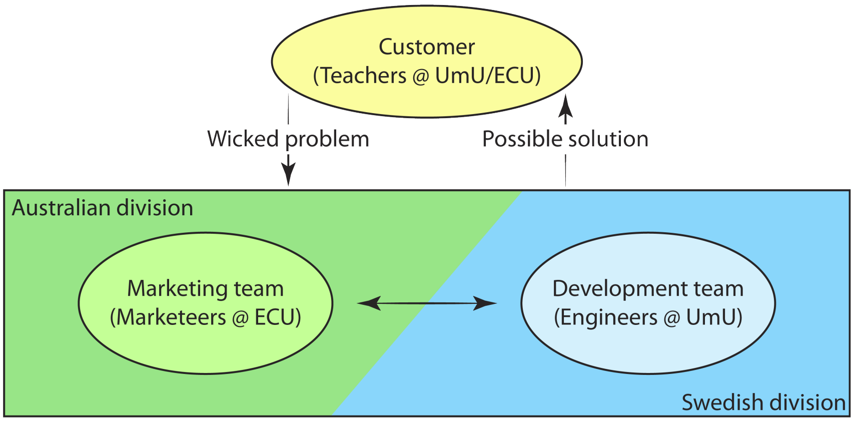

Figure 1. Collaboration setup where the marketing team at ECU and the development team at UmU form a fictional digital agency, and the teachers are their customer.

situations that the students might face when seeking a professional career after graduation.

The collaborative project was first initiated in 2017 and has been active ever since. During fall 2021, the fifth iteration was completed. Three different engineering units at Umeå University have been active in the collaboration over the years: *Prototyping for mobile applications* (fall semester, 7.5 ECTS, 50% pace), *Social Media Technology* (spring semester, 7.5 ECTS, 50% pace), and *Advanced Quality Project Work in Interaction Technology* (fall semester, 15 ECTS, full-time). These engineering units are similar in structure with project work that makes up about half of the first two units while the last unit is based entirely on project work. Regarding the marketing counterpart at ECU, two different units have been involved in the collaboration – *Current issues in marketing* and *New product development*. Regarding these two units, the latter is a better fit for the collaboration because it has a clearer focus on product development. The latest iteration of the project has been between the two post-graduate units *Advanced quality project work in interaction technology* and *New product development*. A major difference to previous iterations is that the engineering students were working full-time with the specific unit during (almost) the full length of the collaboration and the development work.

During each iteration, different wicked-like problems have been presented to the students for them to solve. During 2021, the following question was proposed to the students: "How can technology be used to support isolated elderly in Australia during the pandemic?". Students' learning connected to the CDIO approach and has been framed within the ideas of Design Thinking (Brown, 2008; Gibbons, 2016; Hasso Plattner Institute of Design, 2010). This framework was used as a common ground for the students' collaboration and development (Figure 2). The combination of using design thinking to implement CDIO skills in project-based learning has been discussed by, e.g., Isa, Mustaffa, Preece, and Lee (2019). The motivation for how the project work was structured was to facilitate inter-disciplinary exchange of best practices, as one goal of the collaboration was to make the students teach each other about how they approach problems within their respective discipline while leaving the problem specifics open to let the students determine them. Hence, the idea was to facilitate a community of practice (Lave & Wenger, 1991) among the students from the two disciplines.

The tasks for the two project teams were defined according to the structure of the design

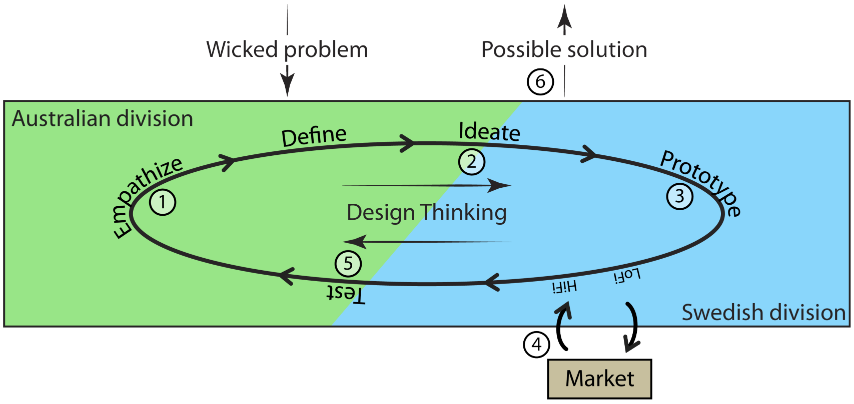

Figure 2. Illustration of the phases in the design thinking approach, together with how they have been divided in the context of the collaboration between ECU and UmU.

thinking approach (Figure 2). However, while the two student cohorts worked collaboratively, each had assessments required by their own institutions. The joint project was part of electable project-based courses and not a capstone project or part of the students' final thesis work.

First (see Figure 2), the marketing team at ECU conducted desktop market research, corresponding to the empathize and define phases (cf., conceive stage), into the needs of the potential customers which the new product development unit is focused on. In the most recent iteration of the project, the focus was on the needs of socially isolated elderly in Australia. As the ECU semester commences before the semester at UmU, the first assessment was done before the joint work started. As part of the market research, the ECU students developed customer personas for the potential market. The findings from the market research and customer personas were then shared with the UmU students, both electronically and as part of a joint session at the start of the UmU semester. To facilitate the collaboration the Swedish students had been asked to jump-start their semester to get some common knowledge before the work by the ECU students started. Second, in a teacher-facilitated ideation session (cf., design stage), the marketing and engineering teams worked jointly towards specifying an idea based on the insights from the market analysis. During this session the two teams, jointly, identified and discussed the problems to be solved as well as the gaps in the market in relation to meeting the needs of isolated elderly. The ideation session utilized the online real-time collaboration tool Mural. Both the engineering and the marketing teams gained insights into the respective other discipline through discussions where the marketing team explained the identified real-world needs, and the engineering team highlighted possibilities and limitations regarding practical feasibility within the time frame of the project. Third, from the information provided in the collaborative sessions and through the collaborative platform (Microsoft Teams), the project entered the prototyping phase (cf., design stage). The prototype phase was sub-divided into two milestones, i.e., a low-fidelity (LoFi) prototype phase using a parallel prototyping approach, and a high-fidelity (HiFi) prototype, for four reasons: (i) to keep as many ideas as possible in the first stage, (ii) to help with time management and provide a tangible product as a basis for discussion in the middle of the prototype work, (iii) to let the teams adjust the product with regards to the initial market analysis, and (iv) to provide a version to the marketing team as a basis for their subsequent work. During the LoFi phase, the engineering students created two LoFi prototypes in parallel which they presented and discussed during a virtual collaboration session. The UmU students integrated this feedback into the LoFi prototype, producing a single refined version. Forth, based on the “final” LoFi prototype, the ECU students used a new software called SpaceDraft to communicate their assessment of the product market fit of the proposed LoFi prototype. The feedback from this software was used by the engineering students and incorporated into the final HiFi prototype. Fifth, the HiFi version of the prototype was tested by the ECU students with customers in the target market (cf., design/implement stages). This gave results that are important for further development of the prototype and, consequently, for potential future launch of the product. Sixth, the students in the marketing team individually created 90-second pitches for funding from the hypothetical organization to take their product based on the HiFi prototype to market (cf., Leadership and Entrepreneurship in the extended CDIO Syllabus). These pitches were presented to their customer, i.e., the teachers and evaluated by their fellow ECU students as well as the UmU students. Importantly, the design thinking phases are not executed in a strictly linear fashion but provide feedback to each other and can be re-iterated several times. For example, prototype results can lead to a better understanding of the customer’s requirements, which affects ideation outcomes and feeds into a revision of the prototype. During the progression of the course, the students were encouraged to stay in touch and to share and discuss their progress, however, no formal requirements were defined regarding the form and frequency. Design processes in general and, in this case, the Design Thinking process have a good fit into the CDIO Syllabus 2.0. Consequently, this collaboration has a focus on conceive (4.3) and design (4.4) with some focus on implementing and testing of the prototype (4.4) along with Leading engineering endeavors (4.7) and Engineering entrepreneurship (4.8).

RESULTS FROM THE COLLABORATION

This paper presents results from an international interdisciplinary collaborative project which has recently completed its fifth iteration. Even though every iteration so far has been successful in terms of satisfied and motivated students, there have been different aspects that needed more attention and have been gradually developed further to create a good learning experience for the students and, at the same time, fulfil learning outcomes of the courses involved in the collaboration. Over the six iterations there have been many challenges which have been addressed in e.g., Mejtoft et al. (2020) and Mejtoft, Cripps, and Blöcker (2021). The biggest challenges over the years are presented in Table 1. The most recent iteration has been focused on creating a learning environment that is close to a real-life professional situation (cf. the setup described above). When asked if they were willing to participate in a similar collaborative project in the future, 63% of the students said that they were “extremely likely to participate” with the rest saying that they were “likely to participate”.

The students believed that the learning environment created through the collaborative project was different from a traditional academic learning environment – *“Getting tossed together with people from a different study discipline [. . .] that is always interesting. Working with a development project side-by-side with marketing students feels very close to a real work situation where several competences are involved”*. Furthermore, the students felt a higher motivation – *“I believe that it’s easier to become more laid back when just taking a course at the university with [ordinary] assignments compared to when doing a collaboration with an external firm or, as in this case, with students on the other side of the world. I feel that something happens to the motivation and the commitment when more [external] parts are involved.”*.

Table 1. Challenges addressed in previous iterations (Mejtoft et al., 2020, 2021).

Introduction	It is hard to give sufficient information and knowledge about the other student cohort.
Interactions	Even though possibilities for interaction were created, both the number of interactions and the quality of the interactions were lacking.
Collaboration	Expanded and deepened collaboration between the groups were requested by the students.
Timing	Timing of semesters between the different countries and real-time timings for meetings are problematic.
Digital tools	Different online platforms between the two universities and different digital skills between the two student cohorts created challenges.

One of the major differences, as experienced by the students, that created a professional situation was that they did not need to know about all the work that was done in the project - *"One difference is that we actually delivered by handing over results [between the two groups]. They did the marketing research. They gave us the information that we analyzed and used for developing the product. The situation when material is handed over is very much like a real work situation [. . .] It's a different type of collaboration, when we collaborate within the class it is more like 'you have this area of responsibility within the project [but we still work together]'. But in this case, we have nothing to do with the other things at all."*.

Overall, a professional situation was simulated by (1) a high level of collaboration and commitment, (2) internationalization, (3) digital collaborative tools, and (4) creating an interdisciplinary community of practice.

High level of collaboration

Post-course surveys from previous iterations have indicated that the students wanted a higher level of interaction and integration between their courses. As a test to see the effects of increased interaction, the latest iteration of the collaboration had the highest level of virtual collaboration so far, in class as well as in the students' own time. Both student cohorts were smaller than in previous iterations, which led to higher levels of interaction and a setup where all students worked on the same project and prototype throughout the course. Several of the online meetings, which were held at lunchtime Swedish time/Thursday evenings Western Australian time, continued past the scheduled end because the students formed personal bonds during the time working with each other. This was the first time in the collaboration where the students actively collaborated in real-time outside of the set class times, not only working together but creating a sense of collegiality. Students commented on the benefits of a high level of interaction and collegiality as: *"You get to know each other and their backgrounds and also their style of approach towards a given task"*, and *"[We were] learning about different styles of communication, commitment to complete tasks"*. The collaboration was commented as: *"One of the best things was when we had meetings in a smaller group, like when we had meetings with [a single ECU team]. That's when we thought that we had the best interaction, because we talked to each other . . . This was when I believed that we got the most out of it [the collaboration]"*.

Communication becomes more important for the students when communicating beyond within their own cohort or with their local teachers. Working with people they did not know beforehand, and whom they did not meet in person, made the situation more real, which had impact on the attitude among the students – *"We always have the attitude that we want to be professional and do a good job. But, even more so in this situation. This was the attitude from both sides in the collaboration"* and *"We had higher demands [on ourselves] because there were more 'strangers' involved"*. This was also shown when students pointed out inappropriate comments from other students that they did not feel were professional.

Internationalization

Working with teams in other countries is common when working with development work, especially within engineering. The present setup created an international setting involving different cultures, time-zones, and languages. According to the results of the survey, all but one student found it easy to work with international students in another area of study. English language proficiency was not an issue in communication among the students, however it was commented that it was a little bit difficult to understand each other, particularly as the Swedish students were working with the ECU students who were both Australian and international students from countries as diverse as China, South America, and South Asia. One major obstacle for working with students overseas were the time zone differences (7 hours between Perth and Umeå), as it *"has taken some doing to schedule availability over several different time zones"*.

Digital collaborative tools

Regarding digital tools to collaborate between the two cohorts, Microsoft Teams and Zoom were used. Learning how to use these tools was regarded as a valuable professional skill, and the tools have become preferred environments for students compared to platforms used at previous iterations (e.g., Slack). For collaboration within their cohorts, students used, e.g., WhatsApp and Facebook Messenger. As part of the joint course sessions, the students used real-time collaborative tools, such as Mural, to develop the concept in real-time. All the students found the real-time collaboration useful, with the majority considering it to be very useful. Mural created a virtual place where the students focused on their task together, facilitated lively discussions, and choosing between proposed ideas through anonymous voting allowed the students to feel comfortable when taking a stand. The students commented on the digital platforms as: *"A great tool that I use in the workplace too"*, and *"I think it was a great platform for the collaboration, it was easy to get in contact with everyone at once or one specific student"*.

Interdisciplinary community of practice

When starting the development work, both student cohorts were lacking in-depth information about the other students, their background, and experience. However, this created an interdisciplinary community of practice where the students had to support each other to create a common learning in the intersection between engineering and marketing. The students commented on this as: *"Having to explain basics and other thing within our area is something I'm not used to but is very informative"*, *"We had to explain our process in an understandable way to students who are not as familiar with the area of our study. In return we got some insights regarding their field of study."*, and *"[A] clash of thoughts which can sometimes lead to a different approach."*. This situation where students have to explain things that they are not used to, and when collaborating and working across disciplines gives, according to one of the students *"different perspectives and knowledge transferring"*.

CONCLUSIONS

Our idea of an international interdisciplinary collaborative setup to create world-ready students was established and tested and refined repeatedly before the global pandemic accelerated the creation of online learning and online working environments. We believe that the range of skills gained by the students when participating in this collaboration has grown during the last couple of years and will be even more valuable in industry in the future. Even though many valuable skills have been gained by the students in terms of disciplinary and interdisciplinary knowledge, one student commented on one of the main outcomes: *"In my experience collaboration is a valuable skill that is appreciated in the workplace"*.

Throughout the five iterations of the collaboration, the level of online interaction between the students at ECU at UmU has continually increased. Initially, the collaboration was driven by the teaching staff, however, it was the students in the most recent iteration who repeatedly requested to meet to discuss and refine their project. The collaborative meetings continued past the end of the semester.

As teachers on the courses, it is extremely encouraging to know that the students appreciate the efforts made to create this learning situation. Even though there have been frustrations and problems, the students commented on the collaboration as: *"It was a fantastic unit, I enjoyed it"*, *"I looked forward to those Thursdays"*, and *"It's fun!"*.

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BIOGRAPHICAL INFORMATION

Thomas Mejtoft is an Associate Professor of Media Technology and appointed Excellent Teacher at Umeå University. He holds a PhD from the Royal Institute of Technology (KTH) in Stockholm and since 2011 acting as the director of the five-year integrated Master of Science study program in Interaction Technology and Design at Umeå University. His research and teaching interests include not only media technology, interaction technology, interaction design, business development and students' learning, but also value creation, marketing issues and technological changes in connected to the media and the media industry. He has been published in e.g., International Journal of Information and Learning Technology, Marketing Intelligence and Planning, and Industrial Marketing Management and has presented at numerous international conferences within different areas including CHI, ECCE and, of course, the CDIO conference.

Helen Cripps is a senior lecturer at the School of Business and Law, Edith Cowan University, Perth Australia. Her research is focused around social media and innovation. She conducts industry-based research across multiple sectors including maritime, retail, electronic health, tourism, and gig economy. Helen's research sits at the nexus of online media, technology adoption and innovation as it draws on her large network of government, industry and academic contacts nationally and internationally. She has undertaken research in Australia, Croatia, Finland, Norway, Sweden, UK, and USA, completing a number of research projects for government and industry clients. Her current research is focused on digital innovation and digital media analysis to investigating the impact of online conversations on brand value and customer service. She currently lectures in a number of topics across the digital marketing, new product development and e-business contexts.

Christopher Blöcker is a PhD student in network science at the Integrated Science Lab, Department of Physics at Umeå University. He has extensive international experience and worked as a research engineer at the National University of Singapore and as a software engineer in Germany. He is enrolled in WASP, the Wallenberg AI, Autonomous Systems and Software Program and his research is focused on understanding the structure of complex networks better. He teaches courses about mathematical modelling with networks, information theory, and technology for social media.

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