A LITTLE GOES A LONG WAY - OPPORTUNITIES FOR MULTIDISCIPLINARY EDUCATION

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ABSTRACT

Ambitions about deep interdisciplinary education may face barriers. However, interaction between student groups does not have to be difficult. We report on a collaboration including more than 200 students from different subject areas, at different curricular stages in a multidisciplinary concept workshop. By engaging with an external event we avoided some of the challenges involved in aligning agendas, while remaining true to the ambitions of giving students Concrete Experience and opportunity to Reflect in and on actions, balancing the ambitions of raising awareness of the relation between subjects and engaging students in collaborating in problem solving based on skills and knowledge from their respective discipline. Our results show how collaborating with industry can help bridge some of the challenges with internal collaboration between students from different disciplines.

Keywords: Professional roles, reflection, experiential learning, concrete experiences.

1 INTRODUCTION

Collaboration and crossdisciplinarity in engineering education is important. However, collaboration between students from different disciplines can also be challenging. Much design and development work involves collaboration of different disciplines [1], [2]. Various factors support or hamper collaboration; e.g. "unified culture with partners," "choosing suitable partners" and "proper organizational culture" [3], and drivers and barriers occur at both actor, project and company level [4]. There is hence a need to prepare students for interactions across disciplines; giving them the skills of their own discipline, but also generic skills concerning communication and collaboration. Inter-disciplinarity is not only a goal that higher education should prepare students for, but can also be a means for organizing learning activities. Inter-disciplinary education enables students to integrate their knowledge and skills to come up with a joint proposition, educating the students regardless of their own trait and trade [5]. Interdisciplinary education also promotes collaboration and communication [6], which are generic engineering skills [7]. In short, interdisciplinary education should facilitate the professional development of engineering students.

1.1 Interdisciplinary education

While they in practice often overlap, a distinction can be made between two overarching types of interdisciplinary learning [8]. One concerns learning about interdisciplinarity; i.e. "awareness and understanding of the connections and differences across subject areas and disciplines". The other concerns bringing together "learning from different subjects and disciplines to explore a theme or an issue, meet a challenge, solve a problem or complete a final project". Distinctions are sometimes drawn between different types of disciplinary collaboration [9], [10]. Simplified; the term multidisciplinarity is used to denote a situation where something is simultaneously approached from different (disciplinary) angles. Interdisciplinarity instead involves an approach with shared methodology and language. Transdisciplinarity goes one step further, spanning traditional disciplines based on a shared understanding. Despite potential advantages of interdisciplinary education, there is also a recognition that it has barriers in form of faculty attitudes, student perception, physical facilities, administration and placement within educational programs – including scheduling [11]. Each course is typically designed to Constructively Align the Intended Learning Outcomes (ILOs), Assessment Tasks (ATs), and Teaching and Learning Activities (TLAs) [12]. Arranging TLAs across educational

programs, assumes that educators have faculty support etc. but also that it is possible to identify relevant student groups and interested collaborators.

This paper presents a case in which students from four academic programs were brought together around an innovation challenge. The ambition was to involve the students in experiential learning [13], by providing opportunity for concrete experience, while also engaging students in reflections in and on action [14], in particular regarding what it is they do in relation to other disciplines. Our contribution answers the research question *How will known barriers for multidisciplinary education manifest themselves when large-scale and unaligned educational settings collaborate through an intermediate broker?*

2 METHOD

The collaboration took place in September 2015 as a concept factory during Electricity Innovation Challenge 2015. The teachers independently of each other took the opportunity to participate in the event, while the organization behind the challenge acted as a broker, facilitating multi-disciplinary educational collaboration.

2.1 The Electricity concept factory event

Electricity Innovation Challenge 2015, EIC2015, was organised September 18th to October 21st to surge open innovation, public interest and to test the demonstration arena under development [15]. On the first day of the challenge a 24-hour concept factory was organized where 43 registered teams participated in order to come up with and refine their concepts. The participants represented start-ups, consultancy firms, global consortia and educational programs. The challenge was organized by a multi-party consortium including public organizations (such as Västtrafik, the public transport authority), private corporations (e.g. Ericsson, involved in the demonstration arena) as well as academic institutions (like Chalmers University of Technology). These organizations also participated at the concept factory in order to present their agenda and answer questions from the teams, making the contest and the concept factory into a triple-helix collaboration [16].

2.2 Educational collaboration

The educational element was a three hour session during the concept generation factory where students from the master program in industrial design engineering (IDE) and interaction design (IxD) supervised students from three bachelor programs - computer science (CS), IT as well as media and cultural entrepreneurship (MCE). The last program run by the University of Gothenburg (GU) and the rest at Chalmers University of Technology (CTH). The CS and IT students were at the time taking the same course. During the concept factory one to two master students supervised a team with the aim to refine their concepts. The participation of the CS and IT students had been planned half a year in advance. Three weeks before the concept factory was held, the teachers of the master students were asked independently if they thought their students would want to act as facilitators during the event. Since the event took place during the evening it was not in conflict with already planned educational activities and an arrangement was made. Students participated in the event on a voluntary basis, meaning that not all students turned up. While some discussions were held prior to the actual event, the student groups were not coordinated in advance, but rather came into the event assigned the role of either facilitators or team members.

2.3 Data collection and analysis

While the event involved four different student groups, the data collection and analysis has predominantly been concerned with the material from two groups of students, IDE and CSIT, since the teachers at the other two programs have not had the means to participate further in the multi-disciplinary collaboration. The common data sources are the course evaluation (both surveys and discussions at the last lectures) and the teachers' observations and reflections. From the IDE students we also have the reports on the designer roles and the teacher's notes from the seminar following the concept factory. The CSIT students wrote reflection reports on their development process (including the role of the concept) and discussed their experiences on the follow-up lecture. The submitted concepts can be accessed from the EIC2015 homepage [17]. Data from the other student groups has been obtained through informal interviews with the course responsible. The data was analyzed

bottom-up, searching for emerging themes [18]. Each teacher analyzed the data from their own course and then the emerging themes were compared and contrasted to each other.

3 RESULTS

This section will first give an overview of the overall educational participation before detailing the CSIT and IDE students' experiences.

3.1 Overview of student participation

The multidisciplinary collaboration included four courses, representing two universities and 290 students. Five teachers with expertise in four different disciplines were involved. Before the event there had been no alignment between the teachers in terms of agendas. An overview of the role of the concept factory in terms of education is found in Table 1.

The IxD students' participation at the event was scheduled as a practical exercise with the purpose to help the event organizers with facilitation. As a bonus the teacher found that the students experienced that they had gained knowledge that junior students lacked. The MCE students had EIC2015 as course project were the aim was to put the knowledge from parallel courses into practice. Overall the MCE students found their participation in EIC2015 both educating and fun.

Table 1. Role of the concept factory for the different student groups

	IDE Students	CSIT students	IxD students	MCE students
Curricular Stage	1st year master	2nd/3rd year bachelor	1st year master	1st year bachelor
Course / Univ.	PPU090 / CTH	DAT255 / CTH	CIU176 / CTH	MEK100 / GU
Discipline	Industrial design engineering	Computer Science & IT	Interaction design and technologies	Media and culture entrepreneurship
Role in event	Facilitators	Team members	Facilitators	Team members
Role of event	The concept workshop is a one off event	EIC2015 serves as overall case for course project	The concept workshop is a one off event	EIC2015 serves as overall case for course project
Assessed	Voluntary	Compulsory	Voluntary	Compulsory
Nr. of teachers	1 teacher	1 teacher	2 teachers	1 teacher
Nr. of students	42 students	153 students	65 students	30 students

3.2 Experiences from the CSIT students

The CSIT bachelor students came from the course "DAT255 Software Engineering Project", the CS students in their 3rd year and the IT students in their 2nd year. The overall aim of participating in EIC2015 was to provide a real-world case and external stakeholders to put the course project on a critical path. Among the ILO is the ability to "elicitate requirements from and design a solution to a real-world problem" and "plan and execute a small software development project in a team". Here the concept factory helped in addressing the first and EIC2015 the latter. The concepts were used partly to assess how the teams delivered external stakeholder value but also as a starting point for a third ILO, "reflect on the choice of software engineering methods used in the project".

We have three kinds of interactions between facilitators and teams based on the CSIT students reported experience; first, the team had already decided upon their concept and did not find the input of the facilitator useful; second, the team found the input of the facilitator not useful since it was in conflict with the bachelor students' course criteria; finally, the team learnt useful tips and tricks that enabled them to come up with or conclude their concept and get rid of loose ends. The team also emphasized that they now understood the need to view their concept from other perspectives than their own, something that the teams applied later during implementation as well.

3.3 Experiences from the IDE students

For the IDE students the workshop was one out of several workshops in the course "PPU090 Industrial Design Engineering – Theory and Methodology". The event had been advertised to them in advance, and new their role was to serve as facilitators as voluntary but recommended. One day before

the workshop they were given a short recap on creativity and idea generation methods, but they had limited chance to prepare for the event as details were unknown to them. One of the ILOs of the course concerned describing and reflecting on problems and opportunities associated with crossdisciplinary and cross cultural product development work. Students were to in group write reports that "relate Industrial design engineering to other design disciplines", and "give an account of drivers and barriers for crossdisciplinary or cross cultural work". An idea with involving the students in the workshop was that they in their respective group could gain concrete experiences from a crossdisciplinary setting, and that they could then compare and contrast first within the group and then to theory in reports.

In a post workshop seminar students expressed that the workshop had been rewarding; allowing them to realize how much they knew after three years of studies (in comparison to the relative novices). In written reports students in a few cases exemplified with situations from the workshop, but did not focus on the workshop as such. However, their own skills and relations between disciplines were intensely discussed in a seminar. It became clear that the experience of facilitating had varied in challenge. Some of the teams had consisted of first year undergraduates with little or no design experience. Teams had in those cases been grateful for help on ideation. This had especially been the case with the MCE students, taking a humanities oriented program. In another case, some consultants with considerable working experiences seemed less open to the students' input.

4   DISCUSSION

The discussion relates the outcome to the aim, reflects on our methodology and puts our contribution in relation to the literature as well as suggests future work.

4.1 Outcome in relation to aim

Since the students' participation emanated from different starting points it's no surprise that they also have different concrete experiences and learnings. That said, the event was successful as platform for giving students practical insights and enabling reflections on their own profession in relation to other disciplines. The event had implications for us as teachers as well, it gave us the opportunity for both experiential learning and reflection-in/on-action. This in turn provides valuable insights in how to organize multi-disciplinary collaborations but also a platform of mutual trust for future collaborations as well as an opportunity to reflect on our role as teachers. It seems that focusing on supplying concrete experiences [13] in relation to ILO within a neutral setting, circumvents the challenges of finding a suitable partner [3] so that a multidisciplinary context becomes a consequence instead of an immediate goal of the collaboration. It is then up to each teacher to constructively align the ILO to the TLA and AT [12].

4.2 Reflections on methodology

The event was not planned as a research study but still enabled teachers with different commitment and course setups to collaborate in multidisciplinary education. The participation in EIC2015 and the concept factory was managed within existing course budgets in terms of hours and monetary expenses. A more systematic data collection strategy with the explicit aim of furthering our understanding of interdisciplinary education could have been done but was beyond the current educational setup and not in the scope of EIC2015.

4.3 A bigger picture

Coming back to the barriers mentioned by Singleton [11], our experience nuances their impact on multi-disciplinary collaborations. *Faculty attitudes* was not an issue since few compromises had to be made between the teachers of the different courses. Rather, each involved teacher could act independently in designing his/her course, and linking it to EIC2015 as appropriate. *Student perception* was probably the most challenging since collaborating with other students in different stages of their professional development and mastery of tools and skills can be a challenge. This was noticeable among the CSIT students where some teams did not take the opportunity to interact. *Physical facilities* were provided by the hosts of the EIC2015, requiring no specific administration from the teachers. Facilities became a free resource on neutral ground. Regarding *Administration* the collaboration had no impact on the overhead. Instead the level of engagement towards EIC2015 was the main challenge, where participation was either a one-time event or a series of course interventions

over six weeks. Each event or intervention required organization similar to that of a guest lecture. *Placement in program and scheduling* was not a barrier since the courses ran in parallel. Here the timing was non-negotiable due to the overall time-line of EIC2015, as teachers we just had to fit in or opt out. That said, a key factor for successful collaboration was that all involved teachers were open to introduce new TLA in their courses to support the ILO.

4.4 Future work

The initiative to involve the students in the workshop emerged out of discussions between the specific teachers and the organizers of EIC2015. Given a chance to revise the setup several future directions could be explored. It would be interesting to give closer attention to the interactions going on between student groups in the concept workshop. By assigning some students the role of observers it could be possible to raise further reflections on the ideation process as well as disciplinary similarities and differences. This could possibly also yield an interesting research material. The different experiences from the IDE students indicated power – Expert vs novice as a possible barrier to collaboration. Another avenue to explore would be to initiate some repeated interaction between student groups. A possible improvement would be to let the supervisors meet the teams half-way through their project to help them evaluate on how close the implementation is to the concept and what has caused the difference, reflect on the challenges the team has encountered and how these were handled and finally see what could be changed or done differently. The procedure would then be repeated at the end of the course as well.

Given that similar opportunities arise around a future innovation challenge, it would be relevant to consider a deeper collaboration with inter- or transdisciplinary ambitions. However, the possible benefits need to be weighed against additional administration and possible barriers. By maintaining a loose coupling the barriers faced were mainly on an actor level [4]. Each teacher here maintained autonomy, aligning the interaction with EIC to ILOs within the respective course. Decisions on whether and how to partake hence remained with the teaching staff. It was possible to maintain existing course practices, limiting risk of problems arising from differences in disciplinary tradition. Changing the setup towards deeper collaboration would likely imply that we would run into well-known barriers [11], not only at individual level but at level of organization, as there would be a need to regulate scheduling, facilities etc. Collaborating with other students that have different experiences and skill sets may be challenging. Assigning students different roles enabled us to include students from different disciplines and educational levels. A deeper interdisciplinary collaboration would most likely also require adjustments of ILOs in overall curriculum, leading to negotiations and bland compromises. Changing ILOs would also likely affect more staff, and possibly making the collaboration sensitive to more barriers.

5 FINAL REFLECTIONS

In the context of collaboration between the teachers on the different courses, EIC2015 came to provide a mutual context. This provided an opportunity to expose students to a range of stakeholders. Rather than having the courses adapt to reach mutual synergies, this neutral ground provided an interface. Without it, it is unlikely that any interdisciplinary activities involving students from the different courses would have been held, despite the fact that several of the teachers know each other since before. Not only did EIC2015 serve to convey an overall motif, it was also, while temporally constrained, flexible enough to allow the different courses to connect to it, without major compromises on course structure etc. In a situation where two of the courses were to collaborate directly, the differences in agendas would have led to quite extensive conflicts in interests. While it is possible that these could have been overcome, aligning agendas would have taken considerable effort to overcome Singletons barriers. The mediated interaction through EIC2015 now instead allowed for agendas to remain compatible but neither supporting nor counteracting each other. For the individual teachers it was sufficient to know that the event(s) mapped onto the ILOs of one's own course, independent of other educational agenda. As a result, a minimum of effort was spent on coordinating the four student groups; while their comments indicate that they found the interaction mutually rewarding.

In conclusion, EIC2015 acted as an intermediate broker, where unaligned educational settings with differing learning goals, student maturity, teacher availability etc. could connect to the flexible interface of the broker and thus independently of other educational settings collaborate through

EIC2015. While the event only lasted for three hours it still facilitated a platform for diverse and multidisciplinary student collaboration, giving the opportunity for both students and teachers to reflect on their own professions as well as training in communication across disciplines; i.e. a little goes a long way.

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