

Challenges in Multidisciplinary Student Collaboration

Reflections on Student Peer Assessments in Design Education

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This paper reports on a study currently conducted in the scope of an Erasmus+ KA2 project on the subject of co-creation in design education. A case study was carried out on a third-year bachelor design engineering course (“Co-creation”) at which 48 students from different study disciplines, levels and countries worked together in groups to tackle societal challenges. This research aims to gain insights into students’ experiences and problems with regard to taking part in a multidisciplinary co-creation process by scrutinising student’s self- and peer-assessment reports. Findings refer to the essentials and challenges of multidisciplinary co-creation processes from a student perspective. In particular, soft skills were highlighted as fundamental skills while working with peers. Moreover, challenges in collaboration, specifically, in a remote learning environment during the COVID-19 pandemic, were noted. Recommendations were provided for design educators to ameliorate the multidisciplinary co-creation and learning environment in order to sufficiently prepare students for Industry 4.0.

Keywords: multidisciplinary design education, co-creation, student experiences, peer assessments, COVID-19

Introduction

Co-creation refers to the involvement of users and other stakeholders (who are not designers) in the design process (Mattelmäki & Visser, 2011). It corresponds to the term ‘collective creativity’ in which more than two people share their creativity (Sanders & Stappers, 2008); assumed to be inherent in everybody (Sanders & Stappers, 2012). Originally, co-creation in design practice has its roots in the 1970’s participatory design movement that advocated the democratisation of the design process involving those individuals, who will be directly affected by its outcome (Ehn, 2008). In terms of context, co-creation practices draw attention to urgent societal problems addressed by, for instance, the United Nations under the Sustainable Development Goals scheme (United Nations, n.d.), and seek ways to solve these problems by involving multiple stakeholders (McAra & Ross, 2020). Since there is not only one correct solution that is customarily expected after following a linear process, these societal problems are generally considered “wicked” or ill-structured problems (Buchanan, 1992). Wicked problems may derive from multiple causes and, thus, they require a multidisciplinary approach (Cooke, Dusenberry & Robinson, 2020). Similarly, co-creation is multidisciplinary in nature and, importantly, is a term discussed not only in the design discipline (professional practice) and design education (Qu et al., 2020), but also in numerous other fields, such as, business (Ramaswamy & Ozcan, 2018), marketing (Whalen & Akaka, 2016), psychology (Carranza, Díaz, Sánchez-Camacho & Martín-Consuegra, 2021) and management (Windasari et al., 2021).

Co-creation in education, in fact, dates back to the 1960’s when the benefits of collaborative learning such as innovative idea generation (Sung & Hwang, 2013) were recognised (Bruffe, 1999; Rock et al., 2018). Moreover, group work has been associated with promoting student engagement and sense of belonging (Masika & Jones, 2016) and bolstering experiential learning (Kolb, 1984), collaborative and cooperative learning (Laal & Laal, 2012). So far, design students have been engaged in co-creation projects in several universities including the



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Glasgow School of Art (GSA) (McAra & Ross, 2020), TU Delft (Stappers, Sleswijk Visser, & van der Lugt, 2007), Middle East Technical University (METU) (Turhan & Doğan, 2017) and Ghent University (Detand & Emmanouil, 2018). Including co-creation practices in design education curricula and providing multidisciplinary environments to students, is of paramount importance for various reasons. For instance, working in multidisciplinary co-creation settings may enhance certain interpersonal skills of students such as empathy (Lee et al., 2019; McAra & Ross, 2020) and teamwork skills (Fink, 2003). In addition, experiencing this multidisciplinary environment in design education has a strong potential to provide students a 'decolonised gaze' especially for approaching wicked or ill-defined problems. This is explained by Giloi (2017, p.89) as follows:

... 'wicked problems' [...] cannot be approached using only one paradigm, procedure, form of knowledge or one group's experience and way of knowing. In the case of design education, students would have to cultivate the dispositions and gazes that allow them to work within these complicated and ill-defined scenarios and to design for and with groups who have different experiences to their own. In adopting a decolonised gaze, design students would not only gain a better understanding of diverse experiences and perspectives, but would gain access to multiple forms of knowledge, knowing and ways of doing (Giloi, 2017, p.89).

Allowing students to take part in multidisciplinary and multinational participatory environments is beneficial for them to adopt a decolonised gaze (Charlotte Smith et al, 2020). Especially in design education, this is essential, since it contributes to broadening students' perspectives (Schultz et al., 2018; Trias Cornú, 2020) and provides them numerous sources of knowledge and multiple ways of knowing, doing and being (Giloi, 2017), which will be necessary to tackle societal wicked problems (Buchanan, 1992). Moreover, engaging students in co-creation projects is in line with the bottom-up approach in design education that offers a sense of 'joint ownership' and allows students to learn-by-doing (Schelvis et al., 2013; Ind & Coates, 2013). Despite the plethora of reported benefits of multidisciplinary collaboration in design education, students are having difficulties during co-creation processes (Karjalainen & Repokari, 2007; Murdoch-Kitt et al., 2020). According to Karjalainen and Repokari (2007), students are confronting the biggest challenges stemming from their different backgrounds, languages and ways of working. Karjalainen and Repokari (2007) report that in their study, students struggled against the difficulties of collaborating with partners from different time-zones and the long distance led to spending more time and effort to achieve good quality communication and collaboration. Moreover, using different terminology and having diverse abstraction levels depending on the disciplines such as mechanical engineering and industrial design were seen as some of the major problems in multidisciplinary co-creation. Wallin (2020) also adds that the amount of time invested by the members in the co-creation work is open to comparison by themselves and this may lead to conflicts among students during a co-creation process. Davies et al. (2009) explains that the imbalance in the group may cause some problems such as social loafing and egoism.

From the skill development point of view, Dhadphale and Baughman (2018) points out that the multidisciplinary work processes may become fruitless for students when teamwork skills are not taught and practiced actively. It has been shown that the effectiveness of the multidisciplinary co-creation processes has been linked with soft skills as well as hard skills (Gago & Rubalcaba, 2020). As explained by Philips et al. (2020), hard skills comprise technical skills that are related to a profession or job, whereas soft skills are transferable interpersonal skills. On the one hand, hard skills are teachable and measurable skills that can be about speaking a foreign language, accounting, using a computer program or having a degree (Tsey et al., 2018; Philips et al., 2020). On the other hand, soft skills pertain to a mindset regardless of a particular job. They differ from hard skills in terms of teachability as they are intangible, personality-oriented and hard to attest (Rao, 2014; Cimatti, 2016). Haselberger et al. (2012) divide 22 soft skills into three overarching categories; *personal skills, social skills and methodological skills*.

According to Haselberger et al. (2012), *personal skills* include learning skills, professional ethics, self-awareness, tolerance to stress, commitment, life balance and creativity/innovation. *Social skills* cover communication, teamwork, contact network, negotiation, conflict management, leadership and culture adaptability. *Methodological skills* refer to customer/user orientation, continuous improvement, adaptability to changes, results orientation, analysis skills, decision making, management skills, research and information management skills. Soft skills are also seen as the skills that cannot be easily acquired by machines if the developments in artificial intelligence and automation cause unemployability of some individuals in the future (Philips et al., 2020). In addition, there is no wonder that with the rise of the Fourth Industrial Revolution (Industry 4.0), individuals will need to adapt to the incremental changes in the technology and soft skills such

as creativity is required for easy adaptation (Cotet et al., 2017; Maisiri et al., 2019).

In this respect, acquisition of soft skills may have a vital role for students' success in multidisciplinary co-creation processes that prepares students for Industry 4.0. However, the association between certain skills and their importance in multidisciplinary co-creation processes has hitherto not been studied in detail. Moreover, in spite of the fact that it has long been argued that it is important to give voice to the students about their experiences (Shor & Freire, 1987), little research has been done on this subject so far (Karjalainen & Repokari, 2007; Elsharnouby, 2015; Dhadphale & Baughman, 2018). Understanding the needs and expectations, as well as, the challenges and problems of students from 'within' their own point of view during a multidisciplinary co-creation process as members of a design team, is essential in order to act on it. Furthermore, this is crucial to empower students to take charge of their learning experience and make them feel that their opinions matter in the learning environment, in which they are seen as "producers" (Neary & Winn, 2009).

Starting from this standpoint, this study focuses on the micro-world of the student teams. In the course under examination, co-creation has been looked at from the perspective of what was essential for the students during the co-creation process in their multidisciplinary and multinational group, and what obstacles they encountered throughout this process. Accordingly, the following research questions were formulated:

- What are the difficulties students face during multidisciplinary co-creation processes?
- What are the essentials of efficient and effective multidisciplinary co-creation processes?

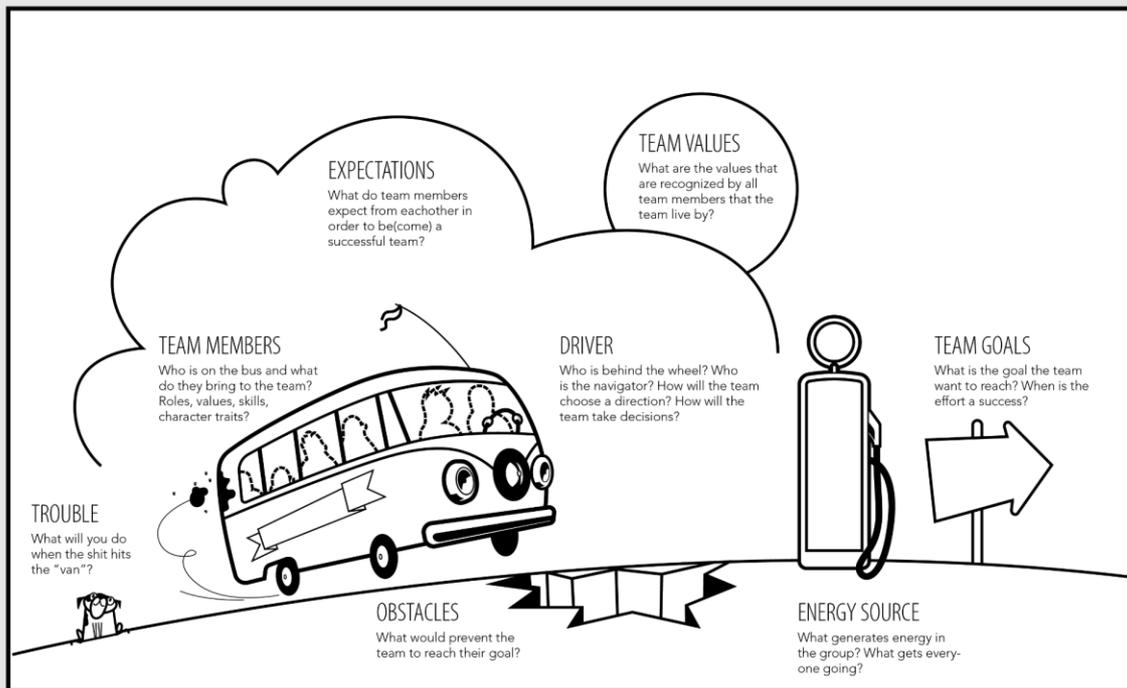
Case Study

A case study was conducted in the university-wide elective course "Co-creation" with 48 students, who worked in 8 groups on 8 different projects during the 2020-21 Fall semester. The project topics ('challenges') relate to real life issues and are offered by a variety of companies, organisations and the public sector (<https://www.callforchallenges.be/en/>). Initially, each student chose a project topic from a list that focused on a societal problem, such as, promoting tap water consumption; creating a sharing system for utensils; providing a safer automobile environment for children with the help of smart fabrics. The students who chose the same project worked together.

Each group employed the course's methodological framework (Design Thinking methodology) in order to make propositions for the societal, wicked problems of their projects during one academic semester. The students came from various departments within Ghent University, including industrial design, textile engineering, psychology and business economics educational programs. Furthermore, 13 of them were Erasmus+ (exchange) students, the majority of whom came from a textile engineering background. This opportunity enhanced the level of diversity achieved in the groups. In that sense, the groups were not only multidisciplinary but also multinational in nature, potentially allowing both expertise and culture exchange to occur on a project and group level alike.

Throughout the semester, students utilized the T-CREPE Planet Platform, which is an online learning platform developed by Ghent University and its partners in the scope of the T-CREPE (Textile Engineering for Co-creation Paradigms in Education) Erasmus+ KA2 project. This platform guided students in the design process from the initial understanding of the problem and its definition, to ideation and testing of ideas. It was a complementary tool in the hands of the teacher to introduce or delve deeper into the Design Thinking methodology in a playful way, especially to non-design students (3rd year design engineering students already had training since their first year). The design process (seen as a 'journey') was represented through the metaphor of an imaginary planet that corresponds to the four stages of the Design Thinking methodology: Discover, Define, Develop and Deliver (Design Council UK, 2021). The four stages were translated as four continents on this planet, which includes general design tools/methods and custom-made games that were co-developed by the European consortium members specifically for this course. Students were invited to go through the continents, one-by-one, and explore tools that help them understand the nature and purpose of each stage in the design process. The games, specifically, allowed them to explore and enhance their understanding of the design thinking process by playing, modifying and designing their own games related to real life problems, possibly related to their course projects. By playing the games, students had the opportunity to discuss and share their ideas, as well as modify and create new games together with their peers for their project topics.

TEAM CHARTER CANVAS



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Figure 1. Team Charter Canvas (Van Der Pijl et al., 2016)

After determining their project topics and forming their groups, students completed the "Team Charter Canvas" (Van Der Pijl et al., 2016), which makes them contemplate on the roles of group members, team goals, expectations, team values and possible obstacles (Figure 1). In the Team Charter Canvas of some groups, it was seen that the students considered "different backgrounds" as an obstacle in reaching their goals. This underlines the importance of conducting a study to understand the reasons behind students' struggles in multidisciplinary co-creation environments in order to remediate them.

In order to deeply analyze the group dynamics and elicit information about these points, students are asked to articulate their opinions of their own performance and also of their peers by filling in a peer assessment report three times throughout the semester. After the first two peer assessment reports, these problems are discussed during the coaching meetings among students and coaches. This case study concentrates on the final peer assessment reports of the students that represent their final thoughts and opinions about each other and the multidisciplinary co-creation process.

Figure 2 explains the journey of the students throughout the semester and highlights the focus of this study, the final peer assessment reports, which are submitted by the students at the end of the semester. It was aimed to investigate the key aspects of effective communication and collaboration among group members from the point of view of the students. Moreover, it hopes to reach an understanding of the problems encountered by the students who collaborated in this multidisciplinary environment in a challenging time period; during the COVID-19 pandemic.

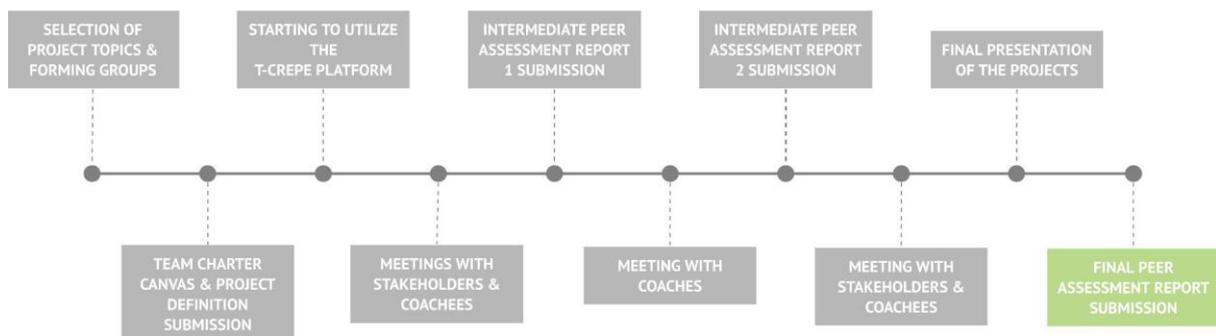


Figure 2. The journey of the students in the semester for the Co-creation course

Methodology

In order to gain insights from students' opinions, various methods can be utilized. A legitimate and direct method is to consult their peer-to-peer assessment reports (Ehmann, 2005). Moreover, the peer assessment reports provide another benefit of encouraging active participation of students in the evaluation (learning) process. Therefore, these reports can be seen as a constructivist tool that supports students in active construction of knowledge in education (Doyle et al., 2019). In this way, students become co-creators of the student assessments, including their own (learning) performance during the course. This act contributes to democratisation of the assessment process (Deeley & Bovill, 2015). For these reasons, this study draws from this source (peer assessment reports) in order to get a better understanding from 'within', that is, by students and of their needs and problems during the co-creation process with students from different disciplines and nationalities.

The report templates were prepared by the teacher and distributed to the students in the beginning of the course. The reports consisted of a rubric with seven criteria; project planning (1), innovation target (2), scientific research method & test results (3), final results (4), team performance (5), documentation of the scientific & design results (6), and communication & collaboration strategy in function of the co-creation process (7). At the end of the semester, the students (n=48) submitted their final peer assessment reports and evaluated the performance of themselves and of their peers during this co-creation process in their own groups. In addition to assessing the performance of each group member including themselves through the given rubric, the students also wrote a small paragraph of their thoughts about their group members and their own performance.

The comments of the students were analyzed with NVivo 12, which is a qualitative data analysis software (QSR International, 1999). The peer assessment reports of the students were read by all researchers in their entirety and coded with NVivo 12 through a combination of inductive and deductive coding approaches by one of the researchers (Saldaña, 2013). The research questions of this study determined two parent codes (deductive approach); (1) essentials of an efficient and effective multidisciplinary co-creation process, and (2) difficulties of a multidisciplinary co-creation process. After defining these parent codes, the child codes under them were generated simultaneously (inductive approach) through thematic analysis. Table 1 provides an example from the coding process and how the child codes are associated with the comments of the students.

Table 1. An example from the coding process with NVivo 12

Codes	Students' comments from the peer assessment reports
Being motivated	"He was a very hardworking and motivated team leader. He managed to stimulate us all to work hard. He was great to work together with."
Multidisciplinary approach - teaching and learning from each other	"Next semester, the Erasmus students won't be in our team anymore and that will be a major adjustment for us. I mostly remember from this group that we were a great team and all had our personal input which made the project on multiple facets (educational, personal, cultural etc.) versatile and diverse. It was very nice to work with such a team and get a taste of what co-creation is really like."
Not contributing to the group assignments	"He is not involved at all and he does not even try to understand. He did nothing during the whole semester for the oral and written

Findings and Discussion

The peer assessment reports of the students provided valuable information from their perspective with regard to the characteristics of multidisciplinary collaboration, e.g., the key to have efficient meetings, as well as the essentials of effective communication during co-creation. Moreover, the reports shed light on the problems and challenges students encountered during this process, also during a remote learning setting due to COVID-19 restrictions. The repetitive patterns found during data analysis demonstrated the significance of certain skills of a multidisciplinary co-creation process as well. The section explicates the findings of this qualitative analysis under two main topics; (1) essentials of efficient and effective multidisciplinary co-creation processes, and (2) difficulties students face during multidisciplinary co-creation processes.

Essentials of Efficient and Effective Multidisciplinary Co-Creation Processes

From the first step (formation of groups) in the co-creation process, students started with sharing the actions that should be taken and **assigning the roles**, e.g. the ‘leader’ / the ‘motivator’ to each member. Students stressed the importance of having a **clear and fair division of labor** in the co-creation process. The roles and works were self-distributed to students by taking their **strengths and weaknesses** into account. For instance, in one of the groups, a psychology student was responsible for taking the lead in preparing and analyzing the data, since that student had prior experience on these tasks. Industrial design students in turn, were considered better at visualization of the concept and thus they created visuals for the project and the group presentations. Moreover, it is stated that students can **compensate for their lacking points** by doing the work in which they are confident.

Leadership, as one of the soft skills (Bancino & Zevalkink, 2007; Chamorro-Premuzic et al., 2010), is considered one of the most essential aspects in a group project and students expressed that they had difficulties when they cannot have an effective leader or they do not know who the leader is. This proves the significance of filling in the “Team Charter Canvas” (Van Der Pijl et al., 2016), which makes students decide on the roles of each group member as the first step.

A key element to ensure good-quality collaboration according to them is **fulfilling the works assigned to them** in a group project. When some group members do not accomplish their own work, this creates an unbalanced situation among the members. Also, in this case, the other students complained that they had to do someone else’s work and this was tiring for them. For this reason, the students stated that their group members should be **responsible and committed**.

Students pointed out the importance of being motivated to take part in this project. As explained by the students, getting involved in the project means taking initiative, sharing ideas, following the project closely, actively participating in the decision-making process and helping each other. Moreover, motivating the other group members was appreciated. The students mentioned that having motivated members in the group, providing positive encouragement, creating a democratic atmosphere, and finding the topic interesting, inspire them to work more on their co-creation projects. This also underlines the importance of giving the students an opportunity to choose their own co-creation project topics in parallel with their personal interests. She was really motivated and her enthusiasm and overall happiness was really catchy. In that way, she **motivated all of us** to be so as well. - Psychology student

From the point of view of students, having an efficient collaboration among group members lies in **being structured and well-organized** and **doing the work on time**. For this reason, the students start with **setting a clear goal**, dividing the work into several subtasks and **arranging weekly meetings** to discuss these tasks. Furthermore, it is emphasized that **setting a deadline** helps students to stay organized, consistent and on time, and it is necessary for further development.

*When we divided tasks, everybody was open minded and comfortable with doing assignments... When we **set deadlines**, every task was always delivered on time so that we could build further on those results. - Psychology student*

The students stated that their group members should be **hardworking, creative, clear and trustable** for an effective and efficient co-creation process. Also, when they have an unexpected problem they should start looking for solutions instead of complaining about the problems. For instance, during the final presentation, one of the students had an issue with her microphone and could not present her part. Then, her group members handled this situation with kindness.

*During the final presentation, despite the issue that we had, she stayed **focused** and I really appreciated that. Indeed, when the PDF wasn't the right one, she managed to find another **solution** and spoke for me when I had to speak but couldn't because of the problem with my microphone. - Erasmus+ student*

Having **empathy, respect and kindness** in the group is also an important point to consider in co-creation. The students underlined the significance of respecting each other's personal time schedule. For instance, in one case, they planned to finish their work earlier because after that time one of the members had a busy program. Furthermore, the students highlighted that they have respect towards **multidisciplinary** backgrounds of group members as well. Having a group member from a different discipline and **gender type** was seen as an advantage for them to have diverse points of views during the co-creation process. They embraced the diversity, accepted this as an opportunity to learn about each other's specialization and this helped them to adopt a 'decolonised gaze' (Giloï, 2017).

I'm going to miss her next semester. It's because of that I find the idea of **co-creation** and **multi-perspectivism** interesting. She studies in another field of study and therefore gives interesting insights that industrial design students never think of. - Industrial design student

Especially in this multidisciplinary environment, the students pointed out the importance of **giving and receiving feedback** for further improvement of the group project as well as their own learning process. This supports mutual learning in the co-creation process (Akoglu & Dankl, 2019). Students mentioned that their group members developed themselves throughout the semester with the feedback they received from their peers, teachers and stakeholders. They explained that when their group members do not provide them feedback, they cannot learn from each other.

*I would like to receive more **feedback** from my group members during the next semester. I often asked for feedback on my work but didn't receive any input. By receiving more feedback, I think I could learn much more from my teammates. - Economics student*

The students mentioned that they did not only talk about their projects but also they had other (ice-breaking) sessions in order to **get to know each other**. In these sessions, they talked about their personal lives, personalities, as well as, likes and dislikes. In addition, they made jokes and used **humor** to create an enjoyable atmosphere in the group. They stated that these **personal meetings** helped them to strengthen their bonds and positively affected the project development process. Also, forming a strong bond and having a **friendly atmosphere** are stated among the aspects that motivate the students to work harder on the project. Moreover, they think that this was also a way to combat the **COVID-19 pandemic** and remind them they are not alone.

*We have had a few meetings which start professionally – arranging everything that was put on the agenda – after which we have a more **personal talk about our lives**. Moreover, we have recently joined an **online event** with the board of AFD Gent to get to know our team as well as the board better. This was a fun evening and I'm sure it has brought us closer together. - Business economics student*

On more procedural aspects of the process, according to the students, students stated that achieving **efficiency in the meetings** is a prominent aspect that must be ensured for effective communication. The students pointed out the benefits of having an **agenda** with objectives, **taking notes** during the meetings and **giving an overview** at the end of the meetings. **Attending all meetings** and having an **active role** during these is the key for having efficient group meetings that should be **organized regularly each week**. The students complained about the members who attended the meetings but did not turn their cameras and microphones on, which is not considered "attendance" by them. Especially during **the COVID-19 pandemic**, having the group members that equally participate in the meetings was a challenge, as reported by the students. The **quietness and shyness** are repetitively defined as an obstacle in communicating effectively.

Lastly, using appropriate and useful **platforms, media and software** for communication was defined as another crucial point for successful collaboration. Since they could not have meetings in person due to the COVID-19 pandemic, this became even more essential. They generally had their meetings on MS Teams. For brainstorming and documentation of their co-creation process, they mainly used a shared Miro board. They explained that it was also helpful in presenting their ideas to their coaches and project stakeholders and to see an overview of what they have done. Google Docs was used for documentation of scientific and design results. Also, Google Slides was indicated as the program they utilized while preparing their presentations. These

platforms share a common essential feature; multiple participants can work on the same document at the same time. This feature gives all participants the opportunity to have access to the files and edit them. Furthermore, they can immediately see the changes made by each group member and this saves them time in building synchronous communication.

Difficulties Students Face During Multidisciplinary Co-Creation Processes

The main problems the students have had during the semester stemmed from the **COVID-19 pandemic**. For instance, some students mentioned that they could not be involved as much as they would like to because of the restrictions of the mandatory use of the online environment for their communication that often were of weak or poor quality. Moreover, co-creation was more challenging for the exchange students who could not travel and come to Belgium due to the COVID-19 travel regulations. Generally, since they could **not actively take part in** the weekly group class assignments and meetings, and they were reported as **late and reluctant to participate**, their group members were not satisfied with the performance of the exchange students. For this reason, they complained that they **had to remind other group members to do their work or had to do someone else's work themselves**. On the other hand, these exchange students explained the difficulty they have gone through also because of the time difference and poor internet connection locally.

The students also mentioned that they were not comfortable with **being assessed as a group** by their teachers. This discomfort was especially detected when there is an unfair division of labor during the co-creation process. The students complained about the ones who did not take any responsibility but tried to take advantage of the other group members in their project, who eventually had to do all the work. In some cases, students deleted the name of the student who did not contribute to the project from their group assignment submissions with the explanation that those students did not participate at all in those instances.

Another problem the students had was about **not trusting each other**. They stated that some students were untrustable because they lied to them and they did not complete their work. This negatively affected other students' approach towards these students.

The **language barrier** was another obstacle for the students during the co-creation process. As mentioned earlier, the students were from different backgrounds, countries and education levels. The level of **English** was not the same for all, and none of them was identified as native English speakers. The students mentioned that some group members could not express themselves easily because they were not fluent in English. Moreover, when they got feedback from their stakeholders in **Dutch**, non-Dutch speaking students found it difficult to translate and access the content. Also, communication became harder when the group members spoke fast and with an accent.

*During the presentation itself, he talked very **fast**, with a strong **French accent** and at some points even somewhat inaudible. He explained the concept .. but it was not that clear to everybody. That might be a working point in other intercultural classes, to speak a bit slower and to articulate very clearly. - Psychology student*

The students explained the factors that demotivated them. One of these factors was group members' **decreased performance during the exam period**. Furthermore, students were not happy when they were **not rewarded**, or **could not achieve their goals**. They also think that **having less participants** in the group increased their workload but they stated that **comparing themselves with other groups** did not have a positive impact on the co-creation process.

Another problem that students had during co-creation was having **selfish, overcritical** members who were '**too active perfectionists**'. Similar to not doing their own work and **being quiet** and **shy**, when the group members did more than they needed to do, it may create an unbalanced atmosphere. In either way, the unbalanced occurrence among group members negatively affected the co-creation process.

*The only thing that I saw is that sometimes she was '**too present**' during the meeting or in the work. Indeed, she likes to do the work herself which is nice because the work is done on time but sometimes other members can't add something more because it is already completed. - Textile engineering student*

Conclusion

Aiming to have an understanding of the students' perspective in a multidisciplinary co-creation course, this study focused on the final peer assessment reports written by the students. Students' evaluation of their group members and themselves shed light on the skill sets and characteristics that are required during a co-

creation process and also the type of behaviors they should avoid for an effective collaboration journey. The peer assessment reports yielded rich data on understanding the factors that aid or/and obstruct effectiveness and efficiency of co-creation processes. They provided practical advice for conducting co-creation projects in an effective way, such as **setting a deadline, giving feedback to each other, and assuring clear and fair division of labor**. In addition, the reports demonstrated that being **helpful, active, clear, punctual, trustworthy, respectful and kind** are the characteristics expected from group members in a co-creation project. Furthermore, since the peer assessment reports also included students' opinions about themselves and expected them to evaluate their own performance during the co-creation process, it served as a way to raise **self-awareness and self-reflection**. In this way, students may have a chance to realize their own lacking points and concentrate on improving themselves especially on these points. The reports include a sentence about self-reflection on the topics that they have recognised in their fellow peers. Thus, this can be a meaningful approach for engaging students in their overall learning process as well.

Furthermore, the peer assessment reports externalized students' opinions on what they appreciated and disliked during their co-creation processes. It can be inferred from the reports that for an effective co-creation process **soft skills** (Bancino & Zevalkink, 2007; Chamorro-Premuzic et al., 2010) are required as well as **hard skills** (Phillips, Phillips, & Ray, 2020). Figure 3 shows the relation between the codes (e.g. motivating the team) generated from the analysis of the peer assessment reports of the students and three subcategories of soft skills (personal skills, social skills, methodological skills) explained by Haselberger et al. (2012). The skills mentioned by the students do not cover all soft skills but the alignment can be seen. This indicates that soft skills such as **leadership, creativity, motivation, teamwork, problem-solving, decision-making, collaboration, communication and management** skills, which were highlighted by the students in this study, have a common denominator: contribution to the enhancement of the co-creation processes.

In this sense, this study implies that improving or developing the soft skills of the students can correlatively increase the effectiveness and efficiency of multidisciplinary co-creation processes. According to Vogler et al. (2018), the best way to improve the soft skills of students, which are also required to be successful in the 21st-century marketplace, is by engaging them directly in ill-defined, real-life problems/situations and active learning, instead of merely relying on conventional, 'passive' teaching techniques such as 'one-way' lectures. In this regard, since Design Thinking provides a roadmap for dealing with these wicked problems, design educators have a pivotal role in contributing to the development of soft skills of students and, consequently, increasing the effectiveness of the co-creation processes.

As far as hard skills are concerned, students indicated the significance of **software program knowledge and fluency in a common language**. The fact that having a good command of the agreed language of interaction is a must for effective communication, cannot be ignored. However, this is not the only way that helps people understand each other. This deficiency cannot be filled completely without language knowledge but at least it can be supported in other ways. For instance, **empathy** is one of the soft skills that is required for building a strong communication channel in design education (Alsager Alzayed et al., 2020). In this case, design educators have an important role in encouraging students towards this end. They may integrate empathy into their courses through providing project topics that require empathy, organizing workshops or other events with people from different disciplines or nationalities, and helping students to have a decolonised gaze. Moreover, since we are moving towards a **digital age**, design educators could consider involving the use of **state-of-the-art software programs** that enhance the effective communication and increase the efficiency of the co-creation process more in their curricula.

The findings of this study regarding the problems of students during co-creation overlapped with the challenges of co-creation mentioned in the literature. On top of that, this study uncovered more difficulties students faced, owing to the peer assessment reports that give a forum for their voice. According to this, the COVID-19 pandemic has negatively affected the quality of collaboration from many angles. The face-to-face co-creation was seen as much easier than remote co-creation by the students. However, the pandemic can be considered as the driving force that accelerates the exploitation of online and virtual tools in design education and co-creation, which can prepare students for professional practice and Industry 4.0 under similar circumstances. The students' strategy to cope with the difficulties of remote co-creation is to **strengthen their personal relationship** with informal meetings. This strategy can be adopted in further studies to increase the effectiveness and efficiency of remote collaboration.

	PERSONAL SKILLS		SOCIAL SKILLS		METHODOLOGICAL SKILLS
COMMITMENT	Being hardworking	LEADERSHIP	Motivating the team	DECISION MAKING	Taking part in the decision making process
	Being punctual		Being motivated		MANAGEMENT
	Fulfilling their job and putting effort		Being a leader	Division of labor	
	Getting involved in the project		Taking initiative	Being problem-solver	
	Following the project closely		Being active	Being structured & well organized	
	Attending all meetings		Sharing ideas		
	Being committed and responsible		Helping others		
SELF-AWARENESS	Assigning tasks according to their strengths and weaknesses	TEAMWORK	Being kind to others		
	Compensating for their lacking points		Providing feedback		
CREATIVITY	Being creative		Respecting each other's point of view		
			Having a global perspective		
			Teaching and learning from each other		
			Making jokes or having a sense of humor		
			Getting to know each other personally		
		Being clear			
		Being to-the-point			
		Being trustable			

Figure 3. The codes generated from the analysis (e.g. being creative) and their association with soft skills divided into three as personal skills, social skills, methodological skills (Haselberger et al., 2012).

In conclusion, it is evident that students from different backgrounds learn from each other when they embark on a collective creativity process. Despite its difficulties, this collaboration should be supported and remediated. With this in mind, it is possible to draw an analogy between multidisciplinary co-creation in this digital age and changing weather. We cannot interfere in the weather changes but we can equip ourselves to survive in any weather circumstances. Similarly, students should be armed with soft skills, which will allow them to blossom in the age of Industry 4.0.

It is hoped that the findings of this study will help design educators create a more beneficial and meaningful co-creation atmosphere for their students. In addition, starting from this point of view, this study may guide students in how to have more effective multidisciplinary collaboration and co-creation processes for their future skills development and for a smooth integration in Industry 4.0 and beyond.

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