PEERS AS EXPERTS TO COOPERATE WITH: A CASE STUDY OF TEACHING ACTIVITIES TO SWITCH FROM INTER-GROUP COMPETITION TO COLLABORATION IN A DESIGN STUDIO

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ABSTRACT

Design based learning is a widely and historically rooted approach to design education through which students learn to design by developing projects within the design studio. The physical or digital space of the classroom becomes crucial for students to collaborate in developing their projects with lecturers, technicians, and peers. Group projects often foster peer learning, allowing students to develop high-complexity projects relatively briefly. However, a great emphasis on the team could inhibit the possibility for students to cooperate at the class level. Inter-group knowledge sharing is often seen as a threat rather than an opportunity for improvement. Through a critical action research iteration, this paper investigates the role of instructional design activities and instructors in mitigating competition in a business-like design studio in favour of a more effective inter-group collaboration. The study was conducted in the final design studio of the Design & Engineering Master of Science at Politecnico di Milano and involved 52 students divided into 12 teams. Data was collected through participant observation in class and a final questionnaire at the end of the course. The contribution aims to present the designed instructional activities, provide a hands-on example of possible strategies, and present emerging themes from the qualitative data analysis.

1   INTRODUCTION

Addressing global challenges necessitates strong collaboration across cultures and disciplines, intensified partnerships, and consistent knowledge sharing. While competition has historically driven societal development, collaboration is increasingly recognised as crucial for sustainable development, as exemplified by the 17th SDG "Partnership for the Goals". In this scenario, collaborative learning becomes a strategic asset in formal education curricula. Employing team-based design activities in instructional projects is an effective way to create a collaborative environment where students learn *how to* design (i.e., design specific competencies) and cooperate with others effectively (i.e., transversal competencies). According to Barkley et al., the shift from the traditional to the collaborative classroom should foster a shift also in students' roles: peers become collaborators instead of competitors [1]. Consequently, peers, self and the community should become an authority and knowledge source beyond the teacher [1]. Previous research in the situated context conducted by the authors showed that team-based instructional projects support these shifts at a team level but might also favour a competitive inter-team environment [2]. Such competition often hinders collaboration and knowledge exchange at a class level. Therefore, teachers should consider the broader context of the class when designing instructional projects, balancing competitive tasks with cooperative tasks to facilitate the exchange of knowledge. Moreover, in school systems where grades are less relevant, students approach projects more casually, leading to self-directed and peer learning. While emphasising evaluation encourages constant commitment, it may discourage risk-taking and knowledge exchange with other teams in the class [2]. Given this contextual observation, the paper aims to present a case study of an instructional design project aimed at reshaping the interactions between teams within a team-based design studio from a highly competitive inter-group climate to a more collaborative one. The shift from objectivism to constructivism in education has led to instructional design focusing on complexity and continuous

improvement [3][4]. The constructivist view holds that learning is a personal process of creating meaning; similarly, instructional design improvement should be based on cycles of reflection and action from which innovation in teaching stems. This approach involves action research, which is a practice-changing practice that helps teachers evaluate their practices and improve their students' learning [5][6][7]. Even if action research is situated and not generalisable [5], understanding how teaching practices evolve through teachers' actions can provide valuable insight into emerging needs and approaches in specific educational contexts [8]. Castoldi [3] identifies three relationships between research and instructional change: i) research on improvements, which provides feedback but does not determine change; ii) research for improvements, which triggers change and is complementary to innovation; and iii) research as an improvement, which reflects and produces a change in professional behaviour and teaching practices and is equivalent to innovation. The latter is most coherent with the action research paradigm and emphasises self-reflective working methods in instructional actions for change. Coherently with all of the above, the present paper aims to present how the change in the instructional design addressed the observed contextual issue of a highly competitive inter-team environment and impacted pursuing the objective of fostering class collaboration on the projects developed in a design studio. Rather than presenting a generalisable solution, the contribution has the goal of disclosing the crucial role of teachers in detecting the inconsistencies of current teaching practices, redesigning coherent instructional projects that guide students to develop sustainable behaviours and attitudes and soundly evaluating these renewed practices.

2 CONTEXTUAL ANALYSES

2.1 The Design and Engineering Master of Science
The Master of Science in Design and Engineering (D&E) is a joint program between the School of Design, Mechanical Engineering, and Materials Engineering at Politecnico di Milano. It trains students in Product Design and Industrial Engineering bachelors to master the design process from concept to manufacturing. D&E courses are mainly in English, attracting international students yearly [9]. Students participate in collaborative design-based learning during the first three semesters of the two-year program. Summative assessments at the end of courses contribute to the graduation score, with design studios weighing more heavily.

2.2 Final project work: the design studio course under investigation
The Final Project Work (FPW) course represents the last design studio of the master's degree. It is the one in which students, divided into project teams, must develop a product of medium complexity by combining the design and engineering skills acquired throughout the master's degree. At the beginning of the studio, teachers propose a general theme to the 52 students in the class. Such a theme is presented in collaboration with a partner company that also provides feedback to the students during the design process and final presentations. Starting from the general theme, teams of four-to-five students develop research and based on that, agree with the teachers on a specific design brief (called counter-brief in the context), which becomes their project area. In the academic year 2022-2023, when the investigation took place, the project's theme was to develop an electric and foldable bicycle in collaboration with a leading Italian bike manufacturing company. The class was composed of 52 students, divided into 12 teams. An interdisciplinary faculty team of six teachers (i.e., three designers and three engineers) and one teaching assistant oversees the project's development throughout the semester. According to their expertise, teachers review the group project approximately every two weeks, providing feedback and suggestions for improvement on the design (e.g., research, concept, functions, aesthetics) and engineering aspects (e.g., material, manufacturing, technical representation). Weekly reviews are moments for formative assessments of students' project development. There are also mid-term and final project presentations when the students receive a summative evaluation (i.e., a mark) from the teachers.

2.3 Observed untoward consequences: poor inter-team climate and cohesion
In the past few years, the researchers, being part of the teaching staff, observed some untoward consequences of the instructional project that became the rationale for redesigning some teaching activities and including a few new ones. Specifically, as mentioned above, it was observed that inter-team collaboration was usually poor, and the competition among teams was very high. Teams of students perceived that their team project was competing with other projects and, therefore, exchanging

knowledge with or helping other teams could have damaged one's outcome in terms of evaluation. Students in the situated context appeared to perceive the team as a safe environment to share information and constructive criticism. Still, they struggled to recognise the classroom group as safe to enact these processes. In the last years, several actions have been undertaken and integrated into the course to foster teambuilding and organisation at an intra-team level [10][11][12] especially considering the cultural plurality of teams. However, the inter-team issues have been poorly studied so far. Considering the team effectiveness framework proposed by Tucker [13] and applying them to the class group, two of the 22 factors and associated recommendations for teachers for task design appeared particularly relevant: team climate and team cohesion. In Table 1, the original factors proposed by Tucker for teams are interpreted and adapted considering the class group. The recommended teaching responses (see Tab. 1) have been considered in redesigning the instructional project.

Table 1. Two poor factors in the class group. Adapted from Tucker [13, pp. 14–15]

Factor	Description	Recommended teaching responses/strategies
Team climate	It determines how freely teammates can share opinions and ideas.	Communicate with students to promote a team climate of inclusiveness, freedom, interpersonal trust and respect.
Team cohesion	It is the tendency for a group to stay united in pursuing its goal and objectives.	Foster positive interdependence between individuals and teams by promoting student-led reciprocal teaching.

3 METHODS

3.1 Action research: instructional activities to foster inter-group collaboration

First, throughout the course, the teaching staff repeatedly made explicit the following metaphor to underline such expected team attitude toward the class group: *"Let's imagine that we are a large design studio to which a major client has entrusted the development of a project. We aim to develop many ideas and turn them into excellent and equally worthy projects"*. This metaphor was used to convey the message that the class shares a common goal, as opposed to the individualistic pursuit of prevailing over the work of others. Coherently with this metaphor, the researchers introduced two sets of activities hinged on fostering inter-group collaboration based on two principles: i) inter-team shared tasks and ii) inter-team help and feedback on projects. These two principles were identified as suitable actions to enhance the class climate toward collaboration.

3.1.1 Inter-team shared tasks: sharing knowledge from the beginning of the design studio

Figure 1. Collaborative board for counter-brief definition and selection

The teams were required to develop two initial tasks collaboratively: the technical research and the counter-brief development and choice. Technical research was proposed at the beginning of the design studio to collect the technical information necessary to develop the design of an electric and foldable bicycle. Instead of asking each team to build its research on all the technical aspects, we assigned a specific topic (e.g., batteries, foldable systems, electric motors). The teaching staff evaluated each delivered research and then shared it with the rest of the class to exchange the retrieved knowledge. In parallel to the technical research, the teams were asked to develop contextual research to diversify the specific counter-brief per each team. Each team developed this process autonomously in the past, often causing overlap between particular design challenges and fostering competition between teams. Given this issue, we proposed the Padlet platform to identify 12 appropriate contextual challenges collaboratively. Specifically, on a shared board with the class, the teams were asked to brainstorm possible contexts to develop the project. Thanks to the teams' contribution, the board grew with different

proposals that students clustered autonomously into themes (see Fig. 1). The teaching staff periodically reviewed the board and commented on the various proposals by highlighting challenges and opportunities. During in-class reviews with the team, the teachers were able to orient each team toward developing a specific, appropriate, and promising challenge among the themes emerging from the board organisation.

3.1.2 Inter-team help and feedback on projects: integrating knowledge and competence exchange

Several formal moments in class were organised throughout the course to foster peer help and feedback on projects. Specifically, three types of activities were proposed. First, the teams were asked to write feedback to all the other teams during the two mid-term presentations and the final presentation on a shared online Padlet board (see Fig. 2.a). Then, after the second mid-term presentation, a peer-help activity was organised to foster knowledge exchange on the projects. During the afternoon dedicated to the activity, teams were free to set a series of appointments for a fifteen-minute review with teams they felt could have helped solve their current design issues. The role of the teachers (i.e., the researchers) was to facilitate the peer help session by keeping track of time. Finally, in the final part of the course, several reviews on the design and manufacturing aspects were organised in the form of a simultaneous review of two teams. During the review, the teams and the teacher contributed to spotting criticalities and finding solutions.

3.2 Evaluation of the outcomes: participant observation and final open questionnaire

The activities' impact on inter-team collaboration has been evaluated throughout the course through participant observation of the researchers in the role of teaching staff. Additionally, at the end of the course, students were required to fill in an open questionnaire that included a specific question related to inter-team and intra-team collaboration (see tab. 2, item 3).

Table 2. Questions asked in the open questionnaire

Nr.	Item
1	What have you learned in this course?
2	Compared to other project-based courses, which have been the advantages of the course (if any)?
3	Compared to other team-based courses, which have been the advantages of this course (if any) in terms of iter-team collaboration (i.e., between teams) and intra-team collaboration (i.e., within your own team)?
4	Which was the thing you liked most?
5	Which was the thing you liked less?
6	Any suggestions for next year?

Completing the questionnaire was elective, and 20 students over 52 participated. To qualitatively interpret the results, the researchers adopted an evaluation coding strategy described by Saldana [14]. Indeed, in evaluation coding, the researchers interpret the qualitative commentary provided by participants on a specific programme policy or action [14]. To perform evaluative coding, the research team reviewed the answers by assigning a series of codes related to positive (i.e., using the sign + between parenthesis) or negative comments (i.e., using the – sign between parenthesis) followed by a specific evaluative code. For instance, the following sentence was coded as follows:

Having critical feedback from colleagues was a good thing, and I also   CODE
liked being able to give advice and feedback to other groups.   (+) inter-team > peer feedback

The codes present two levels. At the highest one, the researcher focused on the aspects related to inter-team dynamics and also included intra-team dynamics to extensively evaluate the student's perception regarding collaborative elements in the class (e.g., $(+)/(-)/(=)$ inter-team or intra-team). Then, sub-codes were developed to interpret the specific aspects emerging from students' answers (e.g., peer feedback).

4 RESULTS AND INTERPRETATION

From the participant observation conducted by the researchers in the teachers' and assistant role throughout the course, it was noted that the students participated in activities related to inter-group collaboration. Also, it was perceived as an overall improved climate of help and support between groups. After collecting and coding the open questionnaire, the data confirmed such observation.
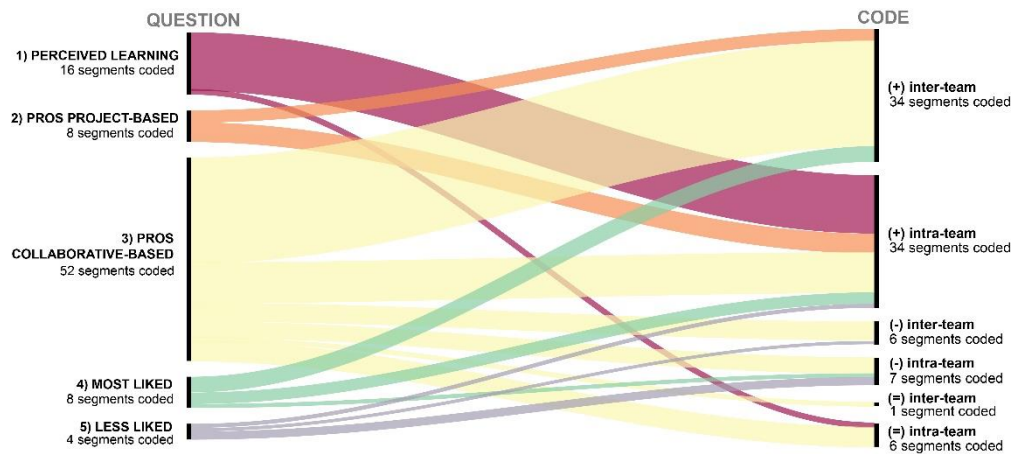
Figure 2. The distribution of the coded segments concerning the questions of the open questionnaire (left) and the higher level of the evaluation coding (right)

Referring to the visualisation proposed in Figure 2, the interpretation of the students' answers through coding showed that text segments that referred to collaborative aspects in the course are in great majority positive (i.e., of the total of 88 coded segments, (+) inter-team counted 34, and (+) intra-team counted 34). Therefore, data showed that students positively perceived the collaborative environment in the course. When asked to compare the FPW course to previous collaborative-based courses, students' answers focused on inter-group collaboration.

Table 3. Subcodes of the high-level code related to inter-team collaboration positive aspects (i.e., (+) inter-team)

Subcodes of the (+) inter-team code	Count	Subcodes of the (+) inter-team code	Count
(+) inter-team	34	10. teaching activities	3
1. awareness	1	**10.1. sharing reviews**	**13**
2. collaboration	**7**	10.1. 1. feedback during presentations	1
3. communication	2	10.1. 2. two-groups review	6
4. culture of help in the class	3	10.1. 3. face-to-face peer help	6
5. knowledge sharing	**10**	**10.2. shared class tasks**	**7**
6. management of time	1	10.2. 1. project briefs	1
7. peer feedback	5	10.2. 2. technical research	6
8. project	4	11. togetherness	4
9. tasks division	2		

By analysing the most recurrent sub-codes (see the grey row in tab.3), it emerges that the inter-team collaborative environment in the class was positively evaluated and that the class showed an increased openness of teams to share knowledge. Specifically, the proposed teaching activity (i.e., 10) was often explicitly mentioned concerning the positive aspects of inter-group collaboration, showing a correlation between the climate and the proposed activities. Hence, a finding is that the proposed activities fostered an enhanced climate of knowledge sharing and cohesion among teams coherently with the two factors considered from Tacker's [13] framework to design the activities. The inter-team improved dynamics emerge prominently with question nr.3, in which students were explicitly asked to evaluate the advantages of the FPW course compared to previous experiences regarding the collaborative environment. On the other hand, the benefits of intra-team collaboration and its relevance according to students' perceptions emerge more from all the questions, showing its perceived importance for the project's success and the overall design studio experience. Among others, students mentioned only the aspects of collaboration related to intra-team dynamics, not inter-group collaboration. The research team interpreted this result concerning the project's complexity and the short time to develop the design project, elements of the course that make the intra-team organisation a crucial part of completing the work to be done successfully. In students' words, organisational skills are not limited to dividing tasks but also include effective communication and conflict-resolution strategies. Students report that these skills are more critical for the project's success than technical abilities. Although students consider inter-team collaboration one of the most successful aspects of the course, it is not perceived as a learning outcome. One possible interpretation is that students hardly connect inter-team collaboration with relevant learning outcomes of a design studio course, as they are not accustomed to considering it as a crucial design competence. Finally, it is worth mentioning that six negative comments related to inter-

group dynamics were coded. Specifically, three students highlighted the fact that not all the teams were equally willing to share information at a class level and committed to the inter-team activities, two students argued that the intra-team activities were less useful in some phases of the design process, and one student mentioned the perception of a competitive environment in between teams.

5 CONCLUSIONS

This paper presented action research in the context of a design studio, where a highly competitive environment creates a barrier to knowledge sharing and cohesion at a class level (i.e., inter-team collaboration). As part of the teaching staff, the researchers redesigned and integrated some new instructional activities to foster cohesion and improve the climate between teams of students developing different projects. The participant observation conducted by the researchers throughout the course and the data collected through a final open questionnaire with students confirmed that the activities fostered an improved climate of help and support between groups. Inter-team collaboration in the course was considered a positive aspect compared to students' previous experiences in collaborative-based courses, confirming that the activities proposed supported this aspect. Therefore, observing an issue in the context (i.e., high competition, poor inter-team collaboration) provided a rationale for changing the instructional design. In the role of teachers, the researchers reconsidered their practices accordingly and more effectively guided students toward sharing knowledge and ideas with other teams.

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