



ENGINEERING SCHOOLS FACING THE THORNY ISSUE OF TRAINING STUDENTS IN COLLABORATIVE SKILLS: FEEDBACK FROM THE FIELD

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ABSTRACT

In a context of transformation and increasing complexity of work due to the development of information technologies, communication and digital networks, the question of the acquisition and development of collaborative skills of engineers in training arises with a particular sharpness. Achieving their acquisition in practice is a major challenge. In France, although included in the training programs for students, the world of training is struggling to find the teaching and learning adapted and capable of developing collaborative skills in engineering students. Thus, the practices and methods implemented are different from one institution to another. It

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goes without saying that the acquisition and development of collaborative skills that are highly sought after on the labor market are unequally distributed among graduates of the major engineering schools. Thanks to a recombination of theoretical approaches, a qualitative and quantitative study conducted at ISAE-Supméca, a French engineering school, in order to obtain an overview of the collaborative skills developed by the students during specific problem- and project-based learning modules, and also in order to provide a critical analysis and feedback about the development of collaborative skills into the students' training program through these applied professional projects that immerse them in work contexts close to the future professional realities. The results show a strong gap between skills development and a focus on the development of skills from the “Process – Deliberation” category.

1 INTRODUCTION

ISAE-Supméca has been involved in educational research for a decade through concrete students' projects involving several stakeholders, from industrial partners to academic partners. Among other issues, skills is a topic of interest, especially collaborative skills.

Our study focuses on the feedback on collaborative skills from ISAE-Supméca's students project realized in collaboration with students from other institutions. More specifically, the aim of the study was to obtain an overview of the collaborative skills developed by the students during these projects.

Our paper is organized as following. Section 2 provides the theoretical framework in which the study took place. Section 3 presents the specific projects analyzed in-depth in order to provide the feedback. Section 4 exposes the methods. Finally, section 5 presents the results and section 6 concludes our paper.

2 COLLABORATIVE SKILLS: ESSENTIAL FEATURES AND ANALYSIS GRID

Although there is a lot of work in the scientific literature on cooperation and collaboration and a keen interest in exploring this concept, no single theory can help to understand the complexity of what is at stake in these dynamic. We will briefly present the theoretical contributions that make it possible to analyze collaboration and cooperation as a process evolving over time.

Collaborative skills result from a social construction within a formalized framework or not (D'Amour, 1997) [1]. We see it as the capacity for the subject to synergize with others by building links in order to achieve a common work (Dejours, 1993, Policard, 2014) [2] [3]. To understand the dynamic nature of the collaborative process, it is necessary to determine the main anchors in which the temporal perspective of the collaborative process is rooted. The approaches taken into account in this work make it possible to account for the dynamic dimension of the collaborative process.

The work of Mattessich and Monsey (1992) [4] offers an explanatory reading of collaboration phenomena. They identified 19 factors influencing the success of a collaboration, which they classified into six groups, related to six topics:



- Related to the environment,
- Related to group membership,
- Related to process,
- Related to communication,
- Related to purpose,
- Related to resources.

Thomson and Perry (2006) [5] present a similar classification. They propose a scale of the collaborative process that covers 5 key dimensions of collaboration, each involving activities related to this process:

- Governance,
- Administration,
- Organizational autonomy,
- Mutuality,
- Norms.

According to Thomson and Perry (2006) [5], the black box of the collaborative process includes three sequences whose structure resembles the models commonly used to illustrate the dynamics of the activity: antecedents – process – results.

The sequential analysis of collaboration proposed by Thomson and Perry (2006) [5] is close to the collaborative skills model of Morse and Stephens (2012) [6]. The latter maintain that the prior analysis of the type of activity carried out collectively by the actors involved in a collaboration makes it possible to identify the different phases of the collaborative action (Sanojca, 2018) [7]. They associate specific skills drawn from the literature with the different stages of the identified collaboration. The originality of their work was to consider that the type of skills used in the collaborative process stems from the very structure of the project. As a result, the authors argue that collaborative skills are skills that adapts to the dynamics of the process in which they are exercised.

According to Sanojca (2018) [7], the term “meta-competencies” (in which they include for example “collaborative mindset) given by Morse and Stephens (2012) [6] is not appropriate with regard to the constituent skills of this group, which are more akin to transversal skills. The “meta-competences” described here can rather be considered as attitudes or predispositions that can influence the choice to collaborate or not.

Sanojca (2018) [7] therefore proposes to establish a correspondence between them and the “antecedents” of the collaboration identified by Morse and Stephens (2012) [6].

By reorganizing all the skills identified in these approaches (Morse & Stephens, 2012; Mattessich & Monsey, 1992) [6] [4] according to the model of Thompson and Perry (2006) [5], Sanojca (2018) [7] obtains a scale of collaborative skills mobilized for the identification of the nature of the collaborative skills implemented by our students.

These three models constitute a theoretical framework of reference for the analysis of our data.

3 CASE STUDIES

For several years, ISAE-Supméca, a French public engineering school, has been offering its last-year students the possibility of carrying out a so-called “synthesis project”. These projects are done in a problem- and project- based learning (PBL) approach and are more precisely based on the socio-constructivist approach and give a central place to the individual in the co-construction of his knowledge from personal experiences and in his interactions with his environment (Vygotsky, 1978) [8]. Students work in teams of three (sometimes in teams of two), during around 200 hours (for a group total of around 400 to 600 hours) on a three-month period (and are almost full-time at the end of the period) on situations requiring the confrontation of points of view and the joint resolution of problems. The particularity of this PBL module is that it allows students to work on a subject proposed by companies on industrial issues, with all their complexity and richness. Some of these PBL include in these working groups at least two second-year BTS (French 2-year studies technician curricula) students, in the framework of the EXAPP_3D² project. These projects have run under the following collaborative projects model.

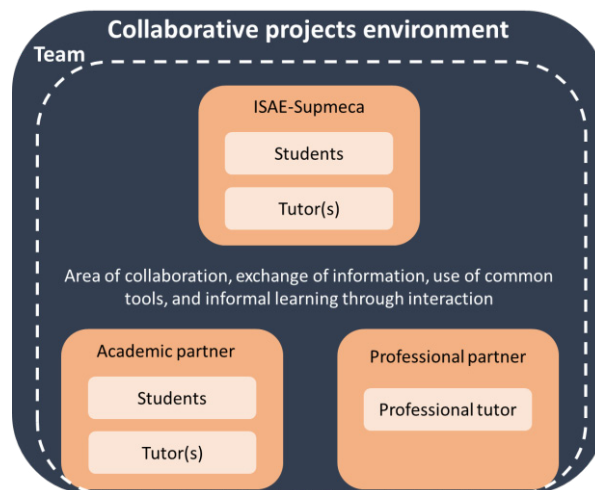


Fig. 1. ISAE-Supméca collaborative projects model [9]

Here, we study projects conducted with two partners: Lycée Voillaume and Lycée Louis Armand, both located in the same region (Ile-de-France) as ISAE-Supméca. As a result, these PBL involve many stakeholders and are focused on collaboration and 3D design and lead to concrete deliverables. A paper published in 2021 presented the frameworks of these projects and focused on academic and industrial tutors feedback in order to highlight some best practices [9].

² EXAPP_3D (Experiment Learning by Problems and Projects via 3D Design) is an ongoing so-called e-FRAN project coordinated by ISAE-Supméca and co-funded by the French Fund Deposits, from September 2016 to December 2022. Among other things, the project aims to promote active learning involving students from secondary school and/or high school and/or Bachelor's degree and/or engineering school in common dedicated projects.



The present works is a new block in the studies of these projects, especially their collaborative aspects.

4 RESEARCH METHODS

An exploration method appeared to be the best way to account for the social interactions between each student and actors involved in the projects, insofar as it induces the use of a qualitative data collection method (Fortin and Gagnon, 2016) [10].

The approach we have favored in this study is comprehensive and inductive. This inductive approach makes it possible to take what can be learned from the data as a starting point.

A collection of data by non-directive individual interview lasting an average of 30 minutes was conducted with eight students (five men and three women aged 21 to 23) contacted with regard to the activities they carried out in groups of two or three. Were excluded from our panel the groups in which we could not interview all the members.

Each of the participants was invited to express themselves on the existing social interactions and the way of working during the project.

The qualitative data collected was analyzed using a computerized tool for processing textual data: RQDA (R package for Qualitative Data Analysis) from the items of our scale. It was a question of assigning to code the corpus when it was obvious to establish its correspondence with one of the items of the scale.

We have also opted for a mix of analysis methods, which combines quantitative and qualitative analyzes according to our progress in understanding the phenomenon studied.

5 RESULTS

The aim of our study was to understand a phenomenon: the acquisition and development of collaborative skills of students involved in collective projects, according to the point of view of students who experience it.

5.1 Overview of declared collaborative skills

In this part we present the action verbs and expressions used by ISAE-Supméca students, from the eight interviews conducted. The interviewees had to describe their collaborative practice based on a broad question: "What exactly do you do when you collaborate?"

The data collected was related to the different items of our scale, made up of skills rewritten and reorganized using the approaches of Morse & Stephens (2012) [6], Mattessich & Monsey (1992) [4] and Thompson and Perry (2006) [5].

These data, presented in Figure 1, are organized according to the different categories of our scale, highlight the average number of expressions listed in the verbatim statements and analysed as well as the number of people for each skill.

The general average occurrence of the statements corresponding to the skills of the scale is just under 4. As a result, only the skills cumulating a number of statements greater than or equal to this threshold were considered significant. They are the lines in bold blue in Figure 1. Skills rarely or very rarely quoted by the students are the line in dark orange.

5.2 Data on the nature of the collaborative skills implemented

These data presented in Figure 2 allow some analysis on the nature of the skills the students pretend to develop through the occurrence of the speech about them.

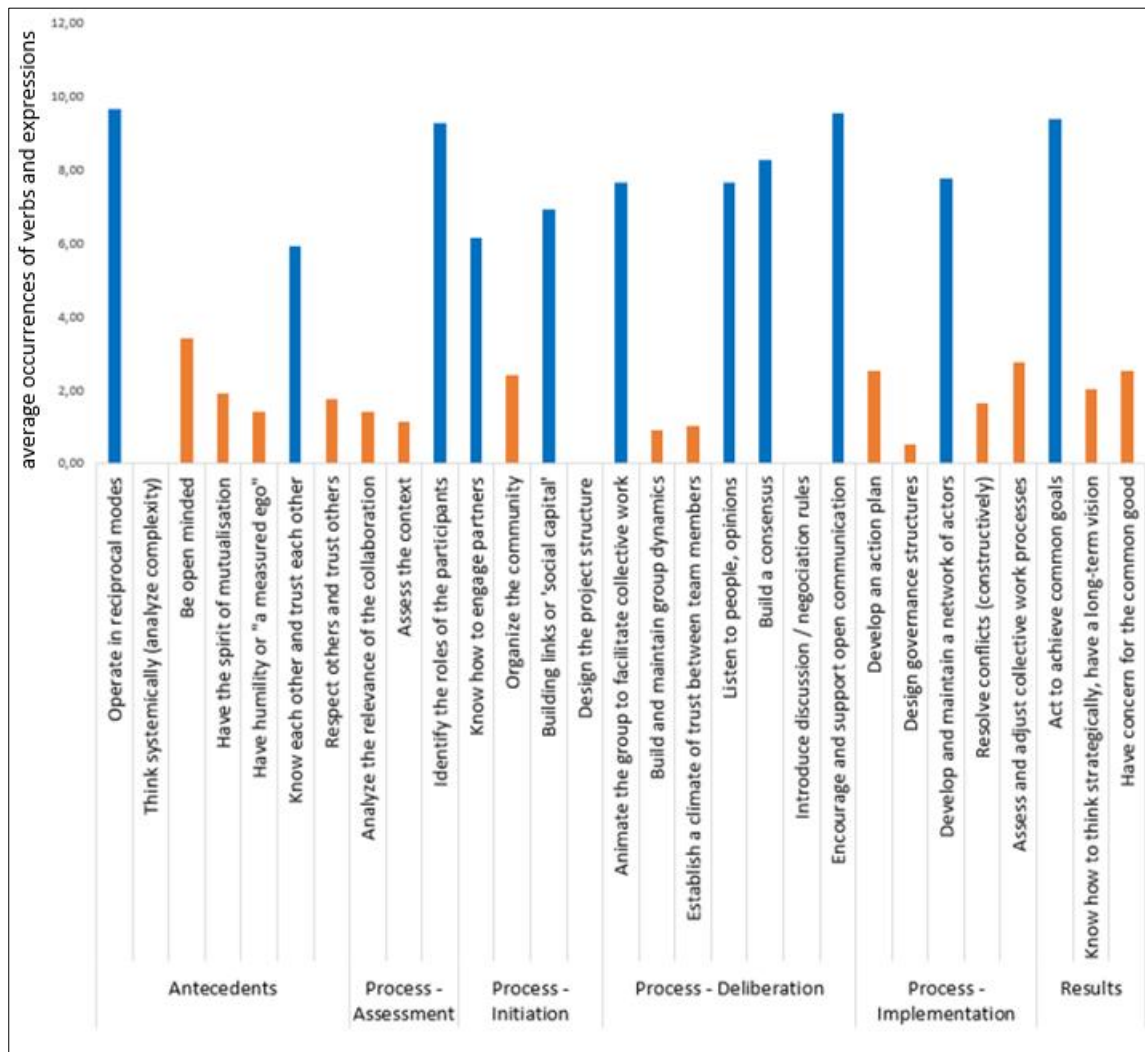


Fig. 2. Average occurrences of action verbs and expressions used by students in reference to each skill as re-written taking into account and reorganizing Morse & Stephens, Thomson & Perry, Mettessith & Monsey approaches

Among the skills with an average occurrence over 4, four items have an average occurrence over 9: these items are : “Operate in reciprocal modes”, “Identify the roles of the participants”, “Encouraging and supporting open communication” and “Act to achieve common goals”, all belonging to different categories. In terms of category, We note that the skills relating to “Process – Deliberation” are numerous to be considered developed (4 out of 7) and among them, “Encouraging and supporting open communication” stands out slightly, just above “Building a consensus”.



On the opposite, some skills are very rarely or even not quoted, but it should be highlighted that although these skills are rarely mentioned, the fact remains that they are the subject of development for some students.

We will now focus more on several significant data with regard to the threshold of 4 already explained. More precisely, we will highlight four other results of our study.

5.3 Development of attitudes related to the collaboration developed

Collective work is facilitated by the knowledge of the members of the group, which is acquired through interactions. This knowledge makes it possible to establish a balance within the group, based essentially on “trust”. In a context of collective work, knowing others is an undeniable asset. Indeed, knowing the members of your group means having knowledge of their skills, the way they work and the soft skills that characterize them. “I knew that we didn't have the same skills at all,” underlined one of the interviewees. So, even if the “Know each other and trust each other” skill received an average occurrence of less than 6, it was quoted by all students and seems important for them.

5.4 Skills related to the implementation process and the achievement of goals

These collaborative attitudes are necessary to enter into collaboration and prove to be very judicious for the collective mode of work. To know is also to adopt a collective work organization which consists of a sharing of tasks by identifying the roles of each. This knowledge of others makes it possible above all to accommodate diverse personalities, accept other points of view and be attentive to each other: to listen to people and opinions.

Consensus building emerges also in parts of students statements; that is, the fact that the members of the group must succeed in converging their ideas to reach an agreement that satisfies everyone, when they discuss the activity.

To reach a consensus, everyone must speak up and communicate. Here the notion of communication refers on the one hand to the interactions relating to the task which are aroused during collective work and the confrontation of points of view and on the other hand to the fact that everyone is encouraged to freely express their ideas without embarrassment.

The items "Know how to engage partners" and "Building links or ‘social capital’" in the category “Process – Initiation” see an average occurrence above 6 and refer to the way students proceed to achieve the goals they have set themselves and which are linked to the concrete organization of collective activity on an equal distribution of tasks within the group. But even by following this modality, students are aware that they must establish links allowing a certain proximity between members of the same group. These goals emanate from a desire to “succeed” in collective activities and to rely on the strengths of the group to achieve them.

5.5 The emergence of a new attitude: benevolence

The analysis of the data also reveals skills acquired by the students and not appearing on our scale. This is the case of benevolence perceived through the



expressions “listen”, “attention”, “comfortable”, “benevolent” used by the interviewees. They emphasize the idea that students strive to interact with members of their group in a respectful and caring way and expect reciprocity from them. Benevolence is a state of mind that promotes the establishment of a healthy work environment.

5.6 Skills not developed according to the students

The analysis of the data also show that 3 skills were not quoted at all by the students in their speeches. These are “Think systemically (analyze complexity)”, “Design the project structure” and “Introduce discussion / negociation rules”. If the latter could maybe seem not so surprising, the two first ones can be surprising, especially in an engineering school. Also, only 3 students quoted the item “Design governance structures”, making this skill far from a priority. This result about skills not or barely mentioned is a small matter of concern about the development of some of these skills in the kinds of PBL modules studied, even with an academic partner and with many situations close to the professional environment.

6 CONCLUSION

We mentioned the importance for training structures in general, engineering schools in particular, to develop the collaborative skills of students. Data from interviews with students show that the collective projects offered to students promote the development of collaborative skills in action.

The development of these skills in situations close to those experienced in a professional situation corroborates the idea that the work situation conveys knowledge and generates skills (Schön, 1983; Orlikowski, 2002) [11] [12].

As a result, by focusing on what students do during collective projects and how they do it, we have managed to highlight the skills constituted by their collaborative practices. Although the data analysis has made it possible to observe the emergence of new skills, it should be specified that it is also important to note the analysis of the data reveals new skills not present in our scale. Indeed, our semi-directive interviews brought a reflective posture from the learners towards their practices and it brought more student awareness of skills practiced and learned.

We can therefore argue with Sanojca (2018) [7] that “There is a strong link between the development of collaborative skills and activity” (p.355).

Also, we can propose the hypothesis, especially because the understanding of each other and their roles in the project was highlited, that the length is important. For this reason, in order to compare results, we intend to conduct a similar study on groups of students working on a shorter period and studying one grade earlier.

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