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From Group Work To Team Work: Comparative Analysis In Three European Institutions

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FROM GROUP WORK TO TEAM WORK: COMPARATIVE ANALYSIS IN THREE EUROPEAN INSTITUTIONS

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ABSTRACT

Addressing the complex challenges of sustainability demands for good teamwork abilities for future technicians and engineers. In our three institutions we adopted

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project-based learning to facilitate the development of these skills – but is this enough? Since group project-based learning involves dealing with complex technical tasks and at the same time learning to work as a team, we wondered how students handle this double challenge. By analysing their perceptions, we attempt to identify what teaching practices could be helpful to shift their experience from groupwork to effective teamwork.

In this paper, we present the differences and similarities in the way we implement group projects in our respective institutions. A common questionnaire was proposed to our students capturing their perception 1) of the value of group project learning, 2) of their ability to carry out such projects in the future, 3) of the group perception of a shared goal and 4) of the quality of interpersonal relations within their group. Finally, we present the results of this first iteration of data collection showing different group profiles. We discuss the teaching practices that may contribute to sustain students' motivation for group-work and their confidence in their ability to achieve complex team projects, first in their academic context and then when facing challenges in their future employment within a changing world.

1 INTRODUCTION

The complexity and interdisciplinary aspects of sustainability challenges need to be addressed with a global mindset. In the twenty-first century, engineers are expected to “know everything”, “can do anything”, “work with anybody anywhere”, “imagine and then make the imagination a reality” (Tryggvason and al., 2006). The question that follows is what is expected from students, and hence from their education?

Looking at the guidelines from the EUR-ACE® labelling agency, especially in the item “Making Judgment Communication and Team-Working” skills, expected Learning Outcomes include the ability to work in teams for handling complex problems with awareness of ethical and environmental issues.

Dealing with complexity and non-technical aspects of engineering, as well as being able to work in teams are part of what is expected worldwide from engineering students (Miller, 2015). This study reports on the ways three European institutions addressed the development of teamwork skills for future engineers and technicians through team-based projects. In this pilot project, by collecting answers to a common questionnaire from students in the three institutions, we aim to understand their perception of the quality of teamwork and of the way they experienced teamwork in project-based learning. Specifically, in comparing the three approaches our goal is to understand better 1) How do students perceive the group-work quality? 2) How do they perceive their skill development during projects? and 3) How they perceive the value of carrying out projects?

In the remaining of this introductory chapter, we present a concise literature review on role of project-based approaches in teaching scientific skills, followed by short presentations of each of the approaches.

1.1 Teaching computer science through projects - some insights from the literature

The subjects taught in engineering training are often complex and abstract. Active learning methods, such as project-based approaches tend to increase student engagement and in-depth retention (Freeman et al. 2014).

In project-based approaches, students must deal with complex and sometime ill-defined problems. Though engaging and persevering in the project can initially appear as difficult, when looking at the studies in motivation the challenges related to project-based approached have a positive impact on students' motivation and engagement. The students' motivation dynamic in learning (Viau, 1994) is rooted in the *perceptions* that a student has of (a) the *value of the task* that is to be done, (b) her or his *ability for performing* the task, (c) the *level of control* she or he has on the task implementation or choice. Team Project-Based Learning offers opportunities for meeting these motivation needs. Concerning the *perception of the activity value*, it seems that students tend to attribute high value in the project's tasks, more than on traditional labs tasks that are neutral and less engaging for students (Picard et al. 2022). Concerning the *level of control*, it is by-design in Project Based learning, for instance trough the choice of teammates, the task agenda, or the nature of the group production. Concerning *confidence in performing the tasks* involved by the project, offering resources and providing feedback help to make students feeling able to perform the activity.

Group-work offers multiple and various opportunities for receiving and giving feedback, both with the teacher and with peers, offering powerful support for learning (Hattie and Timperley 2007). Providing structured opportunities for feedback along the project helps students maintain their engagement throughout the projects. Even when such structured feedback is provided, students must deal with the difficulties of a long-term task, and of working with other people, which may be challenging for students used to more traditional frontal teaching. For exploring the effects of teamwork on students' motivation in project-based learning, Fernandez developed a questionnaire that measures two dimensions characterizing optimal teams: the perception of a common goal, and the rating of the quality of interpersonal relationship within the team (Fernandez, 2010).

Since team project-based approaches are implemented in different ways in our institutions, we use this questionnaire to compare them. The following section presents an overview of our approaches.

1.2 Teaching computer science through projects - how it is done in our three European institutions

In this part, we describe three project-based approaches respectively in HEG Geneva School of Management (*HEG*) at the Western Switzerland University of Applied Sciences and Arts HES-SO in Switzerland, at the University Institute of Technology of Annecy (*IUT*) from Université Savoie Mont-Blanc USMB in France, and in Polytech Annecy-Chambéry Engineering School (*Polytech*) from USMB.

Table 1. Summary of three project-based approaches

	HEG	**IUT**	**Polytech**
Level	Undergraduate	Undergraduate	Graduate
Duration	1 semester (Year 1)	1 semester (Year 2)	4 semesters (Year 3 to Year 5)
Country	Switzerland	France	France
Team size	2 to 3 persons	2 persons	5 to 10 persons
Study type	Working students	Alternants	Classic students
ECTS	3	1	17

The choice of projects topics, group setting, and assessment modalities are different, but their common goal is to support students in developing teamwork skills.

1.2.1 HEG Geneva School of Management (HEG)

The programme of HEG prepares students for technical careers, but with commercial aspects as well. Moreover, they need to be aware of the social, ethical and environmental implications of the technologies they are being trained in. Three years ago, a new first-year bachelor's module was introduced in the second semester, dealing with the Internet of Things (IOT). This was an opportunity to help students master multiple aspects of networking, such as sockets, protocols and device-to-device exchanges. We introduced a significant amount of team project learning into the module.

The first part of the semester focuses on hands-on labs that provide students with basic concepts that will be the "bricks" to be used during the team- project. It is assumed that students have prerequisites in python programming and computer networks. Topics are randomly assigned to students grouped by 3 by affinity.

The projects are designed so that they can be divided into 3 parts, each student being responsible for one of the parts. During the final presentation, students must be able to present the entire project, requiring them to explain strategic and technical choices of parts they were not responsible of. This fosters pair learning and team spirit (especially as the project and group are evaluated as an indivisible entity – all members of a group have the same grade). Nevertheless, cases of remarkable uncooperative behaviour are sanctioned individually.

Three teachers and an assistant supervise the practical work and guide them in solving the problems related to the project. A criteria grid for the assessment is given to students at the beginning of the course. The assessment of the project is at the group level and is based on a written report and an oral presentation/demonstration.

1.2.2 University Institute of Technology of Annecy (IUT)

The Learning and Evaluation Situations (LES) in the French University Bachelor of Technology (BUT) account for a minimum of 40% of the diploma's evaluation and

are often structured as projects. They provide an opportunity for students to apply knowledge acquired from various teaching modules, which are in traditional form: courses, tutorials, and practical work. Several LES take place in each semester and each LES lasts no longer than one semester.

In this paper we focus on the approach adopted for the LES "development of dynamic web sites" at Réseaux et Télécoms dept of the IUT. This LES is associated to several modules: databases, algorithms, dynamic web and initiation to web, and is based on a problem-based approach, driven by clear functional objectives. Students work in pairs and choose their partners and well as a technical project (among several proposed or propose a new one). The problems are structured in a way that allows students to have well identified responsibilities. The evaluation grid and topic distribution are given in advance, with LES sessions scheduled to ensure students have time to complete the work. Teacher-mentored SOS sessions are available, and students are encouraged to explore additional concepts, with links and explanations provided. Choosing additional concepts is optional, and the teacher assists with the selection to ensure attainable challenges.

Final assessments of main module occur after the LES. Individual tests and quizzes are used to assess knowledge of the modules, while demonstrations and Q/A sessions are used to assess the LES. Self-assessments are required, and peer assessments are recommended. This organisation intends to raise awareness of skills learned and promote learning how to learn.

1.2.3 Polytech Annecy-Chambéry Engineering School (Polytech)

At Polytech project-based learning is adopted in several modules, but we focus in this paper on a particular project that is designed at the curricula level of SNI diploma (Numerical Systems – Instrumentation), providing opportunities for interdisciplinary integrative work as well as exploration of additional topics. The project starts in the second semester of Year3 and lasts till the first semester of Year5 accompanying the students throughout most of their learning journey in the engineering school.

The proposed projects have a wide spectrum and are susceptible to mobilize various knowledge acquired in other modules of the curricula, they are not dedicated to reinforcing any individual part of the program. Moreover, these projects work as a mean of colouring the diploma providing the opportunity for self-learning, as part of the material needed is not covered elsewhere in the curriculum. For instance, there is no Robotics module in the curriculum, but there is a Robotics project. The same occurs for the IOT.

Students express their motivated preferences for 2 out of the 5 subjects proposed by the teaching team. Their arguments are considered when forming the project groups, which entail between 5 and 10 students. Once established, the teams do not change, except for students failing their year or going in mobility. Thus, the students must make their team function properly, so if there are tensions, they must be solved. A small of group of teachers tutors each project.

Every semester there is a module in the curriculum that is assigned to the project, with ECTS assigned, and thus an evaluation. Each semester the evaluation is based on (1) a written report (group note by the project tutors), (2) an oral presentation/demonstration (group note by a teacher committee that entails all the group tutors), and (3) a half an hour interview with each one of the students (conducted by 2 teachers). The interview is built around the competences developed by the student (and registered prior to the interview in a Karuta portfolio). This exercise encourages students to reflect on their learning and on the choices to be made. They must connect the learning with the professional project. This kind of interview is presented as an interview managed by recruitment agency: no specific position, but an opportunity for candidate to explain what kind of job he/she desires. Students become aware that project provides argumentation (i.e., illustrated experience) to convince employers during interview. The preparation of the interview as well the exchanges with jury contribute to the self-efficacy development.

2 METHODOLOGY

In comparing the three approaches we tried to answer three leading questions:

- Q1 How do students perceive the group-work quality?
- Q2 How do students perceive their skill development during projects?
- Q3 How students perceive the value of carrying out projects?

We used a common questionnaire in our three institutions, for addressing these questions. The questionnaire and the data collection are presented hereafter.

2.1 Questionnaire

The questionnaire was constructed using questions demanding answers on the Likert scale (*strongly agree, agree, disagree, strongly disagree*). This uniform construction of the questionnaire allowed us to perform descriptive statistical analysis.

For answering Q1, we adapted the second part of the questionnaire of Fernandez (2010) for measuring students' perception of group work quality as represented by the perceived common goal and inter personal relationship.

The **Common Goal (CG)** represents how students perceive the group having a common target. The CG score is calculated from the answers to nine questions. The higher the CG score, the better: students perceive their groups as pursuing a common goal, rather than each member pursuing its own goal.

The Interpersonal Relationship (IPR) represents how students perceive the quality of interpersonal relations within the group. The IPR score is calculated from the answers to seven questions, on a four level Likert scale. The higher the IPR score, the better the students perceive the interpersonal relations in the group.

For answering Q2 **Skill developments (SK)**, we constructed four questions to address students' perception of developing skills that they will be able to use for

carrying other similar projects in the future. An example of SK question is “I feel able of leading a technical project of the same type”.

For answering Q3 **Use value (UV)**, we constructed four questions to address their perception of the value of carrying projects in their education were included in the questionnaire. An example of UV question is “I can better project myself in a professional context (my employability has increased)”.

The SK and UV scores are also calculated using a four level Likert scale. SK and UV questions were designed in order to explore both the immediate perception of task value and the perception of the possible re-use of working on project skills in a long-term perspective.

2.2 Data collection

Students were asked to complete the survey on the Moodle platform of their institution. Table 2 shows the planning of data collection.

Table 2. Data collection –Autumn and Spring semester2022-23

Institution	HEG	IUT	Polytech
Date	14 January 23	20 February 23	24 March 23
Data	9 students, 4 groups	12 students, 6 groups	22 students, 4 groups

3 RESULTS AND DISCUSSION

3.1 Descriptive statistics

Table2 synthetize the results of our analysis. More precisely, for each one of the four dimensions (CG, IPR, SK and UV) we present the mean and standard deviation calculated from individual scores. For each person, an individual score for each of the four dimensions (CG, IPR, SK and UV) is calculated using the answers to the corresponding questions. The calculated score values range from 1 to 4. From these individual scores, and for each institution, the mean value and the standard deviation is calculated for each dimension (presented in Table 3). The comparison between the institutions is made using the Kruskal-Wallis test.

To measure the internal consistency, of the questionnaire we used Cronbach's alpha value for each dimension.

Results showed that the consistency of our SK and UV questions is comparable to that of the CG and IPR questions in the second part of the Fernandez questionnaire. In addition, the Cronbach’s alpha result indicates that our questionnaire is acceptable.

3.2 Comparison of Individual perceptions of group-work quality

Having a common goal (CG): whilst the value for the score is rather similar, we observed that the dispersion of individual answers tends to be lower for Polytech (SD of 0.37 *vs*. 0.45 and 0.47). This can be explained by the fact that the Polytech students are older, and the project duration is longer (4 semesters); the assumption

that there is a clear sense of common purpose among their teams is related to these elements.

Rating the quality of interpersonal relationships (RIP): IUT scored higher than the two other institutions. HEG and Polytech have the same scoring, but HEG scores are less homogeneous. We do not identify a convenient explication for these scores. Nevertheless, it is worth mentioning that both IUT and HEG have a “self-organisation model” as identified and discussed in (Bundgaard and al. 2021): they choose their group first. Topics are chosen later (IUT) or randomly assigned (HEG). As for the project allocation process used at Polytech, students choose the topics among existing proposals, teams are made according to the chosen topics, and the first semester is designed for team building; this approach is part of “subject-centred model” also studied and presented in (Bundgaard and al. 2021).

Table 3. Descriptive statistics - Internal coherence is acceptable for Cronbach alpha > 0.6 – Differences in the distribution of answers are considered significant for p < 0,05

	HEG		**IUT**		**Polytech**		**Tests**	
	Mean	SD	Mean	SD	Mean	SD	Cronbach α	Kruskal-Wallis (p)
Common goal	3.43	0.45	3.28	0.47	3.35	0.37	0.66	0.72
Interpersonal relationships	3.37	0.67	3.66	0.35	3.36	0.35	0.73	0.10
Skills development	3.30	0.49	3.27	0.51	3.01	0.51	0.69	0.17
Use value	3.04	0.50	3.31	0.53	2.86	0.51	0.74	0.06

3.3 Comparison of Individual perceptions of skills development and value of carrying out projects

Perception of developing skills for carrying other projects in the future: Polytech scored lower than IUT and HEG. Polytech students are halfway through projects that integrate many high-level professional and technical skills, assessed through a portfolio. Having this long-term perception of the project, they probably refer to the whole project when answering these questions, which nuances their answers. Moreover, the learning outcomes are situated at the highest level of the Bloom taxonomy (creation) (Forehand 2005), whereas in the others institute they are situated in the third level (application). Consequently, it is possible that Polytech students feel less like they are developing skills for carrying other projects in the future, and this could be another explanation of their lower score.

Perception of the value of carrying projects in the perspective of professional life: IUT students have the higher rating of the value of carrying project, followed by HEG students. For them, the project occurred at the beginning of the Bachelor, and, most importantly, they are already occupying professional position that are related to their field of education, increasing the perception of usefulness.

The better score of the IUT students can be explained by the fact that they project themselves easily in the applicative field of the project. For HEG, a significant part of the students does not project themselves in the applicative themes of the project, being more interested in the business part of their training. Nevertheless, the scores of these two institutes are relatively high, which can reflect the fact that the students are part-time students and know the company well, its needs and easily imagine the projection of projects in the company.

For Polytech, as for the previous indicator, the higher level of abstraction distances students from the "application" level, which can reassure the perception of their employability that these indicators show.

4 CONCLUSION

The main goal of our study was to compare the 3 approaches by answering 3 questions

- Q1 How do students perceive the group-work quality?
- Q2 How do students perceive their skill development during projects?
- Q3 How students perceive the value of carrying out projects?

The projects differ in different aspects, that are namely 1) the duration of the project, 2) the group size, 3) the level of control (the choice students have on group composition and project topic), and 4) the student profiles (employed/study-work *vs* full time students). These differences explain partially the results in the analysis presented in this paper.

It is worth noting that Polytech's project organisation has specific features: designed using competence-based approach inspired by Tardif (Tardif, 2006), its span (over the 3 years of engineering study) and its integrative and explorative nature make it rather unique (we did not find similar approaches in the literature). In the future experiments we consider including different projects from Polytech (shorter span, and more focused on specific topics).

The questionnaire used allowed us to answer the three questions, provided interesting insight for the 3 institutions and the answers are consistent with the way the institutions operate. The results, while allowing for comparisons between institutions, do not allow us to distinguish the contribution of each of the characteristics we have identified. In addition, the number of observations is clearly a limit to our study. In the measurements planned for the near future (this year and next academic year), we will modify some of parameters like for example, the student profile, increasing the number of students, giving the choice of projects when this was not the case, to study the impact. We will also include qualitative data from open-ended questions and focus groups. This will allow to deepen the analysis and confirm or not this first round of results and see how much they are dependent on the populations that answered the questionnaire.

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