Collective and Individual Self-Regulation Processes During a Project-Based Learning Process

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Abstract

In higher education, students are faced with group tasks, such as project-based learning. However, research on self-regulated learning has paid little attention to the details of collective self-regulation. In this framework, the objective of this research was to determine the impact of the feeling of collective efficacy on the performance of groups of students involved in self-regulation processes in project-based learning. The quantitative approach was adopted. The type of descriptive research and field design. The 45 volunteer participants of an education program at the National University of the Altiplano completed a questionnaire that explored different aspects of self-regulation: Use of human resources, setting objectives, collective efficacy, expression of disagreements, and quality of interactions. The questionnaire comprised 20 items rated on a Likert-type scale, ranging from 1 (strongly disagree) to 6 (strongly agree), and included two open-ended questions aimed at understanding strategies for managing doubts and maintaining interest int the project. The results show that the feeling of collective efficiency is a significant predictor of the final grade in the project and that the group's ability to define the objectives precisely and prioritize them contributes significantly to the development of the feeling of collective efficacy. The conclusion exposes the pedagogical implications of these results, emphasizing the essential role of tutors in fostering an environment conducive to collective efficacy by guiding students in defining, prioritizing objectives, and managing doubts effectively. This guidance is crucial, especially in the early phases of project implementation, to establish a dynamic of collective efficacy and develop individual interest in the project.

Keywords: collective self-regulation, feeling of collective efficacy, project learning, self-regulated learning, group dynamics.

1. Introduction

Success requires not only the mastery of knowledge but also the ability to self-regulate effectively [1]. The concept of self-regulated learning designates the processes by which the

learner activates, supports or modulates cognitions, feelings and behaviors to influence and control learning [2]. These processes demonstrate the learner's active participation in order to achieve the goals he or she has set for him or herself. They are working on both individual and group learning. To date, research on self-regulated learning has paid little attention to the details of collective self-regulation [3]. Now, this question is especially pertinent in higher education, where students are increasingly challenged with group tasks, often of long duration, such as problem-based learning or project-based learning.

Working in a team has become paramount in many professions. Therefore, it is not surprising that professional training in higher education, which is conceived around a competence-based approach, attaches particular importance to group learning [4]. In addition, it is highly likely that these learning experiences reinforce motivation both because they are made of situations closer to professional life and because of the control exercised over the learning situation and lead to experience autonomy [5]. Finally, they are at the origin of the construction of new knowledge networks due to the complex situations in which they force students to integrate learning, i.e. to mobilize together resources of different nature [6]. These three reasons: professional relevance, motivational support and integration of prior learning converge to make project-based or problem-based learning particularly relevant in higher education. This is the reason why it is important to better understand the processes that underlie successful collective self-regulation so that higher education teachers can effectively support students who engage in such learning.

From this perspective, this research has been conducted among education students who participated in project-based learning. They were questioned by means of a questionnaire at two stages of project implementation in order to better understand the self-regulation processes, the strategies implemented, their evolution and the difficulties encountered. The article is structured in five parts. The first is the introduction and the second establishes the theoretical framework by presenting the variables that influence self-regulation processes, which will lead to a more precise exposition of the research questions. The third part is focused on the presentation of the methodology implemented. After a detailed presentation of the results in the fourth part, they will be discussed in relation to the research questions formulated and the theoretical framework underlying them in the fifth part. Finally, the pedagogical implications of the results obtained will be examined in the conclusion.

Theoretical Reference

At the conclusion of a recent meta-analysis of research on self-regulated learning among students and adults, it was concluded that the two variables with the greatest effect on learning are goal setting and feelings of personal efficacy, the translation of which at the group level is the feeling of collective efficacy [1]. In addition, research on group work in general [7] and on project-based learning more specifically [8] highlights that the modes of interaction adopted by the members of a group influence the performance of this group. Finally, recent work [9] emphasizes the need to articulate the group and individual levels to study collective learning. The individual motivation of the participants, especially their interest in the proposed project, is also a variable to be taken into consideration in order to understand the self-regulation processes during project-based learning. Each of these four variables will be examined in detail.

Setting Objectives

Self-regulated handling is goal-directed handling. It works as a reference point to allow the student to evaluate the progress of the work and introduce the corrections considered useful to approach the objective to be achieved [10]. When creating a standard against which the activity will be judged, the way in which the objective is defined influences the handling of self-regulation processes, whether individually or as a group. Optimal objective sizing involves taking into account several factors, as identified in [11]. First of all, an objective must be specific. A general objective ("to do the best possible", for example) leaves an ambiguity in the result to be achieved, which can lead to a wide range of actions being considered acceptable. Immediate objectives ("finish the literature research by the end of the week," for example) support motivation more than distal objectives because they provide more immediate feedback for judging progress that reinforces the feeling of personal efficacy. However, distal objectives can support self-regulation if they are combined in a hierarchy of objectives with short-term objectives.

Finally, assuming that the required competences are acquired, a difficult objective generates more effort than an easy objective, particularly because it is at the source of an anticipated satisfaction that underpins motivation. Objectives calibrated in this way can channel attention to relevant activities in order to achieve the established objectives and thus help the learner distinguish priority behaviors from distracting, parasitic behaviors. They also promote the adoption of strategic behavior to mobilize relevant knowledge or to discover and integrate the knowledge required in order to achieve successful learning. [12] and [11] find that setting objectives has implications for both individual learning and group learning. Therefore, this variable is likely to influence the work quality and performance of a group involved in project-based learning.

The Feeling of Collective Efficacy

The feeling of personal efficacy has a significant influence on work effort, persistence, the ability to overcome obstacles and not to become discouraged. Of all motivational variables, it is undoubtedly the most consistent predictor of school or university results [13]. [14] proposed a transposition at the group level of the feeling of personal efficacy, called collective efficacy, and defines it as a belief shared by group members in their ability to collaborate in organizing and executing the actions necessary to achieve the desired result. From a meta-analysis of 96 investigations, [15] found that collective efficacy was positively correlated with group performance. The impact is even stronger since the task requires interdependence, i.e., interaction among all group members to make decisions, evaluate the work done and define the roles to be shared [8]. Collective efficacy emerges as the group is built. It is the product of the group's experience and, in turn, becomes a variable that determines other processes. The genesis of the feeling of collective efficacy remains largely to be specified, little research has studied this matter, which is nevertheless crucial given the impact of the feeling of collective efficacy on group performance [13, 8].

However, it should be noted that while a sense of collective efficacy helps to overcome obstacles and guard against moments of doubt, these are unlikely to disappear completely due to the

complexity of the tasks students face in project-based or problem-based learning. One of the possible strategies for dealing with doubt is to seek help from others. These strategies are in no way incompatible with successful self-regulation. For example, [16] differentiates between dependent help-seeking and adaptive help-seeking. The first is a type of facility implemented for avoiding confrontation with the difficulty, while the second is the result of a well-considered decision taking into account three criteria: the assistance is perceived as really necessary, the content on which the help is expected is precise (additional explanations or confirmation of a result, for example), the person in a position to provide help is clearly identified. The strategies implemented by the groups to regulate moments of doubt remain to be better identified. Particularly, one of the questions asked is to specify the place occupied by the recourse to the tutor's help in all the strategies of doubt regulation.

The Expression and Regulation of Disagreements

Discussion among group members inevitably generates disagreements, the impact of which has been examined in a number of works related to socio-cognitive conflicts [17]. These studies show that the more the different positions of group members are made explicit and discussed, the more creative the group is. On the contrary, the avoidance of divergences reduces the effectiveness of the work. However, the positive impact of disagreements depends on how they are regulated. Disagreement presents a double uncertainty, on content (which is the most convincing argument?) and on competence (which is the most competent?), resulting in two modes of regulation: a so-called epistemic regulation, focused on the understanding of the problem, and a relational or competitive regulation, whose objective is defensive. It aims to protect against a threat to the competences that could be developed if one of the group members, in case of a disagreement, expresses doubts about the competences of another [17, 18]. Project-based learning involves creative, open-ended and complex tasks, so that the problem to be addressed is progressively structured. Under these conditions, it can be thought that the exploration and confrontation of possibilities in a deep way, without fear of conflict, are necessary steps during the initial phase of a project.

Interaction Between Group and Individual Levels

In a group, the regulation of learning is socially shared because, on the one hand, objectives are jointly constructed and, on the other hand, collective efficacy arises from interactions among group members [9]. In addition, it can be argued that group members share metacognitive processes to monitor ongoing activities (so-called monitoring) [19]. However, understanding the dynamics involved in group learning, such as project-based learning, requires a simultaneous two-level approach, the individual and the group. The completion of a project requires everyone's commitment to individual work between group sessions. This commitment will be facilitated by a high level of interest in the project. In fact, among other characteristics, interest is manifested by attention and persistence of effort [20]. If the theoretical framework on the genesis of interest developed by [21] is referred to, student interest is mainly an interest triggered by certain characteristics of the learning situation (novelty of the content, type of work demanded, for example). This first transitory interest must be transformed into a "stabilized situational interest" to support the long-term commitment. Supporting others and sharing this initial interest with others would be one of the mechanisms involved in moving from one form

of interest to another [22]. As a result, exchanges between working group members are likely to be one of the sources that will be used to support individual interest.

From this theoretical framework, four research questions emerge that will be addressed in this study. These research questions are to confirm previous findings (first question) and to fill in the gaps that the inventory of research literature has brought to light (second, third and fourth questions).

- What is the impact of the feeling of collective efficacy on the group's performance, as assessed by the intermediate grade and the final grade obtained in the project? Is there a meaningful effect of the feeling of collective efficacy on these performances often mentioned in group work research?

- What are the determinants of collective efficacy? The hypothesis is that indicators such as the quality of work organization, appreciated by the precision of the objectives to be achieved and their hierarchy, and the ability to express and then regulate disagreements in the context of non-competitive interactions are the determinants of collective efficacy.

- What are the strategies implemented to combat moments of doubt and discouragement? Do these strategies change during the project and in what way?

- At the individual level, what are the strategies implemented to support interest? How do these strategies evolve over the course of the project and to what extent does the group provide support to maintain interest?

2. Methods and Methodology:

Context and Population

This research was conducted during the academic year 2023, with students of the Professional School of Secondary Education at National University of the Altiplano in Peru. In Peru, education studies are carried out in five years, after an admission exam reserved for students in the fifth year of secondary school. The educational strategy of the vocational school is based on active pedagogies consistent with a competences-based approach. This approach seeks to professionalize students, one of whose core competences is project management in a situation of multidisciplinary integration. Therefore, the eighth-grade students experienced a project-based learning experience to help them develop this competence. The general objective of this experience was to solve an educational problem as a team, adopting a project approach that includes an analysis phase and a realization phase. This project approach involved taking into consideration the problems and context of the project, the technical and human resources available, as well as all the project-related constraints, while mobilizing generic tools and methods that are useful for solving the problem and integrating organizational and human aspects. The students were prepared for this experience: they received training prior to carrying out a scientific team activity, awareness of ICT tools and an introduction to the specific vocabulary for project management. In addition, during the project implementation, they were led to identify, combine and transfer the knowledge addressed in various disciplines such as, for

example, linguistics, psycholinguistics, didactics and research. Specifically, the students chose among the projects proposed by the teacher. These were, for example, the creation of a literary blog and the creation of an educational podcast on language. These projects had the same objectives:

- To expand and enrich the vocabulary related to the specific topics addressed in the project;
- To develop the ability to express and support ideas in a clear and persuasive manner;
- To refine oral and written communication skills, adapting to the context and target audience.

Data collection from students was conducted twice, using a questionnaire. Of the 53 students in the cycle covered by this study, 45 (85%) completed it twice. All of them were volunteers to participate. The ethical principles of confidentiality regarding the responses collected, as well as respect for the anonymity of the respondents, were specified at the beginning of the questionnaire.

Questionnaire

The questionnaire consisted of 20 items. Eighteen items were in the form of a Likert-type scale ranging from 1 (strongly disagree) to 6 (strongly agree). For some items, the wording of the extreme scales differed. It will be indicated when the relevant items are submitted. Two open-ended questions completed these 18 items. They were introduced to collect data on group strategies for regulating moments of doubt and individual strategies for regulating interest in the project.

Most of the items required a judgment about group variables distributed in the five subscales presented below. For each subscale, the items selected and the code used to identify them in the data analysis and discussion were indicated. Depending on the formulation, the items can be considered as positive or negative indicators of the dimension being evaluated. The addition of the scores in order to obtain an overall scale score required the recoding of some of them by inverting them (6 becoming 1 and 1 becoming 6). This recoding operation will be indicated by the word “inverted”.

Use of Human Resources (2 Items, Help)

These two items, very close in formulation, were placed at the beginning and at the end of the questionnaire. Responses ranged from “no, not at all” to “yes, very often.”

- In our group, we call on specialists to advance the project.
- Does your group call on specialists to help advance the project?

Setting Objectives (4 Items, Objectives)

The selected items were used to explore the precision of the objectives established, their hierarchy, as well as the planning behaviors implemented to achieve them. On the other hand, a satisfactory operationalization of the perceived objective difficulty was not achieved.

- In our group, specific work objectives could not be established (inverted).
- In our group, we were able to plan the work correctly.
- At the end of our work sessions, we clearly define the work to be done for the following sessions.
- In our group, we have trouble defining what to work on first (inverted).

Collective Efficacy (3 Items, EC)

- I think our work group is working well.
- I think our group will get a good evaluation at the end of this phase.
- Regarding the ultimate success of the project, the group feels confident.

Expression of Disagreements (3 Items, Controversy)

Three characteristics have been retained to make the expression of disagreements operational: their frequency, their object (they do not refer only to secondary points), their treatment (they give rise to in-depth discussion rather than avoidance strategies).

- In our group discussions, we often disagree.
- Discrepancies that may occur during group work involve minor points (inverted).
- When we do not share the same opinion, we quickly find a solution (inverted).

The Quality of Interactions (4 Items, Cooperation)

- Sometimes discussions lead to personal conflicts (inverted).
- In the group, some people think they are more competent than others (inverted).
- No one in the group tries to impose his or her point of view.
- I find that my point of view is not sufficiently taken into consideration in group discussions (inverted).

In addition to these subscales, the questionnaire included two other items. The first referred to individual motivation for the project (2 items). One item explored interest in the project: What is your current interest in the project? Responses ranged from 1 “not at all interested” to 6 “very interested”. An open-ended question explored the strategies implemented to support interest: What are you personally doing to motivate yourself in this project?

The second section investigated the confrontation with doubt (2 items). One item focused on the frequency of moments of doubt: In recent sessions, did the group experience moments of doubt or discouragement? The proposed answers ranged from 1 “no, never” to 6 “yes, very often”. An open-ended question explored the strategies implemented to regulate moments of doubt: How do you collectively struggle with these moments of doubt?

As noted above, the online questionnaire was completed twice, in May (t1) and August (t2), outside the project sessions.

Response Analysis Methodology

For the open-ended questions, the categories of analysis were generated in two stages. First, an a priori analysis guide was constructed by referring to research on motivation regulation strategies and typologies of these strategies produced by several authors [19, 3, 10]. Then, these categories were tested in a first analysis of the collected material, which led to a reshaping of the analysis guides by adding categories not initially planned or by merging theoretically relevant categories, but whose numbers remained too small. These changes will be indicated when the results are presented. Finally, each of the two researchers categorized the responses and examined intercoder fidelity, using Cohen's k coefficient. This evolved from 0 to 1. The closer the coefficient is to 1, the more satisfactory the intercoder fidelity will be. Whether for the regulation of doubt or for the regulation of individual interest, the categories are not necessarily exclusive among themselves, some answers can be distributed in more than one category if several strategies are mentioned. This characteristic did not allow the Chi^2 test to be used for comparing the distribution of responses at t1 and t2.

For other questions, two types of statistical analysis were used. The first consisted of implementing Student's t-test for paired samples. The purpose of this procedure was to detect meaningful changes in the scores of the different subscales between the two administrations of the questionnaire. The second consisted of a series of multiple regressions in order to determine the predictor variables of the initial grade, the final grade, and the t1 and t2 scores on the collective efficacy subscale.

3. Results

Descriptive Statistics

First, the distribution of items at t1 and t2 was examined. Three of the four constituent items of the cooperation subscale present a very low dispersion of scores, indicating that there are too few students to judge that the interaction in their group is competitive. Therefore, no score was calculated for this subscale. In the following analyses, the interaction quality variable, called cooperation, will be operationalized by the responses to the single item "No one in the group seeks to impose his or her point of view". The homogeneity of the other subscales, tested using Cronbach's α coefficient, is between .70 and .82.

The averages, standard deviations, α coefficients and correlations between subscales are shown in Table 1.

Table 1. Averages, standard deviations and α coefficients at t1 and t2.

	t1			t2		
	M	DS	α	M	DS	α
Interest	4.35	0.98	-	4.23	1.05	-
Doubt	2.16	1.24	-	2.84	1.45	-
Cooperation	3.80	1.70	-	4.05	1.45	-

Help	3.29	1.06	.70	3.66	1.10	.71
Objectives	4.21	0.90	.75	4.04	0.92	.82
EC	4.36	0.89	,74	4.29	0.87	.82
Controversy	2.89	,03	.77	2.80	0.88	.73

Note. The α coefficient was not calculated for interest, doubt, and cooperation, measured by individual items.

Evolution of the Scores From t1 to t2

A significant increase is noticed between t1 and t2 in the moments of discouragement and doubt (t for paired samples = 4.04, gl: 72, p <.01) and in the use of human resources (t for paired samples = 2.48, gI: 72, p <0.02). The minimum collective efficacy score is 2 and these scores are rarely less than 4. The cumulative frequencies for scores 2 to 3 are 6 for EC1 (8.2% of responses) and 9 for EC2 (12.3%). Regarding interest, the cumulative frequencies for these same scores reach 11 (15% of the responses) for Interest t1 and 13 (17.8%) for Interest t2. Collective efficacy and individual interest remain high with no statistically significant fluctuations from t1 to t2.

Determination of Collective Efficacy, Initial and Final Grades

Four multiple regressions were implemented in order to predict the initial grade, obtained at the end of phase 1, the final grade and the collective efficacy at moments t1 and t2. For each of these regressions, it was verified that there was an absence of co-linearity between the predictors entered in the regression equation.

1. For the final grade rating, the predictors were as follows: Objectives t2, EC2, Cooperation t2, Controversy t2, and Help t2. The results obtained are significant, although the coefficient of determination remains modest (r2 = .11). Collective efficacy assessed at t2 is the only significant predictor of overall grade (β = .58);

2. The predictors entered to predict the initial grade were Objectives t1, EC1, Cooperation t1, Controversy t1 and Help t1. The regression results are not significant, indicating that it is not possible to predict the initial grade using the predictors entered;

3. The variables Objectives t1, Cooperation t1, Controversy t1 and Help t1 have been introduced to predict EC1. The result is significant (r2 = .29). The variable Objectives t1 is the only significant predictor (β = .35);

4. The same variables, measured at moment t2, were entered to predict EC2, plus the initial grade and EC1. The result is significant (r2 = 52). Three predictors are significant: t2 Objectives (β = .37), EC1 (β = .36), grade 1 (β = .31).

For both EC1 and EC2, the variable “Objectives” is the most influencing factor in predicting the perception of collective efficacy. On the other hand, no effect of variables related to group interaction is observed at any level (determination of collective efficacy or performance).

Regulation of Moments of Doubt and Discouragement

Responses to the following open-ended question, "How do you collectively struggle with these moments of doubt?" were analyzed. The coefficient κ indicating agreement between the two coders reaches .71 at t1 and .73 at t2, which is a satisfactory value. The categories used for the content analysis were the following:

- "Discussion, cognitive function" refers to strategies in which the group recapitulates work, adjusts objectives or seeks new solutions. Example of a given answer: "We clarify things and define achievable and precise objectives";
- "Discussion, emotional function" indicates that group members try to support and encourage each other: "We encourage each other, adopting a more positive attitude";
- "Getting negative feelings out" identifies an emotional regulation mechanism. Group members temporarily disconnect from work to take a break or an enjoyable activity together (laughing, listening to music): "A break to get some fresh air". This category has been added after reviewing the data;
- "Keeping the commitment" means that the group maintains or even increases the work to fight against doubt or discouragement: "We say that, in any case, it must be done";
- "Seek help from the tutor" indicates that the group uses human resources, mainly the tutor: "Discussion with the tutor for a better orientation of the project";
- "Collective efficacy support" designates strategies to support the feeling of collective efficacy. It is the result of the combination of three strategies that have been initially distinguished from the literature on self-regulation strategies: anticipated success, which allows us to neutralize the scope of the current episode by imagining a future episode in which the group thinks it is competent ("We think that the informative part will soon begin"), the activation of memories of success ("It reassures us to think about what we have already done") and finally social comparison with other groups ("When our progress is compared with other groups, this allows us to relativize"). The observed frequencies did not justify the maintenance of three distinct categories.

Table 2. Strategies for addressing moments of doubt (frequencies and percentages)

	Discussion Cognitive function	Discussion, emotional function	Getting negative feelings out	Keeping the commitment	Seek help from the tutor	Collective efficacy support	N
t1	17 (34%)	14 (28%)	7 (14%)	4 (8%)	6 (12%)	2 (4%)	50
t2	20 (34%)	8 (14%)	7 (12%)	4 (7%)	14 (24%)	5 (9%)	58

Note N = total number of responses

The category "Discussion: cognitive function" is the most frequent strategy with no significant evolution (in percentage) from t1 to t2 (Table 2). The main changes concern the use of human resources, which increased from 12% to 24% of the responses expressed, while strategies to support motivation ("Discussion: emotional function") decreased from 28% to 14%. Strategies

to support the feeling of collective efficacy tended to increase, but their frequency remained low. These strategies consist mainly of evoking a subsequent stage of work for which the group feels competent.

Regulation of Individual Motivation

Responses to the following open-ended question, "What do you personally do to motivate yourself in this project?" were analyzed. The coefficient κ indicating agreement between the two coders is satisfactory: .76 at t1 and .72 at t2. Since some responses can be distributed in several categories, 80 units were coded at t1 and 69 at t2. The categories selected for analysis were as follows:

- "Stimulating work" indicates that students regulate their interest when thinking about the intellectually stimulating aspects of the work. The project allows you to challenge yourself and be creative. Example of a given answer: "The topic is interesting to me and I am looking for new ideas to enrich the project and make it more interesting";
- "Anticipated satisfaction" refers to the satisfaction that will be experienced once the work is completed: "I imagine the project when it is finished and my satisfaction if everything works."
- "Utility" emphasizes the usefulness of the project, either in relation to the specialization to be chosen or for future professional life: "I try to see it as an experience of what I will have to do in the future."
- "Responsibility" is a category derived from the social responsibility objective that encourages acting in a way valued by the important people in the environment: "The fact that I am in a group motivates me."
- "Exchanges" indicates that the interest is supported by exchanges or working together among group members (encouraging each other, scheduling additional meetings): "Organizing meetings to balance";
- "Distribution of work" is an aggregate category after reviewing the data. Motivation regulation involves working on what is of most interest thanks to an appropriate distribution of work within the group: "To motivate myself, I work on what is of most interest to me";
- "Documenting" means that seeking additional information on the project topic supports the motivation: "I inform myself on the Internet";
- "Keeping the commitment" indicates that motivation regulation relies primarily on driving control: "I try to regularly immerse myself."
- Responses included in the category "Nothing" explicitly indicate that nothing special is being done to support motivation for the project.

For a detailed overview of the frequencies and percentages of these strategies, refer to Table 3 below.

Table 3. Individual motivation regulation strategies (frequencies and percentages)

	Stimulating work.	Anticipated satisfaction.	Utility	Responsibility.	Exchanges.	Distribution of work	Get documented.	Keeping the commitment.	Nothing in particular	N
t1	5 (6.3%)	10 (12.7%)	14 (17.7%)	3 (3.8%)	6 (7.6%)	3 (3.8%)	19 (24%)	11 (14%)	8 (10.1%)	79
t2	4 (5.7%)	12 (17.1%)	7 (10%)	4 (5.7%)	14 (20%)	-	11 (15.7%)	8 (11.4%)	10 (14.3%)	70

Note. N = total number of responses

Three strategies are particularly used in t1: get documented, keeping the commitment, utility. These three categories represent 55.7% of all responses. These decrease significantly at t2 where they represent only 37.1% of all responses. In contrast, the use of exchanges or in group work increases from t1 to t2. The "Exchanges" category represents 20% of the responses at t2 instead of 7.6% at t1.

4. Discussion

Impact of the Feeling of Collective Efficacy on Group Performance

Several investigations have shown a positive relationship between collective efficacy and group performance [15, 23], finding at the group level the relationship already identified at the individual level between feeling of personal efficacy and individual performance [1]. The results obtained confirm that collective efficacy is a significant predictor of final group performance. However, the effect is modest, which is not surprising since two months separate the two measures and it is likely that multiple variables intervene in this time period to influence the final success. The measured variable is actually the perception of collective efficacy by one of the group members. These beliefs about the collective, if they can be shared, primarily emanate from singular individuals. In order to move to the group level and measure collective efficacy in the strict sense of the term, the most common procedure is to aggregate the individual scores to obtain a group score [8]. Only a majority of the students involved in the project participated in the research; it was not possible to calculate group-level scores. To explain that an individual variable (the perception of collective efficacy) predicts a collective variable (group performance), one must consider that the individual judgment provides a relatively reliable estimate of what collective efficacy would have been if all group participants had been questioned. This is possible due to fairly high and not very dispersed scores on the subscale of perception of collective efficacy. Scores between 1 and 3 in EC1 and EC2 represent less than 20% of the overall scores.

While the perception of collective efficacy significantly predicts the final score, this is not the case for the score obtained at the end of the project's initial phase. The different nature of the evaluations performed in these two phases could explain these results. The first part of the project was mainly an analysis phase in which the group had to take ownership of the project by

collecting documentation on the subject to reach the drafting of a specification. The second evaluation focused more on project implementation. Interdependence among group members probably increased significantly in the second phase because it was up to them to diagnose and find solutions to overcome obstacles related to the development of the educational resource. The effect of the collective efficacy feeling on group performance was manifested more than when the task requires strong interdependence among group members [8]. In contrast, the phase evaluated by the first score is based in part on a collection of documents that does not imply the same level of interdependence among the participants. At this early stage of the project, the individual interest of the participants could be a more relevant predictor of the first score than the collective efficacy feeling. This hypothesis should be tested in future research.

Regulation of the Moments of Doubt

Despite collective efficacy scores remaining high, moments of doubt increased significantly from t1 to t2 as the group was confronted with the actual performance of the educational resource. This confirms what was stated in the introduction: high collective efficacy does not eliminate confrontation in moments of doubt. The regulation of doubt was carried out through exchanges that progressively promoted the metacognitive dimension with respect to the motivational dimension. Once again, the work on setting objectives, in this case their adjustment, played a crucial role. The decrease in motivational support strategies can be explained in two ways. This type of strategy is likely to quickly demonstrate its limits when overcoming difficulties that, in a complex task such as that of the groups involved, need to be analyzed with precision in order to find the right solutions. It is more the recording of metacognition than the support of motivation that must be mobilized for this purpose. In addition, the weaker use of motivation support strategies is correlated with the significant increase in the use of the tutor from t1 to t2. The tutor's intervention, like any helping intervention, contributed to support motivation. It was a kind of side effect. The results show that calling on the tutor's help is a vital strategy for regulating moments of doubt, especially when the project has entered the phase of realization of the educational object. Finally, the few cases of strategies aimed at supporting the very perception of collective efficacy will be noted.

Variables Involved in the Construction of the Collective Efficacy Feeling

Another research question concerned the determinants of the collective efficacy feeling. If this is to be sought in group functioning modes, it remains to identify more precisely the mechanisms involved [7]. This research makes a significant contribution at this point by highlighting the role played by setting objectives. According to the hypothesis proposed, the definition of objectives, their prioritization and the planning processes implemented to achieve them are the main determinants of collective efficacy. In the initial phase at t1, the group could only rely on the analysis of its internal functioning to build this collective trust. In this state, no evaluation is available to judge the work (first evaluation only occurs in May) and the still unusual recourse to individuals minimizes the social feedback that is known to be an important source of support for collective efficacy [14]. The quality of the work organization appears as the essential resource on which the group's efficacy is judged. The collective efficacy established at t1 in turn fed into the collective efficacy observed at t2 combined with two other sources: the results of the first evaluation and, again, the quality of the work organization. It should be emphasized that, all

other things being equal, the definition and prioritization of objectives, as well as the planning processes, remain the main determinant of collective efficacy in t2.

However, it was not possible to demonstrate an influence of psychosocial factors specifically. The competitive interaction variable measured with the item "No one in the group seeks to impose his or her point of view" did not produce any significant effect on collective efficacy at t1 or t2 nor a direct effect on performance. One explanation for this lack of effect could be that the distribution of responses to the item is too concentrated in the positive scales, making a differentiating effect of this item unlikely. Responses attesting to disagreement (i.e., responses between 1 and 3) with the proposition under trial amounted to 45% at t1 and 37% at t2. Although students agree that some seek to impose their point of view, this judgment does not undermine the perception of collective efficacy. It is possible that the impact of a competitive interaction is moderated by its frequency and the way it is expressed, two dimensions that the item alone cannot assess. This would lead to the hypothesis that wanting to impose one's point of view would not have any consequences, as long as it does not become a privileged mode of operation. This hypothesis should be tested in further research. Moreover, for a group member to seek to impose his or her point of view would be all the less harmful than if this mode of interaction were not accompanied by a negative appraisal of people who hold opposing views; that is, the disagreement is dealt with on a cognitive rather than a social level, one of the members presenting himself or herself as more competent than the others [17]. In fact, this is what seems to have occurred, since the item "in the group, some people think they are more competent than others" is rarely approved: 21.8% of positive responses (i.e., responses between 4 and 6 at t1 and 12.1% at t2). It does not appear that "competence threat" type phenomena [18] have appeared on a massive enough scale to have an impact on the work effectiveness of the groups engaged in the project or on the perception of collective efficacy.

The variable expression of disagreements ("controversy" subscale) also did not produce a significant effect on the feeling of collective efficacy. Is it the theoretical relevance of this variable in question or the way it has been implemented? It was noted in the introduction to this article that several investigations have established a relationship between divergence expression and group efficacy [17]. For this reason, it is important to first carry out a critical analysis of the items selected as indicators of the expression of disagreements. It is possible that the understanding of these items was different than anticipated. Therefore, very frequent disagreements could mean that a clear working direction is not achieved, which would makes adherence to the item "In our group discussions, we often disagree" problematic. To find a solution quickly could be seen as a sign of effective group functioning, information that students would have liked to convey by massively adhering to the item "When we do not share the same opinion, we quickly find a solution", while we hypothesize, on the contrary, that students would not adhere to this statement to show that divergences were really discussed. The conclusion is, therefore, that it is above all necessary to rework the choice and formulation of the items that make up the "Controversy" subscale.

Regulation of Individual Interest in the Project

The analysis of individual motivation regulation strategies for the project and their evolution showed that students motivate themselves by acting and controlling their behavior to maintain

commitment to the work, especially at the beginning of the project. They did this, for example, by trying to regularly immerse themselves in the project or actively participate in all sessions. Likewise, documentation, which is also a way of maintaining commitment, supports motivation. The increased knowledge that arises from this dual activity is likely to increase the student's interest in the project. This is consistent with the hypothesis developed by [21] and [22], for whom the development of a knowledge base in long-term memory about a given topic would favor the development of an interest in this topic. The acquisition of knowledge resulting from the strategies "Get documented" and "Keeping commitment" decreased significantly at t2 while individual interest tended to be increasingly fueled by exchanges within the group or with other students outside the group. We propose the hypothesis of a relationship between the differentiated evolution of these two mechanisms. Exchanges are even more stimulating and likely to support individual interest if they can be supported by a broad knowledge base.

5. Conclusion

Before concluding, it should first be noted that the research has certain limitations. Only a portion of the students (85%) participated in the research, which did not allow us to construct group measures. Although it is considered that a group member's judgment of collective efficacy was an acceptable approximation of the latter, one may wonder whether the greater precision provided by a true group measure of collective efficacy would probably not have amplified its impact on the overall score. Secondly, the question of the validity of the "Controversy" subscale remains. It would be desirable to test new items that could assess the expression of disagreement. Finally, it would be appropriate to replicate this research with larger numbers to improve the reliability of the results and increase the possibilities of statistical analysis.

Despite these limitations, the results obtained are combined in a coherent table. First, the perception of collective efficacy has a significant influence on the final performance of the groups involved in a project-based learning, confirming what several researches have already pointed out [15, 13]. In the second place, cognitive and metacognitive processes, in this case all operations related to the definition and prioritization of objectives, play a preponderant role in the genesis of collective efficacy. Their effect on performance is exerted indirectly, through the feeling of collective efficacy that they contribute to maintain and that, alone, produce a positive impact on the overall score. Their importance is also evidenced by the role they are given to overcome moments of doubt and discouragement where one of the most used strategies consists in re-evaluating objectives and priorities. Although the objectives must be correctly established at the beginning of the work, they are not definitively fixed. Therefore, successful self-regulation does not consist of reaching the initially established objectives at all costs, even if they are correctly determined; it implies being able to adjust them as the work progresses according to the results produced. This conclusion is coherent with the conceptions developed in most models of self-regulated learning that consider the latter as a non-linear process involving returns to previous phases [10, 3].

Another lesson from this research is that the development of individual interest in the project is closely dependent on the knowledge acquired. This shows that interest is not the prerequisite for

activity, but rather the result of the latter. Understanding this dynamic of building interest is a critical point for teachers supervising groups, as it may seem contrary to the idea that interest is a prerequisite for activity. However, progressively, this strategy gives way and student-to-student exchanges become one of the main sources to support individual interest, highlighting the interaction between group experience and individual regulation [9].

All of these results have pedagogical implications for the roles that tutors can adopt in project-based learning. They suggest two different types of interventions, aimed at the groups or students that make up these groups. Regarding the groups, the tutors could position themselves as a metacognitive resource, with the aim of supporting them in their work of defining and prioritizing objectives, planning and breaking down long-term objectives into more manageable short-term objectives and more apt to develop a sense of collective efficacy. Concerning individual students, one of the tutors' tasks could be to make them aware of the mechanisms for generating interest in order to help them adopt a proactive attitude of involvement in the work from the beginning of the project.

Tutor interventions could be carried out in two different ways depending on the progress of the project. The initial phase of the project seems crucial, because it is at this time that a dynamic of collective efficacy building and a development of individual interest in the project is established, but it is also the phase during which students are less inclined to call on the tutor's help. At the beginning of the project, the organization of a methodology session would be an opportunity to sensitize the groups to the role of the factors mentioned above. Given their importance, this methodology session should concentrate only on these factors that will determine a positive work dynamic. Therefore, a privileged approach in conducting exchanges with the groups could be, on the one hand, to analyze how they adjust their objectives and plan their work and, on the other hand, to help them identify incompatibilities between objectives of different natures. The tutor's role here would be to facilitate the group's self-observation. This intervention mode illustrates one of the possible ways to implement the "Interrogator" function identified by [24] as one of the essential functions of tutors during project-based learning.

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