

TEAMWORK AND EFFICIENCY IN CHEMISTRY PRACTICAL SESSIONS

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Abstract

Teamwork, i.e., the ability to work effectively with others in a group, is sometimes used in the classroom to help students perform practical activities with greater competence. In fact, this work methodology allows students to foster mutual trust and create a good climate. Having a shared vision of the problems they have to solve allows them to be more empathetic and thus develop soft skills. Students' acquisition of teamwork competence is a continuous and progressive process. Teachers should monitor this process in order to assess the development of teamwork competence. Also, evidence of students' performance during their learning experiences should be collected and analyzed, both by the teacher and by other students. The case study presented in this article was designed to assist in the development of students' teamwork competence. The educational experience was carried out in the Chemistry laboratory practical sessions with students of the Aerospace Engineering Degree at the Universitat Politècnica de València, during their first year. The students worked in the laboratory in pairs. After finishing the third of the four practice sessions, the students were asked to fill in a questionnaire together with the session report (37 recorded their answers). The aim was to assess their involvement in teamwork and their satisfaction with this way of working. It asked about the effectiveness of the teamwork in terms of contributions, time management in the laboratory sessions, their time management until the delivery of the report, their attitude as a team and the quality of the work in the laboratory. Another questionnaire was given to the students at the end of the course with questions about the efficiency of their work as a team, including those about the degree of collaboration in the group, the ability to discuss, learning, motivation and partnership. Students were very supportive of the lab sessions and felt that working as a team motivated them to work better. The first questionnaire showed that about 80% (specifically 81.1%) of the respondents felt that they cooperated very well and had very bright ideas, while the remaining 20% felt that working in a team enabled them to have good ideas and that they worked well together. No student felt that it had been difficult to agree on what they needed to do as a team. It was also found that students felt that their time management was good and that they were generally able to get things done on time (91.9%), while the remaining 8.1% felt that there were delays from time to time and found it difficult to work as a team. Finally, 83.8% felt that the quality of the work was good, while 16.2% felt that the work had been good. The second questionnaire showed that students perceived that their grades could improve with teamwork and that they had a good time doing it. This study will be improved by adding control groups having the same practical sessions but individually in order to contrast the results.

Keywords: Teamwork, process assessment, professional skills, undergraduate.

1 INTRODUCTION

Teaching methods should prepare students for their work environments. This is specially the case in technical universities, such as Universitat Politècnica de València, since students (mostly engineers) need to be ready to contribute to the organizations where they will work.

Organizational structure has changed dramatically during the last century, with new designs being created and tested in start-ups and old companies alike. For example, Johnson & Johnson has a decentralized hierarchy, imitating the organization of start-ups [1]. As the company's CIO explained, "there's a shift from purely functional excellence to end-to-end collaboration. It's not just about frontline decision making, but about how everyone in the organization lines up behind the front line to make their decisions and their actions most effective". Thus, all employees need to contribute with their decisions and the way they tackle their work which leads a company to success. A high level of hard skills is no more the norm. Soft skills, including the ability to work as a team, are becoming more and more critical.

One key factor in businesses is synergy. In the organizations, according to Johnson et al. [2], synergy refers to the benefits that are obtained with activities or resources that are complementary so that their combination is greater than the sum of each one by their own. The most important resource in companies is human resources. Also, the higher and higher competition in a global market introduces a

tension for creativity and innovation in the companies, which asks for small collaborative teams. These teams create flexible company structures that can adapt easily and innovate. Teamwork, according to the Merriam-Webster dictionary, is the “work done by several associates with each doing a part but all subordinating personal prominence to the efficiency of the whole” [3].

Students need to develop teamwork skills among their soft skills at the University so they are ready to contribute to the organizations where they will work in the future. Universitat Politècnica de València has a project based on transversal skills, organized in 2014 by its Science Education Institute (Instituto de Ciencias de la Educación, ICE). Among these competences there is “Team work and Leadership”, which was defined by ICE as the ability to “work and effectively lead teams to achieve common goals of a group of people contributing to their personal and professional development” [4].

Teamwork may be used in the classroom, especially for practical activities [5-7]. When teamwork is implemented, students should perform better as a group, in terms of work quality, compared to work performed alone. This is developed through the reciprocation of help, review of the work by peers, sharing a vision of the problem and contributing solutions, etc.

2 METHODOLOGY

Students attending Chemistry laboratory practical sessions of the Aerospace Engineering Degree at the Universitat Politècnica de València were asked to participate in the experiment. Forty-seven students signed up for the laboratory sessions. Students voluntarily participated and their participation was not related to the qualifications of the subject. They worked in pairs during the first year of Chemistry subject, which comprised four practical sessions.

Students were asked to answer a questionnaire after the third laboratory session (first questionnaire) and another questionnaire at the end of the subject (final questionnaire). Data were collected during the 2021/22 autumn term.

The first questionnaire was answered by 37 students (6 female, 31 male) and collected the students' involvement in teamwork and how they felt about teamwork in comparison to working on their own. Specifically, it asked about their satisfaction in working in a group (Likert scale 1 to 10), attitudes they had in their work as a team (they had to freely choose three words that defined the attitude), and how they evaluated their classmate (three words they had to choose freely), along with questions based on a rubric proposed by RCampus [8]. Those questions are shown in Table 1, and measure how well teams cooperated, how well they managed their timing during the laboratory and in the report delivery, and the attitude and the quality of the work.

Table 1. First teamwork questionnaire.

Question	Choices
1. Contribution	a. As a team, you have very good ideas and cooperate very well b. As a team, you have good ideas and work well c. As a team, you have good ideas, but it is difficult to know what to do
2. Time management during the laboratory session	a. As a team, your timing is very good and finish tasks in time b. As a team, there are delays in the lab work and you have difficulties to work together c. As a team, tasks are not accomplished, and this has affected the completion of the work in the laboratory
3. Time management in report delivery	a. As a team, your timing is good and get things done on time b. As a team, there are delays in the delivery of the report and you have some difficulties in working together c. You do not perform the tasks as a team, and this has affected the presentation of your report
4. Attitude	a. As a team, you have a good attitude towards working together b. As a team, you sometimes have a good attitude towards working together c. As a team, the attitude towards teamwork has been negative
5. Quality of the work in the sessions	a. As a team, you have performed very well in the lab b. As a team, you have performed somewhat well in the lab c. As a team, you have performed badly in the lab

The second questionnaire, which was answered by 40 students (8 female, 32 male), introduced questions about collaboration, discussion, learning, motivation and an evaluation of the other team's member. For each of the questions (Table 2), students had to select a value in a Likert 1 to 5-scale.

Table 2. Final questionnaire.

Block	Questions
A. Collaboration and teamwork	1. I can say that after finishing the chemistry lab sessions my way of working as a couple has improved. 2. I believe/think that working in pairs in the lab sessions increases cooperation between the two students.
B. Discussion	1. There was discussion during the lab sessions.
C. Learning	1. I learned more in the lab sessions by working in pairs than if I had worked on my own. 2. In my opinion, I believe that working in pairs enhances learning.
D. Motivation	1. I believe that working in pairs increases the motivation to work better in the lab. 2. My classmate (partner lab sessions) and I can achieve a better grade by working with another.
E. Partner	1. I think that having a good partner (hardworking and cooperative) is important for working in the lab. 2. It was stressful for me to work in the lab in couples. 3. I enjoyed working in pairs.

3 RESULTS

The answers to the question 'What attitudes do you find most important in teamwork?' with free nouns and verbs as an answer are summarized in Figure 1. Bigger font and blue color indicate higher importance. Specifically, the most sought for attitude was empathy (8 times chosen), followed by commitment and communication (6 times each), patience and respect (5 times). Dialogue, hard work, harmony and open-mindedness were selected 4 times. The rest of the words were leadership (selected 3 times); active, attitude, collaboration, confidence, efficiency, humility, motivation (twice selected); agreement, assertiveness, cheerful, creativity, flexibility, helpfulness, mediation, organization, perseverance, predisposition, responsibility, synergy, team spirit and trust (once selected).



Figure 1. Word map indicating most looked-for attitude in teamwork.

As seen in Figure 1 and the description in the previous paragraph, students were most interested in pursuing common goals (i.e., commitment, hard work) with a good, open climate (i.e., empathy, respect, patience, dialogue, harmony).

In the final evaluation, all students showed satisfaction with the teamwork (all answers to the two questions of that block were between 4 and 5). In terms of discussion, there were teams that discussed much and other that did not discuss (average value, 3.53 with a 1.43 standard deviation). Most students found that working in a team helped them to learn more (answer to first question, 4.48 ± 0.68 ; answer to the second question, 4.73 ± 0.51). Finally, most students thought that their team companion had been a good partner (4.85 ± 0.36) and that he or she had not been a source of anxiety (1.55 ± 0.96), although 3 students found it moderately to highly stressful. Finally, all students found teamwork had been enjoyable (4.80 ± 0.46).

4 CONCLUSIONS

Teamwork is usually encouraged among university students. With this case, we found out what made teamwork exciting for students and how they evaluated the contribution of teamwork to their studies.

In the future, the authors would like to test how teamwork affects the quality of the work and the environment by replicating the work with students both working as teams and students working on their own.

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