

## Perceptions of the development of teamwork competence in the training of undergraduate engineering students

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**ABSTRACT:** The current structures and dynamics of organisations require a steady flow of information and teamwork. Therefore, higher education institutions have implemented programmes to develop soft skills in their students. It is necessary to assess whether there is compatibility between the teamwork skills possessed by professionals trained in the various institutions of higher education with related attitudes to teamwork that companies require for various positions. This article seeks to answer the following questions: What does teamwork competence in engineering mean? Does this competence improve the training of undergraduate students? Are there differences between what academics and students expect and do when they are asked to work as a team? Interviews were conducted with professionals responsible for the selection of engineers in the labour market. Two surveys were designed, implemented and conducted with academics and students. It was found that there were differences between what was required by professors and what was executed by students.

**Keywords:** Teamwork, soft skills, engineering students, competence

### INTRODUCTION

The organisational structure and dynamics of companies have led to major changes in how workers interact and perform their work. At present, competitive teamwork is imposed on individual tasks [1]. The complexity of organisations has led to the need to generate interdisciplinary working groups where knowledge of a specific area should be mixed with other areas to achieve the objectives [2].

Teamwork is a personal disposition and collaborating with the other members with the same objectives results in generating information flows, assuming various responsibilities, solving problems set, and contributing to the collective development [1].

In view of these changes, higher education centres of organisations have endeavoured to train professionals who possess teamwork skills [3]. They have implemented methodologies, which make students interact in different situations that test their performance in collaborative work [4]. They aim to train professionals to have integration capabilities, responsibility and team commitment, communication and expression skills, and leadership, among other things [5]. The development of communication skills has been emphasised as an important feature in group labour relations [6].

It is necessary to assess whether there is compatibility between the teamwork skills possessed by professionals trained in higher education institutions with teamwork related attitudes required by companies when applying for a job. This information is relevant for improving curricula and modifying methodologies used in teaching and developing skills in undergraduate students.

This article seeks to answer the following questions: What does teamwork competence in engineering mean? Does this competence improve the training of undergraduate students? And, are there differences between what academics and students expect and do when they are asked to work as a team?

The research methodology seeks to answer the questions through:

- 1) A literature review to establish how teamwork is understood internationally and within the engineering professional.

- 2) Collection of information from professionals responsible for the selection of engineers.
- 3) Creation of a survey to assess how teamwork skills are formed at the undergraduate level.
- 4) Application of surveys to higher education students and professors.
- 5) Data analysis and discussion of results: frequency analysis and Mann-Whitney U testing.

## LITERATURE REVIEW

Among the psychosocial aspects that strengthen labour competence, the following can be highlighted: integration capacity, interpersonal communication, empathy and ability to understand the culture of knowledge, responsibility and commitment, decision making and time management, recognition of roles, leadership recognition, and respect for the team [5].

In the Tuning Project a list of generic skills that a student must acquire during their undergraduate training has been proposed, divided into generic and specific, including teamwork as an important generic skill. With teamwork, it is intended that students internalise basic attitudes, such as commitment, transparency, consistency and respect. On the other hand, students should reinforce their planning and organisational skills, as well as those related to conflict resolution, argumentation, consensus and decision making skills, for example [7].

In the case of engineers, among the professional skills required by employers, the ability to communicate, teamwork, continuous learning, leadership and innovation were highlighted. Not all of these skills are fully satisfied, so that future engineers are in a deficit situation in the job market [3].

Among the results expected by an engineering student who has completed her or his undergraduate training process, is the ability to work in multidisciplinary teams [8]. Similarly, other studies highlight employers of engineering professionals require both technical skills and soft skills, such as conflict resolution, communication, teamwork and leadership [2][9][10].

Student teamwork may have advantages over individual work, mainly for overcoming some training deficiencies; for example, finding it difficult to argue or to speak in public. The advantages of teamwork range from overcoming difficulties related to the acquisition of conceptual and practical knowledge, to improving their attitude towards learning [4].

Profiles of engineering graduates in Chile are oriented towards the training of integral professionals, with both technical and interpersonal skills and global development. In this sense, an important aspect is the development of teamwork, framed in the ability of social interaction between like-minded professionals and other areas. The goal is to train students in effective communication skills, to teach them different ways of dealing with problems, and to manage projects, people, resources and time efficiently.

The development of these skills becomes a factor to consider when making assessment process engineering programmes that meet the criteria and standards certified by the National Accreditation Commission, the entity that regulates the accreditation of university programmes in Chile [11]. Study plans of engineering programmes in Chile include exercises in which students are subjected to teamwork situations at different stages of training; thereby, simulating the conditions, which will be faced in the work world [12].

## INTERVIEWING PROFESSIONALS WHO SELECT ENGINEERS

Interviews were conducted with 14 professionals responsible for the selection of engineers in the job market. They were asked the following: when evaluating an applicant, do you consider it important to be able to work in a team? What do you mean and how do you define the competence of teamwork? And how do you evaluate whether an applicant can work as part of a team?

All persons interviewed said that it is important to have workers in the company, in different positions, that can work in teams. It was argued that projects today require a multidisciplinary team in which different professionals share their knowledge and know how to coordinate with other team members. Distributed in this way, the workload can be effective in completing tasks.

Additionally, they added that the skills involving teamwork can generate relationships of trust with clients, while helping the growth of the company. Furthermore, the interviewees emphasised the skills required for teamwork, such as empathy, coordination, collaboration, communication, practical thinking and not being confrontational.

When asked to define teamwork, the respondents answered that it was the ability to work with others for a common goal, complementing each other's different knowledge, because the result is the addition of several specialties and crafts. Others focused on soft skills to make effective teamwork, such as empathy, effective communication, active listening, ability to contribute, collaborate and consolidate different opinions and ideas. They also highlighted the importance of

the quality of relationships within the team, because if the team does not have an appropriate relationship, it might not perform as expected, leading to decreased productivity.

The interviewees reported several ways of assessing whether an applicant had the skills to work in a team through different selection processes. Standing out among them were: the job interview, psychological tests and work references. In relation to the job interview, 80% of those interviewed assessed teamwork ability through interviews, which were carried out by the contracting manager or a psychologist. As for psychological tests, a few companies declared their ability to use them, despite stating that in this way, it certainly shows whether people feel more comfortable working in a team or alone and whether they are compatible with the profile being sought for the company.

## SURVEY

With the information presented in the previous sections, specifically in the literature review and interviews with professionals responsible for selecting candidates for various positions engineers, two surveys were designed. The first was aimed at third year students or higher and the second was aimed at teachers of engineering courses.

To assess the competence of teamwork, perceptions were measured separately using a 5-point Likert scale (from strongly disagree 1, disagree 2, neither agree nor disagree 3, agree 4, to strongly agree 5). The following criteria were measured: coordination, fulfilment of tasks and times, conflict resolution, effective communication, leadership and collaboration. In the case of students, they were asked about the level of implementation in practice of each of the criteria, while academics were asked about what they expected students to perform. Students and academics were also consulted about the importance they deliver to the ability of teamwork.

In addition, the students were asked about the percentage of courses in which they had to team up with classmates from the same programme and from different programmes. Meanwhile, academics were consulted on the percentage of courses in which they have requested students to work in teams.

## SURVEY RESULTS AND DISCUSSION

The survey was applied to 221 academics and 220 students enrolled in engineering degrees in Chile. The survey was anonymous and a Google drive form was used for data collection. An analysis of reliability of the instrument was performed by calculating Cronbach's alpha, which academics scored a value of 0.751 and for students was 0.870. Both cases demonstrated the instrument's high reliability.

When students were asked about the percentage of courses in which they had to work in groups or teams, they responded that on average this was the case in 70.05% of their courses. On the other hand, students declared that on average, 72.45% of the courses were grouped with peers following the same career, while only 14.95% in the courses were grouped with peers from a different career. Meanwhile, scholars declared that they asked students to engage in teamwork in an average of 75.11% of their courses.

When students and scholars were consulted on the level of importance they gave to teamwork ability, it was found that the 95.93% of academics rated teamwork as important (agree or strongly agree), while 87.50% of students declared that they consider this skill to be important (agree or strongly agree) (Figure 1).

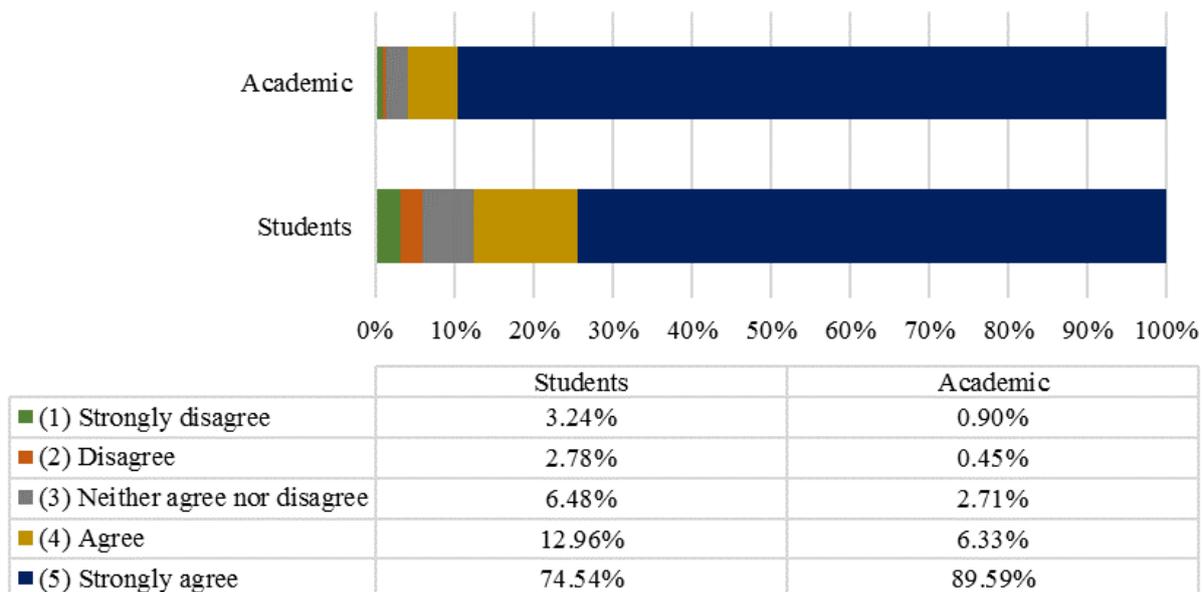


Figure 1: Importance of teamwork - rating by academics and students.

As presented in the survey, teamwork was evaluated against six criteria. Figure 2 shows the comparison for each of those criteria, including what academics and students expect when performing in teams.

Per the results, 92.8% of academics perceived that teamwork developed effective collaboration; i.e. students meet to work together to integrate, discuss and analyse ideas. However, this differs considerably from students' perceptions, as only 49.5% of them said they performed these actions when working in teams. In turn, 86.9% of academics want students to be able to lead the team to achieve the objectives when developing teamwork, while 73.1% of students asserted that they developed that skill in these instances of work.

Moreover, 91% of academics expected students to be able to communicate their ideas appropriately and to listen to other team members, while 83.3% of students said they performed these actions when working in teams. Furthermore, looking at the development of teamwork, 88.7% of academics said that students could resolve the conflicts that it generated, while 75.0% of students believed so.

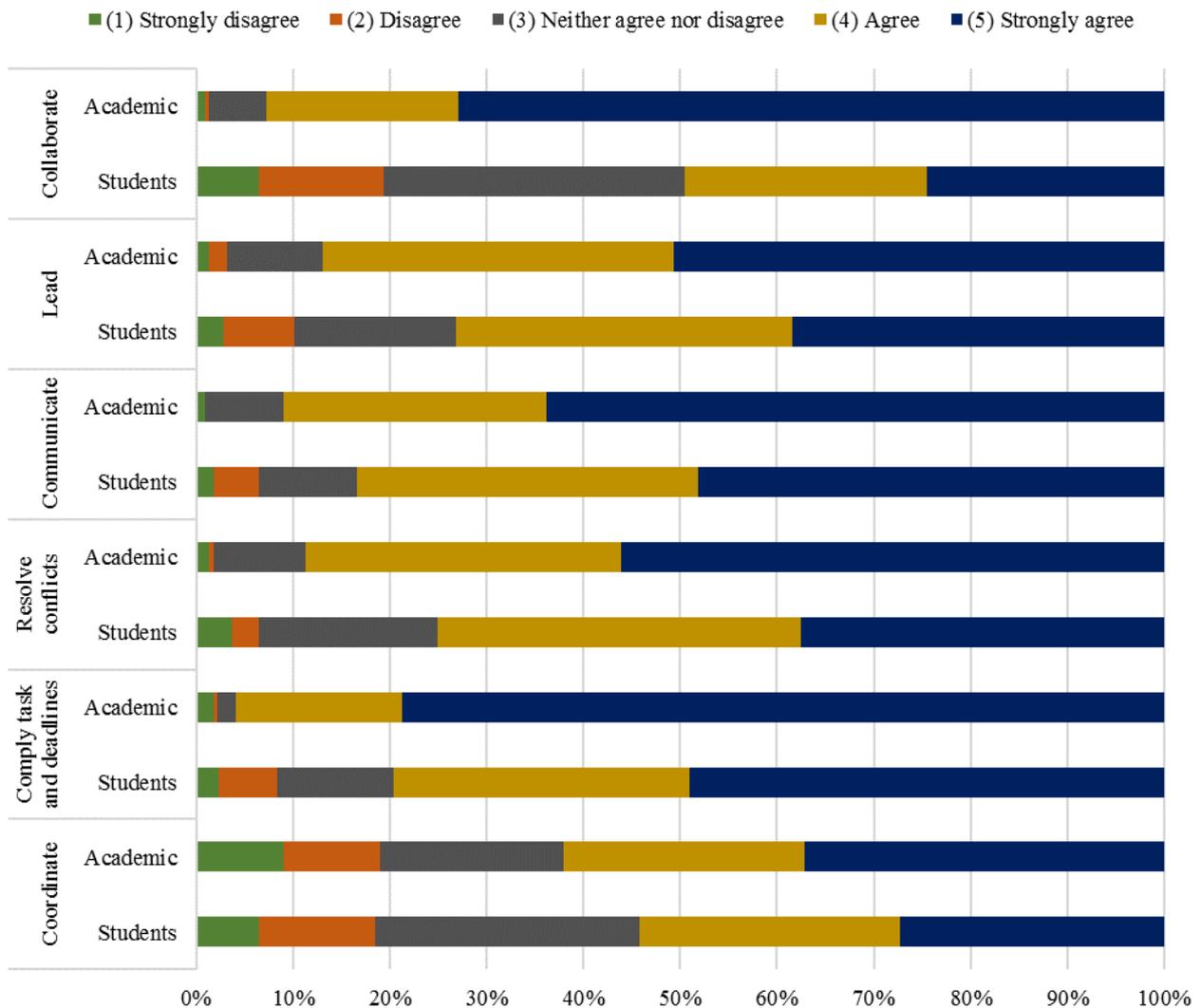


Figure 2: Comparison between what is expected of academics and students executing to perform teamwork, for each criterion.

In addition, 95.9% of academics wanted students to develop teamwork that could complete tasks by the prearranged deadlines and quality, while only 75.0% of students said they met those levels. Finally, 62.0% of academics expected students to develop teamwork skills, with tasks being equitably divided and defined deadlines for compliance, while 54.2% of students said they performed these actions when working in teams. It should be noted that this objective was not regarded as relevant by scholars or students compared to other objectives studied.

To answer the question about whether there were differences between what they expect academics and students to do when they are made to work together, the Mann-Whitney U test was used to verify each criterion with which the ability to teamwork was shown, leading to the following hypothesis being formulated:

- $H_0$  = There is no difference between the expectations of academics and students regarding the criteria  $i$
- $H_1$  = There is a difference between the expectations of academics and students regarding the criteria  $i$

A significance level of 0.05 was defined and the  $p$ -value for each of the criteria for whether  $H_0$  or  $H_1$  (Table 1) hypothesis was obtained. If the  $p$ -value is greater than the significance level, the null hypothesis cannot be rejected and otherwise if the  $p$ -value is less than the significance level, one can reject the null hypothesis, and stay with  $H_1$ .

Table 1:  $P$ -value for each criteria and decision making.

Criteria	$P$ -value	Decision
Coordinate	7.30e-02	There is no difference between what academics and students expect to do regarding the coordination of work ( $H_0$ ).
Comply task and deadline	6.61e-12	There is a difference between what academics and students expect to do regarding accomplish tasks and time ( $H_1$ ).
Resolve conflicts	5.04e-06	There is a difference between what academics and students expect to do regarding resolving conflicts during execution of the work ( $H_1$ ).
Communicate	2.44e-04	There is a difference between what academics and students expect to do regarding effective communication between team members ( $H_1$ ).
Lead	3.42e-04	There is a difference between what academics and students expect to do regarding lead work activities ( $H_1$ ).
Collaborate	6.29e-29	There is a difference between what academics and students expect to do regarding collaborate and work together to analyse ( $H_1$ ).

## CONCLUSIONS

Per the results, it is possible to draw the following conclusions:

It is essential for engineering students to develop teamwork competence as this ability is much needed and required in the workplace. The good news is that in institutions of higher education, academics and students are aware of this need and consider it relevant in the training of engineers.

In most undergraduate courses in engineering careers, scholars asked their students to undertake activities as a group (over 70%), however, in most cases students declared that they did these jobs with fellow students in the same career at the expense of interdisciplinary work (less than 15%). The market is asking for interdisciplinary work.

There are differences between the objectives sought by academics when asking students to apply teamwork and what they perform in such instances. This is mainly linked to criteria, such as compliance tasks and times, conflict resolution, effective communication, leadership and collaboration. The only criterion for which there was no difference between what was expected by academics and by students was coordinating the work.

For future research, it is recommended that there be further investigation of the strategies to be applied by academics to students to develop working in teams and thus meet market needs.

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