

# Collaborative Learning: Team Size and the Scientific Field as Influencers

Dulce Pacheco  
Madeira-ITI  
Funchal, Portugal  
[dulce.pacheco@m-iti.org](mailto:dulce.pacheco@m-iti.org)

Luísa Soares  
Madeira-ITI, University of Madeira  
Funchal, Portugal  
[Isoares@uma.pt](mailto:Isoares@uma.pt)

**Some individuals seem to intuitively collaborate better in teams, and some teams have repetitively superior results. Cooperative work is a growing need in all workplaces, and it has been thoroughly studied. However, literature has not yet clearly identified its predictors, as it does not present consistent results. Some authors report a reluctance in students to collaborate in teams, whereas others describe its huge advantages. This work intends to explore variables that might influence collaborative learning. We hypothesize that the team size and the scientific field of the students might affect team collaboration and team performance. In this study with Pre- and Post-test, team collaboration was measured using the Team Collaboration Evaluator (TCE) and team performance was assessed by the students' perceived team effectiveness and by the final project grade given by the instructors. Analysis of a sample of 99 students, from both Computer Science and Psychology bachelor programs, indicates that larger teams show lower team collaboration, but higher team performance. Collected data confirm differences in the evolution of the perceived team collaboration, according to the students' scientific field. Results are discussed considering the Team Collaboration Evaluator framework.**

*Collaborative learning, Cooperative work, Perceived team effectiveness, Team collaboration, Team performance.*

## 1. INTRODUCTION

The need to work more productively in teams has increased exponentially (Burbach, Matkin, Gambrell, & Harding, 2010). Teamwork skills are highly sought-after in the workplace, as it may improve employee performance and their satisfaction levels (Pacheco, 2015). Providing students with the opportunities to learn collaboratively facilitate active exchange of ideas, increases motivation among participants, and develops a better understanding of diverse cultural backgrounds (Soares & Pacheco, 2014; Pacheco & Soares, 2017). Ad-hoc student learning teams most probably follow a progressive developmental path (Fransen, 2012), with a rapid group development (Morgan, Salas, & Glickman, 1993). However, literature has not yet clearly identified the predictors of team collaboration, as it presents conflicting results (Strijbos, Martens, Jochems, & Broers, 2004). This work intends to explore the variables team size and scientific field of team members, and its connections with the Team Collaboration Evaluator (TCE) framework (Fransen, 2012).

Size of the team has been conveyed as a predictor of team effectiveness (Robbins, Judge, & Campbell, 2016). Some authors show that large teams consistently get higher marks than the smaller ones

(Shaw, 1981), but other researchers show that individuals perform at higher levels when in smaller teams (Seijts & Latham, 2000). It has been reported that smaller teams lack the diversity of skills needed for creating effective problem solving (Rollinson, Broadfield, & Edwards, 2008). Size of the team seemingly affect members satisfaction and, subsequently, may have had some influence on the perceived team collaboration (Foels, Driskell, Mullen, & Salas, 2000).

TCE is an instrument with the potential to be a team tester to predict the emergence of learning team effectiveness during early stages of teamwork (Fransen, 2012). This framework includes four subscales: Shared Mental Models (SMM), Mutual Trust (MT), Mutual Performance Monitoring (MPM), and Perceived Team Effectiveness (PTE). SMM and MPM facilitate the processes of setting goals, establishing strategies, monitoring team processes, engaging with peers, and communicating effectively, what might lead to higher team collaboration (Davies, 2009; Pacheco & Soares, 2017; Salas, Sims, & Burke, 2005; Van den Bossche, Gijssels, Segers, & Kirschner, 2006). Teams with low MT might spend too much time and energy protecting their members' specific interests and not constructively collaborate (Peterson & Behfar, 2003). Moreover, low MT usually demonstrates task

and relationship conflicts that negatively affect performance (De Dreu & Weingart, 2003).

## 2. METHOD

This study was designed as a quasi-experiment, with Pre- and Post-test. A convenience sample was chosen, comprised of one class of Computer Science (CS), and a class of Psychology (Psy) bachelor students, from a University in Southern Europe, in the lecture year of 2013/2014. The experiment was done as part of a class project. The sample involved a total of 112 participants (59 CS; 53 Psy). However, 13 choose not to participate. Out of the 99 respondents, 46% were female.

TCE (Fransen, 2012) weighs perceived team collaboration. Scales SMM (3 items,  $\alpha=.89$ ; e.g. "The degree of agreement within your team on what exactly has to be achieved."), MT (3 items,  $\alpha=.88$ ; e.g. "The extent to which team members are willing to support and help each other."), MPM (3 items,  $\alpha=.88$ ; e.g. "The extent to which you value the effectiveness of the communication within your team."), and PTE (3 items,  $\alpha=.89$ ; e.g. "The extent to which you are satisfied about the quality of collaboration within your team.") were rated using a 1 to 10 scale (1=*Low/Almost Never True* to 10=*High/Almost Always True*). TCE internal consistency was high ( $\alpha=.90$ ). Researchers also included open questions about the teamwork experience in the paper-and-pencil-based questionnaire.

Professors asked students to freely form teams for an 8-week long project, where students had to collaborate to either build and program a robot or to research a topic and write a report. Teams were required to have 4 to 8 participants ( $M=5.79$ ,  $SD=.89$ ). The experiment involved a total of 17 teams.

The Pre-test Questionnaire was filled four-weeks after the teams were formed, so that students can answer the questions based on their team collaboration experience. The second questionnaire was filled one week before the final project deadline, to avoid grading and team dismantling bias. Feedback given by the professors and the final project grade (assessed on a 20-point scale; 1=*does not comply with any objective*, 20=*objectives totally achieved*) were also considered.

## 3. FINDINGS AND DISCUSSION

Small negative relationships were disclosed linking team size with SMM ( $r=-.27$ ,  $p<.01$ ; explains 7% of variance), and with MT ( $r=-.22$ ,  $p<.05$ ; explains 5% of variance). A medium size negative correlation was uncovered between team size and PTE( $r=-.32$ ,  $p<.01$ ; explains 10% of variance). Data

suggests that smaller teams have stronger SMM, MT, and PTE.

A positive relationship arises linking final project grade with team size ( $r=.4$ ,  $p<.01$ ; predicts 16% of variance). It indicates that larger teams have higher grades, confirming Shaw's findings (1981). Also supports arguments that size of the team can predict team effectiveness (Robbins, Judge, & Campbell, 2016). Was not possible to confirm, neither that smaller teams lack the diversity of skills for creating effective problem solving (Rollinson, Broadfield, & Edwards, 2008), nor that individuals perform at higher levels within smaller teams (Seijts & Latham, 2000). Seems to confirm that team size affects members satisfaction and, subsequently, may influence the perception of the team collaboration levels (Foels et al., 2000).

An ANOVA was conducted. It has revealed interaction effects between the measurement time (Pre- and Post-test) and students' scientific fields in all the TCE subscales, namely SMM:  $F(1, 69)=22.43$ ,  $p<.01$ ,  $\eta^2=.25$ ; MT:  $F(1,82)=4.09$ ,  $p<.05$ ,  $\eta^2=.05$ ; MPM:  $F(1,83)=22.28$ ,  $p<.01$ ,  $\eta^2=.21$ ; and PTE:  $F(1,83)=8.79$ ,  $p<.01$ ,  $\eta^2=.10$ . In the Pre-test, the perceived SMM was high, suggesting that the team had gone through a rapid group development (Morgan, Salas, & Glickman, 1993), as it is expected in educational settings (Fransen, 2012). CS teams improved their SMM and MPM levels over time, while Psy teams decrease it. These results confirm previous findings that SMM and MPM facilitate the processes of setting goals, establishing strategies, monitoring team processes, engaging with peers, and communicating effectively, what might lead to higher team collaboration (Davies, 2009; Pacheco & Soares, 2017; Salas, Sims, & Burke, 2005; Van den Bossche et al., 2006).

The decrease experienced by Psy teams on MT might have caused task and relationship conflicts, which usually negatively affect performance (De Dreu & Weingart, 2003). Low MT indicates that team members spend too much time and energy protecting their personal interests and not constructively collaborating (Peterson & Behfar, 2003). This might explain the lower performances within Psy teams. CS students showed a higher perception of their team collaboration level.

The Team Collaboration Evaluator framework revealed to effectively picture team collaboration and establish a correlation with team performance. This framework can be further used in collaborative learning settings to measure mid-project collaboration levels and define strategies to improve the collaborative learning skills of the team members and, consequently, their performance. These team collaboration skills stay with the individuals and can later be applied to other projects, either in academia or industry.

#### 4. CONCLUSION AND LIMITATIONS

Data on this sample shows that larger teams have higher performances. Although, those larger teams perceive their collaboration in lower levels when compared to smaller teams.

Computer Science students perceive team collaboration as evolving throughout the semester. Psychology students perceive their team collaboration at a lower level when compared to Computer Science students. The poorer levels of mutual trust showed by the Psychology teams might have taken them to lower performance rates.

The instrument Team Collaboration Evaluator can be used to measure team collaboration during teamwork and help define strategies to improve collaboration.

This research is a first step towards addressing the determinants of team effectiveness. Researchers are working on additional research to increase understanding of the mechanisms influencing collaborative learning and the causal relationship of collaboration and performance. Students' academic records should be considered so that correlations between past and present performances can be established. Further studies should explore other third variables, such as age, gender, and nature of the task.

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