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Teamwork skills: The case of a practical course

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Abstract

Despite an apparent demand of the industry, recent studies reveal gaps in graduates' preparedness to work in a real-world organizational environment. Beyond professional knowledge and experience, companies are looking for a set of soft skills. While there is a consensus among scholars that teamwork skills can be learned, many researchers emphasize the challenges of teaching real-world processes, dynamics, and the nature of teamwork. To overcome these challenges and better prepare students for the industry, a practical learning course that mimics the industrial settings was developed and taught. This ongoing study aims to explore the specific characteristics of students' teamwork in a practical course delivered in an industrial setting. A qualitative study using semi-structured interviews with 12 course graduates. Based on the initial data analysis, specific characteristics reported by the interviewees were coordination, synchronization, mutual dependency and responsibility for results, and a unique teamwork atmosphere. These findings can be explained by the practical course settings such as the combination of project and industry-based learning, team formation strategy, mentoring support, communication tools, and grading strategy. The intermediate results show the apparent benefits of project-based and industry-based combined learning for improving software engineering students' soft skills.

Keywords: soft skills, teamwork, teamwork quality, practical course, industrial setting, qualitative study, undergraduates

Introduction

Filling up a software engineering vacancy is a challenging task for everyone involved in the process. Beyond professional knowledge and experience, companies are looking for a set of non-technical skills and capabilities, often referred to as soft skills (Groeneveld et al., 2020; Santos et al., 2020). However, recent literature reviews show an evident gap in graduates' preparedness to deal with real-world organizational environments (Groeneveld et al., 2021). Teamwork is considered one of the essential soft skills required by industry. While the academy encourages teamwork and emphasizes its benefits, there is still a gap between what the academy provides and what the industry needs.

To help students become better prepared for the industry world, we developed a practical learning course in collaboration with a global high-tech company. The course was delivered in industry settings by lecturers and mentors from the company who mimed industry settings as closely as possible. Unlike many traditional academic courses, where students chose teammates by themselves, in this course, the company staff was the one who took decisions on the way to assembly teams of students.

This study aims to explore the specific characteristics of students' teamwork in a practical course delivered in industrial settings. This work is part of extensive research studying how to train soft skills and facilitate software engineering students' preparedness for real-world industrial environments. The paper is organized as follows. In the literature background, we provide a brief overview of the core constructs of teamwork studies and emphasize the need for teaching teamwork as one of the fundamental competencies required for modern engineering organizations. The methodology section explains the course settings and research method. In the findings section, we provide examples of the emerged categories. Finally, we discuss how the practical course settings may contribute to specific characteristics reported by the interviewees.

Literature background

During the decades of studying teamwork, scholars from different research fields, including management and psychology, tried to identify core components of teamwork. At the beginning of the 21st century, several seminal works summarized the prior findings and proposed a few models for future studies of the phenomenon. Some of the most cited works from that time are studies of Hoegl and Gemuenden (2001) and Salas et al. (2005). While Hoegl and Gemuenden discussed six constructs of collaboration in innovative project teams, Salas et al. defined the five universal components required to complete any task performed by a team. The teamwork quality, also known as the TWQ model model (Hoegl & Gemuenden, 2001), contains elements of communication, coordination, the balance of member contributions, mutual support, effort, and cohesion. In turn, the big five model (Salas et al., 2005) is focused on team leadership, mutual performance monitoring, backup behavior, adaptability, and team orientation. Each of these approaches separately and various combinations of the constructs identified in these models still serve as a founding framework for studies in the field.

Studying teamwork

The popularity of agile software development (ASD) methods and the vital role of teams in the development process catalyzed further interest in teamwork studies. For example, Poth et al. (2021) discussed the applicability of the TWQ model for the assessment of teamwork quality in large-scale agile organizations. Gomes et al. (2020) argued about the impact of personality on team efficiency, and Lindsjørn et al. (2016) found a positive effect of teamwork quality on learning and work satisfaction in both agile and conventional teams. There is a consensus among both scholars and practitioners that teamwork constitutes one of the fundamental competencies required for modern engineering organizations (Akman & Turhan, 2018; Ibrahim et al., 2018, Lacerenza et al., 2018, Murzi et al., 2020). However, despite the demand from the industry, recent literature reviews show an evident gap in graduates' preparedness to deal with real-world organizational environments (Groeneveld et al., 2021).

Teaching teamwork

During the last decades, significant research efforts were invested in exploring soft skills expected from software and computer science bachelors. The prevalent skills required for software engineering students are interpersonal communication and teamwork dynamics (Groeneveld et al., 2021). While there is a consensus among scholars that teamwork skills can be taught and improved (Britton et al., 2017), many researchers acknowledged the specific to the academic environment nature and dynamics within these teams (Iacob & Faily, 2019).

Several studies addressed the challenges in software engineering education. According to Murzi et al. (2020), many students treat teamwork as a prerequisite for accomplishing an academic course rather than a mandatory skill expected from an engineer. While Raibulet and Fontana (2018) discussed mechanisms to encourage students to collaborate and share knowledge, Stray et al. (2019) examined the impact of social networking tools on the communication and coordination of virtual teams working on a global project.

According to the researchers, working in teams and learning the tools exploited in industry, such as GitHub and Slack was found as essential for the communication during project development in agile teams (Raibulet & Fontana, 2018; Stray et al., 2019).

The additional perspective on teaching teamwork as part of software engineering education can be found in the literature dealing with teamwork competencies. Murzi et al. (2020) emphasized that teamwork is mainly perceived by students as the requirement for executing course works. In turn, Avila et al. (2021) discussed strategies for training students to develop cohesion in scrum teams. Multiple studies within the streams of problem-based, team-based, project-based research, and industry-based also addressed the challenge of teaching teamwork competencies. For example, Sakulvirikitkul et al. (2020) developed and tested model to promote teamwork of computer students. In turn, Jaiswal et al. (2021) emphasized the role of instructor's guidance on the teams' communication and performance. Nyemba et al. (2021) highlighted the differences between problem-based and industry-based learning and emphasized the challenges of finding the industry environments to leverage the advantages of the industry-based approach for future engineers.

In addition to the challenge of students' perception about the importance of teamwork competencies, the process of teams' organization in the academic environment is often much different from the real-world industry environment. Several publications addressed the differences in the performance of teams formed by students and those that the instructor settled. Some representative examples of team composition in the academic environments of undergraduate students are the studies of Flores-Parra et al. (2018), Løvold et al. (2020), and Vasquez et al. (2020). While Løvold et al. (2020) claimed a slight positive difference in teams formed by the students compared to those settled by instructors, Flores-Parra et al. (2018) argued that one should further develop models for teams' formation strategy. In turn, Vasquez et al. (2020) found that a combination of student-selected and instructor-selected approaches improved students' experiences and enabled enhanced course results.

During the last decade, there has been an expanding discussion about the importance of team development interventions in the industrial environments as one of the possible methods to improve teams' performance (Shuffler et al., 2011; Lacerenza et al., 2018). However, the research within this field of studies related to academic environments is still scarce. We believe that project-based and industry-based combined learning implemented through the practical learning courses may help to reduce the identified gaps. Besides, the practical learning courses may contribute for improving software engineering students' soft skills and facilitate their readiness to real-world industrial environments. The purpose of this study is to explore the specific characteristics of students' teamwork in a practical course delivered in the industrial settings.

Methodology

The practical course. We define a practical course as one delivered in industrial settings where students get exposed to real-world settings of a modern organization. The course objectives are twofold: a) to teach students different aspects of software development methodologies, tools, and practices; b) to develop and strengthen the soft skills of software engineering undergraduates. Since the primary purpose of this study is to explore the specific characteristics of students' teamwork in a practical course, in the following paragraphs, we describe course characteristics developed to support this goal.

Project-based learning. The final project of the course was divided into several topics and contained a practical assignment accompanying each new subject learned in the course. Teams were required to present the intermediate results to the rest of the class at the predefined dates. **Team formation**. The company staff made decisions on how to assembly teams of students. The primary principle of team formation strategy was reaching a maximal diversity in each group concerning professional knowledge, experience, and gender. This strategy was implemented using dedicated questionnaires collected from the course participants in advance. **Mentoring**. A software engineer from the company was assigned to each team as a mentor. The mentor's main goal was to advise the team and provide personal and group feedback to the students. **Communication.** Students were requested to use Slack - one of the tools broadly used in the industry and within the company, , as the only means to intercommunicate within and between the teams and contact mentors and course staff. Slack is a multiple purpose communication tool that enhances team collaboration, group awareness, and project coordination (Lin et al., 2016). Slack is useful for providing a user-friendly way of managing and organizing distributed conversations, facilitating knowledge sharing, and enabling easy access to other team members and their expertise (Parra et al., 2022). In recent years, Slack became an alternative for communication among software development teams and other stakeholders (Lin et al. 2016; Stray et al. 2019). Students' participation in the communication process was measured by a number of conversations, posts, questions, and answers in the tool. **Grading strategy and feedback.** The grading process was built to mimic organizations' employee performance evaluation process. The evaluation was performed three times (after week three, after week six, and at the end of the course). The grades refer to the quality of submitted deliverables and the learning process, including communication, team coordination, and performance. For example, one of the guidelines related to communication was encouraging course participants to ask questions and assist each other through Slack. The mentors declared that if some of the course staff didn't get familiar with every student from Slack conversations by the end of the course, these students wouldn't get an A grade.

The method

This research is a case study of the academic course provided by an international high-tech company in the winter semester of 2020. The class was delivered entirely online due to COVID-19 restrictions. The main objective of this study is to explore the specific characteristics of students' teamwork in a practical course delivered in an industrial setting. The research question derived from this objective is *what are the characteristics of students' teamwork in a practical course delivered in industrial settings*. A qualitative approach using the case study research methodology, is especially suitable for obtaining complex data and facts, narrative understanding of a specific phenomenon under investigation (Yin, 2009). In this study, semi-structured interviews were used for data collection. The interview's core included ten questions focused on the students' interest in the practical course, its contribution to the professional and social skills, a learning process, course strengths and weaknesses. All questions were open questions that allowed the interviewees to express their experiences, perceptions, and opinions. The class selected for the interviews contained 14 students, and 12 consented to their participation in the study. The participants' data were anonymized and coded with randomly assigned codes from P1 to P12. Based on the participants' consent, all interviews were audio-recorded and transcribed. Atlas.ti software was used to organize and facilitate data analysis.

In line with the principles of provisional coding (Miles et al., 2018), at the beginning of the research, we defined a preliminary conceptual framework, based on the TWQ constructs. As the analysis progresses, we use and refine this framework iterating between the data and the literature, constantly assessing and interpreting theoretical constructs against the iteratively analyzed data.

Findings

This study aims to explore the specific characteristics of students' teamwork in a practical course performed in industrial settings. Till now, we identified several patterns derived from the initial data analysis. These patterns were prominent in almost every team and point to different, compared to the traditional academic courses, teamwork experiences. Among others, interviewees mentioned different experience related to communication, coordination, mutual support, and effort. These patterns overlap with the TWQ model constructs. According to the literature, the original TWQ model (Hoegl & Gemuenden, 2001) contains six elements: communication, coordination, the balance of member contributions, mutual support, effort, and cohesion. Table 1 demonstrates a subset of TWQ constructs and provides several examples of evidence collected from the field. The analysis of TWQ constructs presented in Table 1 is limited due to the early stage of the study.

Beyond the TWQ model, we identified repetitive patterns that were specific to the practical course settings. These patterns contain team formation strategy, communication tools, mentoring support, and grading strategy. **Team formation strategy.** Based on the questionnaires collected from students before the beginning of the course, the company staff decided how to assemble teams based on the principle of maximal diversity in professional knowledge, experience, and gender. In addition, the course staff ensured that there is no or little former familiarity between team members. All these steps were performed to simulate a real-world organizational environment where a novice engineer joins a team of coworkers. We observed a recurring pattern in the participants' experiences related to the team formation strategy. Initially, the students felt inconvenience, though, later slowly acknowledged the benefits of the different team formation process.

Table 1: Subset of TWQ constructs

Category	TWQ Explanation	Evidence from the field - examples
Communication	"The quality of communication within a team can be described in terms of the frequency, formalization, structure, and openness of the information exchange" (Hoegl & Gemuenden 2001, p. 347).	P10: *We had a lot of communication between the team members, so everyone worked together, and this was an advantage.* P4: *I participated in Zoom sessions like crazy, my team members know my apartment by heart. They know where I study, where I eat, how does my boyfriend look like, and who am I. I never experienced it in any of the other courses, that I took.*
Coordination	"Coordination means that the teams have to develop and agree upon a common task related goal structure that has sufficiently clear subgoals for each team member, free of gaps and overlaps" (Hoegl & Gemuenden 2001, p. 347).	P7: *Learning how to work together is part of the course essence, where everyone has its specific role, though, eventually ought to be synchronized. In my opinion, this issue is critical.* P6: *It was critical because it was part of the essence of the course, learning to work together with other people who each have their own role, which in the end is things that need to be synchronized together. It was very critical in my opinion. More emphasis on independent work and then see how it is integrated together.*
Balance of member contributions	"It is considered essential to TWQ that contributions to the team task are balanced with respect to each member's specific knowledge and experience" (Hoegl & Gemuenden 2001, p. 347).	P11: *Knowing how to divide work properly, makes teamwork more appropriate, where every team member contributes to the team's delivery with his own insights.* P3: *We were assigned into groups, which was apparently very effective, and within the teamwork, every team member contributed in areas of his expertise, and for me, personally, it was absolutely fantastic.*

Here are some representative quotations from this experience. P5: *Since teams were randomly built, my friends were assigned to different teams, and my team was composed of students who I barely knew. This situation yielded and improved knowledge sharing*. P6: *I believe it was the first time, we didn't select the team members, we worked with, nor the team composition. I think it was totally cool and extremely important*. P9: *We weren't asked with whom we prefer to work, but were rather assigned into teams by the course mentors. Initially, disliked it, though, later on acknowledged its logic and was okay with the assignments.*

Communication tools. According to TWQ, "the most elementary component of TWQ is communication within a team" (Hoegl & Gemuenden, 2001, p. 437). In this course, we asked students to communicate and make this communication visible. For that purpose, students were required to utilize Slack - the tool used within the company. Moreover, the students were requested to communicate in Slack only in English, while this is not the native language of every student. The following citation is an exemplary case demonstrating what students were forced to adopt. P2: *Team members were told to rely solely on Slack, however, initially, from time to time we communicated by WhatsApp, for more internal stuff. Though, eventually, we learned how to work with Slack, ask questions, help others, and understand that this tool is useful. Furthermore, Slack was the only alternative to communicate and be advised by our mentors, so we were forced to adopt it, and after all, it was quite convenient*. Here is another evidence showing the advantage of training students to work with the industry common methodologies, tools, and processes. P4: *Oh, it was great. Excellent. We had Slack, so we even did not really use Zoom. At first, I did not understand the potential, and then suddenly you know, you already know the tool, then, you use it, and you understand for a moment why it's good. So, it was really nice, first of all, to get acquainted with a new tool, and it's also a product that is really used in the industry. So it has a very added value in my opinion*.

Mentoring support. Unlike the reality of the engineering companies, where a formal team leader is present, the students' team often does not have such a formal position in the academic environment. To eliminate this difference, a mentor for each team was allocated from the company staff. The mentor's duties included guidance of the team, evaluation of the team member's performance and deliveries. However, the mentor didn't participate in the development tasks and was not responsible for the quality of the results. The study participants especially mentioned the mentor's role in facilitating collaboration within the team. For example, P2 stated as follows. *Mentors guidelines forced everyone on the team to be responsible for the entire teamwork, therefore one has to review everyone's code, and make sure it's okay.* Although each student was responsible for their progress in the course, the mentoring strategy allowed personalized touch and feedback to the team members as described by P4. *None of my professors never approached me to ask how am I doing, in any of the courses. This course was unique. Here I had mentors, who initiated interactions with me, in order to check that I progress as expected and doing fine.*

Grading strategy. The grading strategy used by the course staff forced students to collaborate and make this collaboration visible to the rest of the teams and course mentors. In the following example, one can see students using the Slack tool because the mentors required it for the grade. P12: *In this course there's an issue of visibility. Since this course does not include test, therefore, it's unclear how will I be graded. We were told that we have to participate and to be involved, in order to enable the mentors to make sure we're doing fine, hence, I felt that I must take part in discussions.*

In addition to described in this section, students often reported salient phenomena, such as team atmosphere and mutual dependency. In the next steps of this study, we will assess whether a three-dimensional view of teams' processes, including TWQ aspects, the team formation strategy, and the reported salient phenomena, might be a more accurate prism to understand the team's realm better.

Summary

This paper reports on an ongoing study exploring the specific characteristics of students' teamwork in a practical course delivered in industrial settings. By now, we analyzed the data through the conceptual framework based on the TWQ model and expanded it with the additional insights derived from the course-specific settings. The current study presents the initial results of the data collected from the single course occurrence. The emerging results imply of practical courses promise potential, in means of contribution of a proper team's structure, regardless of students' preference, the importance of adopting a suitable communication tool for enhanced teamwork, and the benefits of the unique mentoring method, maintained within the company's premise. We believe this study has the potential to contribute to both academy and industry and generate a positive social change. First, some of the strategies implemented in this course may be useful for improving software engineering students' soft skills. Second, the skills and capabilities acquired by course graduates may facilitate their readiness to real-world industrial environments. Finally, this type of practical course may further strengthen collaboration between the industry and the academy.

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