

# Investigating effective dynamics of virtual student teams through analysis of Trello boards

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**Abstract**—A recent challenge in distant distributed learning courses is to establish effective collaboration in small teams. Team work in such courses often has to take place asynchronously, which puts additional requirements on communication and coordination. This article describes an ongoing project in which we analyze the dynamics of virtual student teams located in different Universities by examining their Trello activity. The students work together in a project where they need to propose a solution for a business challenge. On the basis of their Trello activity we aim to characterize different patterns of team work in geographically dispersed teams to better understand how collaboration in virtual students teams develops over time. These insights can be used to detect ineffective team dynamics and to generate interventions that promote better collaboration.

**Index Terms**—Collaborative Learning, Remote Learning, Team Work, Team Dynamics, Virtual Teams

## I. INTRODUCTION

Nowadays it is becoming more and more common to work remotely using an online virtual space. For example, an increasing number of engineers have to work together asynchronously in a remote way due to the dynamics of today's global work environment. It is important that such prospective engineers are trained to work together effectively in a remote way. Universities that offer such courses, i.e., offering international projects including working together with students from different countries, need to optimize this form of instruction [1]. More and more universities now offer or design international project-based courses [2], [3], [4], [5], [6]. Hence, more insight is needed in why some teams succeed whereas others fail. Gaining insight in how effective virtual teams collaborate together provides the much needed input in how such courses can facilitate higher levels of learning.

According to the literature, in a collaborative scenario, students exchange ideas to achieve common objectives. Through this exchange of information and communication they learn over time [7], [8]. Working together on an international business case offers opportunities to gain effective communication skills, argue with others in a team about effective cooperation, and develop team work skills that are also needed in today's work environment. By enhancing insight in how such teams collaborate together implementation of collaborative curriculum pedagogy can alleviate how much students learn in such projects [9].

Previous research reveals that collaboration of project teams can be facilitated by computer-supported technology, such as Trello [10]. In some cases teams who use special computer-supported learning environments appear to be more active than teams who do not use such tools/technology. It has been shown that some students find it easier to voice their ideas in an online environment. Furthermore, reclusive team members are found to be more communicative in chats and forums rather than in real life interactions [11]. Furthermore, responsibility for the project is shared, which could facilitate the group to make more extreme decisions than individuals would do. When an online learning environment is used, the responsibility for the project is shared, which enhances better decision making.

There are many online tools to coordinate and distribute the tasks and make it possible to structure team work remotely, like for instance Asana, Trello, Jira, etc [12]. By using these tools, tasks become well monitored and organized even if the team members work in different places. Despite the widespread use of such systems, very few studies aim to explore their effectiveness in cooperative learning scenarios [12].

The pedagogical approach described in this paper is based on challenge-based learning, in which students work on solving real-world challenges provided by a client or a company [13], [14], [15]. In this approach the client or company is required to be involved as a stakeholder in the educational process and mentor the students while they are working on the challenge. This provides a multitude of learning opportunities for students such as the development of communication and group skills, critical thinking, incorporation of feedback, and using continuous self and peer reflection [16], [17], [18]. This of working on a real-life business case is shown to increase student motivation and student engagement [14].

In challenge-based learning researchers and teachers also participate as mentors. They provide feedback about the knowledge formation process and monitor the development of skills and competences. In such a context, the instructors constantly monitor the level of knowledge the learners assimilate during the study process and at the same time facilitate effective collaboration with the stakeholders. For teachers it is important to continuously adapt the methods of teaching / training as well as the contents and tasks, to

continuously optimize the course and facilitate high levels of learning of the students' teams. When more information is available about how effective teams collaborate, teachers and curriculum developers are better equipped to make the required changes.

In this paper we analyze the data from one such challenge-based course and investigate how students that are geographically dispersed collaborate and learn effectively. The rest of the paper is organized as follows: Section 2 presents some background on challenge-based learning, Section 3 provides information about the approach we will take towards the analysis of the gathered data, Section 4 presents our initial reflections of the first data that is collected and Section 5 offers a preliminary conclusion .

## II. BACKGROUND

Challenge-based courses are centered around a case or the so-called challenge proposed and provided by a company. This challenge can be related to considering alternative business models or go-to-market scenarios in relation to the innovation or entrepreneurial case. In most cases the teams need to integrate knowledge from specific areas, such as: business environment, competition, suppliers, partners, environmental, sustainability issues. Lectures will be offered to help the students acquire special knowledge and tools that are important for offering an optimal solution for the challenge.

In a previous publication [19] we presented how we jointly designed a challenge-based course between the University of Trento (UNITN), Italy and Universidad Politecnica de Madrid (UPM), Spain. The results were obtained from questionnaires collected after the course asking the students about how they experienced the course (i.e., positive and negative experiences), which aspects students appreciated less and why and if they found the course valuable.

In total 21 students at UNITN and 23 students at UPM participated. At both Universities there were local teams, that is teams composed only of local students working on the delivery of local challenges, and we had 3 mixed teams, each composed of 4 members, 2 from UNITN and 2 from UPM, working on international challenges. The first results were positive, with students finding the experience improving their abilities to work remotely and to work in mixed teams. We also found that the students who worked in the mixed teams, despite the difficulties of the physical separation, were more motivated to work than the students.

## III. APPROACH, METHODS AND DATA COLLECTION

In this section we describe the analysis approach we are about to take for this study.

The data comes from a setting in which students work in distributed teams between the University of Trento, University of Aalto and University of Madrid. There are in total 8 different challenges students work on. The teams are composed of 3 to 4 members, and there are two teams assigned to the same challenge, thus making the total number of team 16. The cases come from Madrid based clients, and cover



Fig. 1. Example of Trello board in which the students will be assigning and working on the tasks while moving them between the various stages of the project

different industries like gaming, finance and construction. The total number of involved students from Trento is 17, the number of students from Aalto is 22, while the number of students from Madrid is 8.

To manage and coordinate the work on the project, and assign tasks to each other, the students are using Trello. In Trello a common board for the teams was created: see Figure 1. Examples of the "cards" in which student plan their activities are depicted in Figures 2 and 3.

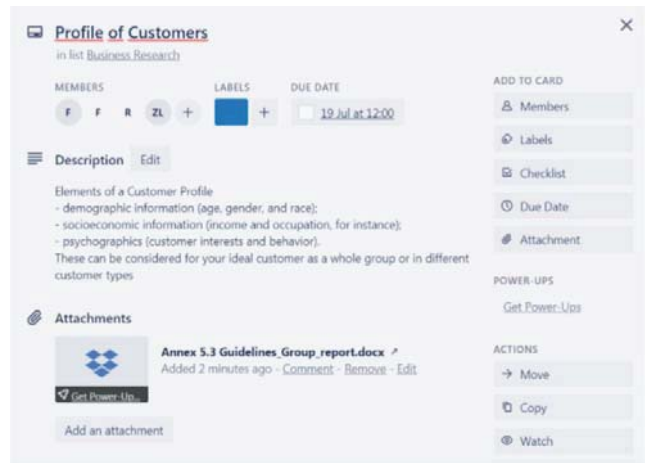


Fig. 2. An example of a "card" on which the students will work during the course

In order to understand collaborative work behavior and work dynamics over time in distributed teams, Trello boards will be evaluated three times during the semester (each three weeks), according to the following criteria, with each criteria being on a scale of 0 to 5:

**Board Quality** - this metric will be derived by examining key aspects of the board, such as if there enough tasks on the board to keep the team busy, if the tasks were described in a reasonable manner, etc. With this aspect we aim to understand the quality of how the teams collaborate at the three points in time,

**Board Progress** – this metric will capture the amount of progress that the team had made from the previous update i.e., were there enough tasks being created and moved through the pipeline in the Trello boards.

The Trello boards evaluation will be conducted by two independent annotators. The idea is to compare work quality

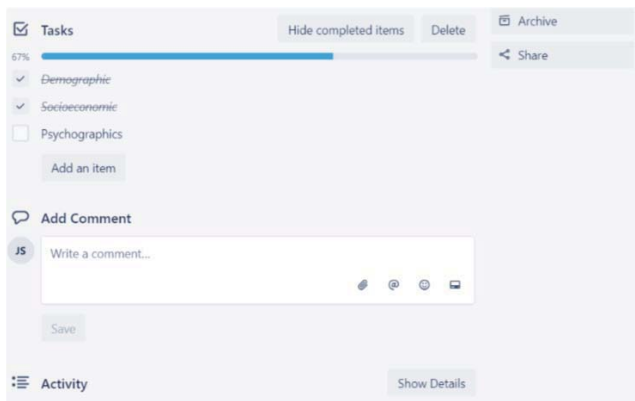


Fig. 3. Another example of a "card" on which the students will work during the course

and progress across the different teams and understand actions that distinguish highly productive teams.

Previous research also shows that teams have difficulties to maintain an adequate level of activity, and there are groups that make a lot of progress during their projects, while other teams were more stagnant with regard to their progress. Activity gaps (longer inactive periods) in the team work are also often identified as a serious problem in the literature.

To examine this in more detail we also analyze the dynamics of the activity of the teams by applying **using sequence analysis**. Trello offers the opportunity to collection logs of all the actions performed in the board (i.e., who created a "card," at what time the "card" was moved etc.). This Trello data can be exported in JSON format (lightweight data- interchange format that is easy to parse and extract data from) which will be further analyzed. Each action performed on the board is an "action" inside the JSON object with a time stamp, member id of the participant who took the action, and further details about the action (if a task was moved between two lists, then the "action" element will contain data from which list to which list the task was moved, if a due date was assigned, if the task was assigned to a member etc.).

The aim of this part of the research will be to identify all different types of actions ("creation of task", "move to task between lists", "assign due date", "assign the task to member" and etc), and then to put each action in order of time sequence and try to characterize different types of team and identify their distinctive patterns of work on tasks. This kind of analysis can further help teachers to detect stagnant teams early in the process and provide adequate support to teams that need help. Furthermore, this type of analyses offers information about effective patterns of collaborating; e.g., we assume that the activity patterns in effective teams will be different as compared to the less effective teams. For example in highly effective teams the chances of following up immediately after a "card" is created (e.g., by assigning the task to a member immediately) will likely occur above chance as compared to less effective teams. Understanding the dynamics of collaborating in such teams over time, using



Fig. 4. Example of Trello board of one of the teams working on the case coming from the real estate sector

such objective, "in situ" data has the potential to advance the team literature in general as well as provide input for education curriculum development.

A last step in the data analysis will be to understand if there is correlation between quality of work and collaboration patterns, that is if and how quality of team work is influenced by collaboration patterns, and if certain collaboration patterns of group work always lead to group work of high quality.

#### IV. INITIAL REFLECTIONS ON THE FIRST DATA COLLECTED

In this section, we share our initial results in terms of the Trello activity and the observed team dynamics.

After the first round of qualitative evaluations, two categories of teams surfaced: a category of teams with high quality Trello boards and allocation of tasks, and teams that still need to define the core of their contribution to the case and how to split and allocate the tasks in an efficient way. The average evaluation on the quality metric after the first round was 3.3, while data for the board progress metric will be available after the second qualitative evaluation.

At the first point of data analysis we lacked the data coming from two teams. These teams still did not create their Trello board yet due to the lack of availability of the company to provide details about the challenge and work with the students.

An example of a Trello board of one distributed team (composed of two students from Trento, two students from Aalto and a local student from Madrid) working on the case coming from a company in the real estate segment is provided in Figure 4, another example of a team working on a challenge coming from a recruitment company (composed of three students, one from Aalto, one from Madrid, and one from Trento) is shown in Figure 5.

From the first results we also work towards defining strategies on how to motivate the students and how to provide support in this setting and a how to encourage students' learning through interaction with each other.

As a next step we'll also try to see if cultural diversity in the teams presents an advantage in virtual teams. We expect that the more the teams are mixed, the bigger variety they will bring in terms of the proposed solution, increasing the overall quality of their work.



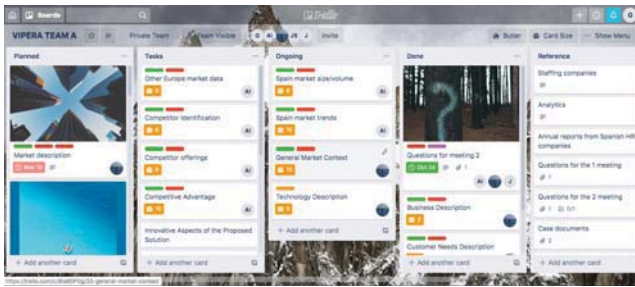


Fig. 5. Example of Trello board of one of the teams working on the case of a recruitment company

One limitation of our approach is the communication with the company (making sure that the case is available) and intervention from the teachers. This can significantly affect the Trello board activity, and thus can influence the effectiveness of the teams we observe with our approach. In the case of the two teams where the challenge provider was absent, the teams show no activity on the Trello board; this inactivity cannot be attributed to poor team dynamics but are due to factors that lie in the specific settings of the challenged- based course. For challenge-based courses it seems important to also maintain a constant connection between the teacher and challenge provider.

## V. CONCLUSIONS

In this paper we explore the relationship between different collaboration patterns in team learning tasks and the quality of team work in teams who are geographically dispersed.

At the moment of writing this research paper, the students are in the middle of their course work, and work intensively towards a good solution for the challenge proposed by the companies.

The data collected from the first part of data analysis (data coming from board quality and progress measurement at different points during the course (and also after) will be insightful in understanding collaborative work behavior / dynamics, and how collaboration develops over time in the teams. It will be helpful to detect teams with poor dynamics (or that need extra help) early in the course, and understand differences in team work.

The data collected to perform sequence analysis will contribute to a better understanding of group work in online courses and to highlight possible starting points for the development of intervention mechanisms and support mechanisms for different types of team based on their patterns of collaboration.

This paper provides information about a study that is currently in-progress. The final results will be available at the end of winter semester of the academic year 2019-2020.

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