IDENTIFYING CHALLENGES IN VIRTUAL TEAMS: A CASE STUDY OF TEAMWORK IN A GAME-BASED LEARNING ENVIRONMENT

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ABSTRACT

Game-based learning (GBL) environments are shown to support open-ended inquiry, collaborative learning, shared knowledge creation and decision-making processes. The study at hand focuses on examining students' descriptions of problematic situations and collaborative learning in a virtual simulation game. We were interested in what kinds of challenges the students encounter in virtual teamwork in GBL. Data of the study stems from gaming sessions in which teams of 5-7 students worked in a virtual learning environment and steered their simulation companies' supply chain in real-time. Students' reflection assignments were analyzed with qualitative content analysis. Our results show that during the sessions students encountered communication challenges, collaboration challenges, organizing challenges and skills and competence issues. As all these are typical for modern dispersed collaborative work, we can state that the game-based course of this study provided the students with opportunities to rehearse and solve these challenges in a virtual working context. Our results emphasize the importance of providing students an opportunity to exercise collaboration and problem-solving skills in authentic, safe and inspiring settings, and that simulation games represent a feasible context for this.

KEYWORDS

Collaborative Learning, Game-Based Learning, Virtual Work

1. INTRODUCTION

Currently, there are novel forces that affect all aspects of life. These forces include globalization, the COVID-19 pandemic, climate change and technological disruptions (see e.g. Kaushik & Guleria, 2020). Work life has also become more complex, and work challenges more difficult to anticipate. Disruptions in the work life bring about requirements for change also for how we teach (Iglesias-Pradas et al., 2021). Working, collaborating and solving shared problems in dispersed virtual teams have increased in various occupations and tasks. Collaborative problem-solving skills are critical in current work life, and need therefore to be included in teaching and learning in higher education (HE) (Gonzalez-Perez et al., 2014).

In contemporary work life specialists work in collaborative, multi-site, dispersed teams and digital working environments, in which fast and efficient decision-making is emphasized. The situations specialists encounter in their daily work are so manifold and complex that they require the ability to share one's expertise and skills to function in versatile multi-site teams. Previous research has established that the success of virtual teams hinges on the team members' ability to jointly, quickly and appropriately address issues (Caputo et al., 2019). Consequently, to respond to these mega trends, it is vital to start developing the required abilities already during education.

Presently, one of the key challenges of HE is that education should be modified to respond to the requirements of work life and to provide skills for critical thinking, flexible problem-solving and versatile collaboration and communication (Riemer, 2007; Binkley et al., 2012). In the global workplace the amount of tasks that require constant decision-making is continuously increasing, and many tasks are associated with rapid information processing and problem-solving (Tendick, Denby & Ju 2016).

Collaborative game-based learning (GBL) environments represent one possibility for addressing these competence development needs. Ideally, education supports open-ended inquiry and heterogeneous, distributed teams using computer-supported collaborative learning (CSCL) technology, where individual team

members contribute a variety of perspectives to the mutual task. GBL environments represent a fruitful context for interactional and collaborative learning and shared knowledge creation (Papastergiou 2009; de Freitas & Oliver, 2006; Chung & Paredes, 2015).

In this regard, Linehan, Lawson, Doughty and Kirman (2009) found that GBL environments offer an excellent opportunity to rehearse and strengthen decision-making processes. In their study of simulation-based learning environments, Hao et al. (2015) found that teamwork brought about remarkable advantages compared to individual work. Lateef (2010) noticed that GBL environments can successfully be used for developing skills needed in problem-solving and decision-making as well as interpersonal and communications skills and team-based competencies. However, more research is needed to understand the kinds of challenges students may encounter in GBL environments. This novel information may help GBL designers as well as HE teachers to develop environments that offer optimal support for 21st century HE learners during their learning experience. In the light of this context, this study focuses on examining students' descriptions of problematic situations and their nature during the collaborative learning process in a simulation game course in multi-site dispersed virtual teams, followed by research question: *What kinds of challenges did the students encounter in virtual teamwork around a business simulation game?*

2. COLLABORATIVE LEARNING IN GBL ENVIRONMENTS

The term game-based learning tends to refer to a learning approach with embedded learning activities in a digital game environment (Chang et al., 2020). Emerson et al. (2020) described that GBL activities consistently incorporate problem-solving tasks to promote students' performance during the learning process. The advantages of GBL can be discussed under several positive educational effects, such as promoting students' learning motivation (Prensky 2003), exhilarating successful learning outcomes (e.g. Yang 2012), and training skills and competences that are challenging to study (e.g. Ronimus et. al., 2014; Koskimaa & Fenyvesi, 2015). Furthermore, educational game environments represent a fertile ground for collaborative learning and shared knowledge construction, in which social interaction has a central role (Papastergiou, 2009). Consequently, the effectiveness and quality of interaction among the participants has a vital impact on the success of learning in GBL environments.

Hao et al. (2015) found that collaboration in simulation-based tasks prompted significant performance improvement. While investigating the effects of games on collaboration skills, Martínez-Cerdá et al. (2018) found that collaborative competencies could efficiently be developed by digital games. Bodnar and Clark (2017), in turn, found game-based learning a promising method for developing students' communicative skills. Furthermore, earlier research has found that learning skills in an authentic environment, for example in a virtual teamwork context, fosters the application of these skills in the real world (Davids et al., 2017; Schartel Dunn, Dawson & Block, 2020).

Research on GBL has also focused on decision-making processes. According to Linehan et al. (2009), game environments foster learning by providing opportunities for rehearsing, enhancing and assessing the decision-making processes of participants. Harviainen et al. (2014) assert that simulation games may be used to promote the learners' reflective and interpretative skills.

Studies over the past two decades have provided important knowledge on GBL, suggesting that games can be characterized by their commitment to the principles of student-centered (Gee 2005; Romero et al. 2012), authentic, social and interactive learning procedures (Prensky, 2003). Yang and Lu (2021) found that specific features of games, such as attractive plot, explicit aim, and assignments to be resolved make them effective, absorbing and manifold learning environments. Furthermore, the application of games for educational purposes offers possibilities for learning by doing (Garris, Ahlers & Driskell, 2002), in which the GBL procedure entails participants to resolve tortuous tasks and progressively obtain expected skills (Karagiannis & Magkos, 2021).

Considering the pedagogical principles of multi-player games, the approach is rooted in the idea of collaborative learning (Romero et al. 2012). Dillenbourg et al. (2009) underline that the educational potential of collaborative learning lies in conjoining individual and social processes. Similarly, Lipponen (2002) found that in teams that collaborate efficiently, participants are more capable of receiving and dealing with a substantial amount of information, leading to novel ideas. In order to complete tasks within multiplayer games, participants are required to process information and confer with their team members (Wuertz et al., 2018). GBL environments have, thus, the potential for amplifying both individual and collaborative information processing and learning.

In the present study, collaborative learning is delineated in the GBL environment in which knowledge co-construction and development of competencies evolve through social activities. The case game environment requires shared decision-making to achieve a shared goal, making it ideal for studying collaborative learning.

3. METHODOLOGY

3.1 Context of the Study

Data in this study were gathered in a university course based on a simulation game called RealGame (Lainema, 2003) in Autumn 2021. The course was part of a virtual business studies programme, in which all study modules were offered by Finnish universities' business faculties. The participating students majored in any other disciplines than business studies. Thus, the students were novices in business studies, but had some basic knowledge as they had taken at least two other study modules before the simulation course.

In the business simulation course students were assigned to 12 teams of 5-7 participants that worked in the simulation environment. Students from eight different universities in Finland included both native Finnish and exchange students, and they took part in the virtual course from different locations. Each team participated in three simulation gaming sessions lasting 6-12 hours, of which each student participated at least for four hours during one session. This allowed for the teams to work in shifts, and all teams took advantage of this opportunity. This way the gaming sessions simulated project work in a dispersed digital team, in which tasks and responsibilities were handed from one team member to another. This setup also amplified the salience of prompt problem recognition.

RealGame is a real-time operated simulation-based business game, which portrays an organisation's supply chain and its delivery process (Lainema, 2003). Participating in RealGame requires that the team members work and collaborate continuously, as the simulation works in continuous time. Thus, when the simulation session starts, the teacher turns on the simulation clock, and then the simulation clock advances hour by hour, illustrating the simulation company's processes and business events with suppliers and their customers. Decision-making in the simulation is ongoing for the duration of the game, and typically one simulation day is processed in 6-10 minutes.

Decisions made by the student teams include basic decisions in a manufacturing business: making component purchases, monitoring inventory levels, ramping up production, steering production shifts, maintaining sales offers, delivering incoming customer orders. These kinds of decisions are typical for a real-world manufacturing organisation that aims at serving its customers by running an efficient supply chain from component purchases to customer deliveries.

3.2 Data Collection and Analysis

In total 66 students handed out their reflection assignments that they wrote after each simulation game session. Data was handled according to appropriate data protection guidelines and practices. Each student gave their informed consent for using their reflection texts as research data. All personal and identifying information was omitted from the data, and all respondents were anonymised and pseudonymised in the final report.

In the data analysis process, qualitative content analysis was employed in an inductive manner (Patton 2001; Krippendorf 2018). The analysis follows the procedure suggested by Elo and Kyngäs (2008). Firstly, tentative analyses of the students' reflection assignments were carried out independently by two of the researchers in order to obtain a thorough understanding of the challenges that the student teams encountered while collaborating in the simulation. Rigour of the analysis process included employing the following techniques: (1) data were gathered from students representing various nationalities, (2) investigator triangulation denoting that two researchers were involved closely in the analysis process, and (3) and rich data representations of the students' reflections were compounded to underpin the results. The qualitative analysis process consisted of following three interlinked steps: *preparation*, *organizing*, and *reporting* (Elo & Kyngäs, 2008).

First, in the preparation step, students' reflective assignments were carefully read through by the first and second author. To achieve a comprehensive understanding of the entire data, an iterative analysis process began by the researchers' several independent reading rounds of the students' reflective assignments, followed by marking all potentially meaningful information in the light of the research question. By doing this, researchers reached a general understanding of the students' accounts. After this, the researchers came together and started

dividing up written texts into smaller pieces based on their initial thoughts, and chose units of analysis through joint discussions. In parallel, researchers labelled these compressed analytical units and composed codes for further analysis.

After the first step, the researchers identified similar student insights under relevant codes, and grouped these into emerging categories. By following this iterative procedure, researchers proceeded into reporting by carefully writing analytic descriptions and combining data extracts in order to create a consistent and compelling description of the findings.

4. RESULTS

Results of our analyses indicate that the challenges encountered by the students during teamwork were related to four different aspects: 1) *communication*, 2) *collaboration*, 3) *organizing*, and 4) *skills and competencies*. Next, we will introduce the key results in Table 1.

Table 1. Summary of the emerging main categories and subcategories

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Category	Subcategory	Data examples
1. Communication challenges	1.1 Lack of communication 1.2 Failure in disseminating appropriate information 1.3 Insufficient communication between shifts	*The main challenge in a communication in my opinion, it is a silence.* (Laura)
2. Collaboration challenges	2.1 Lack of collaboration 2.2 Collaboration conflict 2.3 Lack of commitment 2.4 Highly-dominating team member	*One example of poor collaboration could be when Irmeli and I practically didn't collaborate at all during the first game.* (Ansa)
3. Organising challenges	3.1 Lack of participants in shift 3.2 Poor hand-overs 3.3 Poor organisation of tasks	*After the first simulation day, we noticed that two is too less to handle the process of the game.* (Alvin)
4. Skills and competence issues	4.1 Lack of language skills 4.2 Insufficient business knowledge 4.3. Poor mathematical skills	*An unfortunate incident occurred when it became obvious that Tuovi doesn't really like to speak English and Said doesn't seem to understand Finnish at all.* (Mikko)

4.1 Communication Challenges

Our results revealed that most challenges of the student teams encountered were related to communication. First, students expressed that the most vexing challenges in their teams were **lack of communication** by not contributing to joint discussions or not responding to what the other team members were saying. Moreover, the students reflected that this caused erosion in the team spirit and led to frustration among team members. In some student teams, lack of communication initially led to chaotic teamwork, conflicts, mistakes and compromised decision-making, and eventually, to poor results in the game. Another challenge related to communication was **failure in disseminating appropriate information** to teammates. In the students' view this led to uninformed decision making and unorganized teamwork, as multiple team members worked on the same tasks in the game, reversing each other's decisions. One student described his view as follows:

> *... during the first simulation day when few people were doing the same task without communicating [to] each other and one of them were pricing our products higher and the other person lower and after few minutes they both were like "Is someone else pricing our products at the same time or is this simulation broken"* (Lenni)

In addition, when describing their communication issues, students pointed out that **insufficient communication between shifts** badly affected their teams' ability to perform activities together. Students illustrated their experiences about deficient communication between shifts as well as the demand for more efficient communication during the simulation.

4.2 Collaboration Challenges

Another challenge students often mentioned was related to collaboration in their virtual teams. First, students reported examples of how **lack of collaboration** hampered their joint GBL experience. At worst, students reported of remarkable **collaboration conflicts** in their team, which noticeably rendered difficulties in performing activities together. Under these circumstances, students saw that due to these serious and continuous collaboration problems within their teams they were required to put their own extra effort for accomplishment of the GBL activities.

When describing their approach to collaboration challenges, the students noticed that **lack of commitment** to the joint group activities and processes appeared during the simulation course:

> *It was also noticed that the further the simulation course progressed, the members of the group no longer took quite so seriously the agreed times for a video conferencing or joint tasks. Also, during the simulation, start and finish began to stretch slightly to the wrong direction. So simulation days were reached late and stopped a little in time.* (Lotte)

Moreover, students reflected that they themselves together with some other team members were **highly dominant group members** that led them to take an overactive role in accomplishment of the simulation tasks. This kind of a behavior limited their peers' possibilities to participate in game activities and resulted in unequal contribution to teamwork.

4.3 Organizing Challenges

Our results indicate that organizing challenges in the virtual teams were related to three main issues: lack of participants in shifts, poor handovers between shifts and poor organization of tasks.

In general, students reported that their teams took advantage of the opportunity to work in shifts, as all teams had 5-7 members. Although it was recommended that the teams had at least three people on-line at all times, students reported a variety of examples of how their team was not following this advice. Due to the continuous processing of events in the simulation game, student teams had to pay attention to all aspects in the game all the time, and to continuously make decisions regarding purchases, manufacturing, sales and deliveries as well as to frequently communicate with collaborating teams. **Having too few participants in the game shift** was, thus, an overwhelming experience, and caused a variety of challenges in the teams:

> *When we were short-handed, especially with only the two of us - that caused problems. The worst situation always took place when (just) the two of us were working and the other one left, and two new (persons) came in as a replacement and they needed to be introduced (to the game). One had to change one's way of working and to introduce the situation quickly and to switch to a new task on the go. That created the most challenging situations during the game.* (Jalmari)

Based on our results, teams with proper organization tended to carefully plan how to occupy each shift as well as how to manage the handovers between shifts. Thus, an equally important aspect besides having a sufficient number of participants present was managing the handovers between shifts. Students' views suggest that successful teams preferred a plan for handovers so that there would be an overlap between the team members leaving and entering the game. An overlap would allow for the entering students to get a grip of the current situation as well as of the plan or strategy for the next phases in the game. Having sufficient time to understand what was going on and how to continue from there would prepare for a smoother handover. Other students highlighted that their teams had not planned how to manage the handovers, and hence experienced challenges in these situations.

Furthermore, some students experienced challenges due to **poor organization of tasks**. Students expressed how this resulted either in having one team member being left l out of the teamwork or in wasting time and energy by having multiple participants do the same tasks.

4.4 Skills and Competence Issues

Students taking part in the simulation game represented a variety of different disciplines ranging from natural sciences to humanities. Thus, despite their joint studies in the study programme, students had varying skills and competencies. As many of the teams included exchange students, teams needed to use English in their communication. In this light, students expressed that **lack of language skills** proved a challenge for some of

their team members. Balancing between the varying linguistic competencies of team members induced challenges to teamwork, as teams struggled to find a solution that would allow for working together.

Students had varying levels of comprehension regarding how a business organisation operates. Although all students had already finalized several business courses, their skills and competencies were heterogeneous. Students expressed how this led their teams to situations, where decision-making was not based on adequate understanding of causal relationships between business functions. An example of this is illustrated in the next data extract:

> *I think we didn't calculate our decisions enough, because it was apparent at the beginning of the third simulation day that we had ordered too many machines. We couldn't keep up with the ingredients that we needed to use all the new machines. So in conclusion we used a lot of money but didn't get the use of them that we thought we would.* (Elena)

The skills and competencies issues were also manifested as **poor mathematical skills**. In this respect, students encountered challenges in simulation functionalities e.g. in counting the average costs of a product wrong. They felt they wasted time while trying to figure out where the problem was.

5. DISCUSSION AND CONCLUSIONS

Several studies have shown that GBL environments have many advantages in promoting HE students core skills, such as communication, collaboration and critical thinking for 21st century working life (e.g. Bodnar and Clark, 2017; Martínez-Cerdá et al., 2018). To date, however, students' views on challenges of collaborative GBL environments have been under-represented in investigations of GBL. Therefore, this paper focuses on discussing HE students' experiences of challenges they encountered during their collaborative GBL process in virtual teams. Within the context of the simulation-based business game we identified four divergent main categories of challenges encountered by the students during their collaborative teamwork: 1) communication, 2) collaboration, 3) organizing, and 4) skills and competencies. Our study also provided a detailed description of the particular challenges under these broad phenomena.

This study confirms that effective communication is a key element for successful teamwork in virtual teams. This notion is in line with earlier research on success factors of virtual teams in GBL environments (e.g. Papastergiou, 2009; Ceschi et al 2014). Our findings also emphasize that challenges with communication were related to both the frequency of communication and the content of communication. Thus, in our case, lack of communication, failure in disseminating appropriate information or insufficient communication between shifts diminished the teams' ability to collaborate successfully in the simulation game. These results are in line with Wuertz et al. (2018) who found that in order to accomplish shared tasks within learning games, team members are called to share relevant information and to communicate adequately with their team members. Since effective and appropriate communication lays ground for a successful learning process it is vital that the GBL environment provides technological tools that foster communication and dialogic interaction. In addition, it is paramount that the teacher facilitates and supports the virtual teams in their pursuits to address challenges and solve problems. This way, potential challenges with interaction and communication can be resolved already during the learning process.

The results of our study illustrate that students encountered organising challenges, such as poor hand-over and poor organisation of tasks that hindered virtual teams' success to accomplish shared tasks. This also accords with earlier investigations that suggest that virtual teams pledge themselves less planning or fluent coordination activities (Mathieu et al 2020). Organising for virtual collaboration before the learning activities requires particular attention, and the teacher can facilitate and encourage teams to organise before gaming. Understanding how organising contributes to successful teamwork and how it can be supported adhere to valuable work life skills, as much of contemporary work is carried out in virtual working environments.

In light of the results of this study, heterogeneous skills and competencies brought about challenges for the student teams. Insufficient skills in English and mathematics, and business knowledge hindered communication, collaboration and complicated the joint accomplishment of tasks in the business simulation game. At worst, shortcomings in the vital skills caused drop-outs in the course. Hence, it is important to ensure beforehand that all course participants have sufficient basic level skills and competencies to complete the course in virtual teams, and in this way foster a successful learning experience related to core skills for today's working life.

To sum up, HE students encountered a variety of challenges during their learning process in virtual teams around business simulation game. These challenges were significantly linked with each other, and therefore emerging particular fundamental challenges (i.e. lack of communication, poor English skills) may lead to the

following challenges in virtual teams and in the worst scenarios cause insurmountable challenges, such as conflicts between team members, poor learning experiences or even interrupting of the course.

Recent developments in work life, and particularly the global COVID-19 pandemic have highlighted the criticality of skills needed in virtual teamwork. Today, not only international organisations, but all organisations work at least partly remotely, and much of this work is carried out in teams. Key competencies and skills needed in this line of work include collaboration, communication and organising in teams in dispersed digital working environments. Consequently, it is important that students learn to identify and solve challenges that are characteristic to teamwork in these environments. GBL environments have proven to be promising learning contexts for rehearsing and learning these valuable skills. The results of the present study display the teamwork challenges encountered in a simulation-based learning environment by student teams, and emphasize the importance of providing students an opportunity to exercise these skills in authentic, safe and inspiring settings.

A developed understanding of the nature and origin of challenges related to collaborating in virtual environments allows for educators and employees alike to take these into account when planning for introduction, onboarding and for various team development practices.

HE is increasingly urged to offer relevant and up-to-date education that fosters the development of skills and competencies needed in 21st century society (Ananiadou & Claro, 2009). In addition, universities are prompted to develop education that is more flexible and accessible to learners balancing between work and university studies (Seaman, Allen & Seaman, 2018), who have issues with accessibility (Fichten et al, 2009) and come from less developed areas and countries (Gonzalez et al., 2020). Canals, Burkle and Nørgård (2018) further stress the need for innovative pedagogical practices and modes of delivery with a broader impact. GBL environments offer a potential educational platform that can help to address these needs.

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