A Cooperative and Competitive Serious Game for Operations and Supply Chain Management – Didactical Concept and Final Evaluation

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Abstract—In the last decades, Serious Games (SGs) have been implemented more and more in the engineering field, for both educational and professional purposes. The interest in digital SGs has increased even more in the last years of covid-19 pandemic, due to their location-independent availability and to the possibility to use SGs to apply theoretical knowledge and involve the users in a challenging way. Since the beginning of project Open Digital Laboratory For You (DigiLab4U) in October 2018, the University of Parma started to develop a brand-new SG with a strong focus on Operation and Supply Chain Management. The game has been studied as a multiplayer cooperative and competitive game which projects learners in a fictitious universe where multiple companies compete against each other in the same market. The realization of the game started from the definition of the didactical concept, underwent the user acceptance testing phases (alpha and beta tests) up until reach the release and the corresponding final evaluation feedback.

Keywords—serious game, digital game, operations management, supply chain management, didactical evaluation

1 Introduction

The need for competent and flexible personnel, with a broad set of skills and the possibility to shift among different functions, is an ever-growing necessity for modern and competitive enterprises. Among these functions, operations, logistics, suppliers and customers management are often requested. Also, the focus of companies in a fast-changing world moved from technical and hard skills to collateral, or soft, skills [1].

Similarly, Operations Management (OpM) and Supply Chain Management (SCM) courses were usually asked to convey hard and technical skills to bachelor and master's degree students in engineering. More recently, the focus of these courses moved to better transmit soft-skills like collaboration, team building, communication and leadership, through design-build-test projects [2]. On the same page, Serious Games (SGs)

are characterized by being a reproduction of real-world mechanics by simulating different environments and enabling the possibility to conduct daily actions. Considering these points, Serious Games (SGs) resulted to be an optimal tool to better convey OpM and SCM knowledge to scholars [3].

Indeed, in University of Parma the OpM and SCM courses were held as a combination of theoretical teaching and practical exercises carried out on sheet of paper or with informatic support like MS Excel. This approach, focused on face-to-face lectures, with a limited number of exercises. This method created a good theoretical knowledge of the topic, but also a gap in the acquisition of practical, technological and soft skills. To solve this problem, in 2018, corresponding to the beginning of DigiLab4U project, University of Parma started the devise the Operation and Supply Chain Management Serious Game (the Op&SCM SG, or Op&SCM).

The Op&SCM SG has been designed as a multiplayer cooperative/competitive game in which players are divided in different companies competing in the production of e-bikes. Students play singularly the part of day-by-day operations and collaborate with others to take strategical decisions. This work aims to present the steps followed to develop the game, starting from the didactical concept, moving through beta testing phase, alpha release and final evaluation received by players to reply to the questions:

- **RQ1:** "Does the Op&SCM SG met the Learning Objectives and the Learning Questions set?".
- **RQ2:** "Is there a link between the final grade achieved by students and their evaluation during the game?".

The reminder of the paper is organized as follows. Section 2 presents an overview on SGs in OpM and SCM. Section 3 presents the methodology adopted to design and refine the Op&SCM SG. Section 4 presents the didactical scenario created for the SG, whereas Section 5 presents the beta testing evaluations and the summative evaluation carried out after the alpha release. The results are discussed in Section 6, with conclusions and future works drawn in Section 7.

2 Serious games in operations and supply chain management: an overview

The definition of SG can be expressed as games that provides both entertainment and learning, by making the users deal with complex problems, dilemmas and challenges combined with the fun resulting from the gameplay [4]. With the rise of virtual laboratories, distance learning and online services, this tool has been reconsidered and implemented in education of engineering students and professional [5]. Also, the fact that SGs are based on learning by doing represents a significant advantage being considered one of the most effective teaching styles by numerous teachers and pedagogues and allowing the learners to operate in a real-world environment. This characteristic of SGs enables the possibility for the students to make mistakes without causing real damages and so making SGs ideal tools for the teaching of OpM and SCM [3]. Indeed, due to the increasing importance of these topics, the need for effective and up-to-date

teaching tools and methods is particularly important in this field [6], [7]. In this field, in fact, theory and practice intertwine each other, and it is not possible, or at least not effective, to approach this subject without an overall theoretical and practical point of view. The main goal was to enable the students to fully figure out the main issues that must be faced for the management of Supply Chains [6]. An essential part in the teaching of SCM is represented by the integration of topics learned in previous courses, like OpM or Logistics. Indeed, SCM is focused on the integration of different function within the company, together with the cross-boundary coordination and collaboration with partners. However, functions related to the procurement (procurement management, logistics, etc.) are essential components in SCM and should not be left out [8]. Nonetheless, the current situation, characterized by worldwide competition, uncertain and unpredictable economic phases and geo-political issues (e.g., natural disasters and terrorist attacks), pressure for cost reductions as well as service improvement. Moreover, the ever-increasing frequency of trends and so-called revolutions (e.g. emphases on quality, lean operations, I4.0, sustainability, etc.) increase the complexity of OpM and SCM [9]. From this situation arises the need to manage the different sources of risks to raise the resilience of the supply chain and make stakeholders and partners more confident of achieving higher performance. Having these objectives as final goals, the necessity to develop key competences like collaboration and knowledge transfer between partners, is essential and it needs to be integrated in the university learning process [9].

As already existing examples of SCM SG is possible to find the Beer Game [10] which is card based and probably, the most known and used. In 2015 a new modern version of the Beer Game has been integrated in a SCM course, leading the card based game towards a virtual application [11]. In [11] is also reported how the combination of SG and SCM courses can lead to the acquisition of both taught and untaught knowledge like partnership and collaboration. Also van den Berg et al. developed a SG in SCM with a board game named "Tower of Infinity" and upgraded, on year after, with an high-tech version of the same game in a virtual world [12], [13]. AUSUM [14] is a game focused on the dynamic of a supply chain management in automobile sector. Also, the Fresh Connection [15] is based on strategical decision to be taken and highlights how these decisions influence different functions within a company. On the other hand, among the operation management SG, Learn2Work represents one of the main examples by making available three different scenarios in which the user must bring the company to success. Practice Operation[1] is the last examples, here the users face a 3D game where they have to manage a clothing company by managing orders, resources, procurement of raw materials to complete different production orders and sell them.

3 Methodology

Being Op&SCM a brand-new tool, and a totally new technology in the University of Parma, its development started with a phase for definition of learning objectives and Learning Questions (LQs). The definition of learning objectives has been driven by

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[1] https://www.mhpractice.com/products/Practice_Operations

two different requirements, namely (i) the targets of the OpM and SCM courses, and (ii) the knowledge required in the day-by-day actions done in the company functions, and it can be stated as such. Upon completion of a minimum game session of 16 hours of Op&SCM, gamers/learners will be able to:

– given the accelerated time and the generated events, examine the characteristics of the simulated universe of the game, distinguish the different actions available for each company role and their consequences;
– combine a strategy to successfully address a specific market niche;
– assess the results achieved by the selected strategy and possibly generate a new strategy that is more effective in addressing the target market niche.

We note that the learning objectives are strongly connected to some soft skills, such as teamwork and leadership, that is the need to see and achieve common goals, and problem solving, that is the capability of facing unexpected events and reacting to maximize company performance.

The LQs, on the other hand, have been formulated to better understand the game perception, and aiming to improve the game itself. We have decided, in fact, to analyze the game from different points of view, such as users' interaction and satisfaction, and the theoretical knowledge delivered. These LQs have been generated from, and linked to, the learning objectives listed above. We have created a multidisciplinary team, comprehending OpM, SCM, SGs and pedagogy experts. After some brainstorming and discussion sessions, the final list of LQs has been generated, as it is reported below:

- *LQ1*: "How does the Serious Game enhance the world dynamics perception?"
- *LQ2*: "Is the User Interface adequate?"
- *LQ3*: "Is the support provided adequate?"
- *LQ4*: "Is required a decisional process for the crucial decisions?"
- *LQ5*: "The equilibrium between skills acquired and enjoyment is adequate?"
- *LQ6*: "Is the workload between company functions balanced enough?"
- *LQ7*: "Is the difficulty adequate for the user's level of preparation?"

With clear objectives, the design and development of the SG started in 2019, with the first (internal) alpha test run in June 2020. This testing session represented the initial step of an iterative approach composed by test and feedback steps, repeated for several months and with different testing groups. The first official version of the SG was released for the classes of OpM held at the University of Parma and University of San Marino in the summer semester of 2021. To test this game release, a pre-test and a post-test were conducted, at the beginning and at the end of the above-mentioned classes.

3.1 Game development and testing

The first working implementation of the Op&SCM was preliminary a web app, released in spring 2019. Two different iterative processes, each of which is composed of more steps, were performed. These loops were executed to fix bugs and glitches, test user acceptance, evaluate game effectiveness, and improve parameters' combina-

tion. The former loop is internal (i.e., performed by project staff), and the latter one is external (i.e., open to students). They are reported in Figure 1, with green and orange boxes, respectively.
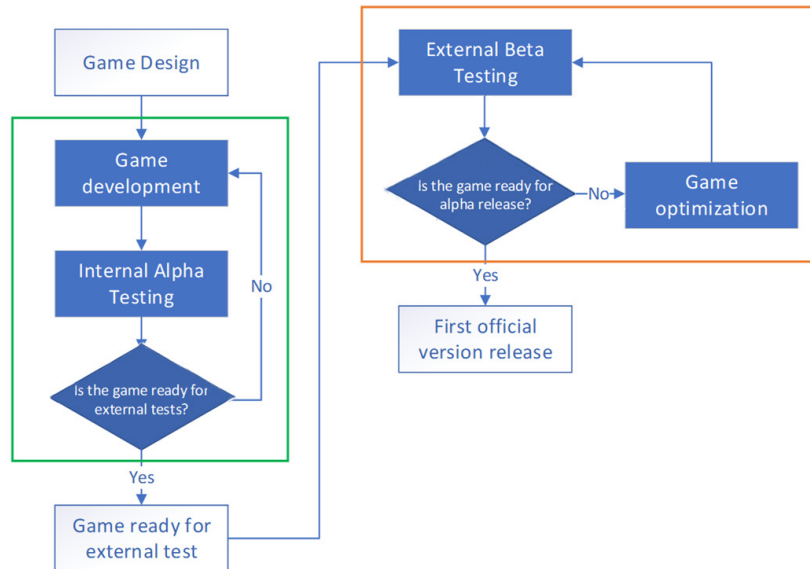

Fig. 1. Testing process

In the first loop (green box in Figure 1), lecturers and researchers played the Op&SCM in two six-hours sessions for the internal alpha tests. At the end of each session, feedbacks were provided, to gather problems, glitches, ideas, and possible improvements. These contributions led to the detection of major glitches and bugs in its first iteration, and to the proposals for parameters optimization in a second iteration. Subsequently, the improved game version has been deemed as adequate from a learning point of view, and ready to undergo a the second (beta) testing, which was delivered to students.

This second testing phase (orange box in Figure 1) has also been replicated twice, with two different groups of students. Here, feedbacks have been newly collected after each game session, and consequent upgrades have been planned and executed. This beta testing phase has been fundamental to assess difficulties that 'unexperienced' players, that are not very familiar with OpM and SCM theory and application, could find during the preparation and the gaming sessions. As an example, a lack of clarity has been noted, both in the game mechanisms and in its interface, as well as a waste of time in the introduction to the game for every new group. These problems have been solved by improving the game's handbook, and by recording introductory videos that have been provided to new players ever since their recording. After these two testing iterations, the game has been released in its as first official version, ready to be used by students during classes. The first users of Op&SCM have been students enrolled in the two bachelor's degree courses in OpM held at the University of Parma and at

the University of San Marino (prof. Romagnoli) in 2021. For each class, two different groups have been formed, one composed of volunteers willing to play Op&SCM and the control group. In both cases, the playing groups had a combination of face-to-face lectures and game sessions. The group of students from Parma played a long run of the SG, while the San Marino group played two different shorter sessions. To best evaluate the Op&SCM SG and the students' willingness to use it, two tests have been conducted. Pre-test has been submitted the first day of class, and it aimed to investigate the perceived usefulness of SGs, the willingness to use them, and the perceived added value of this type of learning tool. The post-test has been delivered to students on the last day of class, and it has been structured by using a framework validated by Iten and Petko [16]. The test is based on a Likert scale and aims to investigate characteristics of the game like (i) usefulness, (ii) simplicity, (iii) fun/enjoyment, (iv) personal ability, (v) fear of use, (vi) intention to use, (vii) clarity of the goal of the game, (viii) strategic approach, (ix) use of prior knowledge, (x) flow, (xi) feedback, (xii) help/assistance, (xiii) enjoyment of the game, and (xiv) competition. The framework has been chosen to reply to the seven LQs listed above.

4 The Op&SCM scenario

The scenario is structured as a universe comprehending different companies competing in the e-bike market. This universe simulates a semi-real-life scenario in which every company is a e-bike manufacturer which must buy raw materials from the suppliers, work these materials to produce final product, and sell them to customers. This design of the game, which reproduce manufacturers' day-to-day actions, enables the possibility for the users to deal with real-life and real-time dilemmas, developing hard skills required in OpM and in manufacturing companies. Also, Op&SCM has been designed as cooperative/competitive multiplayer game where companies are composed by two to three students playing different roles and cooperating. The teamwork becomes necessary to achieve a common goal which is compete and win over the other companies working in the same universe. The three roles played by learners are: purchasing manager (PM), operations manager (OM), and sales manager (SM). The PM role is in charge to manage the inbound operations, the OM manages the scheduling of production and the SM runs the outbound operations as well described by Galli et al. [5]. The collaborations and cooperation between these functions are fundamental to reach an optimal company management. To do so, the users have to share their function information and decide altogether the strategy to follow. Indeed, the serious game does not foresee a common way to reach an optimal management, it is up to the player to decide if producing with a make to order (MTO) strategy, a make to stock (MTS) strategy or a hybrid combination of them. To take such decisions, coordinate each function to achieve the common objective and maintain the strategy chosen, the communication and coordination are a fundamental part of the gameplay.

The decision to design the game in such a complex way has been taken to replicate the complexity, need of coordination and cooperation required inside a company, and

within its supply chain. Also, the game has been developed with the idea to practice and improve soft skills like teamwork, leadership, problem solving, and critical thinking. Another peculiar characteristic of Op&SCM is its high level of customizability, which allows to create different levels of difficulty and different scenarios to be played, by simply altering some game parameters. One of the most important aspects to be considered is the number and the duration of the game sessions, to apply the learning-by-doing concept, and to allow players to shift group composition and roles. To deepen the link between game and learning mechanics, and to understand how and why game parameters and difficulty levels impact on players performances, the interested reader is referred to [17].

5   Op&SCM evaluation and results

The evaluation of the Op&SCM SG is linked to the testing loops of Figure 1, and it allowed to gather two different types of feedback. Indeed, the alpha testing process aimed to fix the major glitches and bugs, optimize the parameters, and create a suitable learning environment for target players. These feedbacks were collected through open discussion, due to the limited number of participants to the testing iterations, and to the number of bugs, glitches, and parameters to be balanced and fixed. Also, these open discussions provided game designers and software experts with the possibility to gather detailed and accurate opinions on major design aspects of the game, such as the timing convention, the overall game mechanics, and the important parameters to be managed and kept under control by company roles.

The second and last step has been the final evaluation that students gave to the Op&SCM SG, after they have played it for a considerable amount of time. In that case, the post-test submitted to students has been the key to understand which parts of the game were balanced, which parts needed improvement or optimization, the perceived difficulty, and the opinion on the number of sessions and the game time. Here, also, a final open discussion moment has been planned to collect open suggestions and ideas, and the feedback has been enhanced with a questionnaire with the scope to investigate the perception of different parameters. The survey has been submitted to the students at the end of each game session. For each item, a Likert scale 1 to 5 (1 = very low, 5 = very high) has been used. The different items that have been investigated are (i) overall perceived difficulty, (ii) perceived difficulty for each single role (i.e., PM/OM/SM), (iii) playability, (iv) friendliness of the User Interface (UI), (v) suitability of the game mechanics with the theory studied in class, and (vi) the perceived level of competition. It has been decided to use direct question, without adopting a structured questionnaire, which has instead been used for the final evaluation. The survey generally reported good results by showing that the overall difficulty level of the game is perceived as average and, among the functions played, OM has been evaluated with a slightly higher level of difficulty [5]. Also, the UI has been evaluated as well designed, and the game practice is in line with the theoretical lessons.
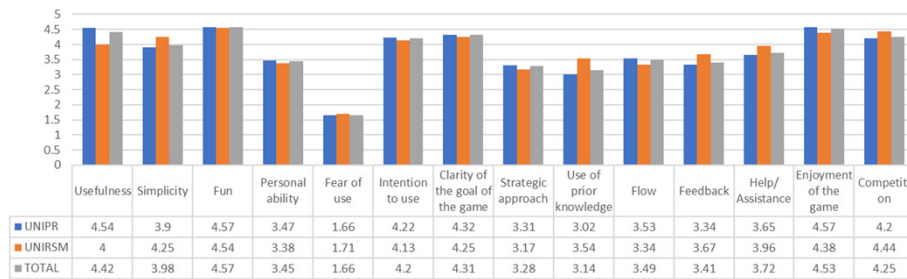
	Usefulness	Simplicity	Fun	Personal ability	Fear of use	Intention to use	Clarity of the goal of the game	Strategic approach	Use of prior knowledge	Flow	Feedback	Help/ Assistance	Enjoyment of the game	Competiti on
UNIPR	4.54	3.9	4.57	3.47	1.66	4.22	4.32	3.31	3.02	3.53	3.34	3.65	4.57	4.2
UNIRSM	4	4.25	4.54	3.38	1.71	4.13	4.25	3.17	3.54	3.34	3.67	3.96	4.38	4.44
TOTAL	4.42	3.98	4.57	3.45	1.66	4.2	4.31	3.28	3.14	3.49	3.41	3.72	4.53	4.25

Fig. 2. Post-test evaluation

The competition perceived has been high, 90% of students reported a grade higher or equal to 4, and the game has been evaluated enjoyable. However, the discussion highlighted the possible benefits of an integrated chat system which was not a built-in of the game.

The last step has been the Summative evaluation which has been carried out by submitting a pre and a post test at learners of the two OpM courses. The pre-test has been submitted to 176 students and the post-test to 102 students, 37 of them has participated as player, the rest represent the control group. The 37 players which played the game have been voluntarily chosen among the 176 beginning students. Indeed, being the two OpM courses not mandatory it was not possible to use a randomized controlled trial (RCT) method. Moreover, the Op&SCM gameplay is structured in multiples long sessions requiring a full participation of the learners. Thus, to enhance the participation of students, a bonus system has been set in which the playing students acquired additional points for the final exam. Once defined the two tests have been submitted mandatorily. The pre-test highlighted the high perception of added value that SGs can bring to the teaching methods used, with the 80% of the interviewee that assigned a grade higher or equal to 4 on that sentence, and more of 70% of students expressed in same way for willingness to use and usefulness perceived. On the other hand, the post-test investigated more in deep all the parameters which characterize the serious game. The test foresees 46 different sentences, divided in the 14 parameters of Iten & Petko framework [16], to enable the possibility for the students to fully express their opinion on the game and, consequently, highlight its strengths and weaknesses. Figure 2 shows a comparison between the groups of University of Parma (UNIPR) and University of San Marino (UNIRSM), and the average value given by all the players. In general, the parameters with a score higher than 3 can be considered evaluated positively, around 3 as neutral, and lower than 3 as negative [16]. The feedback received in post-test can be considered generally positive. Important results have been the vote received by Usefulness (4.42), Fun/Enjoyment (4.57), Intention to use (4.20), Clarity of the goal of the game (4.31), Enjoyment of the game (4.53), and Competition (4.25) which high ranked. The only parameter with a low evaluation is the Fear of usage (1.66) that cannot be considered a negative evaluation due to the purposes of the game.

Indeed, if students would have been afraid to make mistakes, it would have represented a self-defeating attribute for the usage of game being, the game, based on the

methodology of mistake-driven learning. Also, as can be seen from Figure 3, even in the final evaluation gaps have been highlighted between the different roles of the Op&SCM SG. It has been considered the easiest to play the PM role (4.15), SM as second (4.08), and third the OM role (3.69). Even more interesting is the comparison of the evaluation gave to the Op&SCM SG by the learners which played the game and the ones that only saw the introductory videos. Table 1 reports the average grades assigned by students who played the game, by students belonging to the control group, and the absolute and percentage difference between these two values. We note that the average evaluation provided by the players is higher for almost all items/characteristics, apart from Fear of use (−18.4%), Strategic approach (−6.6%) and Use of prior knowledge (−5.2%), which scored lower points in the players group, with respect to non-players. The biggest difference can be seen in Clarity of the goal of the game (+20.8%), Enjoyment of the game (+19.4%), Competition (+19.0%), and Fun/Enjoyment (+16.0%). One last analysis has been carried out, in which the evaluation the students gave to the game has been linked to the final grade they received in their OpM exam. The purpose of this analysis is to preliminary look for correlations between players perception of the game, and their understanding of the subject matter, as evaluated by the final exam.

Preliminarily, we have calculated the correlation between the final grade and the mean evaluation, achieved by averaging out all the different items/characteristics. Afterwards, we calculated additional correlations between the final grade and every single item or characteristic, to underline if a connection exists between students' evaluation (measured in their final grade) and their opinion on the specific item or aspect of the game. The first analysis brought to a negative correlation (−0.47), which is especially generated by the negative correlations between final grades and Personal ability (−0.54), Use of prior knowledge (−0.44) and Strategic approach (−0.38). The other correlation values are distributed between −0.30 and +0.17, not representing a significant correlation between grade achieved, and evaluation expressed.
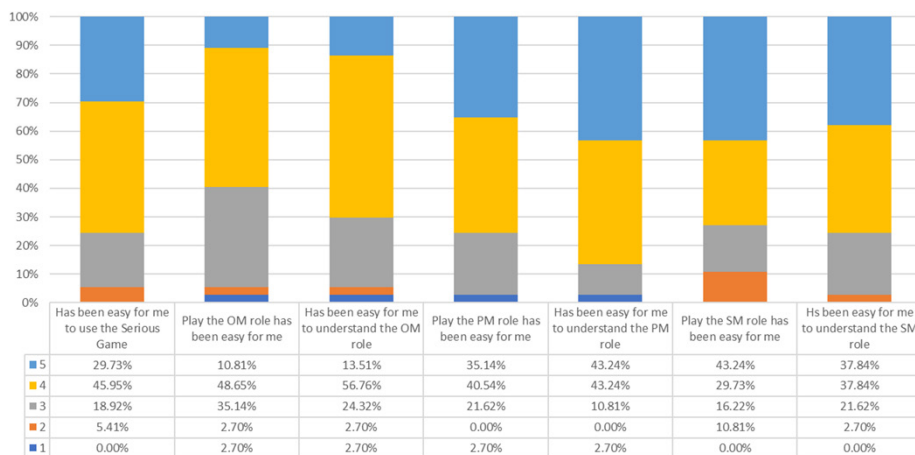

	Has been easy for me to use the Serious Game	Play the OM role has been easy for me	Has been easy for me to understand the OM role	Play the PM role has been easy for me	Has been easy for me to understand the PM role	Play the SM role has been easy for me	Hs been easy for me to understand the SM role
5	29.73%	10.81%	13.51%	35.14%	43.24%	43.24%	37.84%
4	45.95%	48.65%	56.76%	40.54%	43.24%	29.73%	37.84%
3	18.92%	35.14%	24.32%	21.62%	10.81%	16.22%	21.62%
2	5.41%	2.70%	2.70%	0.00%	0.00%	10.81%	2.70%
1	0.00%	2.70%	2.70%	2.70%	2.70%	0.00%	0.00%

Fig. 3. Comparison between role easiness to play

Table 1. Players group and control group comparison

Game Characteristics	Players Only	Non-Players	Absolute Δ	% Δ
Usefulness	4.42	3.80	0.62	12.4%
Simplicity	3.98	3.28	0.70	14.0%
Fun/Enjoyment	4.57	3.77	0.80	16.0%
Personal ability	3.45	2.91	0.54	10.8%
Fear of use	1.67	2.59	−0.92	−18.4%
Intention to use	4.20	3.45	0.75	15.0%
Clarity of the goal of the game	4.31	3.27	1.04	20.8%
Strategic approach	2.82	3.15	−0.33	−6.6%
Use of prior knowledge	3.14	3.40	−0.26	−5.2%
Flow	3.49	3.05	0.44	8.8%
Feedback	3.41	3.09	0.32	6.4%
Help/ Assistance	3.72	3.43	0.29	5.8%
Enjoyment of the game	4.53	3.56	0.97	19.4%
Competition	4.25	3.30	0.95	19.0%

6 Discussion of results

The alpha test showed a good acceptance of the game from the experts, with a specific appreciation of the realistic UI, and of the need for in-team collaboration to achieve good results. Still, from a technical point of view, several bugs and glitches have been found, and immediately fixed. The main discussion topics in that phase were the need of support for students, and the timing convention, that is the ratio between real-life time and game time. The result of beta testing showed a general good evaluation of the Op&SCM SG and its implementation, with a peak in coherence between class theory and game application, and perceived game competition. Also, UI and playability have been considered suitable and achieved good average grades. The differences in difficulty perceived of the different roles have been noted both in beta test and in summative evaluation. This led to the conclusion that a turnover of the role is required to balance the weight of the game among the different functions. In pre-test, the willingness to use the SGs and the usefulness perceived had positive feedback, and these results have been confirmed in the post-test. The beta test results have been confirmed by the post-test evaluation, where the game has been appraised as a good compromise between usefulness and fun, in which the competition and the clarity of the objective represents a key aspect of the success. However, the personal ability, the use of prior knowledge and the strategic approach received a neutral vote in opposition with the mark received on the relevancy between practical aspects and theory. To reply to the **RQ1** ("Does the SCM SG met the Learning Objectives and the Learning Questions set?"), a summary of the achieved results is reported in Table 2.

Table 2. Summary of results achieved for each learning question

Learning Question	Results
LQ1: "How does the Serious Game enhance the world dynamics perception?"	The game is competitive and useful, the strategic approach needed in real world must be improved.
LQ2: "Is the User Interface adequate?"	Yes, students evaluated positively the User Interface (3.97).
LQ3: "Is the support provided adequate?"	Yes, it can be considered adequate. The feedback of the game can be enhanced.
LQ4: "Is required a decisional process for the crucial decisions?"	This point is still open point: the Strategic approach achieved bad average scores, especially among students with higher final grades. A minimum of decisional process is required, but it is not considered fundamental from respondents.
LQ5: "The equilibrium between skills acquired and enjoyment is adequate?"	Yes, Usefulness, Fun/Enjoyment and Enjoyment of the game have all achieved high grades.
LQ6: "Is the workload between company functions balanced enough?"	Partially. The results showed that there is a non-negligible difference between OM and the other two functions.
LQ7: "Is the difficulty adequate for the user's level of preparation?"	Yes. In general, Simplicity had high scores while the Use of prior knowledge achieved a neutral vote.

Also, the calculation of the different correlations between the students' evaluation and their grade achieved during the final exam provides a preliminary answer to **RQ2** ("Is there a link between the final grade achieved by students and their evaluation of the game?"). The analysis showed that, in general, a light negative correlation exists between these numbers. This correlation could be tracked back to the answers received in the items Personal ability, Use of prior knowledge, and Strategic approach. These results, although preliminary, are interesting, and need to be considered more in depth.

Eventually, an interesting result has been achieved in the final evaluation, especially if responses from the players are compared with responses from the control group. Here, almost all the items scored higher values in the players evaluation, with respect to the non-players one, with the only negative differences (between sample and control group) that have been found in Strategic approach, Use of prior knowledge and Fear of use. Obviously, in this last case, a negative answer is also an appreciation of the game (if sample answers are compared with those of the control group), due to the nature of the item itself.

7   Conclusions and future works

In conclusion, the overall feedbacks received on Op&SCM can be considered as positive. The data indicate that players perceived how much competition, fun, and usefulness have been achieved in the game, towards which players showed a great intention to use. Almost all the LQs were answered positively, and this means that most of the learning objectives were met. Additionally, the students who played the game gave, on average, higher evaluation of as much as 12.5%, with respect to the evaluations provided by students who only saw the introduction videos of the game. This last statistic can be interpreted as an interesting result, which confirms that the game exceeded the

students' expectation. Nonetheless, the unanswered research questions, and the negative correlations calculated between the evaluation given by students, and the final grades they received at their final exam, leave some open points. Also, the analysis highlighted a non-homogenous difficulty perceived among the different roles, and the missing need to apply critical thinking and theoretical knowledge developed during the classes, while playing to Op&SCM. These issues have been so far and will be approached in two different ways. First, a rigid rotation of company roles is in practice in different game sessions, also combined with increasing levels of difficulty of the game (see [17] for more details). This rotation, which will be applied whenever players will be spending enough time playing the game, allows to better balance the required efforts for players and levels their experience amongst different functions. Second, a progressive increase in the difficulty of the game should be combined with longer games downtime, during which strategical decisions must be analysed and made to bridge the gap between the use of prior knowledge and strategic decision.

So far, Op&SCM has been used and evaluated in two different Italian-speaking institutions in a single academic year. Data, however, are being collected in other countries (Germany, at present), in across different academic years. This summative evaluation will be replicated and extended in the near future to increase the amount of data collected and enlarge the research questions addressed. The authors are currently working on these points for future research.

8 Acknowledgement

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