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Policy Deployment and Learning in Complex Business Domains: The Potentials of Role Playing

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Abstract

This article focuses on the use of Role Playing games in management education, aiming at demonstrating that they have the potential to provide concrete experiences in which participants can acquire conceptual knowledge and operative skills, both at the individual and the collective level. More specifically, Role Playing games are powerful tools able to support participants' learning at different degrees, since they provide a context and the conditions for concrete experience, reflective observation, abstract conceptualization, and active experimentation. To pursue this aim, a specific Role Playing game was used in an MBA setting focusing on the management of a typical supply chain. Additionally, a nominal group technique facilitated the emergence of group consensus, and the development of improvement policies. The research design and the results of several gaming sessions are discussed and analyzed according to the theoretical framework presented in the article. Overall, this study shows that Role Playing simulations can play a serious and relevant role in management education, providing free and safe environments in which participants can face decision-making issues, and problem-solving challenges.

Keywords: learning, management education, policy deployment, role playing, supply chain management

1. Introduction

Increasing degrees of complexity of markets, high interdependence among customers, suppliers and competitors, unpredictable variations in economic fundamentals and rapid societal changes, are all key elements that decision-makers must be able to take into account and address for. These factors are also particularly relevant when considering education and training projects, especially if designed for managers and PhDs, i.e., those who run or will run organizations and take management decisions with long-term impacts. As Poisson de-Haro and Turgut (2012, p. 210) claim, "successful management requires the ability to understand and apply modern management principles and techniques effectively. Managers are expected to have an in-depth knowledge of models, theories, and processes". To this end, education and training programs should be designed in order to develop new analytical and problem solving skills in learners, as well as support them to think in strategic terms (Boyatzis, 2008) and be creative and innovative when facing business-related issues. Unfortunately, traditional systems of education and training are frequently aimed at encouraging the analytical approach and are often structured on the basis of academic lectures, with an excessive theoretical load and a very limited participation and involvement of the participants. Using this approach, thinking, creativity, reflection and discussion are not well sustained (Elmuti, 2004; Jones & Sallis, 2013), especially when the learners have to deal with highly dynamic and complex business domains, such as supply chain (SC) contexts.

In order to avoid these pitfalls and focusing on management science and management education, quite recently we witnessed an increased use of new methodologies and tools able to create opportunities for participation and interaction, communication and knowledge sharing, reflection and strategic thinking of learners (Schoemaker, 2008). In particular, direct *experience* has been identified as a fundamental factor for education and training programs (A. Kolb & D. Kolb, 2012; Bevan & Kipka, 2012), and *role playing* (RP) and *business simulations* are considered key elements of this new approach to learning and training in managerial settings, especially when team working and group dynamics are fundamental to achieve successful performance (D. Saunders & P. Saunders, 2014).

Starting from these considerations, the article considers a specific RP reproducing a typical SC setting with its main components and decision-making issues.

The main aim of the article is to explore the potentialities of RP when used to support learners to analyze and understand the functioning of complex SC domains, while at the same time facilitating the creation of new knowledge, and the development of problem-solving and strategic management skills.

Furthermore, a second aim of the article is to discuss how a combined use of gaming and group discussion techniques (in detail, nominal group techniques) may successfully facilitate the emergence of group consensus, and the design of improvement policies.

The article is subsequently structured as follows: sections 2 and 3 present the theoretical framework underlying learning in management education and training, specifically focusing on the main features of RP; section 4 presents the gaming experiment, its research design, key data, and the discussion of findings. Some final remarks conclude the article.

2. Literature Review and Theoretical Framework

In broad terms, education and training entail transferring specific skills to learners (i.e., students and managers) and increasing their level of knowledge and competences. However, various educational and training methods not only rely on various tools (e.g., a traditional lecture vs. a case study), but are also aimed at stimulating differentiated kinds of learning (e.g., situated learning, inquiry learning or experiential learning - Andersen et al., 1996; Lengnick-Hall & Sanders, 1997; Lazonder et al., 2008), and may imply a peculiar interaction between the trainer and the trainees. Therefore, in order to select a specific approach for management education, it is useful to focus on the concept of *learning*, which usually entails to (Kolb, 1984; Kim, 1993; A. Kolb & D. Kolb, 2012; Senge & Kim, 2013): (a) acquire new knowledge or skills/abilities, and (b) rely on direct experience/experimentation.

In particular, Kolb and Kim, building on well-established contributions (e.g., Dewey, 1896 and Lewin, 1951), focused their attention on the relevance played by *experience* in learning, developing a specific experiential learning cycle called "OADI cycle" (i.e., Observe, Assess, Design, Implement), included in Figure 1.

This theoretical framework is useful in order to understand *why* individual learning might occur going through the four stages of the cycle, but it does not help in understanding *how* learning might be generated, and *which* tools and methodologies could be used to this end. Moreover, we also need to extend the framework at the group/organizational level (i.e., collective learning) to understand how group dynamics may affect knowledge acquisition. In other words, whereas the concept of learning has been extensively discussed in the relevant literature and maybe considered well established, much work is still required when defining the proper forms for sustaining and facilitating such learning.

In this regard, it is meaningful that the learning process can be viewed according to a traditional *Input-Output model* (Lewis & Maylor, 2007), in which learners become able to transform the *inputs* they receive (e.g., instructions and information) into *outputs* (i.e., new knowledge and new skills). Specifically relating to management and operation research training programs (see Chatti et al., 2012, and Nettleton, 2012 for other disciplines), two different typologies of learning styles can be adopted in order to provide the proper inputs for learners and stimulate the transformation process aimed at creating new knowledge (Santos & Powell, 2001, p. 47):

a) *push learning*, also defined formal learning, occurs when learners have little (or none) power in defining the problem, action or knowledge that is required to improve their own working environment or process. Push learning is the common approach used by consultants and often relates to traditional academic research projects;

b) *pull learning* (also labelled as informal learning) occurs when individuals have a high control in the definition of the problem, action and knowledge required to improve their performance; thus, learners are in charge of learning for themselves by exploring their actions as they work, and this usually leads to high commitment, motivation, creativity, and improvement.

Figure 1 summarizes the previous considerations and concepts.

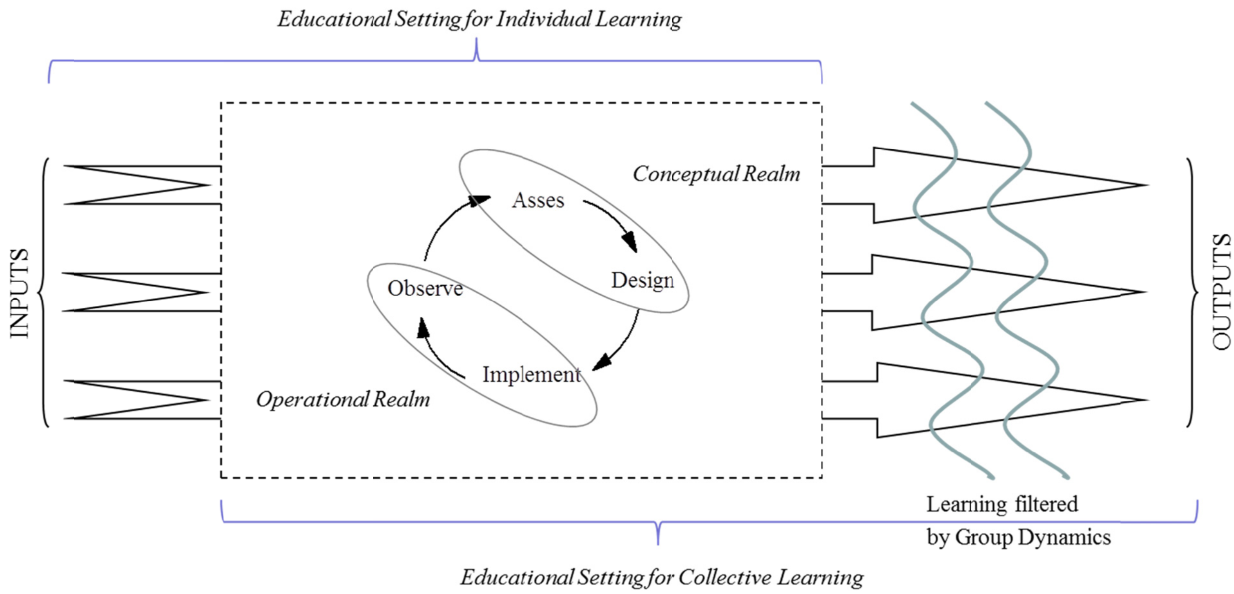

Figure 1. Learning in input-output oriented methods based on experiential learning

The figure clarifies how individual learning occurs exploiting the OADI cycle functionalities. Additionally, and in detail when participants are challenged to actively interact and collectively live a training experience, the process may effectively support collective learning.

Therefore, and regardless of the educational methodology that is adopted, a training intervention should be aimed at transferring to participants increased competences and new knowledge-both at the *operational* and at the *conceptual* level-while at the same time improving their problem solving and strategic thinking skills, both as *individuals* and as a *group* of people or decision-makers. To coherently pursue these objectives, the educational setting should provide all the necessary conditions and tools to transform data into information, and direct experience into new (individual and collective) knowledge and skills.

In this regard, whereas the push learning approach has been widely used in education and consultancy, pull learning methods have received less attention and only recently, their use witnessed an increase, especially when learners are individually and collectively challenged to face complex and dynamic domains. It is our opinion that all these factors open up great opportunities for the use of *Role Playing simulations*.

3. Main Benefits of Role Playing

Role Playing (RP) games and business games are increasingly used in management and OR training programs (e.g., Morecroft & Sterman, 2000; Sogunro, 2004; Barnabèè et al., 2013; D. Saunders & P. Saunders, 2014) to pursue specific educational aims, objectives of individual and organizational learning, as well as improvements in strategic thinking skills, and team working attitude.

The definition of a *business game* is substantially wide, and includes any kind of simulation and role-playing game capable of artificially reproducing specific business systems with their operating conditions and decision-making rules (see Crookall et al., 1987; Sauvéé et al., 2007; Crookall, 2010). In this article, we primarily refer to RP, as a tool able for providing a safe environment in which participants can interact with a simulated business domain, experience firsthand the working and managerial conditions of the business context, and directly observe the consequences of the policies and actions carried out.

In this regard, RP might play a fundamental role in knowledge acquiring, and has all the potentialities to facilitate processes of learning, *if* based and developed according to some fundamental educational and learning conditions, such as the following:

a) The RP game setting is meant to provide a protected and secure environment in which participants are free to develop new skills and/or refine the skills already possessed, and to design and test new policies and strategies, significantly shortening their learning curves (Poisson de-Haro & Turgut, 2012);

b) The gaming environment should be user friendly i.e., simple enough for interaction, so that technical detail or specific skills (e.g., accounting calculations or use of computers) do not undermine the participants' gaming experience, consequently slowing down the learning process (Lainema & Nurmi, 2006);

c) The RP game should be realistic (Adobor & Daneshfar, 2006) and transparent, i.e. the structure of the system represented in the game should be visible, or at least could be analyzed and inspected by the learners (Alessi, 2000);

d) Learning in dynamic domains requires understanding both from a functional and inter-organizational context, being the learners challenged in learning from both a personal and organizational level. To this end, RP should be designed to provide "the learner with a structured approach, enabling individual learning outcomes to be achieved through a cumulative program of scenario based activities" (Pepper & Clements, 2008, p. 21);

e) RP games are most effective when developed according to a "pull approach" to learning, thus providing all the fundamental conditions of an engaging and meaningful experience (Santos & Powell, 2001).

In order to provide further insights, the following section examines a specific RP used in management education.

4. The Gaming Experience

4.1 Overview

The research is based on an RP game-named Beer Distribution Game - used in an MBA setting. The game meant to reproduce the main operational features of a typical supply chain, subsequently challenging the participants to suggest and design feasible SCM policies. As defined by Sterman (2000, p. 663) "a supply chain is a set of structures and processes an organization uses to deliver an output to a customer. The output can be a physical product such as an automobile, the provision of a key resource such as skilled labor, or an intangible output such as a service or product design".

At the operational level, a SC can be viewed as a complex network (Dekker, 2003) supporting three main typologies of flows (Akkermans et al., 2003, p. 286; Stadler, 2015, p. 4): m*aterial flows*, representing physical product flows from suppliers to customers; *information flows*, representing order transmission and order tracking; *financial flows*, representing credit terms, payment schedules and consignment and title ownership arrangements.

Even though the basic structure of a SC is quite simple, its overall management is not as simple, due to the underlying hierarchies, the high level of interdependence among the different actors involved in, and the powerful dynamics involving the complex pattern of stocks and flows, which constitutes these chains. All these elements are obstacles to the fundamental aims of a SC: first, to produce goods for the market, integrating many different firms along the SC; second, to match customer demand with production rates and shipments.

In this regard, the literature as well as the practice have provided enough evidence of the variety of problems associated to supply chain management (SCM) interventions (e.g., Towill, 1996; Lambert & Cooper, 2000; Dejonckheere et al., 2003; Hugos, 2011; Deshpande, 2012; Wisner et al., 2014; Christopher, 2016): in particular, very often SCs exhibit persistent and costly instability and wide amplifications along the supply chain (the so-called "bullwhip effect") (Note 1).

In order to overcome these issues and improve SCM practices gaining competitive advantage (Christopher, 2016), various approaches have been developed with mixed results over the last years (Akkermans & Dellaert, 2005; Dekker et al., 2013; Wisner et al., 2014); indeed, poor performance along real supply chains as well as an incomplete understanding of their behavior are still pressing problems that managers are called on to face, and students need to be trained on.

4.2 Research Design

The Beer Distribution Game is a role-play simulation created at the Massachusetts Institute of Technology (see Sterman, 1989, 1992, 2000 and 2015). The game reproduces the functioning of a SC of beer production. Each player is asked to manage one of the links in the distribution chain, corresponding to four specific companies: factory; distributor; wholesaler; retailer. Subsequently, each player manages one inventory stock, fulfilling orders coming upstream and shipping finished goods downstream. Basically, orders (information) flow upstream, while deliveries (materials) flow downstream along the SC.

Time delays (i.e., time lags) play a pivotal role, particularly challenging the learners to account for logistics and production time. In detail, at each stage the participants are called on to consider both *material delays* (i.e., the shipping delays) and *information delays* (i.e., the order processing delays): such delays consequently influence individual demand forecasting and impact on orders placed across the SC. Figure 2 displays all these elements, specifically portraying a partial and simplified representation of the structural setup of the game.

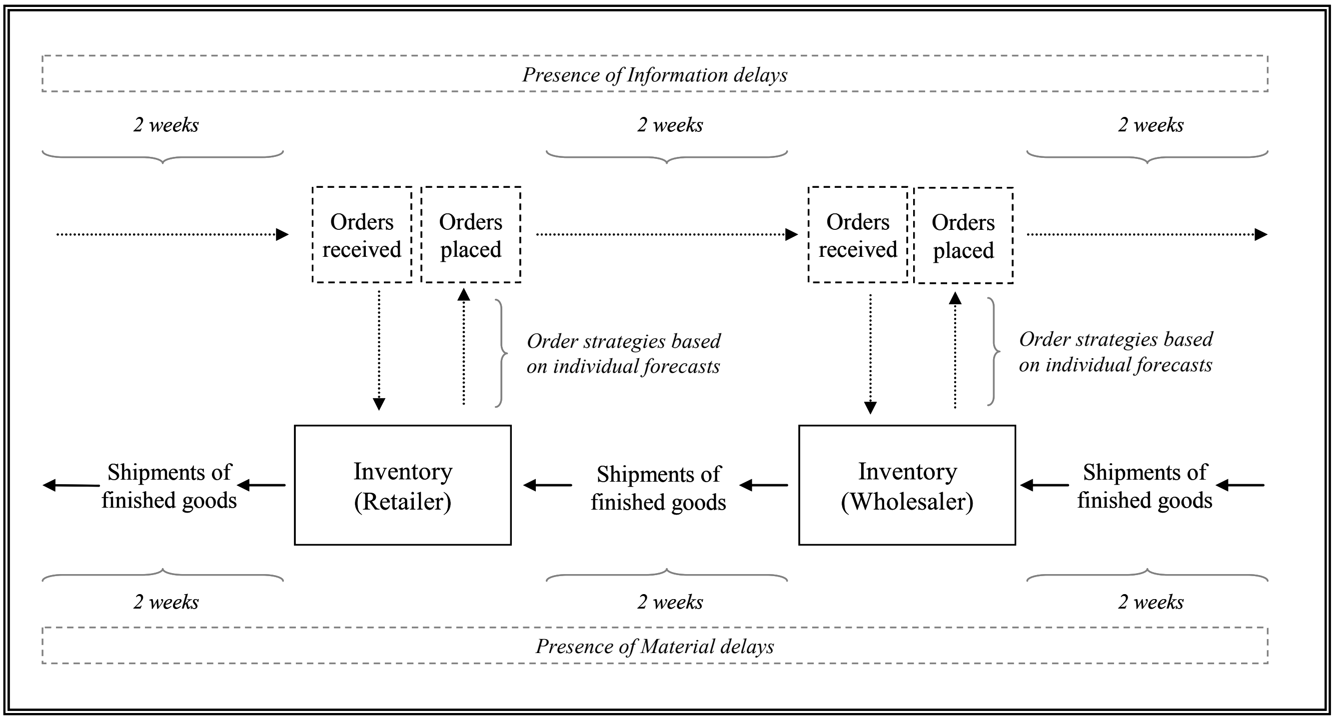

Figure 2. Simplified representation of the SC environment, with material and information flows, and stock inventories

Source: Adapted from Sterman, 2000.

The fundamental goal of the game is to manage the SC as a unique business environment, in order to minimize total SC costs and deliver the goods to customers on time. A second objective of the game is to stimulate the participants to recognize how and why oscillatory behaviors can arise in SC domains and, additionally, to correctly understand how and why amplifications in order strategies (the "bullwhip effect") may occur. The game is subsequently meant to support group discussion and policy deployment, usually in reference to the variety of organizational and operational issues identified during the simulation, and commonly discussed in reference to an SCM program or intervention.

During the simulation, the participants are not allowed to cooperate and share information, although they have complete control on their own inventories and direct observation of inventory levels and shipment rates throughout the SC.

The educational setting in which this game was played comprised Master students attending a course study in management control, all of them with a background in business administration. Table 1 summarizes the main features of the RP gaming sessions.

Table 1. Key features of the gaming sessions

1	Duration of the role playing game	A 0.5-hour briefing session. A 4-hour game session. A 2-hour debriefing and policy deployment session.
2	The lab setting	The participants were divided into teams made of four master students, each of them playing a specific position of the SC. The game was played in its board game version.
3	Time horizon of the game	36 weeks.
4	Decision inputs	Orders placed.
5	Objectives to achieve	Minimize total SC costs. Deliver the goods on time.
6	Performance outputs	Single position costs. Total SC costs, given by inventory holding costs and backlog costs.
7	Exclusions	The game did not include any inconvenience, such as machinery failures, or personnel strikes. No capacity constraints were imposed.
8	Teaching support materials	Transparencies. Acetates. Teaching Note.

The following section provides further details.

4.3 Typical Participants' Performance

The RP game is initialized in equilibrium and during the first (simulated) weeks, the participants learn the mechanics, and are instructed to place order suitable to keep the game in equilibrium. These initial steps are meant to allow them to make sense of the simulated management environment (see Alvesson & Willmott, 2012), and get confidence with the game and its rules. The external demand is predetermined: in order to induce the bullwhip effect, customer demand remains stable for a few rounds (4 units for 4 weeks) before suddenly showing one single increase (to 8 units/week), remaining stable until the end of the game.

All over the world, students and managers called upon to face this dynamic environment registered poor performance, showing astonishing similar decisions, ineffective policies, and misperception of feedback structures and time delays (Sterman, 2015). In particular, typical results show a “boom and bust” dynamic behavior that is characteristic of business cycles: the one increase in customer demand inevitably leads to the bullwhip effect, and to a destabilization of ordering patterns throughout the SC. As Sterman (1992, p. 41; 2000, p. 686) demonstrates, average team costs are about $ 2000, with peaks of more than $ 10000 and a very few teams below $ 1000: it is to noteworthy that optimal performance is around $ 200, and therefore teams average costs are usually a value ten times greater than optimal. Even more relevant is the analysis of amplification, phase lag and oscillation.

- *Phase lag*: the order rate tends to peak later moving from the retailer to the factory; factory production peaks around 15 weeks after the change in customer orders.
- *Amplification*: the amplitude and variance of orders increase steadily from customer to retailer to factory; the average amplification ratio of factory production relative to customer orders is a factor of four.
- *Oscillation*: orders and inventories are characterized by large amplitude fluctuations, with an average period of about 20-25 weeks.

What is particularly relevant in this RP, is that the participants *endogenously* generate oscillations through their managerial policies, even in a situation in which they have good local information and some (even if incomplete and limited) global information.

However, there are some limitations: customer demand is not known in advance and is not communicated throughout the SC; moreover, communication and explicit coordination among participants are not allowed. The educational objectives of this RP game are clear: being not allowed to share information, coordinate decisions and design joint strategies, the learners are individually challenged to face a global optimization problem factorizing it into sub-problems distributed throughout the SC.

4.4 Results

Similarly to typical outcomes of the game, results from the laboratory experiment showed oscillations, amplifications and phase lags as the change in customer orders propagated from retailer to factory. As an example, Figure 3 portrays on the top the orders placed, and in the bottom the net inventory (Inventory - Backlog) for each player belonging to a specific SC team involved in the RP.

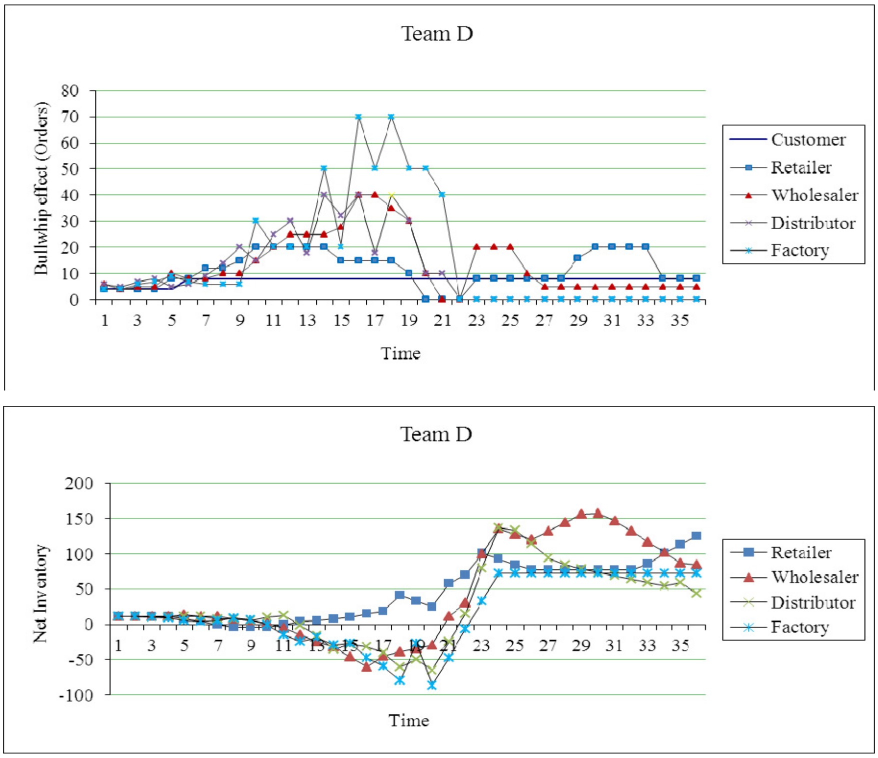

Figure 3. Amplification, oscillation and phase lag from the experiment

More specifically, the first figure shows a typical *bullwhip effect* while the second one shows the inventory fluctuation, with negative inventory representing back order.

Starting with the retailer, inventories decline throughout the SC and almost all the players tend to create a backlog of unfilled orders. As an impulsive reaction, players usually send huge orders upstream. At the same time, not properly taking into account the presence of information-delays and material-delays, the factory increases its production, and inventories along the SC start to rise but are not stabilized around the minimizing cost. On the contrary, inventories significantly overshoot, and players consequently respond by dramatically reducing orders, very often to zero for extended periods of simulated time. Inventories eventually peak and then slowly decrease or stabilize. As highlighted, this dynamic behavior is particularly interesting being an endogenous consequence of the participants' policies, based on limited information and individual forecasts.

Furthermore, it is striking that the patterns of behavior generated in the experiment by several teams are very similar one to the other, even though with differences in magnitude and timing (see Table 2).

Table 2. Individual performance

Position (Team)	Average orders placed	Standard deviation	Amplitude (Max)	Average net inventory	Standard deviation	Amplitude	Average costs per position, per week	Standard deviation	Amplitude
Retailer (A)	6.88	5.21	24	-6.05	13.19	43	10.30	8.99	29
Wholesaler (A)	6.83	7.72	30	3.97	26.24	108	14.86	10.12	38
Distributor (A)	7.36	9.41	35	-2.5	24.92	87	15.75	15.89	61
Factory (A)	8.16	11.03	50	17.03	26.35	90	12.29	11.38	31
Retailer (B)	8.22	4.13	18	-9.86	18.87	59	14.36	14.71	43
Wholesaler (B)	8.38	5.60	20	-6.33	31.24	98	21.91	17.87	58

Distributor (B)	5.83	6.71	20	13.44	20.48	68	11.47	7.00	25
Factory (B)	6.94	9.83	30	-0.86	22.48	66	13.81	14.35	44
Retailer (C)	8.33	6.03	28	-3.11	22.18	74	14.86	12.04	40
Wholesaler (C)	9.44	16.16	55	35.58	79.05	234	42.29	28.26	79
Distributor (C)	9.36	17.74	70	-16.80	63.11	210	34.51	53.68	191
Factory (C)	12.19	27.22	90	54.75	64.93	199	36.45	25.78	70.5
Retailer (D)	11.36	6.52	20	43.88	40.49	129	22.44	19.70	62.5
Wholesaler (D)	13.30	11.23	40	43.22	70.22	218	35.36	26.63	79
Distributor (D)	10.77	13.14	40	25.47	52.98	202	27.44	20.82	68.5
Factory (D)	15.13	21.38	70	16.36	49.75	160	27.68	20.97	87

The outcomes in terms of total cumulative costs are even more relevant when assessing the overall performance of the SC teams, in reference to optimal (or desired) results.

Table 3. Cumulative costs in the gaming experiment

Position (Team)	Cumulative costs per position	Cumulative costs per SC
Retailer (A)	371	1915.5
Wholesaler (A)	535	
Distributor (A)	567	
Factory (A)	442.5	
Retailer (B)	517	2216.5
Wholesaler (B)	789	
Distributor (B)	413	
Factory (B)	497.5	
Retailer (C)	535	4612.5
Wholesaler (C)	1522.5	
Distributor (C)	1242.5	
Factory (C)	1312.5	
Retailer (D)	808	4065.5
Wholesaler (D)	1273	
Distributor (D)	988	
Factory (D)	996.5	

As mentioned, optimal performance should be around $ 200 per each simulated SC; the data show ineffective managerial policies, being teams average costs an abnormal value between 9.5 and 13 times greater than the optimum. As usual (see Sterman, 2000, 2015), in almost all the cases the dynamic behavior generated by the players is *boom and bust* with wide bullwhip effects, thus demonstrating the need of a better understanding of SC settings and the adoption of group discussion techniques to support SCM policy deployment (as we will discuss in sections 4.5. and 4.6.) if this issue is to be faced at the organizational/collective level.

4.5 Sketching the Customer Demand and Reaching Group Consensus

In a similar way as documented by other studies (e.g., Carter et al., 2013), the facilitator instructed the participants to sketch on acetates their views about the customer demand function. This step was individually taken, without any interaction with the other players, exclusively relying on the personal gaming experience just being completed, and on personal mental models (i.e., our way of reasoning and interpret the information we gather and the world around us accordingly-Vennix, 1996).

All the participants (except the retailer who actually knew the customer demand during the simulation) sketched their assumed function for customer demand, depicting wide oscillations. To accomplish this task, players did not need any specific mathematical skill or knowledge, being just required to draw the customer demand on a two-dimension graph.

The graphs thus sketched were subsequently aggregated. The idea underlying the development of a "unique" representation for all the different shapes portrayed by the participants, refer to the opportunity of employing a common "graphic frame" (Sterman & Ford, 1998) to be used by all the participants to reach consensus and agreement at the group level. At the same time, a unique graph provides a white box view of the aggregation, and facilitates individual reasoning and group discussion.

Specifically, Figure 4 displays one set of the functions sketched during one of our simulations. It is meaningful to remind that the game is played according to a step function: customer demand remains stable for 4 weeks (four units/week) before one single increase (to eight units/week), remaining stable until the end of the game.

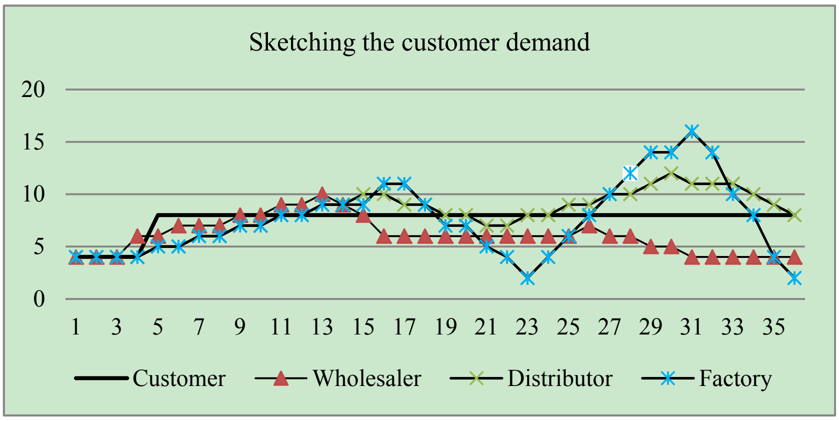

Figure 4. Perceived customer demand, as sketched by the participants

As Figure 4 demonstrates, the participants portrayed shapes substantially far from the simulated customer demand: as opposite to a quite simple "step function" used for the simulation, participants sketched functions characterized by oscillations, amplification and phase lag. Analyzing the data and the sketches together, it was straightforward that the teams generated similar patterns.

This step was instrumental in supporting the participants in gaining awareness and new knowledge. More specifically, as the literature points out (e.g., Carter et al., 2013), this step of *consensus achievement* is fundamental in order to correctly influence the participants' mental models, and inform future group discussion and the development of improvement actions/policies.

In detail, applying this technique was not only helpful in eliciting individual views on customer-demand, but was also instrumental in clarifying the existence of an *endogenous* cause for the oscillations experienced during the simulation, i.e. the players' policies induced the oscillations. This eventually helped to avoid the so-called "the enemy is out there syndrome" (Senge 1990, p. 19)-that is to say, finding an exogenous explanation for the problems experienced during the game -, on the contrary, focusing on the internal functioning of the systems and the policies being implemented.

All these data and considerations informed the final part of the debriefing and supported the policy deployment process.

4.6 Debriefing, Discussion and Policy Improvement

The debriefing aimed at collectively and analytically studying the characteristics and outputs of the simulations, and facilitating policy deployment for SC contexts.

To this end, a Nominal group technique was used to stimulate the participants to reflect on their gaming experience, and subsequently identify, share and agree on a core set of SCM improvement actions.

As pointed out by the literature (e.g., Norton, 1980; Vennix, 1996), a *nominal group technique* is a structured method for group brainstorming and group decision-making, allowing to generate ideas and management policies through a balanced participation of all members of the group (Andersen et al., 2007). The method, which leads to a rank-ordered set of policies/decisions, is particularly useful to encourage contributions and involvement from each participant, even in situations where some team-members may be much more vocal or experienced than others.

Each team member had the task to identify and propose a limited number (maximum of 3) of SCM policies able to improve the business case under analysis. As an example, Table 4 displays the information filled by one of the team that took part to the RP game.

Each group member, relying on his/her gaming experience and personal knowledge, wrote down three feasible SCM improvement actions. The table was then shifted to the next participant who acted like referee no. 1, grading the policies suggested by the previous one, and adding revisions and comments. Thus, each participant, in his/her round, had the opportunity to evaluate and revise/improve the proposals made by the other ones. To do so, brief time (5 minutes) was allocated. The procedure was repeated in clockwise direction until every group member revised all the policies suggested by the other participants.

Table 4. One of the tables used in the debriefing session

	Policy n. 1	**Policy n. 2**	**Policy n. 3**
Participant 1 (Policy Maker) Role in RPG: Wholesaler	Improve communication flows.	Introduce a new inventory policy.	Implement multidimensional performance measurement systems, to have more than just financial KPIs.
		Approval (Yes, Partially, No) and Revisions	
	Yes	Half	Yes
Participant 2 (Referee 1) Role in RPG: Distributor	Talking is essential or at least sharing information in a quicker way.	An inventory policy is already in place. We were instructed how to manage our inventory. We just did not do it.	Costs do not tell the whole story of the game. I was highly dissatisfied during the simulation and I would like to see that in terms of more KPIs.
	Yes	Yes	Half
Participant 3 (Referee 2) Role in RPG: Factory	Implementing a more efficient management information system would help.	Although we were instructed to do so, we did not manage the inventories. And we miscalculated the impact of material and information delays along the SC.	More metrics and indicators may help in managing orders and the inventory.
	Yes	Yes	Yes
Participant 4 (Referee 3) Role in RPG: Retailer	ERPs are well suited for this purpose.	An optimization algorithm could be developed for this SC setting.	It is not only a matter of each position in the game … A multidimensional measurement system would help to assess the performance of all the players and the whole SC. What about a Balanced Scorecard?
Total Score	*3*	*2.5*	*2.5*
Lesson learnt	The method highlighted the opportunity and potential of information systems (specifically ERPs) for SCM settings.	The participants recognized the utility of optimization algorithms and formulas to determine the most efficient policies.	Multidimensional performance measurement systems (such as the Balanced Scorecard) would facilitate the assessment of performance for any individual participant as well as for the whole SC.

As shown, after all the group members wrote down their ideas and completed the tables with scores and comments/revisions, the entire group collectively identified and formalized the “lesson learnt”. Subsequently they discussed the suggested policies to further agree on a core set of them (those ranked with the highest scores).

Overall, this method revealed to be effective in testing the research questions addressed by this article. Particularly, the nominal group technique helped the players to conceptualize the main lessons learnt during the game, identify feasible SCM improvement policies, and discuss new tools and devices to implement for increasing efficiency and performance along typical SCs. It is noteworthy that most of the proposals and policies identified by the participants are mentioned in the literature as feasible solutions to SC problems and for improved SCM practices (e.g., see Towill, 1996; Shah & Ward, 2003; Granlund & Mouritsen, 2003; Gunasekaran et al., 2004; Bhagwat & Sharma, 2007; Prajogo & Olhager, 2012; Jenatabadi et al., 2013; Sterman, 2015; Christopher, 2016).

Subsequently, the final part of the debriefing focused on bringing players' attention on the main underlying criticalities faced during the different stages of the RP.

In detail, the participants identified three main causes of inefficiency and instability, as follows.

1) Lack of information

During the game the players are not allowed to communicate, except for the orders placed. Therefore, the game incentives the participants to forecast customer demand without the possibility to share any information. In this situation traditional forecasting methods, such as adaptive expectations, and stock keeping strategies contribute to generate the bullwhip effect.

2) Complexity of the SC structure

The structure which is typical to many SCs largely contributes to the bullwhip effect. In particular, the presence of information and material delays tends to aggravate it: the longer the lead-time is the more aggressive will be the ordering strategies, thus further contributing to the bullwhip effect.

3) Lack of collaboration and local optimization

Local optimization, in terms of individual forecasting and cost optimization, and a lack of cooperation are key causes for amplification and the bullwhip effect. The subsequent behavior of players is to inflate orders, transmitting ambiguous information along the SC, thus contributing to the bullwhip effect.

All these problems are interconnected and are the consequence of a simple but at the same time powerful principle: *structure generates behavior* (Spector & Davidsen, 1997, p. 132), i.e., the oscillations are endogenously generated due to the specific operational features of the game and the strategies developed by the players.

5. Conclusion

This article explored the potentialities of RP for management and OR education, especially when used to train participants in complex and dynamic decision-making environments (such as SC contexts), and to enhance problem solving skills and cooperative attitudes among "learners". When analyzing and managing such domains, traditional methods of training and education have long proved to be no more effective, and great relevance is increasingly given to approaches based on direct experience, reflective observation, high interaction and abstract conceptualization. To this end, if correctly designed, RP games provide opportunities, conditions and a secure environment in which participants can be active, interact and experiment freely with ideas and strategies, while challenging their own mental models, and support knowledge acquisition.

According to the theoretical framework we presented in section 2, learning is a process whereby knowledge is created by the transformation of experience through a four-stage cycle, i.e., entailing four adaptive learning modes (see Lewis & Maylor, 2007; A. Kolb & D. Kolb, 2012; Senge & Kim, 2013): concrete experience, reflective observation, abstract conceptualization and active experimentation. It is the author's opinion that the gaming approach here presented helped the learners to go through all the four stages of the framework of experiential learning we referred to, and learn a fundamental lesson: integration and cooperation are key elements of performance and efficiency, especially within complex business domains in which the structure of our own management policies endogenously creates the behavior we witness.

In greater detail, in this RP the participants were involved in a concrete playing experience, observed the results of their actions and the interplay of the policies carried out, evaluated the outcome of their decisions trying to build a theory of what happened during the game and about the key features of the business domain they were involved in; finally, they conceptualized their experience in ideas and new knowledge, useful to anticipate and act in front of similar concrete experiences, or to design and implement new managerial policies in real working situations.

In this regard, and in line with other studies (e.g., Andersen et al., 2007; Carter et al., 2013), the nominal group technique was particularly useful as a complementary tool to the RP game, and specifically in order to support the participants in developing improvement policies and generating group consensus. In more detail, the combined used of the RP simulation and the nominal group technique proved to be particularly effective in creating all the necessary conditions to elicit individual mental models and personal knowledge, at the same time sharing ideas and informing group discussion and policy deployment.

In sum, we believe that RP can be an effective training and educational tool, especially when directed at stimulating managers to better understand complex environments and consequently design effective management policies. More specifically, designing RP simulations focused on the operational features of modern SCs may be undoubtedly useful in management training programs as well as in courses on operations management, management control, strategic management, production scheduling and related issues (e.g., Trim, 2004; Berggren & Söderlund, 2008; Barnabè et al., 2013; Davidsen & Spector, 2015), since these games clearly highlight the importance of coordination among levels in an organization, the role of information systems in controlling complex contexts, the implications of various production paradigms, and help the players to understand that managing complex and dynamic business domains raises a big challenge: there is a clear need of *thinking globally* while *acting locally* (Senge & Sterman, 2000).

As to the limitations to this study, it is meaningful to emphasize that depending on the features of the specific game and the interaction taking place, different kinds of learning-which may also include forms of situational, fragmented or opportunistic learning (Kim, 2001)-can occur. Therefore, it is not possible to provide a generalization related to the usefulness of RP. Subsequently and also in terms of future research, the author is very active in testing the potentialities of RP not only in manufacturing contexts, but also in service-based businesses which provide additional challenges the ones addressed in this study. This includes deigning and applying RP games in the healthcare sector.

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Note

Note 1. The bullwhip effect consists of an amplification that from orders moves upstream in the SC to the production. Arising from coordination problems and the presence of time delays not properly taken into consideration, it produces wide amplifications along the supply chain even in the presence of very small variations in customer demand.