Teaching Supply Chain Management with the Beer Distribution Game on Mobile Devices

Bojan Cestnik, Tanja Urbančič

Abstract: *At the University of Nova Gorica we introduced game playing as a didactical approach for learning the role of information support in supply chain management. We implemented a well-known beer distribution game developed at MIT Sloan School of Management more than fifty years ago. The game is regularly used in the Business information systems course in the Engineering and Management study programme at University of Nova Gorica. The supporting computer program that enables the game to be played using mobile devices was developed by the course teacher. The game playing in this course has proved to be very efficient for learning the importance of relevant information flows for better decision making.*

Key words: *Educational games, supply chain management, mobile devices, beer game, e-learning.*

INTRODUCTION

In alignment with the European Commission's communication »Opening up Education« [11] and with the consecutive »Opening up Slovenia« [12] initiative, University of Nova Gorica encourages new IT based teaching methods to be used throughout all its schools and study programs and started activities to use and produce openly accessible educational resources in a more systematic way. The motivation is not just to follow the strategic guidelines, but in the first place to enhance the quality of teaching, contributing to better study results.

Soft skills needed for problem solving and team work are very important for the employability of graduates as well as for general development of economy and society. Yet, in the curricula and educational practice in higher education this is often neglected and subordinated to other academic goals. At the University of Nova Gorica, we put strong emphasis on this educational objective. Prevailingly, we try to achieve it by including individual as well as team projects into curricula, whenever possible based on realistic and practically applicable cases. In addition to this, we have recently decided to introduce game playing as an exercise in which students practice their problem solving skills in situations, simulating reality.

In the continuation we describe our implementation of a well-known beer distribution game on mobile devices and its pilot application in a Business Information Systems course at the School of Engineering and Management, University of Nova Gorica. It is an example of interactive group games in which students learn based on role playing. We present our experience and lessons learned and conclude with our plan for further work.

RELATED WORK

The beer distribution game was developed by at MIT Sloan School of Management in early 1960s as a result of Jay Forrester's work on system dynamics [5, 6]. The game was later recognized as a good demonstration of benefits of information sharing, supply chain management and e-Collaboration in the supply chain [9]. As such, it found its way into education [10, 16]. It also serves one of the objectives of the Business Information Systems course at the Engineering and Management study program, as it illustrates the importance of relevant information flows for better decision making.

The basic idea of the beer game is to simulate ordering and shipping products in supply chains. There are four player roles in the game: brewery, distributor, wholesaler, and retailer. Together they constitute a supply chain that supplies beer in quantities that meet customer's demand. The customer typically exhibits a relatively simple shopping

habit; for the first few game rounds the demand is constant *n* beer packs per cycle, then for the rest of the game the demand is slightly increased (*n*+*m* beer packs). For example, for the first five game rounds (referred to as weeks in the game) the customer's demand is 5 beer packs; then it is increased to 9 beer packs per week for the rest of the game. Note, however, that the customer's behavior is not known in advance by the four game players. The objective of the game is to minimize inventory costs of each player. Keeping a beer pack on stock for a week costs one unit. Backorders (ordered beer packs that cannot be delivered from available stock) cost two units per pack per week. More detailed description of the game can be found in [16]. Figure 1 shows the dynamics of orders and shipments between the players of the game. Note that the orders are processed instantly, while the shipments include a transport delay of one or two weeks.

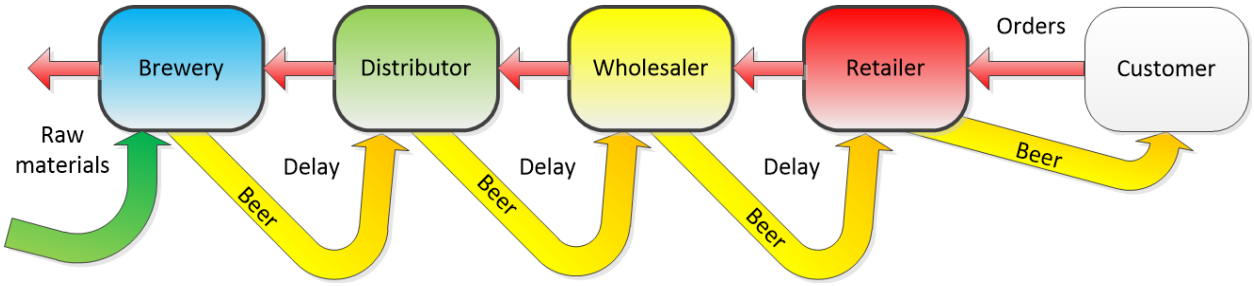

Figure 1: Supply chain roles, orders and shipments for the beer game

Game playing has a strong motivating potential not only for children, but also for adult learners, as discussed in more detail in [14, 2]. In [15] the authors present a thorough review of literature discussing how game-based learning relates to teaching in the classroom. Many authors advocate that learning should be done in context, providing opportunities for practicing newly acquired knowledge in concrete situations. A particular aspect important for our work is learning through role playing, which can be done by using educational games and has been found to be useful for learning of soft skills [8]. Well-chosen games provide a good motivation for repeating the exercise, needed to acquire such skills through practice.

Game playing should be incorporated into the teaching process in an appropriate way, ensuring the necessary and delicate balance between play and learning objectives. In planning the use of educational games we follow findings from the literature and good practice examples. In particular, we take into account work by Garris et al. [7], explaining that a substantial part of the learning is achieved outside the game cycle during reflection and debriefing. This is relatively easy to be planned in the classroom, but becomes an important aspect to be taken into account when we place the game into a mobile setting.

Chen and Denoyelles [1] discuss increasing importance of mobile learning in higher education and give details about usage of mobile devices among students and to achieve as much flexibility and interactivity as possible, we also decided to implement the beer game on a mobile platform.

IMPLEMENTATION DETAILS

The beer game is originally played manually as a board game. To facilitate analysis of the played game Excel is often used as a tool to calculate costs and draw graphs [16]. At the University of Nova Gorica we first implemented a desktop application for playing the beer game. Our application, based on each player's order, automatically calculates all dependent variables of the game (inventory, backorder, costs). The desktop application was designed to support the flow of the game and was implemented in Embarcadero Delphi [3]. The screen shot of the application is shown in the right-hand

side of the Figure 1. In this version, the order data entry of each player (a group of students assigned to play a certain role: brewery, distributer, wholesaler, retailer) had to be completed by the teacher responsible to conduct the game. By pressing the button labeled "Execute one week cycle" after each round, four actions are executed automatically. First, the entered orders of the players are automatically sent and delivered to upstream players in the supply chain. Second, the incoming deliveries of beer units are received. Third, deliveries are prepared and shipped to downstream players. And fourth, the inventory and backorder figures are updated accordingly. The players could then inspect the current standing projected on the whiteboard in the classroom and decide about their orders for the next round. The game is typically played for 40 to 50 rounds. After the end, the final player standings are determined and the recorded players' moves are analyzed and discussed.

The desktop implementation of the beer game has four options that configure the way the information is displayed on screen. These options determine the level of the game detail that is visible to the players. Beer packs in transport (to the left to each player box in the screenshot in Figure 1) can either be visible or hidden. By the same token, incoming orders and outgoing deliveries can be visible or not. The customer (consumer) and his demand can also be shown. Normally, the consumer's role is automatized; as stated in the related work section, for the first few rounds of the game the consumer's demand is 5 packs of beer and is later increased to 9 packs of beer for the rest of the game. However, the desktop implementation enables also manual entry of the customer's orders. Note that with this option additional role of a customer can be introduced in the game.

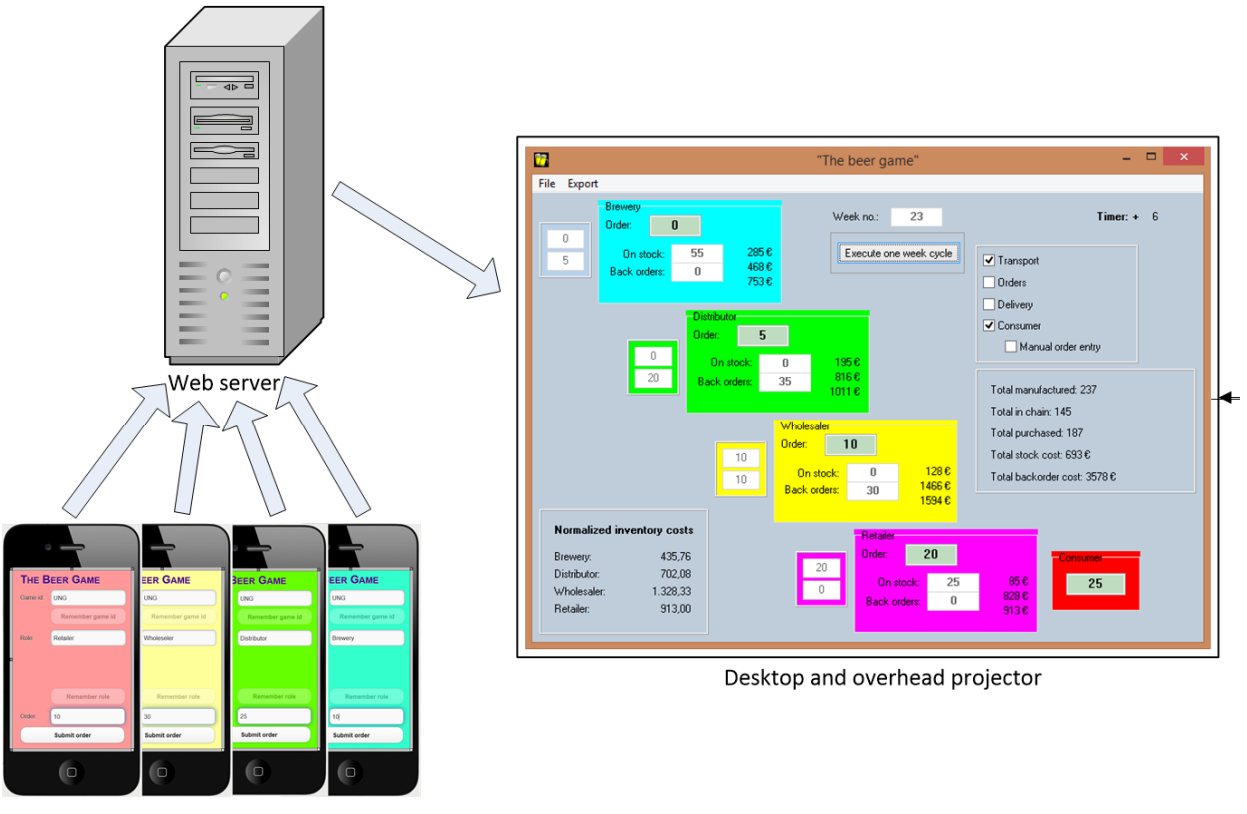

Figure 2: The components and information flow in our implementation of the beer game

One of the shortcomings of the standalone desktop application was the players' orders data entry. This weakness was identified during several games played in the classroom. Each group of students, which played one of the four roles in the game, had

to state their order quantity loud to the teacher who in turn entered the number via the keyboard. The number could be misheard or entered incorrectly, which might have caused unnecessary complications. Also, there was a slight but constant pressure on each student group to come up with a decision in the shortest time possible, sometimes demotivating and distracting the students.

In order to better motivate and engage the students in the game we decided to extend the desktop application with the possibility of remote order data entry that can be executed via mobile devices like smart phones, tablets, laptops, etc. The new flow of information is shown in Figure 2. Each group of students is allowed to enter their order independently using their mobile devices. The entered information is uploaded to a dedicated server and then transferred to the desktop application and instantly displayed on the projected screen, so that the students can check the validity of their entry. When all the player groups enter their orders, the desktop client application disables the information flow from the server and after a short period of time (typically 3 seconds) automatically executes the game round. Consequently, the implemented upgraded beer game can now be played without a teacher's intervention, allowing the teacher to concentrate on observations and comments conducted after the game in a debriefing session.

Implementation on the web server consists of two scripts written in PHP [13]. The first script *beergame.php* implements a user interface for data entry shown in Figure 3. It is implemented using Embarcadero HTML5 Builder [4] and is adjusted to be used on mobile devices like smart phones etc. A user enters *Game id* and *Role*, so that the script knows to whom to assign the submitted ordered quantity. *Game id* is required so that more than one game can be played simultaneously. During the course of the game, in each round the user enters the ordered quantity and submits it to the server by pressing the button *Submit order*. The ordered quantity is then temporarily stored on the web server. The second script named *readdata.php* is used by the desktop application to continuously poll (every 1 second) for the entered data and display the corresponding ordered quantity on its screen.

Figure 3: User interface design in HTML5 Builder [4] for mobile devices data entry

USER EXPERIENCE AND LESSONS LEARNED

The beer game has been played in classrooms during the Business information systems course many times during last four years. From teacher's perspective the game offers a solid ground to discuss several important issues from the course curriculum. For example, it can be demonstrated and discussed how even a relatively simple system can exhibit very complex and difficult to control behavior. The importance of having relevant information at hand when making decisions in the game is also an issue that deserves special attention. Also, the importance of knowing and predicting the customer's habits can be well demonstrated in the class. In addition, the role and benefits of "just-in-time" production without delays in transport can be justified based on the game results.

Besides the topics related to general business informatics themes, the game also offers a possibility to discuss technological issues related to informatics in general. Here, a typical example is the use of mobile devices to support business processes. Required hardware architecture presented in Figure 2 can also be an issue of additional explanations. We observed that even the students with little computer systems background could appreciate and understand the use of components used to build the beer game system.

Since the beer game is a competitive game, the students were highly motivated and engaged to achieve good result. They competed against other roles in the game, as well as against other games played in different classrooms. We found that the students often discussed the past game during the breaks, which rarely happens for other contents of the lectures. In debriefing sessions after the game students pointed out that they appreciate simple setup and complex logics behind the game.

Debriefing sessions offer good opportunities to analyze and discuss completed games and gently introduce other important topics from the course curriculum. To analyze the game results, several prepared graphical visualizations have come in handy [16]. In Figure 4 one of such visualizations is presented, showing the total inventory costs for each role in consecutive rounds of the game.

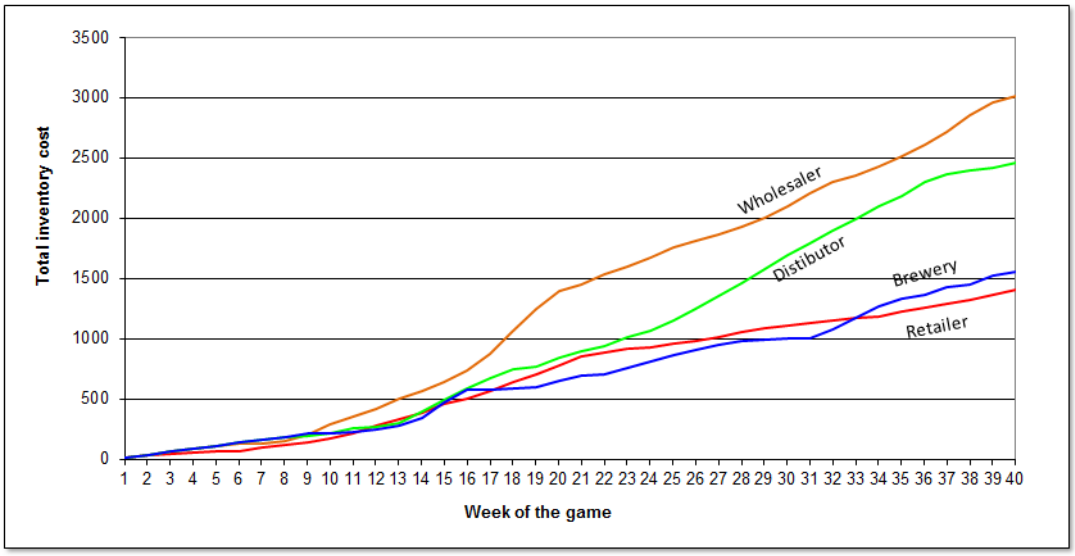

Figure 4: Inventory cost for each player in the beer game

CONCLUSIONS AND FUTURE WORK

In the paper we described our implementation of a well-known beer distribution game on mobile devices and its pilot application in a Business Information Systems course at the School of Engineering and Management, University of Nova Gorica. We presented our experience and lessons learned while playing the game.

In teaching process, game playing has been widely accepted as a suitable learning tool [2]. The most important lesson reported in this paper is that the involved students can better understand the need to obtain and process the relevant information to improve the performance of a business process. The game playing has thus proved to be very efficient for learning the importance of relevant information flows for better decision making.

For future work we consider extending functionality of the mobile application to display additional information (inventory, backorders, and costs) from the beer game. In such way, the game could be played in the classroom without central projected desktop, which could bring additional variability to the game. We plan to make our implementation publicly available for download, since the students often expressed their desire to play the game outside the classroom. We also plan to enable connection to various social networks like Twitter or Facebook, thereby offering the possibility to publish the achieved game results.

ACKNOWLEDGEMENT

The work presented in this paper was partially supported by the ERASMUS project FETCH (Future Education and Training in Computing: How to Support Learning at Anytime Anywhere), project reference no. 539461-LLP-1-2013-1-BG-ERASMUS-ENW.

REFERENCES

[1] Chen, B., A. Denoyelles: Exploring Student's Mobile learning Practices in Higher Education. EDUCAUSEreview online, October 2013. Downloaded from http://www. educause.edu/ero/article/exploring-students-mobile-learning-practices-higher-education on 17 July 2014.

[2] Deen, M., B.A.M. Schouten: Games that Motivate to Learn: Design Serious Games by Identified Regulations. Handbook of Research on Improving Learning and Motivtation through Edicational Games: Multidisciplinary Approaches, 2011, pp. 330-351. IGI Global.

[3] Embarcadero Delphi XE5, http://www.embarcadero.com/products/delphi.

[4] Embarcadero HTML5 Builder, http://www.embarcadero.com/products/HTML5-Builder

[5] Forrester, J.W.: Industrial Dynamics. A major breakktrough for decision makers, Harvard Business Review, Vol. 36, No. 4, 1957, pp. 37-66.

[6] Forrester, J.W.: Industrial Dynamics. Cambridge, MA, 1961.

[7] Garris, R., R. Ahlers, J.E. Driskell: Games, Motivtion, and Learning: A Research nd Practice Model. Simulation & Gaming, Vol. 33 No. 4, December 2002, pp. 441-467.

[8] Klopfer, E.: Augmented Learning: Research and Design of Mobile Educational Games. Massachusetts: The MIT Press, 2008.

[9] Li, M., D. Simchi-Levi: The Web Based Beer Game – Demonstrating the Value of Integrated Supply-Chain Management, 2002.

[10] MIT forum for supply chain innovation. Downloaded from http://supplychain.mit.edu/games/beer-game on 17 July, 2014.

[11] Opening up Education - communication from the Commission to the European Parliament, the Council, the European Economic and Social committee and the Committee of the Regions: http://openeducationeuropa.eu/en/initiative.

[12] OpeningupSlovenia – Nationwide experiment, http://www.k4all.org/openingupslovenia/.

[13] PHP, http://www.w3schools.com/php/php_intro.asp.

[14] Pivec, M., O. Dziabenko, I. Schinnerl: Aspects of Game-Based Learning. Proceedings of I-KNOW '03, Graz, Austria, July 2-4, 2003, pp 216-225.

[15] Pivec, M., P. Pivec: What do we know from research about the use of games in education. In: How are digital games used in schools. Final report, 2009, pp. 121-156. Downloaded from http://games.eun.org/upload/gis-full_report_en.pdf on 16 July 2014.

[16] Riemer, K.: The Beergame in business-to-business eCommerce courses – a teaching report. 21st Bled eConference, Overcoming Boundaries Through Multi-Channel Interaction, June 15-18, 2008, Bled, Slovenia, pp. 588-606.

ABOUT THE AUTHORS

Assoc. Prof. Bojan Cestnik, Temida d.o.o. and Jožef Stefan Institute, Ljubljana, Slovenia, Phone: +386 1236 3350, E-mail: bojan.cestnik@temida.si.

Prof. Tanja Urbančič, University of Nova Gorica and Jožef Stefan Institute, Slovenia, Phone: +386 5 3315 231, E-mail: tanja.urbancic@ung.si.

The paper has been reviewed.