Assessing the Use of Computer Role-play Games in Classrooms

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ABSTRACT

With the advancement of Information and Communication Technology (ICT) in educational settings, simulation role-play games are increasingly being used to replace traditional role-play games. However, it is still unclear whether computer role-play games are effective tools to enhance students' learning process. The purpose of this study is to investigate the extent to which computer role-play games improve students' understanding of the learning material. Two groups of third year undergraduate students from a university in Bahrain participated in this study by playing a manual and computerized role-play game called Beer Game. The first group played the computer Beer Game first and then the manual Beer Game whereas the sequence was reversed for the second group. The findings show that to improve students understanding of the learning material, both role-play games should be implemented in classroom. This study provides useful guidelines and insights to educators interested in adopting these tools in classroom settings.

Keywords: e-learning, Beer Game, role-play game.

Introduction

Role-play games are educational techniques that aim to provide the student with a simplified reproduction of part of a real world or imaginary world (Van Ments, 1999). These games create a system where students play roles in a controlled setting with a particular set of rules (Feinstein, Mann and Corsum, 2002). The use of these techniques helps students relate theoretical concepts taught in class to complex real life situations. More specifically, the

purpose of role-play games is to help students learn the material by focusing on not only 'hearing' and 'seeing' but also 'doing' (Specht and Sandlin, 1991).

Given the benefits of role-play games in facilitating student-learning behavior, it has been used in many fields such as health care (Woodward et al., 1988), mathematics (Lee and Chen, 2009), medicine (Joyner and Young, 2006) and Information Systems (Reimer, 2008). In the past, instructors relied on traditional or manual role-play games to foster students' learning processes. This type of role-play games is where the instructor uses paper, pens, and objects and so on to replicate a system. However, implementing manual role-play games in classrooms becomes tedious because it takes time to organize and set-up the game and requires active involvement of the instructor (Reimer, 2008).

More recently, with the advancement of Information and Communication Technology (ICT), there have been a shift from manual role-play games to computer simulation for use in educational settings because the latter provides visualization and ease of use to foster the learning process among students (DeNeve and Heppener, 1994). However, the literature provides conflicting findings on the influence of computer role-play games on the students' learning process. Some studies contend that computer role-play games in classrooms plays an effective role in enhancing learning (Aubusson et al., 1997; DeNeve and Heppner, 1997; Rendas, et al., 1999), while other researchers have argued that implementation of these technologies in classrooms have limited effect (Kim et al., 2002). Currently, there are limited studies that provide a deeper understanding on how these games promote students' learning process.

The aim of this study is to investigate the use of computer role-play games in improving students' understanding of the classroom material. The main research question of this study is 'to what extent does computer role-play games improve students' understanding of the learning material?' To address this research question, an experimental research was conducted with two groups of students from a university in Bahrain by playing a role-play game called Beer Game. The Beer Game is chosen because it is one of the most widely used role-play game in Logistics, Supply Chain Management and Information Systems and the computer version is being adopted in more than 224 universities from 47 countries (Reimer, 2011).

The next section presents the Beer Game, followed by a brief overview of the variables used to measure students learning. Then, the research method is discussed, which is followed by the analysis of the experiments. Finally, the discussion and conclusion are presented.

Beer Game

The Beer Game is a role-play simulation of a supply chain, which includes four roles, namely the factory, distributor, wholesaler and retailer. The aim of the game is to manufacture and deliver units of beer. The consumer (usually the instructor) drives the game by providing consumer demand on a weekly basis to the retailer and based on the demand, the retailer orders units of beer through two stages (wholesaler and distributor) until it reaches the factory. The factory then manufacturers the products and delivers the units, through three other stages (distributor, wholesaler and retailer) until it reaches the final consumer.

A group of students (two to four) are assigned to each of the four roles in the supply chain. The game runs in weeks (rounds). It starts in week 1 and usually finishes in week 35. Every week, each role places an order and makes deliveries. For example, the distributor's places orders to the factory. The factory then places orders, which become a production order. The game has a two weeks delay, which is also called *lead-time*. When any party places an order in week 1, it will be delivered after two weeks, which is in week 4.

The students in the four roles are not allowed to communicate to each other. They have one objective, to minimize their cost. The cost is calculated by adding inventory carrying cost and back orders (orders that cannot be fulfilled). Inventory holding cost is $ 0.5 per unit of Beer per week and the cost of not fulfilled orders is $ 1 per unit of Beer per week. All back orders must be fulfilled in the following week(s). The only decision that the student in each role makes is the order quantity.

As the game does not allow the parties to communicate, the supply chain members experience a lot of issues such as being out of stock or have over-stock, which adds cost. These issues can be addressed by adopting IS because these technologies improve processes between companies and facilitate information sharing. Therefore, the Beer Game becomes a useful teaching exercise to show students how IS can be used by organizations to have more efficient and effective supply chains.

Manual Beer Game

In the manual Juice Game, students use paper, pens, envelopes and cans to play the game. The table setup for students in each role is shown in Figure 1. Each week, students in each role receive incoming orders and incoming deliveries and send outgoing order and outgoing deliveries. Every week the number have to be filled in a works sheet to calculate the total cost

The participants fill their orders in small paper sheets, put them in an envelope on the outgoing orders slot and the instructor or a teaching assistant moves each envelope to the next party. Similarly, when the students in each role receive incoming deliveries, these numbers are filled in their work sheets, outgoing deliveries are calculated and a paper slip of the quantity is put in a can and placed in the outgoing delivery slot. In addition, the students are made aware of a two weeks delay (lead-time) to receive the orders placed by them (see the two extra fields between the tables in Figures 1 and 2).

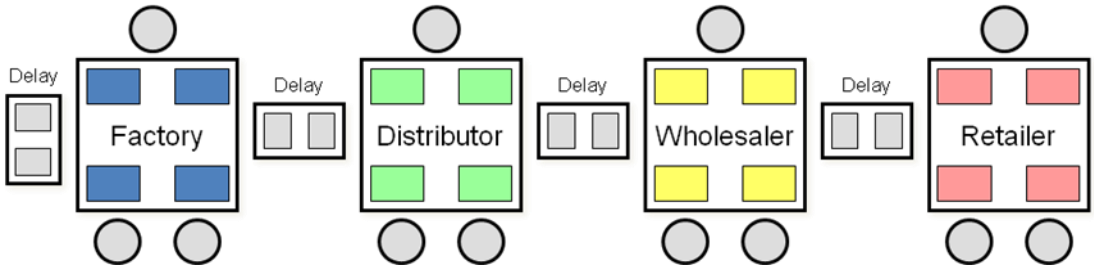

Figure 1: Manual role-play setup (Reimer, 2008)

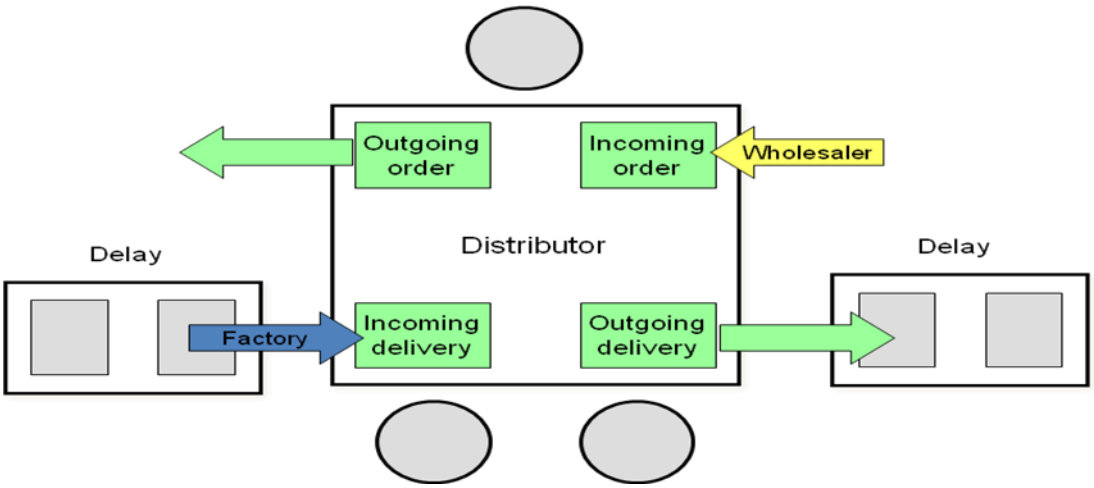

Figure 2: Manual role-play table setup (Reimer, 2008)

Computer Beer Game

The computer beer game has been developed by Kai Reimer and can be downloaded from www.beergame.org. The software is being adopted in more than 224 institutions from 47 countries (Reimer, 2011). The game is in a form of a client-server application. The students log on to the game using their email address and password via a web browser. Once all four roles have logged on, the instructor starts the game from the server. All the orders and deliveries are electronically received and sent. As shown in Figure 3, the students do not

perform any calculations; all the student does is simply decide on the order quantity with the objective of reducing their total cost.

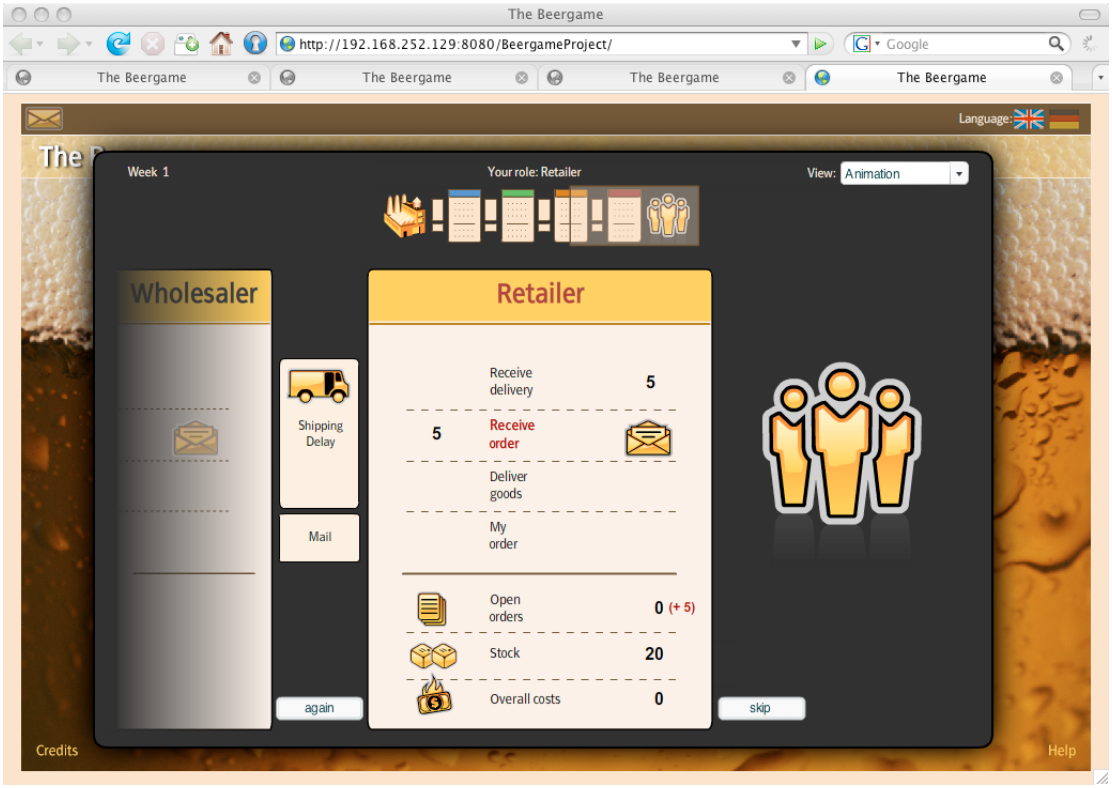

Figure 3: Computer Beer Game (Reimer, 2011)

Measures of students' Understanding of Supply Chain Concepts

This study adopts De Freitas and Oliver (2006) framework on how to evaluate the use of role-play games to determine how learning process takes places. The authors argue that evaluation of the learning process depends on the context of the study, the learner specification, pedagogic considerations and mode of representation (tools for use). In the context of this study, students' understanding is measured by the extent to which students become familiar with the concepts of lead-time, calculations of cost and understanding of supply chains. These three measures are explained below:

Lead-time: It is measured by the extent to which students are familiar with the concept of lead-time and it's impact on the supply chain.

Calculations: It is measured by the extent to which the student is familiar with the calculations to obtain the final cost.

Overall understanding: it is measured by extent to which the students understand the concepts of the supply chains and the need to use IT to managing problems in supply chains.

Research method

This study adopts an experimental research approach because it helps the researcher to bring about a change in a situation, while not influencing the participants. The primary data collection technique used in this study was semi-structured interviews. The data was collected from students taking an E-Business course at the Information Systems Department at a University in Bahrain. These students played the Beer Game (the name was changed to Juice Game for cultural reasons as alcohol is a prohibited drink among Muslims) as part of their course project. Two classes were involved in this study, which formed two experimental groups. The two experiments were conducted in the first semester of 2011. The participants in both experiments were interviewed two times (once after playing each game). All interviews lasted for approximately 15 to 20 minutes. An interview protocol was used as a guide in all interviews. It included questions relating to topics such as students' experiences using the game, understanding of concepts of supply chain and the comparison between both role-play games. The data were transcribed after the interviews and were analyzed by finding common themes through pattern matching logic (Yin 2003) using Nvivo software.

Prior to conducting the experiments, participants were provided with a description of the study. Ten students participated in the Experiment 1 and 11 students participated in the Experiment 2. The students in both experiments were assigned into groups and each group was assigned a role (either a factory, distributor, wholesaler or retailer). The first experimental group started by playing the computer beer game and then they were interviewed after the game. Then in a week time, the same group played the manual beer game and then they were interviewed for a second time. The second experimental group played the manual beer game first and then the computer beer game. This group was also interviewed after playing each game.

The data was analysed by using three indicators (lead-time, calculations and overall understanding of the supply chains). For instance when as student indicated that he/she understood a concept a value 'yes' was given, whereas if a student indicated that he/she did not understand the concept a value 'no' was given. In this way, all three concepts were precisely measured.

Rigour in the study was achieved by following the guidelines as suggested by Yin (2003). In particular, the focus was on construct validity, external validity and reliability. The construct validity was established by having participants reviewing the interview transcripts. External validity was achieved by applying replication logic. Multiple respondents were used to achieve literal replication.

The reliability of the study was achieved by: (a) clearly conceptualizing variables: The variables were clearly conceptualized as they were defined prior to conducting the empirical study; (b) using an interview protocol: An interview protocol was developed and used in all interviews; and (c) maintaining a database: All the interview data was managed within Nvivo.

Experiment 1

In this experiment, the students first played the computer role-play game. They were explained how the game works and the steps to log on to the system. These students were interviewed after the game. Then, in a week time, the same participants played the manual role-play game and then they were again interviewed after the game.

The participants were asked questions to assess their level of understanding of concepts such as lead-time, calculation of cost and supply chains problems and issues. These three were used as indicators to assess the computer and manual role-play games. The value 'yes' indicates an improvement in these concepts, while 'no' indicates that the student did not understand the variable (concept). A summary of the data analysis concerning each of the variables and improvement in the level of understanding of students relating to supply chain concepts is presented in Table 1.

The results indicated that in the computer role-play game only a few students (four out of 10) understood the concept of lead-time. The four participants stated that the lead-time was clear in the game and therefore the value is yes:

> *Yes, the lead-time was obvious in the computer game; I knew it when I played the game.* Participant A

> *Yes, the truck was on the screen, we could see it.* Participant J

However, six participants indicated that they did not understand lead-time in the computer game and therefore have a value of 'no'. Even though the lead-time was explained in an earlier class and shown as an animation on the screen, these participants did not understand the concept. For example the two quotes below explains students' views:

> *I understood lead-time when I played the manual game, in the computer game it was not so clear.* Participant C

In addition, most of the participants (eight out of 10) were not familiar with the formulas of the calculations required in the game and could not understand the cost. This is because the participants did not need to do the calculations in the computer role-play game as all they had to do is to enter the order quantity in the game and the costs were calculated automatically:

> *I like the manual game better because we know what happened, how we calculated the cost. In the computer, we only put the numbers. In the manual, we work more.* Participant D

The two students that understood the calculations from the computer role-play game stated that they had practiced it before the session and had to know the calculations to minimize their cost.

> *I understood the idea from the computer game… The things were moving faster from the computer. Because you explained to us on the computer first when we put the numbers in the sheet we thought we had to enter them but there were already there on the computer but we understood them [the calculations].* Participant J

Table 1. Summary of Experiment 1

Participants	Computer role-play game		Manual role-play game		
	Lead time	Calculations	Lead time	Calculations	Change in understanding of concepts after the manual role-play game
A	Yes	No	Yes	Yes	Improved
B	Yes	No	Yes	Yes	Improved
C	No	No	Yes	Yes	Improved
D	No	No	Yes	Yes	Improved
E	No	No	Yes	Yes	Improved
F	No	No	Yes	Yes	Improved
G	No	No	Yes	Yes	Improved

H	No	No	Yes	Yes	Improved
I	Yes	Yes	Yes	Yes	No change
J	Yes	Yes	Yes	Yes	No change

The data indicates that students after playing the manual role-play game had a better understanding of the concepts of lead-time and got familiar with the calculations. These students explained that because there are delay cans between each group, they are able to understand the lead-time concepts. They could understand the calculations better because they were calculating the costs manually:

> *I think the manual game helped me understand better because when we write the numbers, it is easier rather than put it in the computer… we can see when they [other supply chain members] delivered and receive orders.* Participant H

When the students were asked if they preferred the manual role-play game, most of them recommended both games in class. They stated that in the manual game, they could to understand the concepts of lead-time and calculations and supply chain concepts and then they could easily play the computer role-play game once they got familiar with these concepts.

Summary of Experiment 1

The data from eight participants indicates that students got a better understanding of the concepts of the supply chains after playing the manual role-play game. This finding is inconsistent with findings of some studies in the literature (for example, DeNeve and Harpener, 1997). In addition, these eight students preferred to play both games. They also suggested that the manual role-play game should be played before the computer role-play game so that students get familiar with the important concepts and thus will be able to play the computer role-play game. However, two students believed that the computer role-play game was still sufficient for understanding supply chain concepts.

Experiment 2

Similar to the previous experiment, the participants were explained the aims of the research and given a consent form. The primary purpose of this experiment was to assess (a) students' understanding of supply chains when the sequence of the games is reversed, that is having the

manual role-play game first and then the computer role-play game and (b) whether changing the sequence of the games would provide any new findings.

Similar to the previous experiment, the participants were asked questions to assess their level of understanding of concepts such as lead-time, calculation of cost and supply chains problems and issues. These three were used as indicators to assess the computer and manual role-play games. The value 'yes' indicates an improvement in these concepts, while 'no' indicates that the student did not understand the variable (concept). A summary of the results from the 11 participants is shown in Table 2.

The data indicates that all the students that were interviewed after playing the manual role-play game understood the formulas and calculations completely:

> *Yeah, it [the calculations] was easy. No problems. It's pretty basic accounting* Participant L

In terms of lead-time, three out of 10 students did not realize that the manual game had a lead-time. However, the remaining seven students understood that they would receive their deliveries after two weeks of placing their orders.

> *I was imagining I was living the real situation. I was sending an order. For example, I was ordering products when I had low inventory, so I made the order but I didn't know what I'd get in two weeks and if I would need additional inventory. So I didn't know if I'd have orders or not after two weeks. I felt I was not in a game but working in a real life situation.* Participant K

In addition, the data indicates that all students understood the concepts of supply chains from the manual role-play game:

> *I already understood all this [the concepts] in the manual. It [the computer Beer Game] was not different from the manual game.* Participant P

Table 2. Summary of Experiment 2

Participants	Manual role-play game		Computer role-play game		
	Lead time	Calculations	Lead time	Calculations	Change in understanding of concepts after playing the computer role-play

					game
K	Yes	Yes	Yes	Yes	No change
L	Yes	Yes	Yes	Yes	No change
M	No	Yes	Yes	Yes	No change
N	Yes	Yes	Yes	Yes	No change
O	Yes	Yes	Yes	Yes	No change
P	Yes	Yes	Yes	Yes	No change
Q	No	Yes	Yes	Yes	No change
R	Yes	Yes	Yes	Yes	No change
S	No	Yes	Yes	Yes	No change
T	Yes	Yes	Yes	Yes	No change
U	Yes	Yes	Yes	Yes	No change

Moreover, all participants stated that they preferred to play both role-play games in the same sequence as the experiment. More specifically, the data indicates that participants thought that the manual role-play gives them a good understanding of the formulas, calculations and movement of orders and deliveries. Then, the computer game could be used for execution because it is faster and creates a better structure to the role-play process:

> *In the manual game we were focused on the formula, on the calculations, on understanding flow of products in supply chain, we didn't focus on the order. In the electronic game, we were predicting the demand, how much to order, how much to order the inventory, we didn't focus on the calculations, and we focused on the demand and order.* Participant U

> *I think playing the manual first was helpful before playing the computer game. In the manual we will understand how to calculate, the cost better and then the computer will be faster for playing, the manual game was too slow*. Participant T

Summary of Experiment 2

This experiment shows all students did not have a preference any particular role-play game but preferred to play both role-play games. Students showed a better understanding of the concepts because they played the manual game first and then the computer game. Therefore,

this confirms that playing both games was more beneficial to the students. The manual role-play game should be played first and then the computer role-play. The findings indicate that students regarded the manual role-play useful for practicing the formulas and understanding the concepts and strategies of the game, while the computer-role play was more enjoyable and faster. They do not need to know calculate the cost for each of the 35 weeks in the computer role-play game. The participants thought that a few weeks were sufficient in the manual role-play and once they got the practice and they could use the computer-role play game to expedite the process.

Conclusion

This study examined the extent to which computer role-play games improved students' understanding of the learning material. The results were compared between the manual and the computer role-play games using two groups of students. The findings show that computer role-play games cannot entirely replace the manual role-play games. To enhance students' learning, it may be necessary to play both, with the manual role-play game played first, and then the computer role-play.

In addition, there are inconsistent findings in the literature on the influence of computer role-play games to improve students learning process (Kim et al., 2002). This study provides new explanations on the effectiveness of using both types of role-play games. The manual role-play game could be used at the start of the learning process as students can relate to concepts by seeing objects and doing. Then, the computer role-play game can be used for the faster execution of the game.

Moreover, to the best of the researcher's knowledge, this is the first study that compares between a manual role-play game and computer role-play game to assess students' understanding of the material. Previous studies have compared the use of computer role-play games with traditional lectures or text book learning (DeNeve & Heppener, 19997; Kern, 2000; Kim et al., 2002; Liu et al., 2011). This is problematic as these are two different types of analysis, which creates many confounding variables that may affect these studies findings.

In addition, previous studies have relied entirely on surveys to examine the difference between traditional lectures and computer role-play games (DeNeve & Heppener, 19997; Kern, 2000; Kim et al., 2002). Surveys do not provide rich explanations as to why in some situations the computer role-play game is effective for student learning and in other cases there are no change. In this study, 21 participants were interviewed using a rigorous method.

This provides a richer understanding on the influence of role-play games in classroom settings.

The limitations of this study should be noted. The participants of this study were third year university students. It would be interesting to compare the results with lower level students or postgraduate level students. In addition, in this study the Beer Game was used as a tool to assess the influence of computer role-play game in improving classroom learning. While the findings may be applicable to other role-play games in other domains, the context and variables used to measure students' understanding should be taken into consideration.

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