“Measuring learning motivation of students in supply chain management games setting: a case study of Innov8.0 game”

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SECTION 3. General issues in management

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Measuring learning motivation of students in supply chain management games setting: a case study of Innov8.0 game

Abstract

Information systems play a massive role in measuring, analyzing, improving and controlling educational environment. In this paper researchers evaluated impact of Innov8.0, 3D online game on supply chain management education environment. This study evaluated the effects of game based education rather than traditional classroom on motivation of tertiary level students. To measure the efficiency of educators' reliance on this game to lift students' motivation in learning from games to boost students' motivation in learning, the authors conducted an experimental study and used the Keller's ARCS instruments as motivation measurement inventory. The results indicate significant improvement to motivation of the experimental versus control group. This paper scientifically addresses impact of Innov8.0 as a tool for teaching supply chain management education, discusses data of field tests and finally describes the results.

Keywords: ARCS model, experimental design, computer games, Innov8.0, supply chain management education.
JEL Classification: D83, I23.

Introduction

A digital game offers virtual reality with information, takes instruction from players and draws a set of conditions to play and moves to a succeeding stage. The basic difference between traditional and digital game is instructions are not written into a manual. It is technically instructed into some written code and the aesthetic comes with buttons, navigation pointers and a story line increasing the appeal of playing it. Research suggested a game does not contain items which are related to family and it introduces different levels to users and consists of different features for play (Oblinger, 2006). Nowadays, digital games are not only part of the entertainment, they opened a wide area of research on education, training and human behavior. The term "game" must be defined to explore further potentials and implications of our research. "A game is a system in which players engage in an artificial conflict, defined by the rules, that results in quantifiable outcome" (Salen and Eric Zimmerman, 2004). Computer games engage players in different competitive activities and the story line behind the game is very important for engagement and motivation for players. According to researchers, the objective of computer games is not only for entertainment but can also include various training like education, health and strategic communication (Zyda, 2005).

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According to Juul (2011) several criteria describe a game which are:

- rules;
- goals;
- emotional attachment;
- consequences of game play.

Same researcher argued that the link between digital and non-digital games are the rules themselves that can either be imposed by the human participants or by the computer. Classification of digital games is characterized by several researchers. For the purpose of this research, we can describe computer games based on interactivity, rules, control (Garris et al., 2002; Prensky, 2001; Vogel et al., 2006) and a specific goal (challenge) to achieve (Malone, 1981). Additionally, interaction between game and player offers to observe the progress towards goal by continous feedback through score or level (Prensky, 2001). In the game like SimCity, it allows players to develop a city which leads to their enjoyment without having notion that they are engaging in competition with other players.

The purpose of this paper is not to present a formal definition of either digital games or traditional games, or it is to compare the two. We aim to evaluate a specific game on the domain of learning supply chain management, and how the game interacts with students' motivation in a learning environment.

1. Games and motivation

Several researchers suggested that games like role playing, first person shooting and simulation games can be applied for teaching and learning (Su and Cheng, 2013; De Grove et al., 2012; Moreno-Ger et al., 2008; Kebritchi and Hirumi, 2008). Researchers believed that learning through games boosts students' motivation and assists them to construct knowledge (Liu and Chu, 2010). Prensky (2001) describes how this experience occurs in gamers once they achieve a mental state where there is an optimal match between the challenges presented and the player's ability to solve them. This results in a thoroughly engrossing experience where the motivation to play is so strong it overpowers all other concerns (e.g. players will not feel tired or hungry). Another way, digital games are seen as a source of intrinsic motivation is when a player needs to achieve victory in a state of flow during game play (Ryan et al., 2006). Researchers mentioned that the reason behind engaging in games and not other activities is deriving the flow of experience during game play (Egenfeldt-Nielsen, 2005). Numerous researchers argued that motivation is a highly important feature in teaching and learning (Dick et al., 2005; Keller, 1983; Schunk et al., 2008; Wlodkowski, 1999). Learning topic, timing and style of learning depend on motivation (Schunk et al., 2008). High self efficacy and high level of engagement in learning can be achieved by students who are motivated (Wouters et al., 2013; Miller and Robertson, 2010). The ARCS model is the most widely-used motivational model applied to the design and development of computer-assisted instruction programs (Su and Cheng, 2013; Bai et al., 2012; Papastergiou, 2009) and online learning environment (Astleitner and Hufnagl, 2003; Keller and Suzuki, 2004; Lim, 2004). Applying the ARCS model has also been reported to reduce the attrition rate in distance learning programs (Visser et al., 1999) and improve learners' self-directed learning (Gabrielle et al., 2006).

After ARCS was presented in literature of education, it was extensively adopted in numerous case studies. Further validations are required to do more investigation on games based learning and teaching.

Game based education and its impact on motivation with effect size are given in Table 1 below.

Table 1. Year and effect size

Author	Year	Effect size
Papastergiou	2009	0.41
Anneta	2009	0.81
Wrzensien	2010	0.80
Kebrichi	2010	0.49
Bai	2012	0.30

In this paper we report a study conducted and the lesson learnt on how supply chain management would be evaluated, motivation-wise, by a significant number of students, specifically by asking these student users to evaluate the motivation factors of Innov8.0 game. The investigation aims at assessing not only the capabilities of the game, but also those features of the system that would encourage or discourage students from engaging and be motivated with the game.

2. Digital game: a tool to teach supply chain management

The foundation of supply chain management is based on the supply of raw materials to the final deliverable product. Supply chain management describes how organizations could use and implement technology, capabilities and processes from their suppliers. According to author, supply chain management is a philosophy that covers intra-enterprise activities by integrating business beneficiaries together with a common goal of optimization and productivity (Tan, 2001). Similar definition was found from author Kopczak (1997) who stated that supply chain management means a combination of suppliers, manufactures, distributors and resellers though materials, products and information flow. Research framework, case studies, teaching methods of supply chain management were investigated, specially guidelines and pedagogy in various researches (Johnson and Pyke, 2000; Vollmann et al., 2000). According to Faria (1997), utilization of business games increased over past decade as many evidences were found even at early 70's and 80's in Business Games Handbook (Graham and Gray, 1969) and the Guide to Simulations/Games for Education and Training (Horn and Cleaves, 1980).

Recent research identified the importance of supply chain management course should aim to provide both theoretical and practical knowledge of real world life (Jain et al., 2009). Research also revealed that teaching supply chain management in higher education is very challenging (Vuksic and Bach, 2012). Research also suggested various digital games and software tools to provide efficient and effective learning for students. But behavior of a system and its ability can be measured by simulation modelling. For supply chain management, simulation demonstrates dynamic behavior, for example bullwhip effect variation from supply chain to consumer (Forrester, 1958; and Lee et al., 1997) which was identified in MIT Beer Game (Kaminsky et al., 1999). Finished goods inventory of a product in serial supply chain was illustrated in The Beer Distribution Game (Senge, 1990).

A summary of digital games to teach business process management and supply chain management is given in Table 2 below.

Table 2. Summary of digital games in BPM and SCM

Game	Year	Developer	Purpose	Reference
Beer Game	1960	MIT Sloan School of Management	Bullwhip effect and advnatges on integrated of supply chain management. Simulation of product distribution.	Hieber and Hartel (2003); Goodwin and Franklin (1994); Kaminsky and Simchi-Levi (1998); Jacobs (2000); Kimbrough et al. (2002)
Vensim Simulation Package	1998	Ventana Systems Inc.	Mortgage approval process Loan officer work Surveying on propertiy to check value	Anderson and Morrice (2000); Grossler et al. (2003)
TAC (Trading Agent Competition)	2000	Supply Chain Management Laboratories at Carnegie Mellon University and Swedish Institute of Computer Sciences	Trading agents for effectively coordinating sourcing Procurement, production Customer bidding decisions.	Wellman et al. (2001); Collins et al. (2004); Arunachalam and Sadeh (2004); Wellman et al. (2007)
Mortgage service game	2000	Anderson and Morrice	Design of supply chain management principles	Anderson and Morrice (2000), Akkermans and Vos (2003); Zhou et al. (2008)
Internet based supply chain simulation game (ISCS)	2001	Nigel Wild and Charles Hunt	Purchasing and fulfillment Production planning and production, Regional distribution center (RDC) Local distribution center (LDC), and third party logistics.	Zhou et al. (2008); Merkuryev and Bikovska (2012)
Tiancalli06	2006	Benemérita Universidad Autónoma de Puebla, Mexico	Component purchase system Customer selection system Supplier selection system Inventory system	Galindo et al. (2006)
SBELP (Scenario-Based E-Learning Products)	2008	Siddiqui	The traditional chain The value of information The true market	Siddiqui et al. (2008); Merkuryev and Bikovska (2012)
Blood supply game	2010	Mustafee	Illustration of supply chain management principles in make to stock environment	Mustafee and Katsaliaki (2010); Merkuryev and Bikovska (2012); Tobail et al. (2011)

3. Overview of Innov8.0 2.0 game

In this research, we are investigating the motivational effect on learning using Innov8.0 games. A small description of the game is given below.

IBM Business Process Management (BPM) simulation game INNOV8.0 2.0 provides players (IT and Business) a virtual environment of BPM. This game features an educational environment by asking its users to generate an optimize model for supply chain and make a company profitable. Several other problems on the supply chain will also occur in the game to solve and feedbacks will provide to guide players on the right track. The game is now available at the following link http://www-01.ibm.com/software/solutions/soa/innov8/full.html.

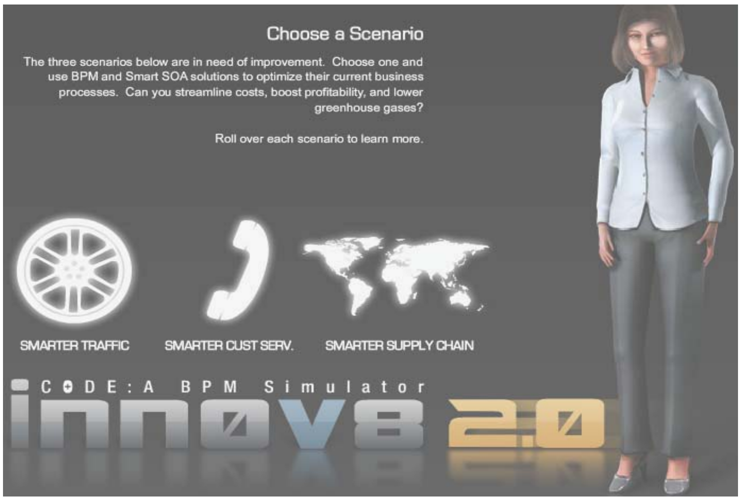
This 3-D simulation game is for teaching business skills to students and business professionals. Players, for example, find out how to eliminate waste while managing a "green" supply chain or improve customer service and maximize profits while running a call center. Compare to other digital games to learn about supply chain, Innov8.0 assists the player to understand the simulation of business strategies and technology management and its impact on company's performance.

According to the official website of Innov8.0, many colleges and universities are already using this game to teach their students. This game was already downloaded by nearly over 2,000 universities from IBM website to be demonstrated in their classrooms. The gap between technology and business was minimized in Innov8.0, by making a bridge between these two disciplines with various events on technology management (see Table 3), it also corresponds non sports events like business operations, but provided an interactive method to train employees.

Table 3. Game modules

Modules	Description
Smarter customer service	This module was designed to test Service Oriented Architecture solutions to improve the relation between client and company. Gameplay also features about efficiencies and performance.
Smarter supply chain	To optimize the supply chain process model, various problems are given in the game play and players need to reshape the basic model to an efficient model to improve companie's performance.
Smarter traffic	BPM skills with real world traffic simulations and handle/reduce the traffic crowding were the main features of this module.

*Smarter supply chain module of the game will be presented in greater details in the chapter of our experiment.



4. Research settings

4.1. Goal and research question. The primary research question of this paper is as follows.

Is the Innov8.0 supply chain management game-based teaching more motivating than traditional teaching methods?

Several authors have already hinted about the impact of games on students' motivation (Bai et al., 2012; Papastergiou, 2009; Wouter et al., 2013). We follow this trend and hypothesize the following:

H1: Students who played games have higher level of attention than traditional group.

H2: Students who experienced games have higher level of confidence in learning than traditional group.

H3: Students who participated on game-based learning have higher level of confidence than traditional group.

H4: Students who played games received higher level of satisfaction than traditional group.

4.2. Experimental design. We adopted an experiemental design approach with a set of two conditions on students learning environment. Control group did not recieve any idea of supply chain management game. The experiemental group received treatment with Innov8.0 game for learning the basics of supply chain. The research was undertaken in an existing course of supply chain management in a well known public university in Malaysia. Our sample size was 60 (30 in control and 30 students in experimental). Distribution of group and gender is shown in Table 4 below.

Table 4. Frequency distribution of participants

Gender	Group 1 (experimental)		Group 2 (control)	
Male	13	43.3%	7	23.3%
Female	17	56.7%	23	76.7%
	30	100%	30	100%

The diagram (Figure 1) represents the research framework.

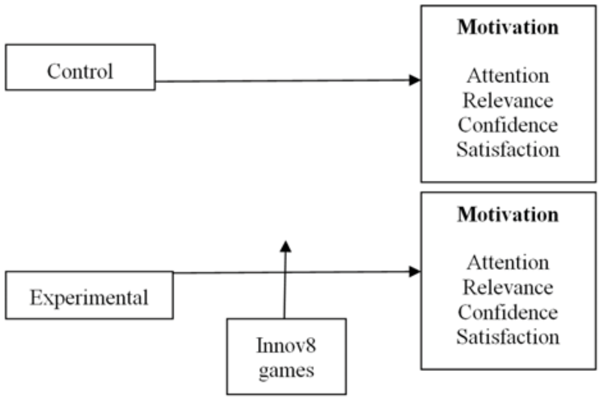


Fig. 1. The research framework

4.3. Measurement of motivation. The Instructional Materials Motivation Scale (IMMS) has 36 items of Keller's contains 36 items. Relevance and Confidence constructs have 9 items each. Satisfaction construct has 6 items and Attention consists of 12 items. Response scale ranges from 1 to 5. As a result, minimum score of IMMS is 36 and the highest is 180. To response of our hypotheses, we added the value to each four subscales for both control and experimental group. Item allocations for each construct are given below (Table 5).

Table 5. Item allocations in each construct

Attention	Relevance	Confidence	Satisfaction
2	6	1	5
8	9	3 (reverse)	14
11	10	4	21
12 (reverse)	16	7 (reverse)	27
15 (reverse)	18	13	32
17	23	19 (reverse)	36
20	26 (reverse)	25	
22 (reverse)	30	34 (reverse)	
24	33	35	
28			
29 (reverse)			
31 (reverse)			

Results of effect size were calculated by

Cohen's $d = M1 - M2 / s_{pooled}$,

where $s_{pooled} = \sqrt{[(s_1^2 + s_2^2) / 2]}$

M1 = mean value of result of experimental group;

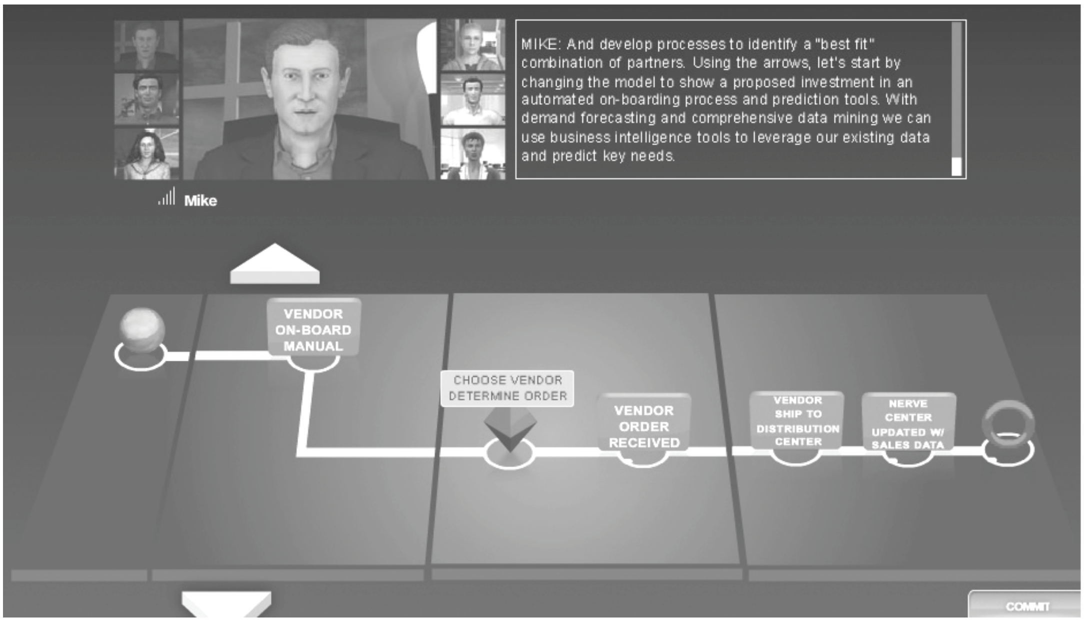
M2 = mean value of result of control group;

S1 = standard deviation of result of experimental group;

S2 = standard deviation of result of control group.

4.4. Task scenario. At basic setting, begin with some case studies adopted from Innov8.0 supply chain management game. For control group, the case study was taken from the scenario of the game.

Scenario 1:

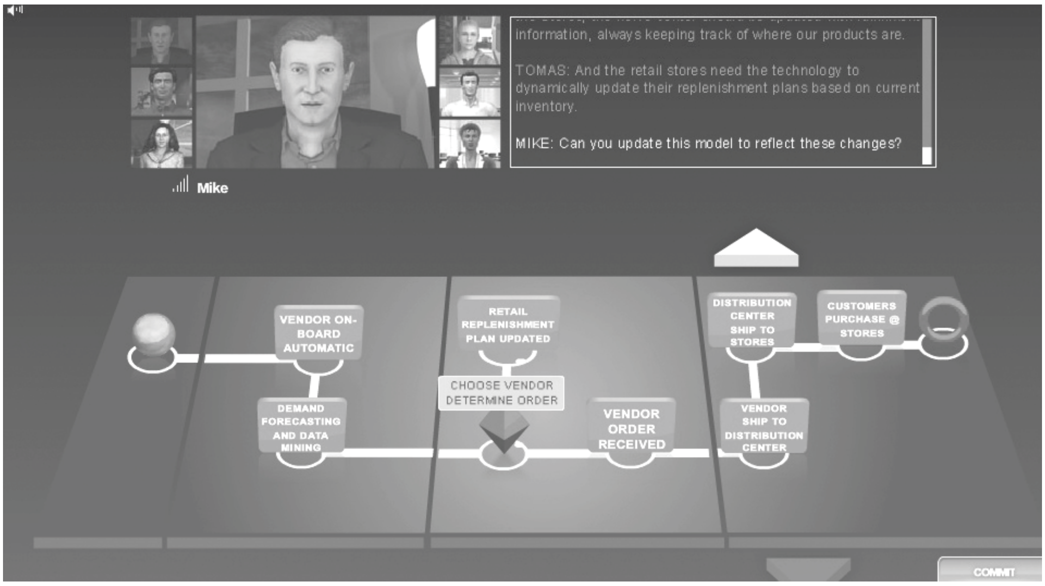


Manager of the company was facing a problem – it takes too a long time to bring new vendors; they were entering huge volume of data by hand. As a result, company needs to create a global ecosystem of partners to deliver customized solutions the customers need. In the first scenario, manager asked player to change the model in order to show a proposed investment in an automated on boarding process.

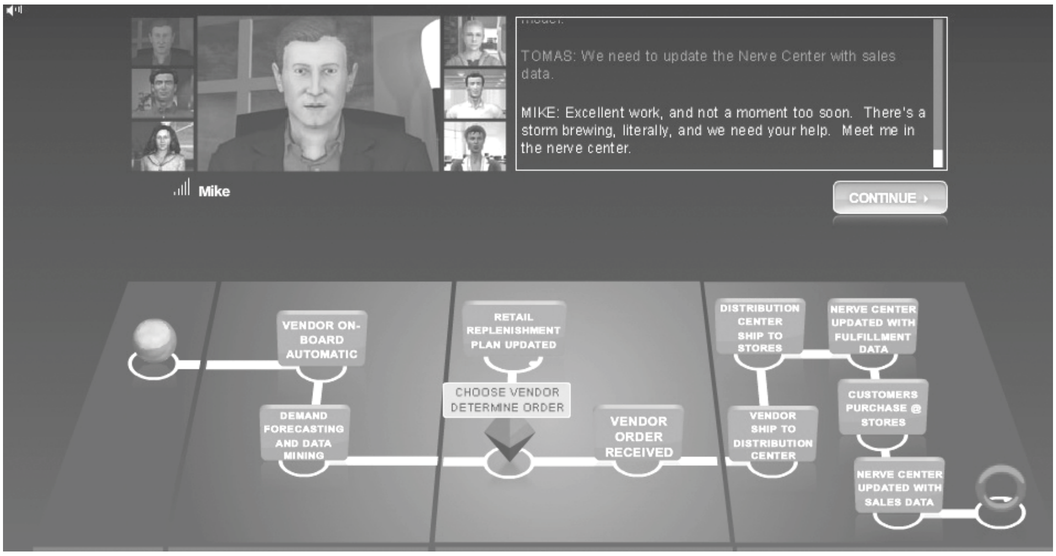
Scenario 2:

Manager asks the player to develop a tool to predict customer lifestyle and forecast the key needs. As a consequence, he needs to integrate the data of a nerve center so that they can work from a central dashboard. This is to allow the entire chain to know where the products are in the pipeline. According to manager, an internal nerve center that houses rules to automate and update refreshment plans so he will ask the player to update the model to reflect the changes.

Scenario 3:



As the item shipped from the distribution center to stores, fulfilment information about track of their products needs to be updated by the server center. The retail store also needs the technology to dynamically update their plans based on current inventory. The manager asked the player to update the model to reflect the change. After finishing each step, student will get a final model which will solve the problem faced by that organization.



In each step, students will receive feedback which will guide them to select the right model for the solution.

Three solutions were given for each scenario on paper (control group) and in the games (experimental group). They were called upon to select the correct answer. The control group did not get any graphical content of the case study, they only received a sketch of the current supply chain model. On the other hand, the experimental group received the games to play and discover the correct solution for that problem with an interactive feature. After successfully completing playing the game, all students were asked to answer questionnaires adopted from Keller's Motivational Scale. In the next step, we run an independent sample t-test to analyze our results.

5. Data analysis and result. Reliability analysis for each constructs are shown in Table 6 below. For higher reliability, researchers removed item C2 and item C4. All constructs' items reliability are more than 0.70 which represents our items are high reliabile to measure constructs (Carmines & Zeller, 1979; Nunnally and Bernstein, 1994; Bland and Altman, 1997; DeVellis, 2003; Sekaran and Bougie, 2010).

Table 6. Reliability analysis

Scale	Cronbach Alpha
Attention	0.84
Relevance	0.90
Confidence	0.71 (Item C2 and C4 deleted)
Satisfaction	0.86

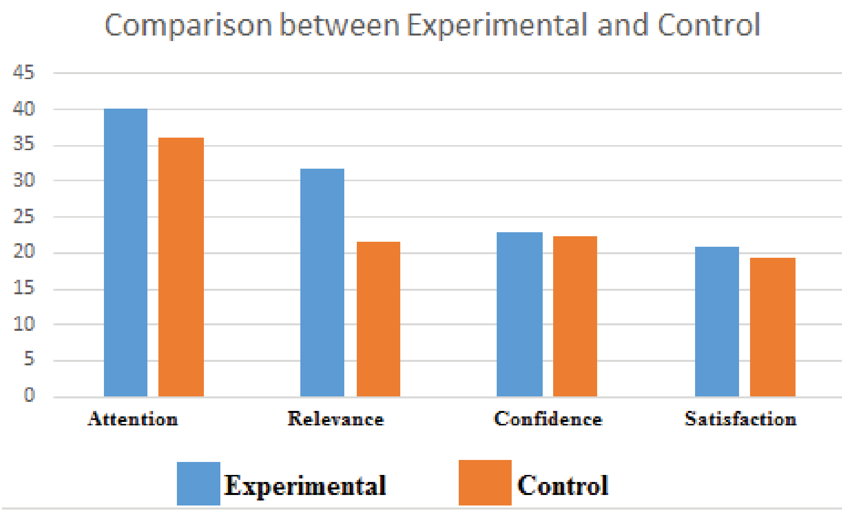


Fig. 2. Graphical representation of mean values

Figure 2 shows the graphical representation about mean difference between experimental and control group on four constructs of ARCS. Table 7 includes details infomation of overall perfomance measurement of two groups.

Table 7. Mean and standard deviation

	Group	Sample	Mean	SD
Attention	Experimental	30	40.20	6.71
	Control	30	36.10	5.50
Relevance	Experimental	30	31.66	5.62
	Control	30	21.66	5.66
Confidence	Experimental	30	22.90	4.01
	Control	30	22.43	2.56
Satisfaction	Experimental	30	20.93	4.02
	Control	30	19.20	3.88

Table 8. Comparison of the two groups with regards to attention

Mean difference	t-value	df	p value	Effect size
4.1	2.587	58	0.012	0.66

In Table 8, p value is less than 0.05, this indicates our results have strong evidence to reject the null hypothesis. The positive effect size shows that game-based learning provides more attention to the students compared to traditional lecture.

Table 9. Comparison of the two groups with regards to relevance

Mean difference	t-value	df	p value	Effect size
5.00	3.42	58	0.001	0.88

The analysis of data shows (see Table 9) that, the probability of null hypothesis is less than 0.05 which is very strongly statistically significant to reject the null hypothesis. These results can be explained that students exploring game-based learning is much more relevant than traditional lecture.

Table 10. Comparison of the two groups with regards to confidence

Mean difference	t-value	df	p value	Effect size
2.46	2.83	58	0.006	0.78

In Table 10, the results show that difference of confidence level between two groups is strongly statistically significant as p value is less than 0.05. The evaluated results from the survey show effect size difference is 0.78 which is massive and positive. As a result we can conclude that after playing games, students from experimental group are confident enough about their subject matter.

Table 11. Comparison of the two groups with regards to satisfaction

Mean difference	t-value	df	p value	Effect size
1.73	1.69	58	0.096	0.43

From the result of t-test between control and experimental group about satisfaction (See Table 11), it was found that p value is greater than 0.05 but less than 0.1 which means it is highly unlikely to reject the null and we could conclude there is very weak evidence that the level of satisfaction of game playing group is higher than traditional group.

6. Limitations

The limitation of our paper is the sample size and the large differences in numbers between male and female participants. Due to limited time and student enrollment of this course, we could not reach more students in this research. However, this research can be used for hypothesis development for further exploration about the impact of supply chain management game. Though in our research, frequency of female participants is higher than male students, several researchers mentioned in their research that there is no influence by gender on game-based learning (Ke, 2009; Papastergiou, 2009). This issue was contradicted from other author's research (Klawe, 1999). In our case, we ignore the impact of gender differences in our research. In future, we aim to investigate the relation of ARCS motivation and actual learning achievement of students by playing this game.

Conclusion and practical implication

The outcome of our paper indicated strong significant impact on students' attention, relevance, confidence and a weak significant impact on students' satisfaction. Our results supported with various researches of game-based education show impact on students' motivation that digital game-based education potentially seems to increase students' motivation boosting the subject matter rather than the traditional classroom education (Bai et al., 2012; Kebrichi and Hirumi, 2010; Olson, 2010; Papastergiou, 2009; Li and Kuo, 2007). Our findings suggest that the simulation Innov8.0 games can be effective tools in assisting students understand difficult scenarios of supply chain. Educational games need not necessarily rival commercial entertainment games in production value to gain students' interest, although weak appeal in design on games interface may lead to boredom to students (Squire et al., 2000).

Our data indicate, this game can be used to teach the basics of supply chain management for undergraduate students. We hope, this paper will draw attention to this emerging and important area of instruction, and will motivate studies on supply chain that will allow us to more finely analyze the effects of this game-based teaching approach.

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