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Enhancing Information Systems Teaching Practices with Game-Based Learning: The Melbourne Beer Game

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Enhancing Information Systems Teaching Practices with Game-Based Learning: A Case Study on the Melbourne Beer Game

Full research paper

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Abstract

The literature has recognised the value of the Beer Game simulation program in teaching and learning supply chain management (SCM) concepts. However, existing Beer Game programs were developed with outdated technologies with limited supporting resources. This study aims to identify improvement opportunities to enhance the Beer Game features, develop a new game called the Melbourne Beer Game using the latest web technology and offer detailed lesson plans that adhere to game-based learning principles. This paper offers a contribution to academia by providing a feature-rich and flexible game that can facilitate teaching and learning of the intricacies of supply chain dynamics and the decision-making process within the supply chain. To pedagogy literature, this paper shows that the development of teaching guidelines that align with a specific learning approach, such as game-based learning, is crucial to facilitate the teaching and learning with the Beer game to ensure optimum learning outcomes.

Keywords: supply chain management, beer game, teaching practices, game-based learning

1 Introduction

The field of supply chain management (SCM) is diverse and draws together multiple disciplines, including information systems, logistics, and human resources management (Jüttner et al. 2003). The COVID-19 pandemic has also provided a contextual background for the criticality of this multidisciplinary approach to managing supply chain risks. However, studies have shown that teaching SCM and its multidisciplinary nature is important yet challenging (Vanany and Syamil 2020). The complexity of the SCM field due to the back-end nature of many SCM processes and technologies (Connolly and Stansfield 2006) inhibits tertiary educators' ability to expose students to SCM knowledge. Therefore, it is difficult for students to envision the dynamic nature of multiple factors affecting supply chain performance, the interactions that occur between supply chain parties, and the balance that must be achieved to elevate performance (Lawrence et al. 2019).

Technologies can help this process by simulating the supply chain's intricacies (Vanany and Syamil 2020). A computer and Internet-based business simulation approach in which each student assumes the role of a firm such as a retailer, wholesaler, distributor, or factory in a supply chain has received attention from researchers and SCM educators for several decades. One of the most common SCM simulations is the Beer Game developed in the 1960s (Kaminsky and Simchi-Levi 1998). The objective of the game is to give students first-hand experiences with the bullwhip effect resulting from inaccurate demand, sensing the value of information in dampening the effect (Hieber and Hartel 2003). Research provides evidence that playing the Beer Game has successfully provided students with a greater understanding of SCM concepts (Hieber and Hartel 2003; Parker et al. 2007).

While the value of the Beer Game in teaching SCM concepts has been well documented in earlier literature, our review identifies exciting improvement opportunities in two areas. First, while the SCM literature has investigated the use of the Beer Game to understand the challenges in managing the supply chain (Lawrence et al. 2019), limited studies have investigated the usefulness of the Beer Game in enhancing students' understanding of the complexity in the decision-making process in each firm. This is mainly because of the limited user interface of the earlier Beer Games that focuses on portraying the situation of the entire supply chain (Roser et al. 2021) instead of visualizing the data to facilitate the data-driven decision-making process in each firm. Therefore, improvement in the Beer Game dashboard to support teaching and learning of data-driven decision-making, particularly for the experimentation of different ordering policies, is needed.

Second, while the SCM literature has also provided educators with various teaching practices when using the Beer Game to teach SCM concepts to students, most of those guidelines were developed in the context of conventional face-to-face workshops (Lau 2015; Sparling 2002). In the wake of the COVID-19 pandemic, there is an increasing prevalence of blended and remote learning (Chen et al. 2022). One of the popular pathways is to engage learners with the game-based learning approach (Chan et al. 2021), which has proved to be beneficial in enhancing learning (Howard-Jones and Jay 2016; Plass et al. 2015). Therefore, there is an opportunity to develop a web-based version of the Beer Game and complement existing Beer Games by developing teaching guidelines in the context of blended and remote learning that adhere to the game-based learning principles to enhance the learning outcomes.

To address the current knowledge gaps, this study aims to develop a new Beer Game user interface that facilitates the learning of decision-making process in each firm and offers detailed lesson plans that adhere to game-based learning principles for teaching with the Beer Game in a blended and remote learning environment. This study offers a modest contribution to the literature on the practice of teaching SCM to students in tertiary education.

In the following sections, we provide a brief literature review, present the new Melbourne Beer Game, and outline the proposed teaching guidelines. We then present the evaluation of the Melbourne Beer Game based on a user testing session with students at an Australian university and conclude with recommendations for future studies.

2 Literature Review

2.1 Constructivism Paradigm and the Beer Game

Baruque and Melo (2004) mention three epistemological views of learning, namely behaviourism, cognitivism and constructivism. The constructivism paradigm acknowledges that there are multiple meanings and perspectives outside of educators' view, and there are multiple ways to acquire an understanding of reality (Lainema 2003). Within this epistemology, learning occurs during the interaction between individuals and reality through experiences to jointly construct knowledge

(Lainema 2003). In this perspective, educators do not disseminate knowledge through instruction but rather through facilitating the development of skills related to knowledge construction and interaction during the knowledge construction by students themselves. However, the constructed knowledge is not automatically considered valid knowledge. Educators contest it with alternatives and judge the newly constructed knowledge based on its viability (Duffy and Cunningham 1996).

In a similar vein to the constructivism paradigm, experiential learning theory (Kolb 1984) posits that the most powerful adult learning occurs when learners have direct experience by taking action and reflecting on the outcomes (Kolb 1984). An experiential learning approach receiving increasing attention by researchers and SCM educators is the use of business simulations which aim to help students experience the dynamic nature of supply chains and their information and material flow (Hieber and Hartel 2003; Sparling 2002). Such approaches to education are often employed by SCM educators. This is because business simulations can provide a more authentic, life-like context in which students can explore, construct new knowledge and learn by doing (Cybulski et al. 2006). In this perspective, the popularity of the Beer Game can be attributed to its effectiveness in facilitating an experiential learning approach to learning SCM concepts.

2.2 The Beer Game: Development and Challenges

In the last two decades, supply chain management scholars have contributed to the development of the Beer Game. A full-text review of 11 highly relevant papers is conducted. Some key findings are presented in Table 1 and Table 2. A seminal article on this topic is Kaminsky and Simchi-Levi (1998), which elaborates on the limitation of the Beer Game developed by MIT in the 1960's in teaching supply chain management concepts. Consequently, Kaminsky and Simchi-Levi (1998) proposes a computerised Beer Game with three advanced options to simulate supply chain practices, namely the global information option (i.e., visibility in all chains), centralised option (i.e., all chains managed by one entity), and short lead time. This paper is a cornerstone of the Beer Game development that links computerised game features with the concepts of Bullwhip effect, Centralisation effect, and Lead time effect on supply chain dynamics (Kaminsky and Simchi-Levi 1998). Following that, Reyes (2007) extends the Beer Game by introducing a parallel interaction feature. In this extension, each supply chain segment (i.e., retailer, wholesaler, distributor, factory) consists of more than one entity. The game becomes more realistic as a buyer often liaises with multiple suppliers and involves in rationing and gaming effects within the supply chain (Reyes 2007). In the following decade, Lau (2015) exploits the Beer Game design and comes up with the idea that all supply chain members can communicate with each other to design and execute strategies in facing demand volatility. This modification illustrates the concept of "global optimisation" in the supply chain and reflects "real" situation where all supply chain members are interacting formally and informally (Lau 2015). Next, Sarkar and Kumar (2016) introduce the disruption part, demonstrating how supply chain disruption can propagate along the chain. Finally, Roser et al. (2021) makes a major overhaul of the game by modelling and teaching additional effects of supply chains such as the different countermeasures like pull system, better communication, and reduced replenishment time. It can also model the increased fluctuations due to the introduction of additional variants besides beer (i.e., wine) and their impact on the necessary inventories and levelling strategies.

While these new developments in the game provide a better understanding of various phenomena and SCM-related concepts, there are some technical difficulties in these different versions of the beer game. For example, an early stage of computerised beer game might limit social interaction as it is played virtually and individually without any chance for players to communicate (Kaminsky and Simchi-Levi 1998; Reyes 2007), except in the game by Lau (2015). The parallel interaction feature developed by Reyes (2007) also makes it challenging to manage and administer the game as the number of players is increased significantly. In addition, most of the development in the last decade focuses on portraying the situation of the entire supply chain after a specific intervention or disruption (Roser et al. 2021; Sarkar and Kumar 2016). Hence, there is a development opportunity to enhance the earlier Beer Games to not only illustrate the behaviour of the supply chain but also to simulate the data-driven decision-making process of each firm in the supply chain. It aligns with (Wamba et al. 2018) that highlights the importance of swift decision-making in a dynamic environment as an SCM-related concept that should be acquired by students and professionals. The earlier Beer Games do not sufficiently facilitate and emphasise this aspect (see Table 1). This is mainly because the user interface of the earlier Beer Games focuses on portraying the situation of the entire supply chain (Roser et al. 2021) instead of the data-driven decision-making process in each supply chain member. Most importantly, most of the earlier Beer Games have been developed using outdated technologies and cannot support teaching and learning in a blended and remote environment. The Melbourne Beer Game proposed in this study is intended to address the limitations of these earlier Beer Games.

	Game Features								
Article	Visibility in the supply chain	Centralised supply chain	Short-lead time	Parallel-interaction supply chain	Communic ation strategy	Pull system strategy	Product variants	Leveling strategy	Disruption impacts
Kaminsky, P., & Simchi-Levi, D. (1998)	X	X	X						
Reyes, P. M. (2007)				X					
Lau, A. K. (2015)		X	X		X				
Sarkar, S., & Kumar, S. (2016)									X
Roser, C., Sato, M., & Nakano, M. (2021)			X		X	X	X	X	

Table 1 Synthesis of Beer Game development

	Teaching Approaches						
Article	Readings	Debriefing	Lectures	Tutorials	Discussions (guided or non-guided)	Student's report	Student's presentation
Jackson, G. C., & Taylor, J. C. (1998)		X		X			
Sparling, D. (2002)		X	X		X		
Reyes, P. M. (2007)	X	X			X		
Lau, A. K. (2015)	X	X	X	X	X	X	X

Table 2 Synthesis of teaching approaches

2.3 The Beer Game and Teaching Practices

Apart from the game development, it is also important to understand how the Beer Game is utilised in teaching activities. Particularly, it is important to understand the effective teaching approaches that incorporate Beer Games as educational tools. In the literature, Jackson and Taylor (1998) elaborate on the importance of walking through the players during the game (i.e., tutoring activities) and a debriefing process to convey the learning points to all participants after the game. Sparling (2002) then complements the teaching approach by including a lecture session prior to and after the game using designated supply chain teaching modules. This modified approach is proven to be effective in enhancing the effectiveness of learning using the Beer Game. Later on, Reyes (2007) takes a more proactive approach by providing essential readings for students or executives who will participate in the game before the session. This strategy reduces the time needed for the initial lecture sessions. Finally, Lau (2015) integrates all elements and proposes two initiatives, namely student's report and presentation after the game. These initiatives give a chance for students to reflect on their learning process and share and acquire more knowledge through interaction with other students during the presentation (Lau 2015).

While all these papers have outlined their complete learning and teaching approaches (Table 2) we argue that there is still an opportunity to enhance their teaching approaches to ensure the effectiveness of learning using the Beer Game. The majority of these guidelines are developed in the context of conventional face-to-face workshops (Lau 2015; Sparling 2002). There is an opportunity to enhance the current teaching approaches to suit the trend of blended and remote learning (Chen et al. 2022) and adhere to the constructivism paradigm and the experiential learning approach (Kolb 1984; Lainema 2003). Specifically, the Beer Game enables game-based learning as a form of experiential learning (Sugahara and Lau 2019) which is widely documented to enhance the learning performance and outcomes through affective (e.g., enjoyment), cognitive (e.g., cognitive load), and behavioural (e.g., intention to participate in learning) mechanisms (Koivisto and Hamari 2019; Sailer and Homner 2020). Therefore, apart from developing the Melbourne Beer Game with improved features, this study also intends to develop a set of teaching guidelines based on sound pedagogical principles (i.e., constructivism ➔ experiential learning➔ game-based learning) that can be applied in the tertiary education setting.

3 The Melbourne Beer Game

The development process of the new beer game and its teaching bundle consists of three phases, namely (1) the requirement gathering and design, (2) the software development, and (3) the design of a set of exemplar lesson plans. In the first phase, we identify specific requirements of the game and design the game with additional features and the latest web technologies to overcome the limitations of various versions of the Beer Game. In the second phase, we develop the software (i.e., user management module, game user interface module) and perform user tests and bug fixing. In the third phase, we develop a set of exemplar lesson plans based on a Game-based learning approach for teaching with the game.

3.1 Features and User Interface for Simulating Decision-Making Processes

Overall, the Melbourne Beer Game has all the major features of the previous Beer Games as shown in Table 1. It is particularly unique in terms of the ease of use with teaching and learning features, and the user interface for stimulating students in learning the data-driven decision-making process in the supply chain in addition to displaying the situation of the entire supply chain (Roser et al. 2021). Relevant to the first one, the Melbourne Beer Game is easy to set up and simple to teach. For example, a new game can be created by simply copying the settings of an existing game. Consumer demand can also be easily auto-generated based on predefined patterns with added random noise. Learning outcomes can be shown to students before the start of the game. Finally, the supply chain is displayed graphically to students and information about a supply chain is shown intuitively on a graphical supply chain.

Specific to simulating the decision-making process in the supply chain, the Melbourne Beer Game is equipped with a "dashboard-like" user interface, as in Figure 1. The game data is presented to students both in tables and charts to simulate a more realistic business scenario of management decisions using a dashboard. For example, whenever an order comes in, the order and inventory charts will be updated to facilitate a holistic view of the firm's current capability in fulfilling the order from the downstream supply chain and decide on the tactical strategy to maintain that capability by putting subsequent order to the upstream supply chain. The cost chart also enables students to assess the consequences of each decision that has been made and consider those consequences for the upcoming decisions. A reminder can be configured to pop up to remind students to make their order submission after a preconfigured

time e.g. 2 minutes each round, to simulate the importance of swift decision-making (Wamba et al. 2018).

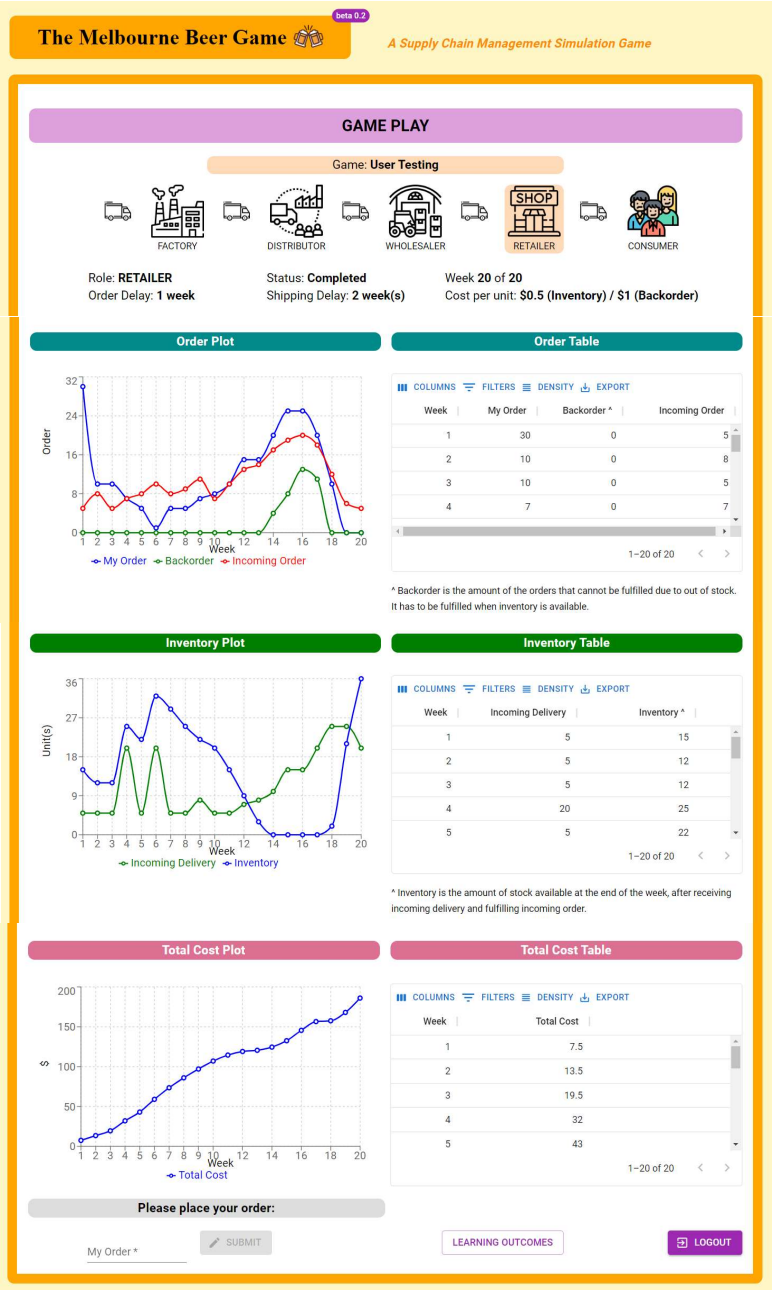

Figure 1 User Interface of the Melbourne Beer Game

In addition, the progress of all running games will be displayed on a single screen on the game administration page, refreshing every 5 seconds. This interface captures the dynamic of the supply chain whenever a critical decision, such as putting in an order, has been made by any supply chain member. The result of a game can be shared with students using a generated web page URL. Students can also download all the game data from the online result page as CVS files for their analysis after class. Therefore, we believe that this brand-new interface provides a learning avenue for the intricacies of decision-making within the supply chain which are rarely captured in the previous versions of the Beer Game (Sarkar and Kumar 2016; Roser et al. 2021).

3.2 Teaching Guidelines

In the teaching guideline development, we first consult with the main principles of Game-based learning and ensure that all elements are available within the Melbourne Beer Game. Plass et al. (2015) considers that games for learning should have a basic structure of three key elements such as (1) a challenge, (2) a response, and (3) feedback. Within the game, the challenge is reflected in the time-restricted decision-making process or thinking to put order to the upstream supply chain in consideration of the demand, inventory, backorder and shipping information. The response part is a continuation of the challenge as students have to respond by submitting order quantity to the upstream supply chain in the game interface as the outcome of their decision-making. Finally, the feedback element is represented by the resulting cost of their decision on the order quantity submitted. Thus, the new Beer Game addresses the three key elements of game-based learning.

In the next stage, we develop the teaching guidelines that are oriented to the Beer Game. According to Juul (2011), games have six necessary and sufficient features: (1) rules, (2) variable and quantifiable outcomes, (3) values assigned to outcomes, (4) player effort to influence outcomes, (5) player attached to outcomes, and (6) negotiable consequences of activities. Based on these items, when teaching with the Melbourne Beer Game, it is essential that students clearly understand: (1) the rules of the game, such as the scenario of the game and what information is available to them, (2) how the cost per week is calculated based on the inventory and backorder level, (3) winning the game is to minimize the total cost, (4) how their order decisions will affect the total cost, (5) the game facilitates fun and engaging learning experience, and (6) playing the game is part of an assessment task of their learning.

To further clarify the above points, we develop a five-stages teaching practice (Figure 2) that can be applied in a blended and remote learning context to teach SCM concepts via our web-based Beer Game. In this case, we design the teaching practice for Business-to-Business Electronic Commerce subject that is offered to Master of Information Systems students. The learning outcomes are (1) appreciate supply chain dynamics, (2) describe the effect of transportation delay and information sharing on supply chain management, (3) explain the causes and impact of Bullwhip effect, and (4) identify initiatives to mitigate the Bullwhip effect and increase supply chain performance.

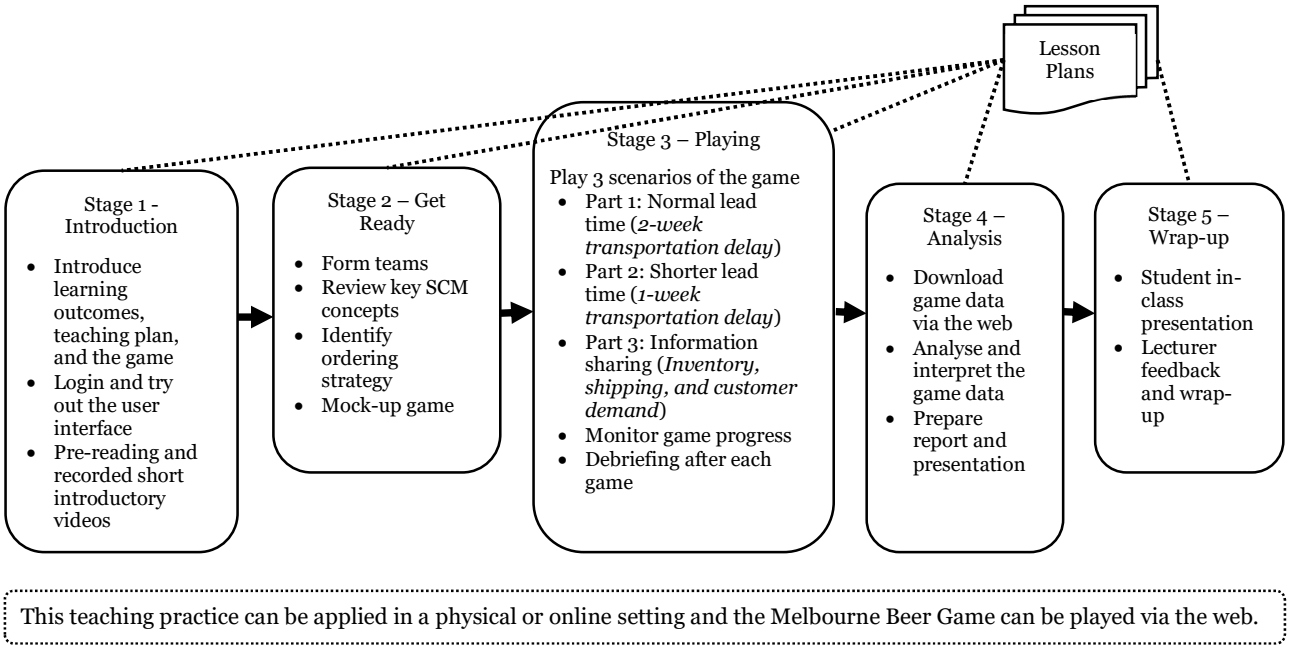

Figure 2 A Five-Stage Teaching Practice for Blended and Remote Teaching

Here is the five-state teaching practice designed based on Lau (2015) and Roser et al. (2021).

- In stage 1 – introduction:

  - Students are introduced to the learning outcomes, teaching plan, and game. They will log in to the game and try out the user interface. Pre-reading and recorded short introductory videos should be provided to students 1 week earlier.

- In stage 2 – get ready:
  - Students will form teams and play a mock-up game to gain a clear understanding of the game rules and user interface. Research in game-based learning shows that the goals and rules of the game should be provided explicitly and early (Federoff 2002). Key SCM concepts will be reviewed to ensure that students have sufficient prior knowledge to learn from the game, which is essential for effective learning according to constructivism (Pritchard 2013). They are also guided to identify their ordering strategy for the game.

- In stage 3 – playing:
  - Students will play the game under different scenarios to experience the bullwhip effect and the different factors in play. Lau (2015) and Roser et al. (2021) demonstrated that playing the game multiple times under different scenarios could offer students opportunities to experiment, experience, and reflect to gain a more in-depth understanding. The game will be facilitated by a tutor experienced in game-based learning and blended and remote learning. The tutor can use the game administration page to monitor the progress of all running games via the web. After each game, students are guided to reflect on the game experience and re-examine their strategy for the game as reflecting on the experience is essential to turn it into knowledge and skills (Lau 2015).

- In stage 4 – analysis:
  - Students will analyse and interpret the game data, which can be downloaded from the game via the web, and prepare their report and presentation.

- In stage 5 – wrap-up:
  - Students will present their findings to the class. The lecturer will provide feedback and wrap up the learning experience to consolidate their learning.

In each stage (equivalent to a semester week), we propose a lesson plan template (Table 3) consisting of detailed teaching and learning activities, teacher or facilitator activities, student activities, and objectives. The lesson plans combine the best teaching strategies with the Beer Game to achieve learning objectives such as reading, debriefing, lectures, tutorials, discussions, student's reports, and student's presentations, as depicted in our synthesis table of teaching approaches (Table 2). In each activity in the lesson plan, we review the activities of the lecturer based on the best practices from previous Beer Game research to ensure they can optimise the game-based learning experience.

For example, Table 3 shows the lesson template from stage 2 that focuses on facilitating students to apply their knowledge of SCM concepts to identify an ordering strategy to play the Beer Game and to learn the game rules and user interface with a mock-up game. In this lesson plan, learning is achieved through a combination of reading, playing, decision making, discussion and debriefing approaches. The lesson plan also specifically notes the requirement to familiarise students with the game rules and user interface before playing the game. This specific requirement should be noted by educators to maximise the learning. Game-based learning is most effective when the game rules are clear to students and students can easily get started with the game (Federoff 2002). Therefore, this lesson template ensures the adherence of the educators to the best practices from previous Beer Game research, social constructivism paradigm and game-based learning approach.

Timing	T&L activity	What the teacher does?	What the student does?	Why?
5 mins	Recap the weeks 1-7 plan and what we are doing this week	• Briefly review the plan and what we will do today	• Recall the plan and get ready to work on the activities today	• To prepare students for the activities today
15 mins	Prepare for the mock-up game	• Briefly review and the learning outcomes and the goals and rules of the game (GBL) • Put students in groups and roles in a supply chain • Help students to login to the game • Review the game user interface • Explain what data students need to collect	• Understand the learning outcomes • Ask questions if there is anything unclear about the game • Sit with the group and with the supply chain • Login to the game • Learn the game user interface • Understand what data will be collected from the game	• To ensure students are ready for the mock-up game
10 mins	Review the key supply chain concepts	• Review the key supply chain concepts that are necessary for the game. According to constructivism, it is important that learners have enough prior knowledge and skills so that they can learn new knowledge and skills (Pritchard, 2013). • Discuss some order strategies with students	• Recall the key supply chain concepts • Discuss some order strategies and how they can be implemented in the game with the class	• To ensure students have the necessary prior knowledge and skills before playing the game
20 mins	Play the mock-up game	• Start the game • Monitor the progress • Help students who seem to have difficulties	• Play the game • Explore the game user interface • Try different ordering strategies • Ask questions if in doubt	• To make sure students can get started with the game easily. Out of the "Ten habits of highly successful competition organizers" suggested in (Togelius, 2016), one recommended habit is to make learners really easy to get started with a competition.
10 mins	Debriefing	• Discuss what have been learned and any problems encountered	• Reflect on what have been learned and any problems encountered	• Reflect on the learning today and get ready for Part 1 of the game

Table 3 Exemplar Lesson Plan for Stage 2 – Get Ready

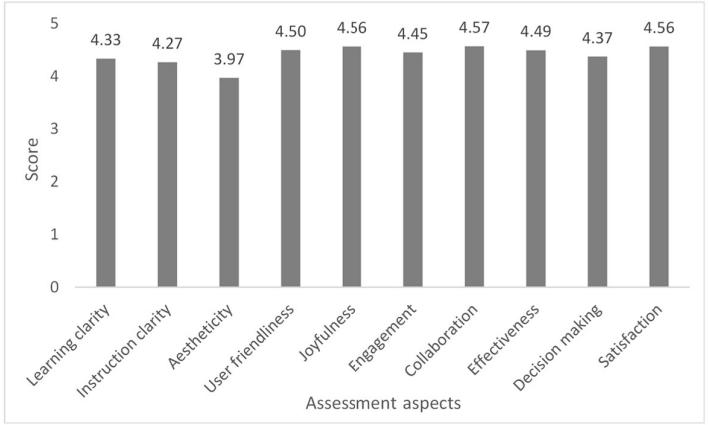

Figure 3 User Testing Result

3.3 User Testing Results

We evaluated the new Melbourne Beer Game and its teaching bundles by performing two user testing sessions online via Zoom. A total of 27 students participated in those user tests. They were Master of Information Systems students at an Australian university and Bachelor of Information Systems students at an Indonesian university. The students were separated into four teams of 2-3 students and assumed the roles of a retailer, wholesaler, distributor, and factory in a supply chain. The Beer Game was played with 1-week order delay, 2-week transportation delay, and no information sharing. During the session, we simulated a one-hour teaching practice of stage two – get ready and applied all instructions in the corresponding lesson plan. We conducted the introduction and class discussion in a virtual meeting room via Zoom. Students were then assigned to different virtual breakout rooms to play the game. After the simulation, we asked students to fill in a questionnaire with a total of 10 main questions consisting of two groups of assessment criteria. First, we assessed the features of the Melbourne Beer Game independent of the teaching activities. This assessment included the clarity of instruction provided in the user manual and the game, the aesthetic of the game interface, the user-friendliness of the game, and whether the game provided an enjoyable learning environment. The second group of criteria assessed the combination of the game and its teaching practices. It included the assessment of whether the game and its teaching practices enabled a more engaging learning environment, allowed meaningful collaborative work among students, and facilitated business decision making simulation. It also assessed whether learning supply chain concepts through the game and its teaching bundles was more effective and satisfying than conventional lectures and tutorials.

All 27 students participated in the questionnaire. In terms of their knowledge, 70% of respondents have an average knowledge of supply chain management, whereas 19% and 11% have below-average and above-average knowledge, respectively. Overall, students show a high perception of the Melbourne Beer Game in both features and teaching practices (Figure 3). On a scale of 1 to 5, students demonstrate high satisfaction as the majority of assessment aspects score above 4. Importantly, the average scores of assessment aspects related to the teaching practices is 4.49. It shows that the teaching bundles that are developed based on game-based learning principles fit very well with the Melbourne Beer Game to enhance learning effectiveness. The question on whether the dashboard-like charts and tables in the user interface allow students to visualize the game data and make decision more easily has an average score of 4.37. In the debriefing, students also express that the dashboard-like user interface provides them with a more authentic business decision-making experience. The teaching practice is also effective in facilitating teaching and learning with the game in an online setting. Therefore, the newly developed Beer Game and its teaching guidelines proposed in this study address the current gaps in Beer Game development and teaching approaches in the literature.

However, there are also challenges encountered by the teaching team in teaching with the game via Zoom. First, students who are used to conventional face-to-face learning can easily find playing a real-time simulation game with other students online new and unfamiliar. Therefore, it is recommended that students be provided with sufficient assistance and time to try out the game user interface with their teammates. Second, students usually are excited about game-based learning but might have anxiety due to the competitive nature of games as discussed by Lau (2015), particularly in the more unfamiliar online setting. As such, the teaching staff should keep the teaching pace slower at the start to allow students to gain more confidence and seek feedback from students from time to time. Teaching staff should also emphasize “learning” over “winning”. It is more important for students to enjoy and learn from the game experience. Game-based learning should be an enjoyable experience. According to Roser et al. (2021), the Beer Game was reported to be a fun and interactive way to learn how supply chains work. Third, if some teaching staff are not familiar with and experienced in delivering game-based learning in a blended and remote environment, sufficient training and self-practice are necessary to ensure effective teaching. Forth, students may encounter more problems the first time playing the game; therefore, a higher than usual staff-to-student ratio such as 1 to 10 might deliver a smoother and more effective learning experience. Lastly, teaching staff need to keep a good balance between teaching enough prior knowledge to students so that they can learn from the game and not too much so that they can be surprised by the actual behaviour versus the expected behaviour of supply chains. Roser et al. (2021) suggests that surprise is an important element of the Beer Game and is very effective to break down preconceptions and open students for new knowledge.

4 Conclusion

Teaching SCM and its multidisciplinary nature to students is important yet challenging. Technologies such as simulation games can lessen the challenge and better facilitate teaching SCM. In this study, we

offer a synthesis of the development of various Beer Games as a widely used simulation game to teach SCM concepts to students and its teaching approaches. We identify two improvement opportunities, namely the development of a new Beer Game that enables the learning of data-driven decision-making process within the supply chain and the creation of teaching guidelines that optimise the learning outcomes based on game-based learning. We propose the Melbourne Beer Game that is equipped with dashboard-like charts and tables to facilitate better data-driven decision-making among students while playing the game. In addition, we develop a five-stage teaching practice with individual lesson plans to guide educators in teaching SCM concepts via the game. Our user testing session provides initial empirical evidence that the new game and its teaching practices are well-received and appreciated by students as a better way to maximise their learning experiences. Therefore, this paper offers a modest contribution to the SCM literature by showing that the Melbourne Beer Game can facilitate the learning of the intricacies of supply chain dynamics and its data-driven decision-making process within the supply chain. Furthermore, to pedagogy literature, this paper shows that the development of teaching guidelines that align with the Game-based learning principles is crucial to ensure the optimum learning outcomes with the Beer Game. Apart from these contributions, future research is needed to further evaluate the value of the Melbourne Beer Game and its teaching practices in different settings and with a larger group of students. Particularly, there is a need to extend the user testing to include all stages of the proposed teaching practice to get a more comprehensive and valid evaluation.

5 Reference List

Baruque, L. B., and Melo, R. N. 2004. "Learning Theory and Instruction Design Using Learning Objects," *Journal of Educational Multimedia and Hypermedia* (13:4), pp. 343-370.

Chan, K., Wan, K., and King, V. 2021. "Performance over Enjoyment? Effect of Game-Based Learning on Learning Outcome and Flow Experience," *Frontiers in Education*: Frontiers, p. 185.

Chen, C., Landa, S., Padilla, A., and Yur-Austin, J. 2022. "Post-Pandemic Assessment of Online Teaching and Learning in Higher Business Education," *International Journal of Educational Management*:ahead-of-print).

Connolly, T., and Stansfield, M. 2006. "Using Games-Based Elearning Technologiesin Overcoming Difficulties in Teaching Information Systems," *Journal of Information Technology Education: Research* (5:1), pp. 459-476.

Cybulski, J., Parker, C., and Segrave, S. 2006. "Touch It, Feel It and Experience It: Developing Professional Is Skills Using Interview-Style Experiential Simulations," *ACIS 2006: Proceedings of the 17th Australasian Conference on Information Systems, Adelaide Convention Centre, 6th-8th December 2006: thought leadership in IS*: Australasian Conference on Information Systems.

Duffy, T. M., and Cunningham, D. J. 1996. "7. Constructivism: Implications for the Design and Delivery of Instruction,").

Federoff, M. A. 2002. *Heuristics and Usability Guidelines for the Creation and Evaluation of Fun in Video Games*. Indiana University.

Hieber, R., and Hartel, I. 2003. "Impacts of Scm Order Strategies Evaluated by Simulation-Based'beer Game'approach: The Model, Concept, and Initial Experiences," *Production Planning & Control* (14:2), pp. 122-134.

Howard-Jones, P. A., and Jay, T. 2016. "Reward, Learning and Games," *Current opinion in behavioral sciences* (10), pp. 65-72.

Jackson, G. C., and Taylor, J. C. 1998. "Administering the Mit Beer Game: Lessons Learned," *Developments in Business Simulation and Experiential Learning: Proceedings of the Annual ABSEL conference*.

Jüttner, U., Peck, H., and Christopher, M. 2003. "Supply Chain Risk Management: Outlining an Agenda for Future Research," *International Journal of Logistics Research and Applications* (6:4), pp. 197-210.

Juul, J. 2011. *Half-Real: Video Games between Real Rules and Fictional Worlds*. MIT press.

Kaminsky, P., and Simchi-Levi, D. 1998. "A New Computerized Beer Game: A Tool for Teaching the Value of Integrated Supply Chain Management," *Global supply chain and technology management* (1:1), pp. 216-225.

Koivisto, J., and Hamari, J. 2019. "The Rise of Motivational Information Systems: A Review of Gamification Research," *International Journal of Information Management* (45), pp. 191-210.

Kolb, D. A. 1984. "Experience as the Source of Learning and Development," *Upper Sadle River: Prentice Hall*).

Lainema, T. 2003. *Enhancing Organizational Business Process Perception: Experiences from Constructing and Applying a Dynamic Business Simulation Game*. Turku School of Economics and Business Administration.

Lau, A. K. 2015. "Teaching Supply Chain Management Using a Modified Beer Game: An Action Learning Approach," *International Journal of Logistics Research and Applications* (18:1), pp. 62-81.

Lawrence, J.-M., Hossain, N. U. I., Nagahi, M., and Jaradat, R. 2019. "Impact of a Cloud-Based Applied Supply Chain Network Simulation Tool on Developing Systems Thinking Skills of Undergraduate Students," *Proceedings of the International Conference on Industrial Engineering and Operations Management, Toronto, Canada, October 23-25*.

Parker, C., Chan, C., and Saundage, D. 2007. "Using Multimedia and Interactive Games to Enhance Students' Understanding of Scm," *SCMIS 2007: Proceedings of Fifth International Conference on Supply Chain Management and Information Systems*: Monash University, pp. 1-13.

Plass, J. L., Homer, B. D., and Kinzer, C. K. 2015. "Foundations of Game-Based Learning," *Educational psychologist* (50:4), pp. 258-283.

Pritchard, A. 2013. *Ways of Learning: Learning theories and learning styles in the classroom*. Routledge.

Reyes, P. M. 2007. "Parallel Interaction Supply Chain Game: An Extension of the Beer Game," *Decision Sciences Journal of Innovative Education* (5:2), pp. 413-421.

Roser, C., Sato, M., and Nakano, M. 2021. "Would You Like Some Wine? Introducing Variants to the Beer Game," *Production Planning & Control* (32:6), pp. 454-462.

Sailer, M., and Homner, L. 2020. "The Gamification of Learning: A Meta-Analysis," *Educational Psychology Review* (32:1), pp. 77-112.

Sarkar, S., and Kumar, S. 2016. "Demonstrating the Effect of Supply Chain Disruptions through an Online Beer Distribution Game," *Decision Sciences Journal of Innovative Education* (14:1), pp. 25-35.

Sparling, D. 2002. "Simulations and Supply Chains: Strategies for Teaching Supply Chain Management," *Supply Chain Management: An International Journal* (7:5), pp. 334-342.

Sugahara, S., and Lau, D. 2019. "The Effect of Game-Based Learning as the Experiential Learning Tool for Business and Accounting Training: A Study of Management Game," *Journal of Education for Business* (94:5), pp. 297-305.

Vanany, I., and Syamil, A. 2020. "Teaching Supply Chain Management Using an Innovative Practical Game," in *Supply Chain and Logistics Management: Concepts, Methodologies, Tools, and Applications*. IGI Global, pp. 837-856.

Wamba, S. F., Gunasekaran, A., Papadopoulos, T., and Ngai, E. 2018. "Big Data Analytics in Logistics and Supply Chain Management," *The International Journal of Logistics Management* (29:2), pp. 478-484.

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