Gamification Methods for Teaching Logistics and Supply Chain Management

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ABSTRACT

In the recent decades Gamification has been getting more popular at teaching methods in supply chain management (SCM). Many universities and companies are using SCM simulators as a tool for increasing perception of real Supply Chain (SC) whereas being experienced in SCM will hang on passing long time and energy. Making changes in supply chain and applying innovative ideas for educational purposes is risky and costly and somehow impossible but with a proper SCM simulator students would experience very similar behavior of a real SC by applying what they have learned about SCM. They can see the effects of their decisions on any part of SC, they will learn how to build a successful team work in group team players and the competition between groups will be a great memorable lesson. The aim of this study is to make a comparison between 4 famous simulation games (named; Electronic Beer Game, Supply Chain Game, The Fresh Connection TFC, SCM Globe Game) to find different skills to teach SCM and logistics scientific subjects and their strengths and weaknesses. In this study we are going to perform an exploratory research on previous related lectures and famous SCM simulation games and their abilities to teach SCM and in parallel random sample interviews from students and some company employees have arranged to find out players views and impressions about games and their perception of SCM subjects. Result of this research the user friendly parts and the weaknesses parts will be evaluated by ranking the characteristic of the games in a criteria table and final comparison and conclusion will be discussed.

Keywords: Gamification, Supply Chain Management, Simulation

JEL-Classificattions: C63, A22, I21

Lojistik ve Tedarik Zinciri Yönetiminde Oyunlaştırma Metotları

ÖZET

Son yıllarda oyunlaştırma metotları, tedarik zinciri uygulamalarında oldukça yaygınlaşmıştır. Uzmanlaşma ve tecrübe sahibi olmanın uzun sürdüğü Tedarik zinciri konusunda birçok üniversite, gerçek senaryolar için simülatörler kullanmaktadır. Tedarik zinciri boyunca yeni fikirlerin ve yaratıcı düşüncelerin uygulanması pahalı ve riskli olduğundan, uygun simülatörler oldukça yararlıdır. Bu kapsamda, verilen her kararın sonucu önceden görülebilmekte, başrılı bir takım çalışmasının nasıl yapılabileceği öğrenilmeke ve rekabet akıllarda kalıcı olmaktadır. Bu çalışmanın amacı; Electronic Beer Game, Supply Chain Game, The Fresh Connection TFC, SCM Globe Game adlarındaki 4 farklı simülasyon oyunu arasında karşılaştırma yapmak ve bu dört oyunun zayıf ve güçlü yönlerini ortaya çıkarmaktır.Bu çalışmada parallel oturumlarda öğrencilere ve sektör temsilcilerine oyunlar hakkındaki görüşleri de sorulmuş ve derinlemesine bir araştırma yapılmıştır.
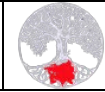
Anahtar Kelimeler: Oyunlaştırma, Tedarik zinciri yönetimi, simülasyon

INTRODUCTION

These days in teaching field of Supply Chain Management (SCM) we hear a lot about Gamification, Simulation Games and Serious games, but what do they really mean? What are the differences between them? Are those a real necessity for today SCM teaching classes? How could we compare them? What are their teaching techniques and their strength and weaknesses? Which SCM scientific subjects would be practiced via games?

The calendar confirms it, we are well into the 21st century the digital age, but university classrooms shout OLD SCHOOL. The blackboard is probably white, and there may be a faculty workstation, projector, and screen displaying PowerPoint presentations. University students are bored and uninspired in many of today's classrooms. Traditional learning strategies are not successful for the emerging challenges of the technology age (As cited in Rhodes et. al.,2017: 206-207).

Business leaders also argue that the new generation of employees does not have enough practical experience when they step into the workplace, requiring a large amount of training to rectify this problem. A recent concept, known as Gamification, can contribute a solution to this problem. Gamification promotes the use of games and elements of games in education to provide a learning environment to which the youth of today could possibly relate to. With

gamification, a learning environment for teachers and students, either in the workplace or in the classroom, can be developed to challenge and build on their existing knowledge (As cited in Henning et. al.,2017: 105-106).

The goal of gamification is typically to induce experiences common to gaming, and to create and increase motivation or engagement via these experiences. At the core of gamification applications is not only the entertainment or enjoyment of the system use itself, but the external consequences that the system motivates the user towards individual behavior and activities or organizational performance (As cited in Warmelink et. al.,2018: 1108).

Supply chain management and logistics are key ingredients for success in today's highly competitive global environment. In traditional education, the content is typically taught using textbooks, handouts, and slides. Because supply chain and logistics management is practical, traditional teaching methods may be less appropriate for such courses, as old-fashioned lectures may bore newcomers and experienced employees. Traditional teaching methods may not cover practical materials and may not stimulate students' desire to learn with a high level of learning efficacy. To overcome these problems, the integration of gaming and education has become a supplement for logistics education (As cited in Liu et. al.,2017: 1009).

1. GAMIFICATION, SIMULSTION GAMES, SERIOUS GAMES

Simulations create an environment where learners can apply theory and practice skills in real-world issues related to their discipline. A powerful tool for learning simulations allows facilitators to integrate multiple teaching objectives in a single process. Simulations motivate students, provide opportunities for active participation, promote deep learning, and develop communication skills, and link knowledge and theory to application (As cited in Rhodes et. al.,2017: 215).

A Serious Game (SG) is before all a game, which has not as primary purpose the entertainment but supports a serious purpose to train, search for or promote three possible cognitive levels: knowledge, skills or behaviors. There are rarely feedbacks and virtually no interaction with eLearning whereas simulation and SG are essentially based on that notion. On the one hand simulations must be realistic as they represent a real phenomenon without alteration of its

perception, resulting sometimes in a balance sheet. On the other hand SGs promote a "serious" purpose that must process a kind of entertainment and must end with success or failure. Intrinsic serious aspects have to remain intact but the process to reach the serious purpose and the appearance are often strongly altered. Gamification is a process that adds score (*e.g.* points) to an activity as a feedback purpose with respect to its properties in terms of the content and form (Gobron, 2017).

All of these approaches flow between each other and can be mixed and matched in any way needed to create the best solution for a client. Never limit yourself by definitions, semantics, lack of understanding or lack of willingness to try new things! This represents the majority of things you should have in mind when you hear the word gamification. Limiting yourself to the standard definition is going to reduce how effective your thinking will be when it comes to designing solutions for people (Marczewski, 2016).

Figure – 1, Game Thinking Spectrum (Marczewski, 2016)

Around the mid-point, the solution will not only have the look of a game, they will also share structural comparisons. Challenges, narratives, scoring systems, RPG (Role Playing Game) elements, feedback, progress etc. (Marczewski, 2016)
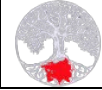
Figure-2, Differences between Gamification, Simulations, Serious Games and Games (Marczewski, 2016)

Following example would be a close study to this paper. The learning success of five games – the Beer Game, the LEGO Car Game, the Train Game, the Off Roader LEGO Car Game, and The Fresh Connection (TFC) simulation game was determined through the questionnaires with 195, 78, 12, 11, and 72 participants respectively. The three-dimensional matrix illustrates the relationship of the knowledge, abstraction, and emotional immersion between the games. The results of the emotional immersion dimensions were influenced by the number of rounds that were played, and the period of time for which the students had to participate **(As cited in M. Henning, et. al.,2017: 110).**
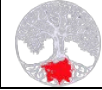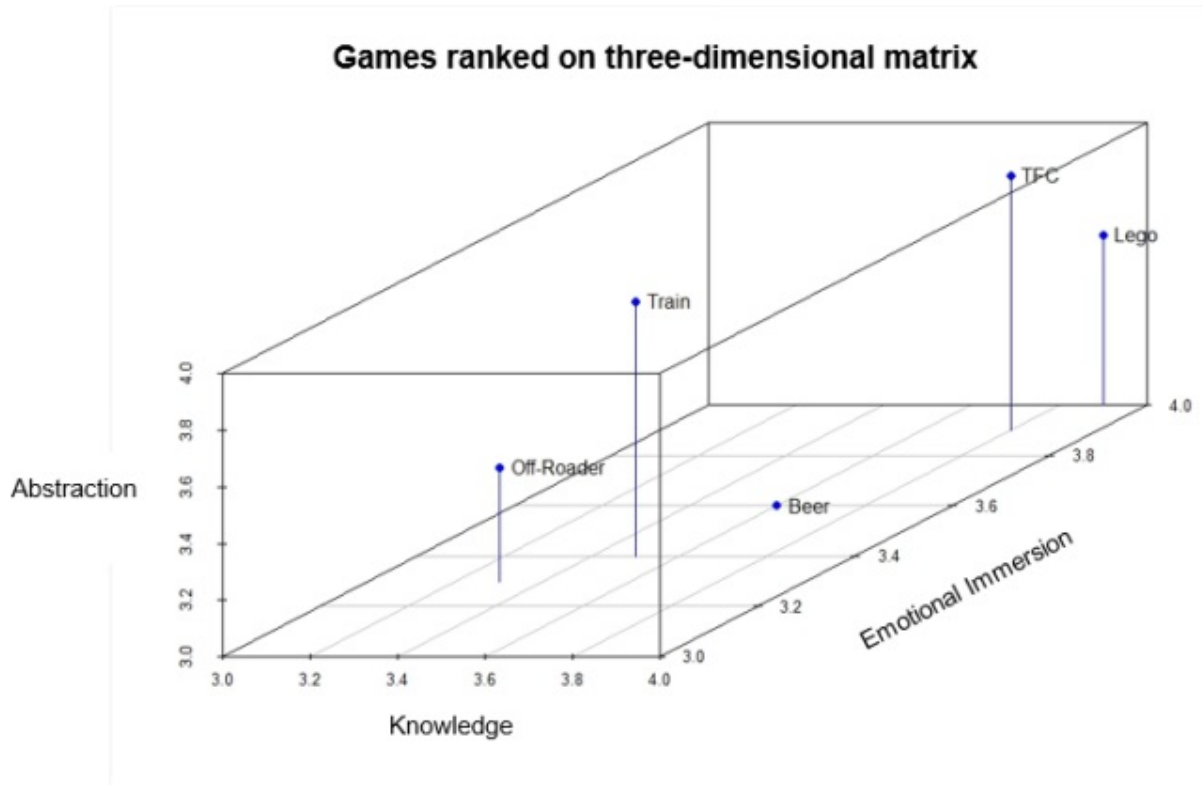
Figure 3 - Measuring the learning success of the games (M. Henning, 2017)

1.1. Beer Game as described by Supply Chain Academy

The Beer Game is a role-play simulation game that lets participants experience typical coordination problems of (traditional) supply chains, in which information sharing and collaboration does not exist. In more general terms, this supply chain represents any non-coordinated system where problems arise due to lack of systemic thinking.

This experiential, competitive business simulation game demonstrates the need for coordination throughout the supply chain. Suppliers, manufacturers, sales people, and customers have their own, often incomplete, understanding of what real demand is. Each group has control over only a part of the supply chain, but each group can influence the entire chain by ordering too much or too little. Further, each group is influenced by decisions that others are making.

This lack of coordination coupled with the ability to influence while being influenced by others leads to the Bullwhip Effect (shortages and overstocks across the supply chain). In the Beer Game participants enact a four stage supply chain. The task is to produce and deliver units of

beer: the factory produces and the other three stages deliver the beer units until it reaches the customer at the downstream end of the chain.

As a consequence of the bullwhip effect a range of inefficiencies occur throughout the supply chain:

High (safety) stock levels

Poor customer service levels

Poor capacity utilization

Aggravated problems with demand forecasting

Ultimately high cost and low levels of inter-firm trust

While the effect is not new, it is still a timely and pressing problem in contemporary supply chains. (Supply Chain Academy Corporation, 2018)

1.1.1. The Electronic Beer game by Responsive.net Corporation

Insights E-Beer is based on a board game developed at MIT several decades ago, to teach system dynamics in the context of a supply chain. Four team members each take a different position on a simple linear supply chain: retailer, wholesaler, distributor, and factory. Team members place materials orders to their upstream neighbors in response to demand from their downstream neighbors. The objective of the game is to minimize the cost of fulfilling demand. Cost is a function of backlogs and inventory.

A game typically takes 30 to 40 minutes. In one typical application, student teams play two games back-to-back in class. In the first game, students only see local information. In the second game, all four students see retail demand, all orders, and all inventories. Students then experience first-hand how the availability of information can improve supply chain performance.

Student management is a central feature of the software. Instructors use an online interface to create and populate teams, view students, view games in progress, and debrief game results in class. If a student is missing from a team, the server can play the student's position. If a student

shows up late, the student can still join a game and take over the server's position (Responsive.net Corporation, 2018).

1.2. Supply chain Game by Responsive.net Corporation

The Supply Chain Game is an online supply network simulator. In a typical setting, students are divided into teams and compete against each other in one or two assignments lasting a week each. To meet different demand patterns in five regions, student teams set production and inventory control parameters, transportation choices, and add new factories and warehouses. The objective of the game is to maximize cash position at the end of the game. The game is designed for use in supply chain electives or core courses that emphasize supply chain management. Learning objectives include:

- Forecasting
- Inventory and production control
- Supply network design
- Logistics

1.2.1. SC Game, Assignment described by Sam Wood

Your team has been hired to manage the supply chain for the Jacobs Industries. You can make the following changes to the supply chain:

- New factories and warehouses in regions outside Calopeia.
- Capacity additions to existing factories.
- For each factory the finished goods inventory level at each warehouse that would trigger production of a new batch for that warehouse.
- For each factory, the size of batch produced for each warehouse.
- Whether batches are transported from each factory to each warehouse by mail or by truck.

Your objective is to maximize the cash generated by the foam technology over the remaining year of its lifetime.
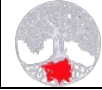
1.2.2. SC Game, Decisions described by Sam Wood

Jacobs's management would like to serve the new markets it has identified if serving those markets is profitable. However, serving those markets could be logistically complex. Some decisions to be made include:

- Which new markets should Jacobs sell to?
- When should Jacobs begin serving its new target markets?
- Should Jacobs continue to serve its original market?
- Should the factory in Calopeia be expanded?
- Should factories in other regions be built?
- Should warehouses in other regions be built?
- How should Jacobs schedule production?
- How should inventory in the warehouses by managed?
- How should chemicals be transported from factories to warehouses?
- Which warehouses should serve each target market?

You have been hired to make these decisions. Your goal is to maximize cash position generated by the foam technology over its lifetime (Responsive.net Corporation, 2018).

1.3. The Fresh Connection (TFC Corporation, 2017)

The Fresh Connection is an innovative web-based business simulation. It engages participants in making strategic decisions in the management of a manufacturing company of fruit juices. Working in teams of four, participants will represent the functional roles of sales, purchasing, supply chain and operations. They will be confronted with various real-life, real-time dilemmas. Cross-functional understanding and collaboration are key components, as teams work together to turn the company around.

The Fresh Connection immerses its participants in turning around a manufacturer of fruit juices. Faced with declining performance, the management team must get the company back on track as soon as possible. It is a high-pressure environment in which effective supply chain management is the key to success.

The management team has four roles:

VP Purchasing: Responsible for selecting the right suppliers and agreeing SLAs (Service Level Agreement) with suppliers, including possible collaboration options.

VP operations: Must decide on capacity in warehouses and production areas and approve investment in bottling lines and mixers. Can introduces various improvement projects. Has the ability to outsource outbound warehousing.

VP Supply Chain: Manages inventories (safety stock and lot size settings), production intervals and the frozen period of production.

VP Sales: Agrees SLAs with customers, manages the product and customer portfolio, and forecasts demand and can introduce collaboration concepts.

Every decision a participant makes has trade-offs, both within and across roles, so participants will only succeed if they align all the disciplines. As the simulation evolves it becomes clear that a supply chain strategy is essential for success and that the strategy must be deployed to functional levels and below to be effective. Winning is about generating the best ROI for the business while still managing your own team's Key Performance Indicators and targets.

Watching the Fresh Connection Introduction Briefing by the Strategy Director on YouTube https://youtu.be/s7ICHtLlFAY would give us a vision through this game.

The Fresh Connections designed for any professional who works as part of cross-functional teams along the value chain. This can include:
- General managers
- Operations managers
- Production managers
- Supply chain managers
- Logistics managers
- Warehouse managers
- Sales/Marketing managers
- Financial managers
- Procurement managers/buyers
- Planners/forecasters
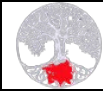
1.4. SCM Globe Game (Hugos, 2018)

Easily and accurately model any supply chain by defining just four entities: products; facilities; vehicles; and routes. Then place them on a map of the world. Their interactions are simulated at the click of a button to project the results of key decisions. It's so simple and fun it could be a game... but it's a mathematically rigorous supply chain simulation. What works in the simulations also works in the real world. SCM Globe is a cloud-based application used in classrooms and online courses.

A Multiplayer Supply Chain Game Competition, Cincinnati Seasonings is the case study most people start with when they begin using SCM GLOBE. There is a factory manufacturing food seasonings sold as a packaged product called the "Spicy Cube." In addition to the factory, there is also a warehouse and three stores, each with their own product demand and quantities of product on-hand. The objective of the case is simple: Meet product demand at the stores for 30 days while lowering operating costs and inventory as much as possible.

This simulation and reporting concept can be used to create a multiplayer game composed of SCM GLOBE and Google spreadsheets. Google is used by many educational organizations and thus integrates with the .edu email accounts of both instructors and students.

Through this process of connected spreadsheets we can create a simple competition where each player copy-pastes their results from their personal SCM GLOBE simulation into a personal Google spreadsheet that's connected to every other player and the course instructor. This provides a live scoreboard showing each player's gross profit achieved, and this is the metric used to judge the performance of each player's supply chain. Whoever has the highest gross profit wins.

Players use data from their supply chain model (demand from the stores, quantity on-hand of all facilities, and production rate in the factory) and make their own forecasts in Google Sheets to aid them in their decision making. For example: Every store has a daily demand and a quantity of the demanded product in stock in the store. How many days will it take before the store consumes the storage it has? Knowing this is critical for determining the delivery schedules with the trucks. We don't tell the player how many days of stored supply they have, but they do know what the quantity on-hand and daily demand in the stores and thus can figure it out for themselves.

The use of the worksheets also allows players to expand the simulation to three months (or more if they wish). Each month serves as an individual turn in the game, it works as follows:

First month (1st turn) — players logon to the SCM GLOBE accounts and import the Cincinnati Seasonings case study from the SCM GLOBE online library. In this first turn every student will have the same store demand and quantity on-hand for the Spicy Cube product in all facilities. This is the original case study many students are already familiar with.

Second month (2nd turn) — there are two changes: Demand at the stores, and quantity on-hand in all five facilities. Demand is changed by the instructor and the new store demand levels are the same for all players. The instructor can choose to have demand go up or down or stay the same at any of the three stores.

Product quantity on-hand — each facility for each individual player will have different quantity on-hand amounts based on the decisions each player made in their first turn. Each turn runs for 30 days. Each player starts the second turn with the quantity on-hand they ended up with on day 30 of their first turn.

Third month (3rd turn) — the store demand and quantity on-hand will change again based on the criteria mentioned above.
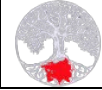
The player that has the highest cumulative gross profit by the end of the third turn wins the competition (Hugos, 2018).

SCM Globe Goal by Mhugos: Keep stores supplied with products while also reducing inventory and operating costs. There are many ways to do it, just as there are in the real world:

-   change production rates
-   try different vehicles, schedules, and delivery routes
-   move facility locations… some ideas work better than others

Simulate your ideas and see where they lead. Simulations produce data to create monthly Income and Expense Reports plus key performance indicators. The numbers show which ideas deliver the best results – and which players win.

https://youtu.be/9JnMaztM4Ms watching given link would give a vision about SCM Globe real simulation game.

2. METHODOLOGY

Four famous high tech computer game have been selected; Electronic Beer Game, Supply Chain Game, The Fresh Connection Game (TFC) and SCM Glob Game. Main scenario and characteristics were described in previous section.

In this study after exploratory qualitative literature search on selected games, the collected data will be clarified and classified to groups named as a) SCM scientific subjects b) Game Teaching Techniques c) Time characteristic and d) Approximate cost for student usage (as we know cost always matters even as teaching parameter).

In parallel we have made 5 interviews for each game a random sampling of university students and company employees whom had played and experienced the games to check our findings and add new common experienced information to our data.

Finally according to our total observation the game characteristics would be ranked by their importance in teaching SCM. The game's strength and weaknesses would be described in comparison and conclusion part.

3. FINDINGS

3.1. SCM Scientific Subjects

In the following table, SCM common scientific subjects of the games which find out by this research related to these four SCM games and the quality of covering the subjects by the games are placed. We ranked high coverage 5 point, mid as 3 and low as 1 point for seeing the results in a chart.

Table -1 SCM Scientific subjects covered by simulation games

Topics codes :	E-Beer	SCM	TFC	Globe
(D) Demand Forecasting and fulfillment	High	High	High	High
(F) Finance and Cost minimization	Mid	High	High	High
(G) General SC Management and Planning	Low	High	High	Mid
(S) Supply Management (Procurement)	Low	Low	High	Low
(I) Inventory Management	Mid	High	High	High
(N) Network Design	Low	High	Mid	High
(O) Operations Management	Low	Mid	High	Mid
(R) Routing and Distribution	Low	Mid	Low	High
(W) Warehouse Management	Low	Low	Mid	Low
(B) Bullwhip	High	Mid	Mid	Mid
(L) Lead Time	Mid	Mid	Mid	Mid
(P) Production Management	Mid	Mid	High	Mid
(M) Marketing and Sales	Low	High	High	Low
(C) Contract Management	Low	Mid	High	Low

Table -2 SCM Scientific subjects scoring for simulation games

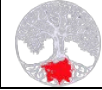| Topics codes :	E-Beer	SCM	TFC	Globe
(D) Demand Forecasting and fulfillment	5	5	5	5
(F) Finance and Cost minimization	3	5	5	5
(G) General SC Management and Planning	1	5	5	3
(S) Supply Management (Procurement)	1	1	5	1
(I) Inventory Management	3	5	5	5
(N) Network Design	1	5	3	5
(O) Operations Management	1	3	5	3
(R) Routing and Distribution	1	3	1	5
(W) Warehouse Management	1	1	3	1
(B) Bullwhip	5	3	3	3
(L) Lead Time	3	3	3	3
(P) Production Management	3	3	5	3
(M) Marketing and Sales	1	5	5	1
(C) Contract Management	1	3	5	1
Total scores for scientific subject covering	30	50	58	44
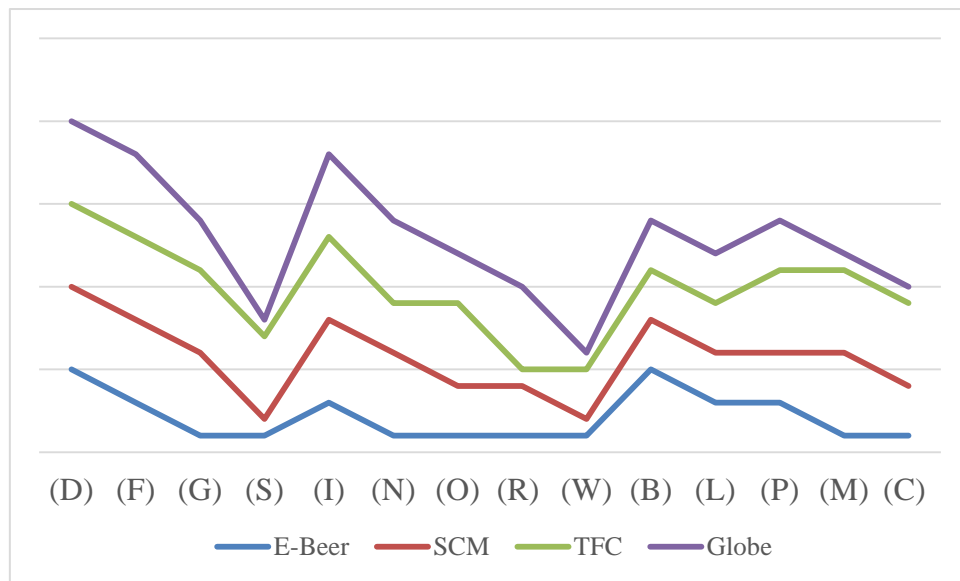
Figure -4 SCM Scientific Subject Coverage by Games

3.2. SCM Teaching Techniques

Below table shows the simulator techniques for teaching SCM related to each game. In table-3 and 4, in the last right column we have added importance as our study's vision related to teaching technic importance and value (With same ranking as previous part, high coverage 5 point, mid as 3 and low as 1 point). It's necessary to inform that we have put 0 for importance of the quantity of a variable (for example number of Roles) but not for its effectiveness.

Table -3 Simulator techniques for teaching SCM

Teaching Techniques	E-Beer	SCM	TFC	Globe	Importance
Real Life dilemmas	Mid	Mid	High	High	High
Competitive Sense	Mid	High	High	Mid	High
Decision Making & Result experiencing	Low	High	High	Mid	High
To Put SCM Strategies into Action	Low	High	High	Mid	High
Player can make changes in Variables	Low	Mid	High	Mid	Mid
Number of Rounds (Stages of the game)	2	2	4	3	-
Number of players in each team	4	4	4	1	-
Team Building – Team Work	Mid	High	High	Low	High
Facilitator performance indicating	Mid	High	High	High	High
Transportation Choices available	-	√	-	√	Mid
Number of Roles	4	4	4	3	-
SC Role as Supplier	-	-	√	-	Mid
SC Role as Manufacturer/Production	√	√	-	√	Mid

SC Role as Sales	-	√	√	-	Mid
SC Role as SC management	-	√	√	-	High
SC Role as retailer	√	-	-	-	Mid
SC Role as Wholesaler	√	-	-	-	Mid
SC Role as Distributer	√	√	-	√	Mid
SC Role as Operations	-	-	√	√	Mid
Abstraction	Low	High	High	Mid	High

Table -4 scoring simulator techniques for teaching SCM

Teaching Techniques	E-Beer	SCM	TFC	Globe	Importance
Real Life dilemmas	3	3	5	5	5
Competitive Sense	3	5	5	3	5
Decision Making & Result experiencing	1	5	5	3	5
To Put SCM Strategies into Action	1	5	5	3	5
Player can make changes in Variables	1	3	5	3	3
Number of Rounds (Stages of the game)	2	2	4	3	0
Number of players in each team	4	4	4	1	0
Team Building – Team Work	3	5	5	1	5
Facilitator performance indicating	3	5	5	5	5
Transportation Choices available	0	1	0	1	3
Number of Roles	4	4	4	3	0
SC Role as Supplier	0	0	1	0	3
SC Role as Manufacturer/Production	1	1	0	1	3
SC Role as Sales	0	1	1	0	3
SC Role as SC management	0	1	1	0	5
SC Role as retailer	1	0	0	0	3
SC Role as Wholesaler	1	0	0	0	3
SC Role as Distributer	1	1	0	1	3
SC Role as Operations	0	0	1	1	3
Abstraction	1	5	5	3	5
Total of Quality points × Importance rate	90	191	204	136	-

3.3. Time Characteristics

Following table demonstrates simulator's time parameters. For evaluating time characteristics due to difference time schedules which would be required in teaching centers, we just have evaluated the Debriefing time.
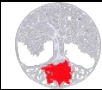
Table -5 Time Characteristics

Time Characteristic	E-Beer	SCM	TFC	Globe
Debriefing duration lasts	Low	Mid	Low	High
Normal Game Duration	40 min	1 week	2 days	1month
Ideal workshop duration (days)	2	14	5	90

Table -6 Time Characteristic evaluation

Time Characteristic	E-Beer	SCM	TFC	Globe	Importance
Debriefing duration	Low	Mid	Low	High	High
Scores	1	3	1	5	5
Debriefing total score	5	15	5	25	-

3.4. Cost characteristics

Table-7 demonstrates estimate game usage cost per student. Cost for student usage is not clear and it would be changed with respect to countries, number of students and etc.

Table -7 Cost usage for students

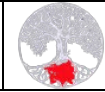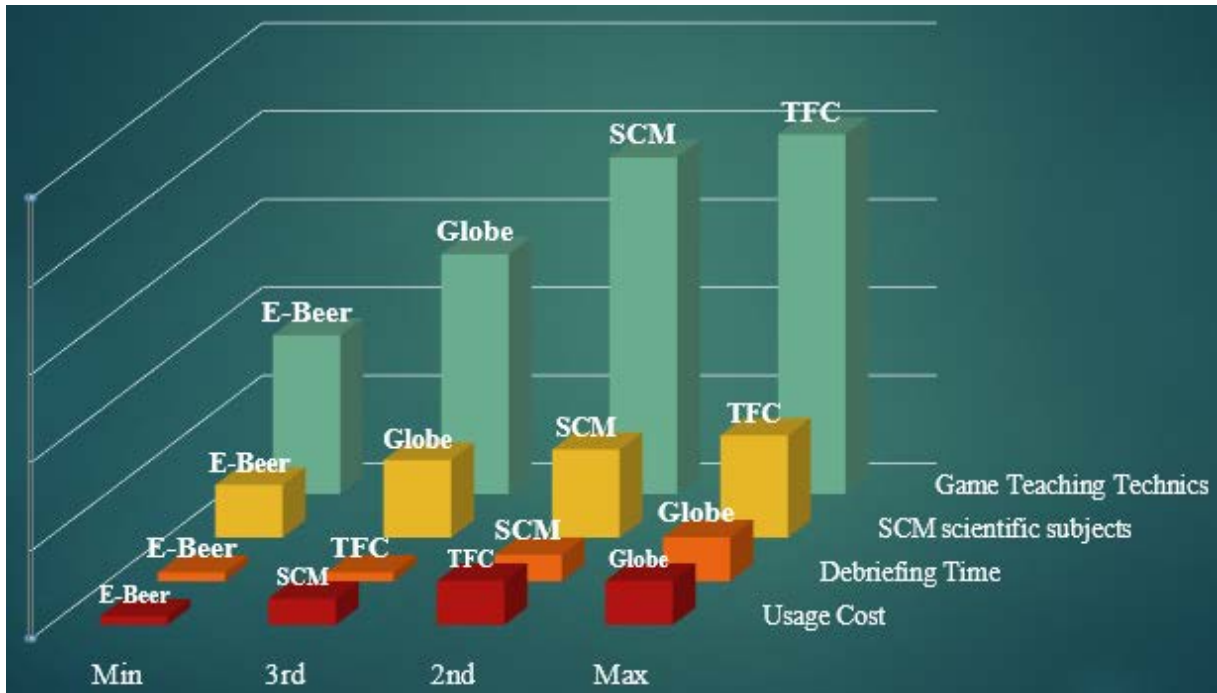| Cost Characteristic	E-Beer	SCM	TFC	Globe	Importance
Usage Cost($) Nov2018	10-12	20-24	55-62	55-65	-
Usage Cost	Low	Mid	High	High	High
Scores	1	3	5	5	5
Usage Cost total Scores	5	15	25	25	-

Figure -5 Comparison of SCM Simulation Games

4. CONCLUSION

Considering figure-4, we can say all four games have paid proper attention to demand fulfillment, finance issues, inventory on hand and production. Less attention to warehouse management, supply and procurement were paid except TFC. The common special friendly sides of TFC and SCM are general supply chain management and sales. The strength of SCM Glob is in routing and distributing even on real map and E-Beer is very good for teaching bullwhip effect.

As mentioned players usually play the SCM games in groups. Most games have special Roles for each participant in which responsibility sense to the player, in parallel managerial skills for running the given role in SC would be challenged and would give deep memorable learning lesson to participants. One of the most important roles is supply chain manager which specifically covered by teaching techniques in TFC and SCM games. This role would emphasize the duty of SC manager for team building and putting all chains in same decided SC strategy and controlling the progress.

Regarding to time and cost characteristics SCM globe would be suggested for long term educating periods and E-Beer as ice-breaker and quick SCM debriefing and reasonable usage fee, TFC and SCM are proper for middle size workshops with considerable different fees (maybe that's why TFC stands in first stage for scientific subject and teaching technics figure-5). SCM game subsequently is a proper game for teaching SCM.

We know that others may have other opinions, then it is open for all to interpret and add value for future studies.

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