The Impact of Game-Based Learning on First-Year Undergraduate Students on Knowledge and Motivation: An Example From the Logistics Field

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Abstract
The paper aims to study the impact of utilizing the learner-centered framework on Game-Based Learning (GBL) on first-year university students. The objectives of the study are 1) Game-based learning can achieve knowledge for the learner. 2) Game-based learning can create student learning motivation. The game implemented in this study is called Beer Game, which is a web-based role-playing simulation of beer distribution in the supply chain. The sample was 42 students who studied the Introduction to Logistics and Supply Chain Management subject. To measure knowledge level, the samples got the tests before and after playing the game. (Pre-test and Post-test). To evaluate the learner motivation level, the study used satisfaction questionnaires. The result of the level of knowledge of samples showed that 95.12 percent of total sample students got a better score, on the Post-test than on the Pre-test. The learner motivation survey showed the average ($\bar{x}$) was 4.62/5.00 meaning it was very satisfied with game-based learning. In conclusion, Game-Based Learning (GBL) can create learning motivation and knowledge for first-year undergraduate students.

Keywords: Game-Based Learning (GBL), Beer Game, Supply Chain, Logistics, Learner-Centered

Introduction

In education, teachers are currently confronted with the dual challenge of cultivating student learning motivation while concurrently elevating their knowledge levels. The responsibility on teachers has intensified as they seek effective methods to render the learning process engaging and enjoyable. In light of this, Game-Based Learning (GBL) emerges as a promising pedagogical approach. Notably, for first-year students, educators grapple with a spectrum of challenges encompassing diverse backgrounds, motivation and engagement, the transition to higher education, foundational knowledge gaps, and the cultivation of study skills, technology integration, and more (Naong, M. et al., 2009). Consequently, creating an environment that captures the attention and provides a positive learning experience for first-year students is imperative for educators.

The primary objective of this research is to substantiate the notion that GBL holds the potential to enhance both student learning motivation and knowledge. By leveraging games as educational tools, teachers can create an environment that not only stimulates interest but also augments the overall learning experience for students.

Game-Based Learning (GBL)

Game-Based Learning (GBL) facilitates immersive learning experiences in a virtual environment, allowing students to practice and reinforce specific skills, knowledge, or behaviors (Jan & Gaydos, 2016).

Games, in this context, play a role in promoting logical and critical thinking, as well as contributing to the development of social skills, language abilities, communication skills, and creative and problem-solving capabilities (McFarlane et al., 2002).

Educational games are considered to have the potential of deeply engaging learners with any topic, allowing active participation in learning process (Wallner and Kriglstein 2011).

Beer Game

A well-known and widely used simulation game in the field of logistics and supply chain education is called the Beer Game. The Beer Game is a simulation that immerses participants in the common coordination challenges encountered in supply chains. Originally conceived at MIT (USA) in the 1960s, this role-play simulation offers an experiential understanding of supply chain dynamics. The purpose of the Beer Game is to experience systemic effects and to introduce the need for supply chain and network management, and to minimize inventory cost and backorder cost.

The Beer Game involves a four-part supply chain with a retailer, wholesaler, distributor, and factory, each managed by a separate person. In this team game, each player is responsible for managing the inventory of one echelon by placing orders. The orders and beer cases move in opposite directions. The goal is to minimize the total cost incurred by the team for each echelon, calculated by adding up inventory and backlog costs at the end of each simulated week (Sterman, 1989).

Lately, a developer has transformed the traditional board game of Beer Game into a web-based version available for free play on the internet. This study utilizes the web-based edition

developed by MA-system, a Swedish consulting company specializing in business logistics. Drawing inspiration from the original board game, this version streamlines the mechanics to make it more user-friendly.

Methodology & Research Design

The research aims to investigate two main objectives:

1) Game-based learning (GBL) can achieve knowledge for the learner.
2) Game-based learning (GBL) can create student learning motivation.

This study utilizes an experimental approach, wherein a designated class engages in playing a specified game. Data collection is conducted, and subsequent analysis is carried out to draw meaningful insights from the gathered information.

The Research Sample

- The participants consist of first-year students enrolled in the Logistics Technology bachelor's program at Rajamangala University of Technology Isan, Thailand.
- This research pertains to the Introduction to Logistics and Supply Chain Management subject.
- The game used for Game-Based Learning is the Beer Game Simulation, a web-based version created by MA-system, a Swedish consulting company specializing in business logistics.
- The sample size comprised 42 students (n=42).
- Experimental data collection occurred during the first semester of 2022 (October, 2022).

Data Collection and Data Analysis

1. To assess students' knowledge levels gained from Game-Based Learning (GBL) activity:
    - A Pre-test was administered before engaging in the game, comprising 10 questions covering all the knowledge objectives of the game.
    - Implementing a Post-test to determine whether students acquired the necessary knowledge to successfully complete the GBL activity; the post-test mirrors the pre-test.
    - Analyzing pre-test and post-test results using statistical measures such as Mean ($\bar{x}$), Standard Deviation (S.D.) and Percentage (%).
2. To evaluate learner motivation levels stemming from GBL activity:
    - Employing satisfaction questionnaires based on the Likert Scale.
    - The questionnaires are segmented into three sections: Learning Motivation, Learning Effectiveness, and Satisfaction Overview.
    - Examining the outcomes using statistical measures, including Mean ($\bar{x}$), Standard Deviation (S.D.), and Percentage (%).

Finding & Conclusion

1. To assess students' knowledge levels gained from Game-Based Learning (GBL) activity:

Before engaging in Game-Based Learning (GBL), the participating students were required to complete a pre-test using Google Form. They were allotted a time limit of 15 minutes to

answer a set of 10 questions. Subsequently, the teacher elucidated the rules and mechanics of the game.

The gaming session comprised two rounds. The first round served the purpose of familiarizing the students with the game's rules, while the second round involved actual gameplay, with a prize awarded to the winning team. Following the conclusion of the GBL session, the participants underwent a post-test through Google Form, with the post-test questions mirroring those from the pre-test. The comparison of students' scores is presented in Table 1.

Table 1: The comparison of the samples' scores between pre-test and post-test.

Sample	Score Pre-test	Score Post-test Score	Different	% Different
Student No.1	4	5	1	25%
Student No.2	4	8	4	100%
Student No.3	5	10	5	100%
Student No.4	5	7	2	40%
Student No.5	3	5	2	67%
Student No.6	3	8	5	167%
Student No.7	6	10	4	67%
Student No.8	4	8	4	100%
Student No.9	6	10	4	67%
Student No.10	6	9	3	50%
Student No.11	8	9	1	13%
Student No.12	6	9	3	50%
Student No.13	5	7	2	40%
Student No.14	6	9	3	50%
Student No.15	3	7	4	133%
Student No.16	2	9	7	350%
Student No.17	1	6	5	500%
Student No.18	6	10	4	67%
Student No.19	4	10	6	150%
Student No.20*	6	5	-1	-17%
Student No.21	3	9	6	200%
Student No.22	4	7	3	75%
Student No.23	2	7	5	250%
Student No.24	1	7	6	600%
Student No.25	6	9	3	50%
Student No.26	3	4	1	33%
Student No.27	4	7	3	75%
Student No.28	4	9	5	125%
Student No.29*	6	5	-1	-17%
Student No.30	5	10	5	100%
Student No.31*	6	5	-1	-17%

Sample	Score	Score	Different	% Different
	Pre-test	Post-test Score		
Student No.32	1	10	9	900%
Student No.33	3	6	3	100%
Student No.34	2	7	5	250%
Student No.35	2	7	5	250%
Student No.36	2	8	6	300%
Student No.37	6	9	3	50%
Student No.38	3	9	6	200%
Student No.39	2	5	3	150%
Student No.40	4	8	4	100%
Student No.41	4	8	4	100%
Student No.42	2	3	1	50%
Total	168	320	152	
Average	4.00	7.62	3.62	90.50%
S.D.	1.958879604	1.88630314		

P.S.:* Participants who achieved a post-test score lower than their pre-test score

The findings indicate that 92.85% of the total sample, specifically 39 participants, achieved Post-test scores surpassing those of the Pre-test. The experimental outcomes align with the anticipated results. In specific numerical terms, the average Pre-test score stood at 4 out of 10, while the average Post-test score exhibited a notable increase to 7.62 out of 10, representing a 90.50% improvement.

The teacher conducted interviews with students who scored lower on the post-test compared to the pre-test. During these interviews, it was discovered that student's No. 20 and No. 29 both assumed the role of retailer in both game rounds. They expressed difficulties in managing the supply chain effectively, particularly in coordinating the flow between manufacturer, distributor, and wholesaler roles. As a result, they lacked a comprehensive understanding of supply chain management. Additionally, student No. 31, who played the distributor role, experienced a loss of focus during the game, leading to a lack of comprehension of the rules and underlying theories. This loss of attention contributed to their challenges in grasping the intricacies of the game.

In summary, based on the test scores, it can be concluded that Game-Based Learning (GBL) not only fosters learning motivation but also enhances the knowledge level of the learners. The participants were first-year students enrolled in the Logistics program. The research utilized the Beer Game as the selected gaming approach.

2. To evaluate learner motivation levels stemming Game-Based Learning (GBL) activity:

To evaluate students' learning motivation, the researcher distributed a questionnaire using Google Form, which participants filled out after completing the post-test. The questionnaire employed a 5-point Likert scale to gauge the satisfaction of the respondents, with the scale interpreted as follows: 5 points for extremely satisfied, 4 points for very satisfied, 3 points for neutral, 2 points for slightly satisfied, and 1 point for not satisfied at all. Additionally, the

questionnaires were organized into three sections: Learning Motivation, Learning Effectiveness, and Satisfaction Overview, with the results presented in Table 2.

Table 2: The satisfaction of the learner motivation level from Game-Based Learning (GBL)

Session 1: Learning Motivation	$\bar{x}$	**Meaning**	**S.D.**
Game-based learning helps make the classroom atmosphere more interesting.	4.65	Extremely satisfied	0.52
Game-based learning makes it fun for me.	4.60	Extremely satisfied	0.53
Game-based learning is new to me.	4.63	Extremely satisfied	0.57
Game-based learning makes me more interested in the lesson.	4.70	Extremely satisfied	0.51
Game-based learning allows me to understand lessons better.	4.53	Extremely satisfied	0.62
Total Average	4.62		
Session 2: Learning Effectiveness	$\bar{x}$	**Meaning**	**S.D.**
I understood the content logistics and supply chain from the game I played (Beer Game)	4.49	Very satisfied	0.59
The game I played (Beer Game), I was able to understand the process of logistics and supply chain operations.	4.51	Extremely satisfied	0.54
In the game I played (Beer Game), I was able to understand inventory costs in the supply chain.	4.51	Extremely satisfied	0.59
The game I played (Beer Game), I was able to understand an overview logistics and supply chain system.	4.49	Very satisfied	0.59
In the game I played (Beer Game), I was able to find ways to solve problems related to supply chains.	4.53	Extremely satisfied	0.54
The game I played (Beer Game) helped me learn basic logistics and supply chain management courses more easily.	4.56	Extremely satisfied	0.58
Total Average	4.52		
Session 3: Satisfaction Overview	$\bar{x}$	**Meaning**	**S.D.**
Satisfaction Overview of Game-Based Learning Activity	4.77	Extremely satisfied	0.42
Total Average	4.77		0.42

The survey conducted on a sample of students revealed a high level of learning motivation, with an average ($\bar{x}$) score of 4.62 out of 5.00, indicating an exceedingly satisfactory response to Game-Based Learning (GBL).

In terms of learning effectiveness, the survey results indicated that students concurred on the beneficial impact of Game-Based Learning in enhancing their understanding of subjects such as Supply Chain, Logistics, and Inventory Costs. The average ($\bar{x}$) score for this aspect was 4.52 out of 5.00, signifying a high level of satisfaction among the respondents.

Furthermore, the overall satisfaction level of the sample population was notably high, as evidenced by an average score ($\bar{x}$) of 4.77 out of 5.00. This result reflects an exceptional level of contentment with the Game-Based Learning approach.

In conclusion, based on the satisfaction results, it can be inferred that Game-Based Learning (GBL) has the potential to significantly enhance student motivation for learning.

Discussion

Knowledge Level: The research findings reveal that 92.85% of the total sample size, specifically 39 participants, achieved higher scores than the Pre-test. This indicates a favorable outcome in the experimental group, signifying improved knowledge levels among the majority of GBL participants. To enhance understanding of all positions within the supply chain, the teacher should establish a condition requiring participants to switch player roles during the game. Furthermore, playing the game more than twice is recommended to allow participants to rotate through all positions, ensuring a comprehensive understanding of supply chain management.

Learning Motivation: The learning motivation average of 4.62 out of 5.00 is a strong indicator that the game-based learning approach has successfully motivated students. This phenomenon can be attributed to the implementation of collaborative activities involving the students. Specifically, group work was incorporated, wherein participants engaged in playing games under specified conditions for the attainment of prizes. Notably, incentives were awarded to the group demonstrating proficiency in winning, fostering heightened enthusiasm among students for game participation. The deliberate structuring of incentives aimed to cultivate a heightened interest and commitment to the gaming experience, thereby fostering an environment conducive to enjoyable and stimulating learning.

Suggestion

Comparisons with Traditional Teaching Methods: Implications for future research, to provide a comprehensive view, the research should consider comparing the effectiveness of game-based learning with traditional teaching methods.

Student Engagement: Beyond satisfaction, it would be interesting to explore the level of engagement that students experienced during the game-based learning sessions.

Potential Challenges and Limitations: Acknowledge any challenges or limitations encountered during the implementation of game-based learning. This could include technical issues, time constraints, or any difficulties in adapting the method to different learning styles.

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