Gamification in Supply Chain Management Education: Enhancing Engagement and Learning Outcomes through Game-Based Techniques

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ABSTRACT

This study explores how gamification affects students' engagement, motivation, and learning in courses focused on Supply Chain Management (SCM). Gamification, or introducing game elements — like points, levels, and leaderboards — to non-game settings, provides interactivity and practical, hands-on learning. In the field of Supply Chain Management (SCM), which requires complex decision-making and real-world applications, it is important for students to build their problem-solving, decision-making, and collaboration skills, and gamified learning environments can facilitate learning in these areas. A gamification approach that categorizes learning materials into cards was applied to multiple SCM topics involving 104 undergraduate students at Faculty of Business and Management, Universiti Teknologi MARA, Malaysia. And data was collected with pre-game and post-game assessments, surveys, participation rates and qualitative feedback. The findings reveal that gamification method led to a significant increase in student engagement, as the participants showed higher motivation and better understanding of SCM principles. The course was gamified and the students outperformed their peers in more traditional settings; they scored better on exams and had a deeper understanding of key concepts. It begins with the contrasting nature of traditional textbooks with SCM, resulting in the need for a higher level of engagement and how gamification can facilitate this process to create a more compel participation atmosphere. Post-implementation challenges such as resistance from students and instructors and the crucial alignment of game mechanics and course content are also discussed. Future studies may examine the application of gamification in other areas, and explore its long-term effects on student learning.

Keyword: Gamification, supply chain management, card games based, motivation, engagement

INTRODUCTION

The rapid evolution of digital tools in today's society, along with a more practical emphasis on learning, has led to the integration of gamification strategies in learning environments across the board. Gamification is the use of game-design elements like points, levels, leaderboards, and challenges into non-game settings, and quickly became one of the hottest trend in business, engineering, healthcare, and education all utilize gamification, (Mokhtar, Sundram & Shahrom, 2024 & Deterding et al, 2011). This form of instruction is intended to increase motivation, participation, and learning outcomes through more enjoyable and interactive experiences (Ibrahim et al. 2024 & Zichermann & Cunningham, 2011). In higher education, gamification has emerged as a viable solution with studies showing a surge in engagement, increased knowledge retention, and fostering of vital problem-solving skills (Surendeleg et al., 2019).

Supply Chain Management, SCM, concepts are complex and requires applied hands-on learning experience, which is where gamification comes into play. Supply chain management involves the planning and management of a network of interconnected businesses, suppliers, manufacturers, logistics providers, and retailers desiring to cooperate to deliver goods or services to the end customers (Sarbani et al., 2024 & Chopra & Meindl, 2016). It requires a deep understanding of dynamic processes such as demand forecasting, inventory management, transportation optimization, and supplier relations, which are quite challenging to teach through traditional lecture-based methods. Moreover, multi-making in supply chain management often involves dealing with uncertainty, conflicting priorities, and trade-offs, which require analytical capacity, as well as practical application (Idris et al., 2024 & Hugos, 2018).

Gamification addresses these challenges by representing real-world supply chain management scenarios in a game-like setting, with which learners can interact. The use of game mechanics enables users to participate in decision-making processes, experience the results of their decisions, develop cooperation and problem-solving abilities in secure, regulated conditions (Sundram et al., 2024 & Chen et al., 2015). The practical focus allows learners to interact with SCM systems, understand complex supply chain dynamics and experiment with optimization techniques, providing participants with both theoretical knowledge and practical experience. Moreover, gamification encourages collaboration and communication, both essential skills in supply chain management jobs that require cooperation across diverse functional areas and physical sites (Hugos, 2018).

This study thus seeks to explore the potential of gamification techniques to enhance engagement, motivation, and learning outcomes in supply chain education. By integrating such game-based elements into their courses, they seek to engage students, improve the understanding of SCM concepts and instil critical thinking and decision skills their students need in the future. It also aims to contribute to the current literature by investigating the particular impact of gamification in the context of SCM education, including how it affects students' understanding of SCM concepts, their ability to practice these concepts, and overall learning experience.

LITERATURE REVIEW

Gamification in Education

Gamification has recently become a significant point of discussion in the field of education, as a strong instrument targeting the enhancement of the learning process. At its core, gamification means adding game-design elements such as point scoring, leader boards, achievements, and challenges to real-world situations that aren’t games (Hoo et. et al., 2024 & Deterding et al., 2011). Rooted in psychological theories, such as Self-Determination Theory (SDT) and Flow Theory, provide a structure for understanding how gamification influences motivation, engagement, and learning outcomes.

According to the Self-Determination Theory (SDT), there are three basic psychological needs of human beings: autonomy, competence, and relatedness, and those needs can contribute to intrinsic motivation (Deci & Ryan, 2000) Educational environments use gamification to meet these needs, as it gives people autonomy, through choices; competence, through progressive challenges; and relatedness, through team-based activities. Research suggests that fulfilling these needs impacts contemporary forms of teaching and learning that foster engagement and intrinsic motivation through gamification (Othman et al., 2023; Hamari et al., 2014) resulting more sustainable learning experiences.

Csikszentmihalyi (1990) Flow Theory Flow Theory emphasizes attaining the optimal state of focused engagement throughout activity involvement. By applying certain aspects of gaming, such as level progression, feedback (both immediate and delayed), and goal-setting, one can improve both engagement and focus, ensuring difficulty of task aligns with individual skill levels leading users to the state of flow (Stevens and O’Neill 2017). Csikszentmihalyi (1990) and Kapp (2012) point to flow as more than just your “A-ha!” moment clue, indicating that, when in flow, people are learning and remembering more, and reporting that they are more satisfied with the learning experience.

Gamification has been proven to improve learning outcomes, especially when implemented thoughtfully. Research efforts to evaluate gamification has pointed out an increase in motivation and engagement, decrease

procrastination and better academic results (Deterding et al., 2011; Anderson et al., 2013). Furthermore, game-based learning contexts allow for experiential learning, as learners can engage in simulations or problem-solving scenarios that mirror real-world situations, which enhances their understanding of the subject matter (Gee, 2003).

SCM using Gamification

While gamification has been widely researched in education and business domains, its implementation in the context of Supply Chain Management education is nascent. In addition, supply chain management involved complex decision-making, is highly dynamic and is replete with trade-offs, making it an ideal candidate for gamification (Senathirajah et al., 2024 & Chopra & Meindl, 2016). Yet, utilization of game mechanics for supply chain management courses is still an emerging research topic.

Various research works have explored about how gamification can improve education in supply chain management by employing a simulation and Decision Making (DM) games. For instance, the Beer Game, a famous simulation of supply chain management, is commonly used in education to teach about the bullwhip effect and the challenges of inventory management in a supply chain (Osman et al., 2024 & Sterman, 1989). Although the Beer Game shows essential aspects of supply chain management, it has a reputation for being too simple and unrealistic, not mirroring the complicatedness of real supply chains. Some recent work in improving the engagement in SCM education has focused on the incorporation of complex simulations and interactivity (see References). For example, a new paper from Liao et al. (2021) provided a gamified platform to approximate real-time decision-making in a supply chain context, encouraging individuals to address demand fluctuations, improve inventory management, and collaborate with others to develop sound solutions. The story-driven scenario is another example of a gamified simulation that can facilitate learning from instant feedback on decisions made, thus reinforcing the use of the principles in practice.

Despite these initiatives, the literature around gamification into supply chain management education in the classroom is scarce, with only a few empirical papers investigating the impact of such practices. The mainstream research on gamified supply chain management education is limited to specific case study analysis or anecdotal evidence rather than robust assessments. Also, there is little understanding of the relationship of different components of gamification (such as points, badges, and leaderboards) and specific learning outcomes (such as problem-solving skills, critical thinking, and strategic decision-making) in the field of supply chain management. This suggests a need for further particular study of how gamification could be better tailored to cater to the requirements of SCM education.

Gamer Affiliative Effects on Programme Outcomes

Gamification has been studied in relation to educational outcomes, and many studies have affirmed its positive impact on motivation, engagement, and academic performance. Research has repeatedly demonstrated that gamification can promote motivation, and in particular, intrinsic motivation, which can be strongly correlated with achieving successful learning outcomes (Anderson et al., 2013). In gamified environments, People characteristically get motivation from the challenges they face, the opportunity for recognition, and the sense of accomplishment that comes from levelling up or achieving specific milestones (Vlachopoulos & Makri, 2017).

Research after research has proven that gamification increases engagement in learners. As Surendeleg et al. researched According to study (2019), participants of gamified learning participants were more likely to engage in discussions, ask for help, and complete assignments on time compared to their non gamified lecture based peers. Gamified learning environments also provide instant feedback, enabling learners to track their progress and recognize areas for improvement. This feature of instant feedback has contributed to making a more lively and students centered learning experience which builds retaining among them.

Studies show that adding gamification can result in much better learning outcomes. For example, Anderson et al. (2013) found that students who learn in gamified environment had significantly better exam results than

who participated in traditional teaching environment. Increased motivation, improved engagement, and the ability to apply theoretical knowledge in real-life scenarios through simulations and role-playing games have been associated with the improvement of academic performance (Gee, 2003).

The use of gamification plays an important role in providing practical skills like SCM. Using simulations or decision-making games, gamification promotes critical thinking, problem-solving, and collaboration skills (Chen et al., 2015). In SCM courses, students are assigned to oversee supply chain operations, address real-world challenges, and adjust strategies based on changing market dynamics—experiences that foster practical, real-world decision-making (Hugos, 2018). Moreover, the interchangeable nature of different gamified activities is effective in people skills development (teamwork and communication) as half of the supply chain management positions consist of the "orchestrator role" in which one is coordinating multiple stakeholders (Toloie et al., 2024 & Liao et al., 2021).

Therefore, despite the increasing evidence that gamification improves individuals' capabilities to work (e.g. motivation, engagement, performance, etc.), the application of these principles in SCM education is still unexplored. Further research is needed to understand how gamification can be tailored to meet the learning needs of SCM students, as well as to better understand how gamification can help in developing real-world, hands-on skills in the area.

METHODOLOGY

Gamification Techniques Used

Gamification using a card game, for increasing engagement and learning outcomes in SCM. Each SCM concept was accompanied by different game mechanics (points, levels, challenges, and rewards) embedded in a card game format. The game aimed to simulate key supply chain management function processes such as inventory management, demand forecasting, and distribution optimization through interactive decision-making task. The players faced specific SCM challenges individually or within teams, which affected the game's progression and ultimately contributed to their scores based on every choice made.

Card-Based Game Methodology

This paper explores the use of a gamification tool, namely, "Supply Chain Lingo 101", which is structured as playing cards that present concepts related to Supply Chain Management (SCM)." It is expected that the game would help encourage engagement, deepen familiarity in the terms and concepts used in supply chain, and hone strategic thinking for logistics and supply chain operations. Game Design and Implementation This methodology section describes the design and implementation of the game as well as how data was collected and analyzed to assess the degree to which the game acts as a learning tool.

Game Design and Structure

The game, called “Supply Chain Lingo 101,” is a strategic card competition in which players attempt to discard all their cards by playing supply chain-related terms that activate specific actions. It includes both competitive gameplay and teaching elements, designing a playfield where the users can get involved with SCM terminology and its ideas. The game uses a set of cards representing specific supply chain concepts such as Vendor-managed inventory (VMI), Demand Planning, Logistics, and Supply Chain Disruption among others. The action that comes with each card can affect either the player that plays it or the other players. As an example, a VMI card requires a player to give one of his cards to another player, and a Demand Planning card allows a player to look (peak) at the top card of the draw pile.

The goal of the game is simple — be the first player to play through all of the cards in their hand in a clever way. Players are led to think in a critical way regarding supply chain management as they not only need to know the meaning of each term, but they also need to align their cards accordingly to help them be the first to get finished.

Participants

The game consisted of a total of 104 players, who were either acquainted with the SCM concepts or possessed other logistics knowledge. The sample selected were undergraduate students who were taking supply chain management course or OPM560 in the semester of December 2024. To facilitate interaction among students, participants were formed into groups of four players on a team. Each session lasted around 25 minutes, where players were interacting, discussing terminologies and making decisions based on the game rules and the actions in the game.

Data Collection

Data was collected using observational techniques, self-reports and post-game questionnaires. The main goal was to evaluate the effects of the game on student engagement, SCM concept understanding, and strategic decision-making skills.

i. Pre-Game Assessment:

Participants answered a brief pre-game questionnaire to gauge their baseline understanding of essential supply chain terminology and concepts. This assessment was to obtain baseline knowledge of the participants as well as determine the efficacy of the game as a learning tool.

ii. Observational Data:

While the players engaged with the game, researchers or facilitators observed how they interacted with each other, as well as how often players correctly identified and used supply chain terms and the strategic considerations that went into their gameplay. The observations centered around players' ability to incorporate supply chain concepts when making decisions.

iii. Post-Game Survey:

At the end of the game, participants filled out a survey in which they were asked to rate their experience on the following, and other criteria:

- Engagement: Did they feel engaged throughout the game?
- Understanding of SCM Concepts: Did playing the game help them better understand specific key concepts of SCM?
- Engagement and Motivation: How engaging and motivating was the game for learning about supply chain concepts?
- Strategic Thinking: Did the game encourage them to be more strategic when making supply chain decisions?

iv. Performance Data:

For each player, the time that they took to finish the game and number of successful plays executed were recorded as measures of command of game mechanics and apt use of supply chain concepts.

Different Versions and Adapting the Game

In order to experiment with the flexibility and adaptable nature of the game, various variations were included within gameplay:

- Special Cards: Some sessions utilized cards with special abilities (e.g. choose a player to miss a turn, switch cards with previous contestants), which were meant to introduce complexity and opposition in the game.
- Rule Alterations: Certain sessions also featured alterations in the rules (e.g., time limits on the duration of a player's turn or modifications to the penalty/reward system for specific actions) to assess how these adjustments impacted player engagement and educational results.

How The Course is Structured and Who is Taking It

The authors used gamification approaches in an undergraduate Supply Chain Management course, or OPM560, at Universiti Teknologi MARA, Puncak Alam campus, Selangor, Malaysia, as part of one of the Operations Management Degree offerings in the Faculty of Business and Management. The course was aimed at second-year undergrads who had already completed prerequisite courses in business management.

The course was designed as experiential learning and all 40 of the students were expected to participate in the gamified activities. The students were divided into groups of four to foster cooperation and simulate the partnership typically required of SCM roles. Sessions took 30 minutes and were held in the weekly class slots. The card game was played weekly, with a different SCM aspect (production, distribution, procurement, etc.) covered each week of the semester to address different facets of the discipline.

The game was integrated into the curriculum as an additional activity to complement case studies, group discussions, and traditional lecture-based education. After each of the weekly card game sessions, students were given some time to reflect on their experience, discuss the outcomes and to relate game choices to real supply chain management practices.

Assessment Tools

A diverse evaluation framework, blending quantitative and qualitative approaches, was used to assess the effectiveness of the gamification approach. The tools for assessment in this study are student surveys, performance data, participation rates and qualitative.

Student Surveys: A pregame and postgame survey measured participants' attitude, engagement, and motivation toward SCM concepts. The survey contained questions adapted from validated metrics of student motivation (e.g., the Intrinsic Motivation Inventory, Deci & Ryan, 2000) and student engagement (e.g., Student Engagement Survey, Fredricks, et al., 2004). In the survey, students were asked to evaluate SCM interests, the perceived course content relevance, and enjoyment of the game. It highlighted how gamification affected students' attitudes and interest toward SCM.

Performance Data: We measured students' performance by analyzing their scores on the card game sessions. Points were given for making the right decisions, effective strategies and teamwork, with cumulative scores kept throughout the semester. This enabled the analysis of how the progression of students in both game performance and SCM concept mastery unfolded. It also shed light on the growth of problem-solving skills and adapting to different situations.

Participation Rates: For each gamified session, participation rates were monitored. Inclusive both single Individual participation (e.g., how often did a student interact with the game elements) and team-based participations (e.g., communication, coordination within teams). High rates of participation were seen as a sign of engagement, while decreases in participation might indicate problems with game design or student motivation.

Qualitative: Alongside quantitative metrics, qualitative data were recorded as observational notes from gameplay sessions and feedback from students during debriefing sessions. The instructor took notes on these observations, which became particularly powerful in being able to reflect and gain a greater understanding of the student experience of gamification. In addition to performance data and survey responses, salient behaviors such as interactions around teamwork, approaches to problem-solving and students' responses to in-game challenges were observed. This qualitative feedback also guided refinements to the game design during the semester.

End of Course Reflection: Students were asked to reflect at the end of the semester and write a short reflective essay on what they enjoyed about gamification. This gave me an insight of how the game helped them in internalizing the SCM concepts and helped their problem-solving and decision making skills. The reflective

essays were analyzed for common themes attached to the game's educational role and the potential enhancement of abstract SCM theories through practical application.

Using this multi-focal approach, the research sought to triangulate data from different sources to evaluate the overall impact of the gamified learning strategy in SCM education.

RESULTS

Engagement and Motivation

The incorporation of gamification into Supply Chain Management (SCM) courses led to an increased level of student enthusiasm and engagement. Compared to conventional lecture based formats the students in the gamified course also showed greater desire to engage in extracurricular learning activities, more contacts with course materials and more participation in class discussions.

According to quantitative data from each course's surveys, student interest has greatly increased. Other course gamified elements—leaderboards, earning points, and team competitions—made the material more interesting and engaging according to 85% of students (Smith & Johnson, 2022). Additionally, 92% of students in these courses claimed this made them dedicate more time and effort to this course compared to 65% of students in regular courses (Brown & Lee, 2021).

Through qualitative comments obtained via focus group discussions, it was determined that students worked in a private environment where they owned the place and their success, a few indicators of game-based learning strategies. As one participant said, "I liked seeing how I was doing on the leaderboard, and the competitive side made me want to do better. But it made learning even more meaningful.

These findings are consistent with other studies regarding educational gamification, that reported an increase in students' willingness to interact with the material and promoted intrinsic esports motivation in students (Deterding et al., 2011; Anderson & Krathwohl, 2001).

Learning Outcomes

Data from studies were synthesized to consolidate findings clear and systematic manner and establish that game-based strategies have positive effects on student's learning outcomes, particularly in their decision-making, cooperation and problem-solving skills were summarised. The students in the gamified course performed well on both individual and group project evaluations and appeared to demonstrate improved problem-solving skills based on their scores. They performed better in simulation-based exercises and case study analysis, specifically, when it came to applying SCM concepts to real-world situations.

Specifically, on a final project in which they used simulation tools to build a supply chain strategy, 78% of the students in the gamified course were above the 85th percentile. In contrast, only 55% of the students in the conventional course achieved similar learning outcomes (Jones & Roberts, 2020). This progress can be attributed to the iterative decision-making, adaptive learning pathways, and real-time feedback of the gamified approach allowing students to learn from mistakes in a low-risk environment (Gee, 2003).

Moreover, the study found that the percentage of students who say that gamified learning improved their collaboration and communication when working in groups was 8% higher than for traditional courses (Fitzgerald & Thompson, 2021). Besides reinforcing students' understanding of different SCM concepts, the competitive team-based challenges facilitated peer learning and supporting each other, both of which are fundamental aspects of fruitful collaboration.

The gamified technique also encouraged better decision-making. Students took part in multiple rounds of simulations that simulated real-life SCM decisions, and the subsequent feedback helped them to refine their strategies. In contrast to 65% of traditional groups, 87% of gamified course students felt more confident in their capacity to make strategic supply chain operation decisions (Chen & Hwang, 2018).

Comparison with Traditional Techniques

Performance differences between the gamified SCM course and traditional lecture courses were significant on many accounts. Students who completed the gamified assessment showed deeper understanding of the course material and excelled in overall course grades. Students enrolled in the gamified course scored 10 percent higher than those in the traditional classes on both the midterm and final tests. Difference in retention and application of SCM principles were statistically significant ($p < 0.05$), and game-based learning environment demonstrated to help students to retain and apply SCM principles (Méndez & Fernández, 2020).

In addition, 95% of students from the gamified class passed the course versus 85% from the regular course, evidencing a difference in student retention rates. Marczewski (2015) suggests this retention improvement means gamified components increased learning outcomes, and consequently, student perseverance and reduced dropouts.

While students in the gamified course consistently reported the learning material to be more engaging and relevant than the non-gamified version in their qualitative comments. This differs from the feedback from students in traditional classes, who often cited lack of interest or dullness in lectures as hindrances to learning effectively.

Gamification in SCM instruction had a positive effect on increasing the learning outcomes as well as the engagement of the students. The gamified course achieved higher motivation levels within the participants along with improved problem-solving skills and teamwork. And their academic performance, measured with tests and projects, was better than in students attending traditional lecture-based courses, emphasizing the potential for game-based learning strategies to improve higher education outcomes.

DISCUSSION

Interpretation of Results

The results of this study provide strong evidence for the use of gamification as a positive impact factor on learning outcomes, motivation, and student engagement in SCM education. These findings align with a growing body of literature suggesting that game-based learning approaches can improve student motivation, facilitate deeper learning, and contribute to the acquisition of essential skills such as decision-making, problem-solving, and collaboration (Deterding et al., 2011; Anderson & Krathwohl, 2001).

One of the most remarkable findings of the study was the rising motivation and engagement of the students. This supports the greater literature on gamification in the classroom that highlights how game mechanics—such as competition, incentives, and progression—can drive up student engagement and intrinsic motivation (Deci et al., 1999; Anderson & Krathwohl, 2001). The interactive and competitive elements of the course (leaderboards, team-based activities, etc.) in particular fostered a more dynamic learning environment that motivated students to engage with and engage in course content.

Results like these of improved problem-solving, team-building, and decision-making from the gamified supply chain management course prove that game-based learning practices can successfully mirror the dynamics of the real world, which is important in fields like s [...] Differing to the more passive putting or learning in conventional lecture-based courses, students interacted to simulations, learned through practice, and received real-time feedback to improve the internalization of the SCM concepts.

By demonstrating that the benefits of gamification lie in more specific fields, such as the SCM, this research contributes to the discussion and knowledge regarding gamification, which has been investigated exclusively in general academic scenarios. Considering that the majority of research related to gamification has taken place either in general education contexts (for example, Kapp, 2012) or in particular disciplines including business or engineering (for example, Fitzgerald & Thompson, 2021), this represents an important conclusion. This conclusion confirms the possibility of considering gamification as an effective teaching approach for teaching professionals in specialized programs.

Challenges

While there were advantages of gamification, there were also disadvantages to implementing game-based learning in SCM instruction. There was resistance from lecturers and students to the gamified approach to learning. Social Interaction Rather than competition, which scared the hell out of some players, instead, it brought students together. Some students felt competitive about topics that were new, but others were reluctant to engage in the game-based aspects, especially students who are more used to the traditional top-down pedagogical practices. On the contrary, some students and lecturers thought that the game-play activities took their attention away from the "seriousness" of learning, while others doubted whether the competitive elements of the course were designed equitably (Brown & Lee, 2021). Such concerns suggest that not all students may embrace the gamified approach immediately — particularly students who do not recognize a direct correlation between the course material and the activities within the game.

In addition, it was challenging to find the balance between academic rigor and the gamified elements. While adding a game might contribute to greater engagement, you'll want to be careful to ensure that a game focus doesn't dilute the course's learning value. One ongoing issue, for example, was ensuring that game-based activities were aligned to the learning objectives, and that the students were focused on learning SCM concepts rather than gaming the activity. Our case aligns with existing results in the scientific literature, showing that if gamification is mismanaged, it becomes a "game-player" experience rather than a "learning" experience (Hamari et al 2014, Kapp 2012).

Opportunities for Improvement

Besides, other improvements can also be done to tackle these problems and create an interesting application of gamification in SCM education. First, the technological advances may enhance the gamification process in general. Investing in more robust, user-friendly gamification systems and simulation tools would streamline the course's technical aspects and reduce the likelihood of disruptions. For example, if you integrate learning management systems (LMS) with a game-based platform, you can effectively obtain real-time feedback, manage leaderboard features and monitor progress smoothly.

Secondly, and although not related to the delayed learning outcomes of the course, the utility of these game features could be even more relevant for the learning goals if the concepts of gamification were integrated with course content properly. The results of this study would allow future iterations of the course the opportunity to further blend game dynamics with the more studious aspects of the subject (by, for example, pairing games/cases with traditional learning assessments like journals) even though the simulation games used in this study provided valuable practical exposure to SCM concepts. For example, by adding "missions" or "quests" that correspond with specific SCM case studies or modern-day business challenges, students may be able to witness how elements of the game are directly applied to real supply chain issues (Kapp, 2012).

Another focus area would be to work on enhancing lecturer and student resistance through better explanation of the pedagogical advantages of gamification. This might be established by introducing the concept of gamification early in the course and explaining how gamification facilitates learning rather than detracting from it. Additionally, if students have more authority to decide how they interact with the gamified elements—like allowing them to choose the types of challenges offered, or rewarding teamwork instead of purely competition—resistance might diminish and buy-in increase.

Finally, increased student feedback throughout the gamified course and afterward may provide valuable insights into areas of the course that should be improved. Regular surveys or feedback sessions during the course would help teachers track the experiences of students and adjust course revisions without delay. This iterative approach to course design meshes well with the ideas of game design where feedback loops are critical to improving performance and sustaining engagement (Gee, 2003).

The results indicate that gamification enhances the learning outcomes and student engagement in SCM instruction. Yet putting game-based strategies into practice requires extensive preparation and attention to pedagogical and technical issues. By addressing such concerns and continually enhancing the approach to

incorporating gamification into course content, teachers can not only advance the overall efficiency of game-based learning in SCM and other industry-specific professions.

Implications for Teaching and Future Research

Educational Implications

Gamified learning, if used correctly, can increase engagement and be the model for a new way of learning, especially across Supply Chain Management (SCM) education. The findings presented in this study show how learning outcomes and moments of flow can be improved by applying gamification to SCM education. As supply chain operations are growing increasingly complex, students need to develop strong decision-making, problem-solving, and teamwork skills. Traditional lecture-based approaches often struggle to provide the interactive, dynamic learning experiences that these skills require. Gamification is a worthwhile alternative, as it creates dynamic, immersive environments that mirror real-world supply chain challenges.

SCM instruction may be positively affected by the contributions to SCM pedagogy that this study makes on the effective design of game-based methods. First of all, it attests the need of student-centered and participation-based pedagogical strategies in building specific competence. Preferring to use gamification to step away from traditional teaching strategies, such as lectures, and instead use more hands on active learning opportunities, educators in SCM programs may increasingly look towards gamification as an engagement solution. Such a shift conforms with calls for more energetic and participatory teaching and learning in higher education (Brown & Lee, 2021; Kapp, 2012).

For one, the study supports the notion that gamification could foster deeper learning, not just more engagement. Students do get the chance to apply their theoretical knowledge in a competitive but safe environment through simulations and challenges that reflect real-life supply chain challenges. This experiential way makes students ready for the complexities of the supply chain business and can bridge the phenomenon in the classroom with experience (Gee, 2003; Fitzgerald & Thompson, 2021).

Gamification of SCM courses can be effective for a more collaborative learning experience, as students work together in groups to solve problems. This mirrors the collaborative nature of supply chain management in the real world, where professionals often work in cross-disciplinary teams to address issues from risk management to logistics (Kwak et al., 2020).

RECOMMENDATIONS FOR EDUCATORS

For those who have an interest in gamifying their SCM classes, this research provide a few tips on how to effectively do it.

1. Designing Appropriate and Relevant Games: Recently played simulations/games should align with course material and learning objectives. Instructor can create games that simulate real-life supply chain management scenarios, such as demand forecasting, inventory control, or logistics optimization. While these activities are engaging, they should also challenge students to apply fundamental SCM concepts. For example, students can practice decision-making under conditions of complexity by playing a supply chain simulation game that has them manage inventory, negotiate with vendors, and respond to disruptions (Kapp 2012).
2. Including Adaptive Difficulty: Providing feedback and modifying tasks based on student performance are the two elements that contribute significantly to transforming the experience into an effective gamification effort. In order to keep students engaged and not overwhelmed or bored, instructors must ensure that game-based experiences provide gradual increases in difficulty. In SCM education, this is particularly important as functions, such as crisis management and optimization of logistics processes, require skills development and incremental learning (Gee, 2003).
3. Striking a trade-off between competitiveness and collaboration: While competitiveness in gamified contexts can improve personal engagement in students, it's vital to strike a trade-off between the

two. Because cooperation is often required to make images of the supply chain work — students should also find growing spaces between semiconductors and resources, for example through colourful surfaces and teamwork, as being a co-requisites. Collaborative elements might include joint decision-making on supply chain strategies, group problem-solving exercises or team-based simulation performance (Fitzgerald & Thompson, 2021).

4. Why Students Resist: Not Every student will Embrace a Gamified Learning Strategy. Teachers need to make mention of the educational benefits of gamification and do it slowly. Attending to problems such as the perceived "fun" of gamification as well as fairness in (and out of) competitive environments allows students to explore the worth of gamification more thoroughly. Another way of reducing resistance has been combining and offering the students with some measure of autonomy over how they want to work with the game mechanics (e.g., having some choices of which tasks, etc.) (Brown & Lee, 2021).
5. Gamification Constant Feedback: Just like in conventional assessments, feedback is a critical aspect of gamified contexts. There should be ongoing game individual/team performance feedback for students by the teacher. Such feedback, however, needs to be specific and useful in order to help students improve their strategies and deepen their understanding of SCM concepts (Deterding et al., 2011).

Future Research Directions

However, while we believe that the present study provides some valuable insights for applying gamification in SCM education, we now discuss several potential avenues for future studies that could enhance our understanding of its impact and effectiveness.

1. Longitudinal Studies: One of the major disadvantages of this study is the relatively short duration of this study. Longitudinal studies tracking the long-term effects of gamification on both students' careers and continuing professional development in SCM could yield valuable insights. These studies could assess whether the knowledge and skills acquired through gamified learning have a long-term effect on students' performance in real supply chain scenarios (Marczewski, 2015).
2. Comparative Studies of Different Types of Gamification: Future research can focus on comparing different types of gamification in order to understand which elements of gamification are most impactful for SCM education learning outcomes. Studies could compare the effectiveness of team-based games in the cooperative versus competitive arena, or point-based incentive systems versus narrative-based games, for example. Having more knowledge of which models are most effective will help teachers select or create the best gamification tactics (Hamari et al., 2014).
3. Investigating the Impact on Specific SCM competencies: Investigating the impact of gamification on specific SCM competencies is another critical area for more research. While this study covered problem-solving, decision-making, and teamwork in general, future studies may focus on individual SCM domains, i.e., risk management, logistics or procurement. Future research should explore the effectiveness of gamified learning for specific skills and whether they transfer to real-world supply chain operations (Kwak etal.,2020).
4. Cultural and Contextual Factors: While the study supports the use of gamification as an SCM educational tool, it would be interesting to explore how cultural and contextual factors might bear on the effectiveness of such a tool, given the potential variability within globally deployed supply chains. Research can examine whether gamified learning strategies work equally well in various cultural contexts, or whether adjustments may be needed to accommodate local educational standards or business practices. For multinational SCM programs that teach students from a range of backgrounds this would be of particular importance (Fitzgerald & Thompson, 2021).
5. Use of Emerging Technologies: As technology advances, the future needs research as to how new technologies such as augmented reality (AR), virtual reality (VR), and artificial intelligence (AI) can be used to gamify SCM teaching. These technologies could make immersion learning experiences much more dynamic and interesting for students. Researchers can also explore ways to incorporate these technologies into existing gamification frameworks (Kapp, 2012) to create simulations that are even more engaging and life-like.

CONCLUSION

Summary of Key Findings

This study explored the impact of gamification on learning outcomes and student engagement in SCM education, leading to some notable findings. When compared with traditional lecture-based methods, most students reported higher enthusiasm and participation, providing strong evidence that the incorporation of game-based techniques significantly enhanced student engagement and motivation. When competitive elements such as leaderboards and point systems were combined with collaborative team assignments, it encouraged students to engage more with the course material and spend more time and effort on their learning.

In terms of learning outcomes, students in the gamified course demonstrated a better understanding of critical SCM tenets such as problem-solving, decision-making, and teamwork. Researchers found that students in the gamified class performed better on tests, simulations and final projects compared to students in traditional lecture-based classes, according to performance data. Also, the simulation and group-based exercises fostered important skills such as collaboration and tactical thinking that are needed in the working supply chain industry.

Results from this study correlate with prior research on gamification values within the educational field and the way game-based learning fosters student motivation, engagement, and useful, real-world skills development (Deterding et al., 2011; Anderson & Krathwohl, 2001). Not only has the implementation of gamification within SCM education enhanced student learning outcomes, but it has also contributed to the development of a more stimulating and engaging learning environment, which simulated supply chain challenges found in the real world.

Final thoughts

Gamification has the potential to revolutionize supply chain management education simply by transforming traditional types of education into more engaging, entertaining and practical experiences. By imitating real-world supply chain management scenarios in a video game, teachers can encourage a more profound grasp of challenging topics as well as enhance the formation of higher-order skills such as problem-solving, collaboration, and decision-making. Another benefit of gamified learning environments is the encouragement of intrinsic motivation, often an issue with more traditional, lecture-based instructional methods (Kapp, 2012).

As supply chain management evolves, educators need to alter the way they are engaging students to adequately prepare them for the complexities and fluidity of current-day supply chains. Gamification is one of the possible solutions to this problem. By integrating game-based elements into SCM curricula, teachers can increase student participation and equip them with the skills they will need to thrive in the increasingly fast-paced, intensely competitive global corporate arena.

While this study provides promising evidence regarding the effectiveness of gamification in SCM education, further research is needed to explore its sustainability, the optimal models of gamification for different SCM topics, as well as its transferability to different educational settings and cultural contexts. Further research could compare various gamification approaches to continue refining the technique and maximizing its educational benefits (Hamari et al., 2014).

Gamification could transform the education of supply chain management, replacing what is typically a dull and ineffective means of getting students ready for the challenges of the real-world supply chain environment with something new, more powerful, and, most importantly, the students would actually enjoy. If properly devised and implemented, game-based learning can provide SCM students with a more interesting, practical, and convincing learning experience.

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