Examining the Impact of Gamification on Teaching and Learning Activities in Supply Chain and Technology Management Courses

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ABSTRACT

Gamification has emerged as an innovative pedagogical strategy aimed at enhancing student engagement and improving students' perceived understanding in higher education. However, empirical evidence regarding its effectiveness in improving conceptual understanding within technical management disciplines remains limited. This study examines the impact of gamification on students' understanding of supply chain management (SCM) and technology management concepts. A quantitative pre–post research design was employed involving 180 undergraduate students enrolled in SCM-related courses at a Malaysian public university. Gamified learning activities, including interactive quizzes, collaborative problem-solving games, and decision-analysis exercises, were integrated into classroom teaching over six weeks. Students' perceived understanding of SCM terminology and concepts was measured before and after the gamification intervention using a structured questionnaire based on a five-point Likert scale. Paired sample t-test analysis revealed a significant improvement in students' understanding following the gamified learning sessions ($p < .05$), indicating the effectiveness of gamification in enhancing perceived conceptual understanding. The findings suggest that gamified learning environments can transform traditional passive learning into interactive experiences that facilitate deeper engagement and knowledge retention. The study contributes to the growing body of literature on gamification in management education by providing empirical evidence of its improvements in students' perceived understanding in supply chain and technology management contexts. Implications for teaching practice and curriculum design in higher education are discussed.

Keywords*:* Gamification, Supply Chain Management Education, Technology Management, Active Learning, Higher Education, Learning Outcomes

INTRODUCTION

The increasing digitalization of higher education has transformed the way knowledge is delivered and consumed. In business-related disciplines such as supply chain management (SCM) and technology management, students are expected to understand complex terminologies, interconnected processes, and dynamic decision-making environments. However, traditional lecture-based approaches often lead to passive learning, limited engagement, and superficial understanding of technical concepts.

Teaching complex, technical disciplines like supply chain management presents pedagogical challenges in higher education due to the abstract nature of concepts and terminology. Traditional lecture-oriented modes often fail to engage students deeply, resulting in superficial comprehension and limited long-term retention (Sailer et al., 2021). Meanwhile, gamification (the application of game design elements) in non-game environments has gained traction as a strategy to enhance motivation, participation, and learning effectiveness (Hamari et al., 2023).

Prior research highlights gamification's positive influence on engagement and self-reported learning outcomes across various disciplines (Dicheva et al., 2020). However, the specific effect of gamification on students'

understanding of specialized terms and content in SCM and technology management remains underexamined, particularly when measured using structured pre- and post-participation assessments.

Despite widespread adoption of gamified learning activities in business education, it is unclear whether these approaches meaningfully improve students' understanding of specialized SCM and technology management terminology, beyond enhancing motivation and participation. Most studies focus on engagement outcomes rather than cognitive learning gains (Koivisto & Hamari, 2020). Although numerous studies have reported positive effects of gamification on student engagement and motivation, fewer studies have examined changes in students' perceived understanding using structured pre–post assessment designs (Klimova & Pikhart, 2021; Sailer & Homner, 2020).

Existing literature lacks evidence within SCM and technology management courses, especially in Southeast Asian university contexts (Nguyen et al., 2022). Furthermore, few studies isolate the effect of gamified elements on technical vocabulary comprehension, as distinct from general course content learning (Johnson et al., 2021). This study addresses these gaps by evaluating gamification's impact on students' self-reported understanding of SCM-related terms before and after gamified learning interventions. Thus, the current study aims to assess the impact of gamification on students' understanding and engagement in SCM and technology management courses.

LITERATURE REVIEW

Gamification Theory and Learning

Gamification refers to the strategic integration of game design elements—such as points, leaderboards, challenges, badges, and real-time feedback—into non-game contexts to enhance motivation and engagement. Contemporary research conceptualizes gamification not merely as a motivational tool but as a structured instructional strategy capable of influencing cognitive and behavioral outcomes (Sailer and Homner, 2020; Hamari et al., 2023). The theoretical foundation of gamification is frequently anchored in Self-Determination Theory (SDT), which posits that intrinsic motivation is fostered when learning environments support autonomy, competence, and relatedness (Ryan & Deci, 2020). Game mechanics such as progress tracking and feedback can enhance perceived competence, while collaborative challenges promote relatedness among learners. However, scholars caution that gamification may become superficial if it emphasizes extrinsic rewards without meaningful alignment to pedagogical objectives (Deterding, 2021). Thus, theoretical discussions increasingly highlight the importance of instructional coherence rather than mere gamified features.

Gamification in Higher Education

Within higher education, gamification has been widely implemented to address declining engagement and passive learning behaviors. Empirical evidence suggests that gamified interventions can increase classroom participation, motivation, and interaction (Alhammad & Moreno, 2021; García Sánchez et al., 2022). For instance, quiz-based platforms incorporating leaderboards and badges have been associated with higher levels of student interaction and immediate formative feedback (Lee & Hammer, 2021). Similarly, simulation-based and scenario-driven games have demonstrated potential in enhancing applied problem-solving and decision-making skills (Huang et al., 2023).

Despite these promising findings, results regarding learning gains remain inconsistent. While some studies report improvements in academic performance, others indicate minimal or no significant cognitive impact beyond increased engagement (Koivisto & Hamari, 2020). This inconsistency suggests that the effectiveness of gamification depends heavily on instructional alignment, assessment integration, and the nature of learning outcomes being measured (Deterding, 2021). In many cases, studies rely on post-intervention perception surveys rather than objective or comparative learning assessments, limiting the strength of causal claims. Therefore, although gamification appears beneficial for engagement, its influence on measurable knowledge acquisition warrants further empirical validation.

Gamification in Management and Supply Chain Education

In business, operations, and supply chain management (SCM) education, gamification has been used primarily through simulations and competitive classroom activities. Supply chain simulation games, for example, allow students to visualize demand variability, coordination challenges, and inventory fluctuations, thereby making abstract concepts such as the bullwhip effect more tangible (Nair et al., 2022). Such experiential learning tools are consistent with constructivist principles, where knowledge is actively constructed through problem-solving and reflection.

Gamified learning activities can improve learner engagement and educational outcomes when appropriately designed (Sailer & Homner, 2020). However, existing research in management education largely emphasizes engagement, teamwork, and decision-making skills rather than the mastery of foundational terminology (Tan et al., 2024). Given that technical vocabulary forms the basis for higher-order analysis and strategic reasoning in SCM, insufficient attention to terminology comprehension represents a notable gap. Furthermore, empirical studies focusing specifically on SCM and technology management contexts, particularly within emerging economies, remain limited, indicating the need for context-specific investigations.

Measuring Learning Outcomes in Gamified Contexts

The evaluation of learning outcomes in gamified environments remains methodologically diverse and, at times, inconsistent. Many studies measure engagement indicators such as attendance, satisfaction, or self-reported enjoyment, rather than structured assessments of knowledge acquisition (Klimova & Pikhart, 2021). While these affective measures are important, they do not necessarily reflect improvements in students' perceived understanding or long-term retention. Therefore, previous reviews have recommended the use of more rigorous evaluation methods, including pre–post assessments and effect size reporting, to better assess the educational impact of gamification (Sailer & Homner, 2020; Klimova & Pikhart, 2021).

Moreover, few studies differentiate between short-term excitement and sustained learning improvement. Without comparative baseline measurements, it is difficult to determine whether perceived improvement reflects actual conceptual gains or merely heightened enthusiasm. Addressing this limitation requires structured instruments that measure the same constructs before and after intervention. Accordingly, the present study adopts a pre–post survey design to evaluate changes in students' understanding of SCM and technology management terminology, thereby contributing more robust evidence to the ongoing debate regarding the educational effectiveness of gamification.

Research Design

This study employed a quantitative pre–post experimental design complemented by a perception-based survey to evaluate changes in students' understanding of supply chain management (SCM) and technology management terminology following gamified learning interventions. The pre–post approach enabled the measurement of perceived cognitive improvement by comparing students' self-assessed understanding before and after participation in structured gamification activities. This design is appropriate for examining instructional interventions in higher education settings where randomized control groups are not feasible, but measurable change over time is required.

Participants

The participants comprised undergraduate students enrolled in Supply Chain Management, Operations Management, and Technology Management courses at a Malaysian public university, specifically from Universiti Teknologi MARA (UiTM). A convenience sampling approach was adopted, as participants were drawn from courses taught during the semester of data collection. Approximately 180 students voluntarily participated in the study. The sample represented learners exposed to core SCM concepts, including logistics coordination, inventory management, demand forecasting, and digital supply chain technologies. Participation was not linked to academic grading, ensuring independent and unbiased responses.

Gamification Intervention Framework

The gamification intervention was designed as a structured experiential learning strategy to enhance students' perceived understanding, engagement, and application of Supply Chain Management (SCM) and Technology Management concepts. The intervention was integrated into the normal classroom teaching process rather than replacing conventional instruction. It combined instructor-led teaching with collaborative game-based activities to encourage active participation, peer interaction, and contextual application of theoretical knowledge.

The intervention was developed around two gamified learning tools: Supply Chain Lingo (SCL) and the Supply Chain Decision Analysis Tool (SPDAT). SCL is a terminology-based card game designed to reinforce students' understanding of key SCM concepts and technical vocabulary through collaborative discussion and problem-solving. SPDAT is a scenario-based analytical tool that requires students to apply SCM concepts to realistic business situations by identifying supply chain issues, analysing alternatives, and recommending appropriate solutions.

The overall intervention consisted of four sequential phases: pre-intervention assessment, gamified learning activities, reflective learning, and post-intervention assessment (Figure X). Before the intervention, students completed a questionnaire measuring their perceived understanding of SCM concepts and terminology. The lecturer then introduced the learning objectives, explained the game rules, and clarified the expected learning outcomes before the gamification sessions commenced.

Students were organised into collaborative groups of four to six members to promote teamwork, communication, and knowledge sharing. Throughout the intervention, the lecturer acted as a facilitator by monitoring group discussions, providing immediate feedback, clarifying misconceptions, and relating game outcomes to real-world supply chain practices.

Procedural Implementation

The intervention was implemented during Weeks 8 and 9 of the semester in the Supply Chain Technology (BTM535) and Introduction to Operations Management (OPM530) courses. These weeks were selected because students had already completed the introductory topics and possessed sufficient foundational knowledge of SCM principles. Each gamification session followed a standardised instructional procedure to ensure consistency across classes.

Phase 1: Pre-Intervention Assessment

Students first completed a structured questionnaire measuring their perceived understanding of SCM concepts and terminology using a five-point Likert scale. This assessment served as the baseline for comparison with post-intervention responses.

Phase 2: Supply Chain Lingo (SCL)

Students participated in the Supply Chain Lingo activity in small groups. Each group received a set of terminology cards containing key SCM concepts such as reverse logistics, bullwhip effect, cold chain, blockchain, and inventory management. Students were required to explain each concept, discuss its practical application, and relate it to real organisational examples. Group members earned points for providing accurate explanations and relevant examples.

During gameplay, the lecturer facilitated classroom discussions by correcting misconceptions, providing additional explanations, and encouraging students to connect theoretical concepts with current supply chain practices.

Phase 3: Supply Chain Decision Analysis Tool (SPDAT)

Following the terminology activity, students were presented with authentic business scenarios involving supply chain challenges. Working collaboratively, each group analysed the assigned scenario using the SPDAT worksheet by:

- identifying the supply chain issue;
- analysing contributing factors;
- evaluating possible alternatives;
- recommending an appropriate solution; and
- justifying their decision based on SCM principles.

Each group subsequently presented its analysis to the class, followed by the lecturer's feedback and peer discussion. This activity encouraged students to apply theoretical knowledge to practical decision-making situations while promoting collaborative learning.

Phase 4: Reflection and Debriefing

At the conclusion of each session, the lecturer conducted a structured debriefing to reinforce the learning objectives and summarise key SCM concepts addressed during the activities. Students reflected on their learning experiences, discussed challenges encountered during gameplay, and identified concepts that required further clarification. The intervention was scheduled during the eighth and ninth weeks of the semester for the Supply Chain Technology (BTM535) and Introduction to Operations Management (OPM530) courses, ensuring that students had acquired foundational knowledge of key SCM concepts beforehand. Students were organized into small collaborative groups to participate in gameplay, with lecturers facilitating the sessions by providing real-time clarifications of SCM terminologies. For example, when a “reverse logistics” card was played, lecturers explained its definition and practical application, reinforcing theoretical understanding through experiential engagement.

Post-Intervention Activities and Iterative Refinement

Following completion of the gamified learning sessions, students reviewed a sustainability-related supply chain case and applied their learning using the SPDAT framework. They subsequently submitted individual reflective responses through UFUTURE, the university's learning management system. The reflections focused on students' perceived understanding of SCM concepts, the usefulness of the gamified activities, and suggestions for improving future learning sessions.

Students also completed the post-intervention questionnaire, which contained the same perceived understanding items administered before the intervention, together with additional items measuring engagement, motivation, and overall learning experience. Using identical pre- and post-intervention items enabled direct comparison of changes in students' perceived understanding following participation in the gamified activities.

The lecturer reviewed students' reflections and questionnaire feedback to identify recurring themes regarding learning effectiveness, classroom engagement, and areas requiring improvement. Suggestions provided by students—including the incorporation of additional real-world case studies, more complex decision-making scenarios, and greater integration of sustainability issues—were used to refine subsequent implementations of the SCL and SPDAT activities. This iterative refinement process ensured that the intervention remained aligned with course learning outcomes while continuously improving students' learning experiences.

Table 3.1: Intervention Framework

Phase	Activity	Lecturer's Role	Student's Role	Duration	Expected Outcome
Phase 1	Pre-intervention questionnaire	Explain the study and administer the survey	Complete questionnaire	20 minutes	Baseline perceived understanding
Phase 2	Introduction to SCL and SPDAT	Explain rules and learning objectives	Listen and prepare	15 minutes	Understand game procedures
Phase 3	Supply Chain Lingo (SCL)	Facilitate gameplay, clarify	Discuss terminology and	45–60 minutes	Improved perceived understanding of SCM terminology

		concepts, and provide feedback	examples in groups		
Phase 4	Supply Chain Decision Analysis Tool (SPDAT)	Present case scenarios and guide discussion	Analyse cases and recommend solutions	60 minutes	Apply SCM concepts to practical situations
Phase 5	Reflection and Debriefing	Summarise key concepts and facilitate reflection	Reflect and discuss learning experiences	20 minutes	Reinforce conceptual understanding
Phase 6	Post-intervention questionnaire	Administer post-test	Complete questionnaire	20 minutes	Measure changes in perceived understanding

Instruments

Data were collected using a structured, self-administered questionnaire developed to measure students' perceived understanding of Supply Chain Management (SCM) and Technology Management concepts before and after the gamification intervention, as well as their perceptions of the gamified learning experience. The questionnaire was developed based on the learning outcomes of the courses, relevant literature on supply chain management education, and previous studies on gamification in higher education. The instrument consisted of three sections.

Section A collected respondents' demographic information, including gender, age, academic programme, year of study, and course enrolled. These data were used to provide a comprehensive demographic profile of the respondents.

Section B measured students' perceived understanding of SCM concepts before and after the gamification intervention. The same nine items were administered during both the pre-intervention and post-intervention assessments to facilitate direct comparison of students' perceived understanding. Responses were measured using a five-point Likert scale ranging from 1 (Very Poor Understanding) to 5 (Excellent Understanding).

The perceived understanding scale included the following nine items:

1. I am knowledgeable about the principles of supply chain management.
2. I am knowledgeable about the impact of management on supply chain activities.
3. I am capable of describing supply chain management.
4. I am proficient in applying supply chain concepts within the business environment.
5. I can implement supply chain management principles in a business environment.
6. I can oversee the administration of supply chain activities within an organisation.
7. I comprehend the management of supply chain activities.
8. I can articulate the significance of supply chain management.
9. I understand the process of allocating supply chain activities to achieve organisational goals.

Section C evaluated students' perceptions of the gamified learning activities following the intervention. This section measured students' engagement, motivation, and overall satisfaction with the gamified learning experience using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

To ensure content validity, the questionnaire was reviewed by academic experts in Supply Chain Management and Technology Management. Their feedback focused on the clarity, relevance, and appropriateness of the questionnaire items in relation to the study objectives. Minor revisions were made to improve wording and ensure alignment with the intended learning outcomes before the instrument was administered.

The internal consistency reliability of the perceived understanding scale was assessed using Cronbach's alpha coefficient. The pre-intervention scale demonstrated excellent reliability with a Cronbach's alpha value of 0.990, while the post-intervention scale recorded a Cronbach's alpha value of 0.965. Both values exceeded the recommended threshold of 0.70 (Hair et al., 2022), indicating excellent internal consistency and confirming that the instrument was suitable for subsequent statistical analyses.

Table 3.2: Reliability Analysis of the Perceived Understanding Scale

Construct	Number of Items	Cronbach's Alpha
Pre-Gamification Perceived Understanding	9	0.990
Post-Gamification Perceived Understanding	9	0.965

Data Analysis

Data were analysed using IBM SPSS Statistics Version 28. Prior to analysis, the dataset was screened for missing values, incomplete responses, and data entry errors. Only completed questionnaires were retained for analysis.

Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarise respondents' demographic characteristics and overall response patterns. The demographic profile included information on respondents' gender, age, academic programme, year of study, and course enrolment.

The internal consistency reliability of the perceived understanding scale was evaluated using Cronbach's alpha coefficients. The results demonstrated excellent reliability for both the pre-intervention ($\alpha = 0.990$) and post-intervention ($\alpha = 0.965$) scales.

To determine whether students' perceived understanding differed significantly before and after the gamification intervention, paired-samples t-tests were conducted. Cohen's d effect size was calculated to determine the practical significance of the observed differences, with effect sizes interpreted as small (0.20), medium (0.50), and large (0.80) following Cohen (1988). Statistical significance was established at the 0.05 level ($p < .05$).

Ethical Considerations

Ethical considerations were carefully observed throughout the study. Participation was voluntary, and students were informed about the purpose of the research before data collection commenced. Informed consent was obtained from all participants, and they were assured that their decision to participate or withdraw from the study would not affect their academic standing or course grades.

All responses were collected anonymously, and no personally identifiable information was recorded. Data were treated as confidential, securely stored, and reported only in aggregate form to protect participants' privacy. The study was conducted in accordance with the ethical principles governing educational research involving human participants. Where applicable, ethical approval was obtained from the UiTM research ethics committee prior to data collection.

RESULT

Respondent Profile

A total of 180 valid responses were obtained for analysis. In terms of gender, the sample comprised 95 female students (53.0%) and 85 male students (47.0%). Although female respondents slightly outnumbered their male

counterparts, the relatively balanced gender distribution provides a representative perspective on students' experiences with the gamification intervention.

In addition, the majority of respondents were between 20 and 21 years old (n = 144, 80.0%), while the remaining 36 respondents (20.0%) were aged 22 to 23 years. This age distribution reflects the typical age range of undergraduate students enrolled in supply chain and technology management programmes at the university.

With respect to the year of study, most participants were Year 2 students (n = 151, 84%), whereas 29 respondents (16%) were in Year 3. The higher representation of Year 2 students is consistent with the curriculum structure, as the selected courses are primarily offered during the second year of the undergraduate programme. The inclusion of Year 3 students nevertheless provided additional insights from students with relatively greater academic exposure to management-related subjects.

Figure 1 illustrates that most respondents (70%) were enrolled in the Bachelor of Office System Management programme. This indicates that the findings primarily reflect the perceptions of students studying business programmes with a strong technology and operations orientation.

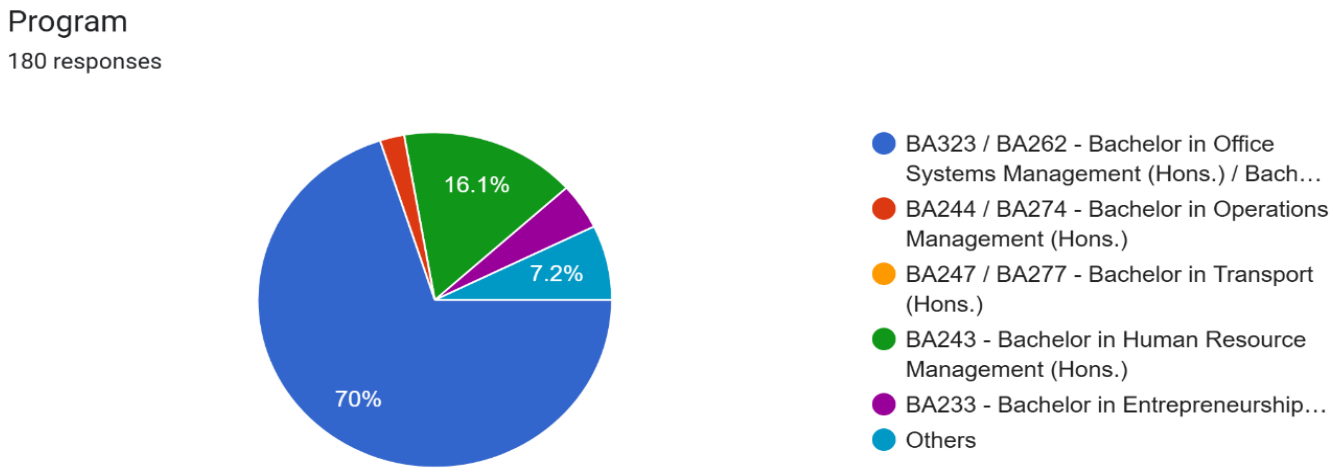

Figure 1: Distribution of Respondents by Academic Program

Figure 2 indicates that more than two-thirds of the respondents (71.1%) were enrolled in BTM535 Supply Chain Technology. Consequently, the study findings are largely representative of students undertaking courses directly related to supply chain management.

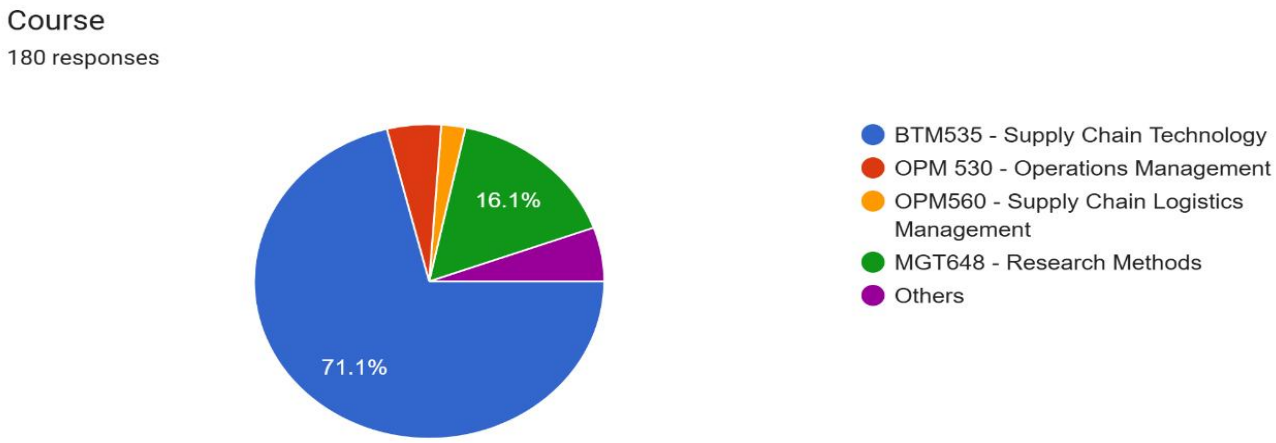

Figure 2: Distribution of Respondents According to Course Enrolment

The demographic distribution suggests that the sample largely represents students from technology-oriented management programs and supply chain-related courses.

Frequency Analysis

The following frequency analysis displays the distribution of responses on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) for both pre- and post-gamification assessments (N = 180).

Pre-Gamification Frequency Analysis

Table 1 below shows that before the intervention, the student responses were widely distributed, with a significant concentration in the Disagree (2) and Neutral (3) categories across all items.

Table 1: Pre-Gamification Understanding

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Q1: Knowledge of principles	7.22%	26.67%	25.00%	26.11%	15.00%
Q2: Impact of management	8.33%	26.11%	26.11%	22.78%	16.67%
Q3: Describing SCM	7.78%	26.11%	29.44%	22.78%	13.89%
Q4: Applying SCM concepts	10.56%	26.67%	23.33%	25.56%	13.89%
Q5: Implementing SCM principles	10.56%	25.56%	25.56%	25.56%	12.78%
Q6: Overseeing administration	12.22%	23.89%	21.67%	27.78%	14.44%
Q7: Comprehending management	10.00%	26.11%	26.11%	25.56%	12.22%
Q8: Articulating significance	11.67%	23.89%	25.56%	26.67%	12.22%
Q9: Allocating activities	8.89%	23.33%	27.78%	26.67%	13.33%

Post-Gamification Frequency Analysis

After the gamification session, the distribution shifted drastically toward Agree (4) and Strongly Agree (5). The scores for "Strongly Disagree" and "Disagree" dropped to near-zero levels.

Table 2: Post-Gamification Understanding

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Q1: Knowledge of principles	0.00%	1.67%	10.56%	52.22%	35.56%
Q2: Impact of management	0.00%	1.67%	9.44%	51.67%	37.22%
Q3: Describing SCM	1.11%	1.11%	14.44%	46.11%	37.22%
Q4: Applying SCM concepts	0.00%	2.78%	9.44%	52.78%	35.00%
Q5: Implementing SCM principles	0.56%	1.67%	10.00%	54.44%	33.33%
Q6: Overseeing administration	0.00%	1.67%	11.67%	48.89%	37.78%
Q7: Comprehending management	0.56%	1.67%	12.78%	45.56%	39.44%
Q8: Articulating significance	0.00%	2.22%	12.22%	49.44%	36.11%
Q9: Allocating activities	0.56%	1.11%	11.11%	48.33%	38.89%

Descriptive Analysis

To evaluate the effectiveness of the gamification intervention, a paired sample t-test was conducted comparing students' perceived understanding of supply chain terminology before and after participating in gamified learning activities. The paired sample t-test (Figure 3) revealed that the difference was statistically significant, $t(179) = 12.49$, $p < .001$. The calculated effect size using Cohen's d indicated a large effect ($d = 1.24$), suggesting that the gamification intervention had a substantial impact on students' perceived conceptual understanding.

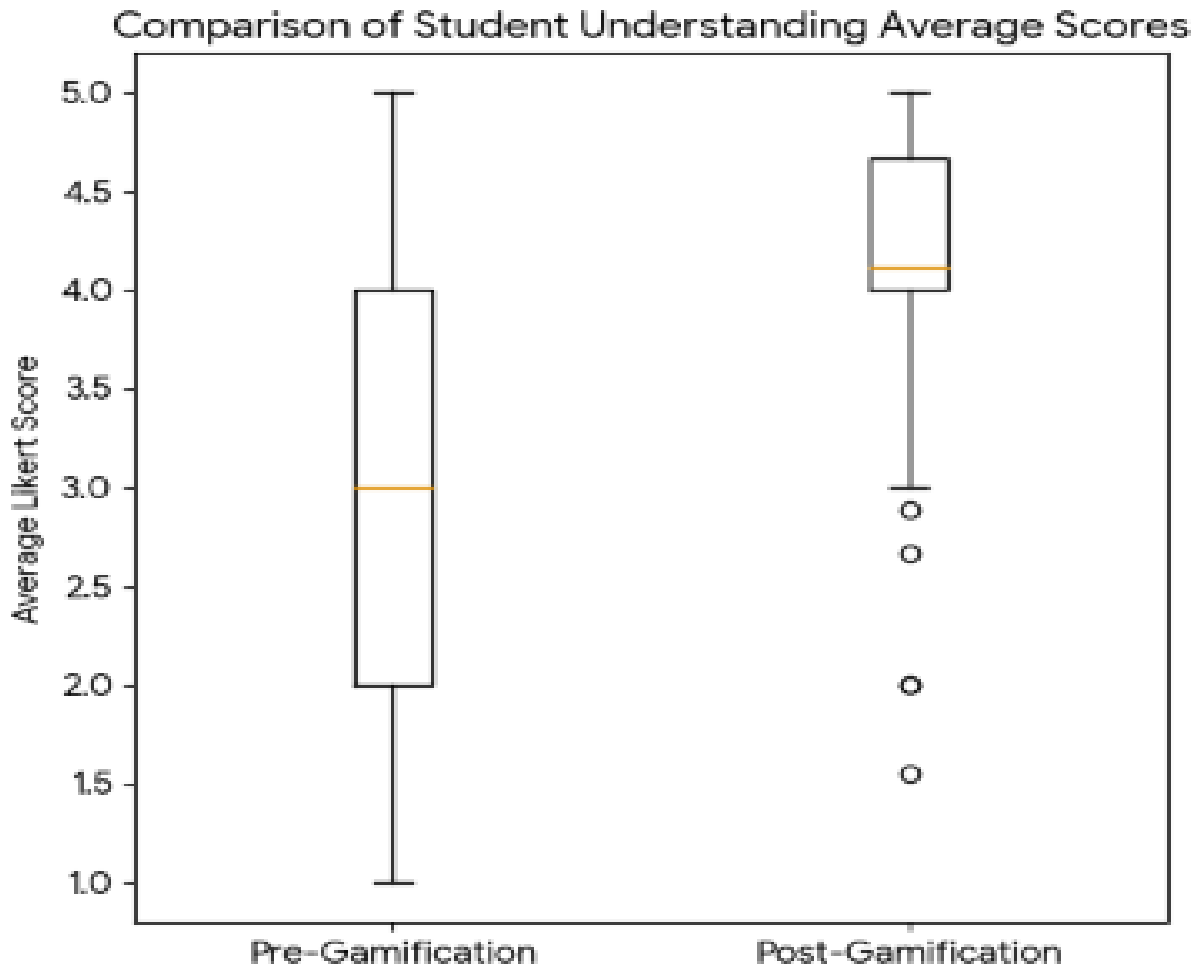

Figure 3: Comparison of Students' Mean Perceived Understanding Scores Before and After the Gamification Intervention.

Table 3: Descriptive Statistics of Student Understanding (Pre- vs. Post-Gamification)

Variable	Mean	SD
Pre-gamification	3.08	1.16
Post-gamification	4.21	0.65

The results indicate a statistically significant improvement in students' understanding following the gamification intervention. The mean score increased from M = 3.08 (SD = 1.16) in the pre-assessment to M = 4.21 (SD = 0.65) in the post-assessment. This finding concludes that prior to the intervention, students' understanding was moderate, with mean scores hovering around the neutral point (3.00). The highest pre-intervention score was in knowledge of principles (3.15), while the lowest was in the articulation of SCM significance and management comprehension (3.04). Following the gamification session, all items exceeded a mean score of 4.10, indicating that the majority of students "Agreed" or "Strongly Agreed" that they had mastered the concepts. The most significant improvements were noted in students' perceived ability to "apply" and "implement" SCM concepts, which are often difficult to grasp through traditional lecture-based methods. The decrease in Standard Deviation (from 1.16 to 0.65) suggests that student performance became more consistent and uniform after the gamification activity.

DISCUSSION

The findings of this study provide empirical support for the effectiveness of gamification in enhancing students' understanding of Supply Chain Management terminology. The results demonstrate that students exposed to gamified learning activities exhibited higher levels of conceptual comprehension compared to those

experiencing conventional teaching approaches. This finding reinforces the argument that interactive learning environments can significantly enhance cognitive engagement and knowledge retention in higher education.

The results are consistent with the theoretical assumptions of Self-Determination Theory, which suggests that learning environments that promote autonomy, competence, and relatedness can strengthen intrinsic motivation and learning performance (Ryan & Deci, 2020). In this study, gamified elements such as quizzes, competitive challenges, and instant feedback provided students with opportunities to participate actively in the learning process, thereby fostering a sense of competence and achievement. As a result, students were more motivated to engage with complex SCM terminology and concepts.

Furthermore, the findings align with previous research indicating that gamification enhances student engagement in digital learning environments. For example, Alhammad and Moreno (2021) reported that gamified instructional strategies significantly increased students' participation and motivation in online learning contexts. Similarly, García-Sánchez et al. (2022) found that gamified activities improved collaborative learning and classroom interaction among university students. The present study extends this literature by demonstrating that gamification can also improve students' perceived understanding of discipline-specific knowledge, particularly in management-related courses such as SCM.

The results also support prior studies highlighting the effectiveness of gamified simulations in management and logistics education. Nair et al. (2022) demonstrated that supply chain simulation games enable students to visualize complex operational dynamics such as demand variability and inventory fluctuations. Such experiential learning environments allow students to move beyond theoretical memorization and develop deeper conceptual understanding. In the current study, the gamified activities likely facilitated similar cognitive processes by encouraging students to interact with SCM terminology through quizzes and competitive tasks repeatedly.

However, while gamification appears to improve learning outcomes, its effectiveness depends heavily on instructional design and alignment with learning objectives. Previous research warns that gamification implemented solely for entertainment purposes may fail to produce meaningful educational benefits (Deterding et al., 2021). Therefore, educators should carefully integrate gamification elements into course structures to ensure that they reinforce learning objectives rather than merely increasing classroom novelty.

Overall, the findings contribute to the growing body of literature on technology-enhanced learning in higher education by demonstrating that gamified instructional strategies can improve students' conceptual understanding in management-related disciplines. The study highlights the potential of gamification as a pedagogical tool for transforming traditional lecture-based instruction into interactive and student-centered learning experiences.

CONCLUSION

This study examined the impact of gamification on students' perceived understanding of supply chain management (SCM) and technology management concepts in higher education. Using a quantitative pre–post research design involving 180 undergraduate students, the study explored changes in students' self-reported understanding of SCM terminology and concepts following participation in gamified learning activities.

The findings indicate a significant improvement in students' perceived understanding after participating in the gamified classroom activities. Before the intervention, many students reported relatively low confidence in their understanding of supply chain concepts. Following the intervention, participants reported higher levels of perceived understanding and confidence in applying SCM terminology. These findings suggest that well-designed gamified learning activities may enhance students' perceptions of their conceptual understanding and create more engaging and interactive learning environments. However, because the study relied on self-reported measures and employed a pre–post design without a comparison group, the findings should not be interpreted as evidence of actual knowledge mastery or causal improvements in learning outcomes.

The study contributes to the growing body of literature on gamification in management education by providing empirical evidence that gamified instructional strategies are associated with improvements in students' perceived

understanding and engagement. The integration of Supply Chain Lingo (SCL) and Supply Chain Decision Analysis Tools (SPDAT) provided students with opportunities to connect theoretical concepts with practical applications through collaborative and experiential learning activities. These findings support the potential value of gamification as a complementary instructional approach for teaching complex management and technology-related subjects.

From a pedagogical perspective, the findings encourage educators and curriculum designers to incorporate thoughtfully designed gamified activities, such as simulation exercises, interactive quizzes, collaborative challenges, and scenario-based learning, to promote active participation and strengthen students' confidence in their understanding of course content. Nevertheless, such approaches should complement, rather than replace, other evidence-based instructional strategies, and claims regarding improvements in actual learning achievement should be interpreted cautiously.

Despite its contributions, this study has several limitations, including the use of convenience sampling from a single institution, reliance on self-reported measures of perceived understanding, and the absence of a control group. Consequently, the generalizability of the findings is limited, and causal inferences cannot be established. Future research should employ randomized controlled trials or quasi-experimental research designs that include comparison groups to better evaluate the effectiveness of gamification. Researchers are also encouraged to incorporate objective measures of academic achievement, such as examination scores or performance-based assessments, alongside students' perceptions. In addition, longitudinal studies involving multiple institutions and diverse student populations would provide further evidence regarding the long-term effects of gamified learning on student engagement, conceptual understanding, and knowledge retention.

In conclusion, gamification represents a promising instructional strategy for supporting student engagement and enhancing students' perceived understanding of supply chain and technology management concepts. When carefully aligned with learning objectives and supported by sound instructional design, gamified learning activities have the potential to enrich higher education teaching practices while providing a foundation for future research using more rigorous experimental methodologies.

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