THE FRESH CONNECTION AS AN EXPERIENTIAL LEARNING TOOL IN INDUSTRIAL ENGINEERING EDUCATION: A CASE STUDY

T.J. Kok[1*] & M. van Zyl-Cillié[1]

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Contact details
* Corresponding author
53309049@nwu.ac.za

Author affiliations
1 School of Industrial Engineering, North-West University, South Africa

ORCID® identifiers
T.J. Kok
https://orcid.org/0009-0001-9639-2488

M. van Zyl-Cillié
https://orcid.org/0000-0003-3320-706X

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ABSTRACT

Industrial engineering curricula are traditionally based on a foundation of science and mathematics. Given the nature of these disciplines, industrial engineering students often lack the opportunity to engage with content practically. Experiential learning (EL) is an educational process in which students learn through doing, and incorporating this into engineering education has proven to improve learning outcomes and experiences. The Fresh Connection (TFC) is a commercially available supply chain management business game that can be used to incorporate EL into the industrial engineering curriculum. This research is a case study of using TFC as an EL tool in the supply chain management module of an undergraduate industrial engineering programme at a South African university. Although the results show some gaps between the theoretical concepts covered in TFC and this case study's undergraduate supply chain module, it is concluded that TFC is an effective EL tool. Furthermore, the research concludes that TFC positively affects student learning outcomes and experiences.

OPSOMMING

Bedryfsingenieurskurrikulums is tradisioneel gebaseer op 'n grondslag van wetenskap en wiskunde. Gegewe die aard van hierdie dissiplines, het bedryfsingenieurstudente dikwels nie die geleentheid om prakties met inhoud om te gaan nie. Ervaringsleer (EL) is 'n opvoedkundige proses waarin studente leer deur te doen, en die insluiting daarvan in ingenieursopleiding het bewys dat dit leeruitkomste en ervarings verbeter. The Fresh Connection (TFC) is 'n kommersieel beskikbare voorsieningskettingbestuur-besigheidspeletjie wat gebruik kan word om EL in die bedryfsingenieurskurrikulum te inkorporeer. Hierdie navorsing is 'n gevallestudie van die gebruik van TFC as 'n EL-instrument in die voorsieningskettingbestuurmodule van 'n voorgraadse bedryfsingenieursprogram aan 'n Suid-Afrikaanse universiteit. Alhoewel die resultate 'n paar gapings toon tussen die teoretiese konsepte wat in TFC gedek word en hierdie gevallestudie se voorgraadse voorsieningskettingmodule, word die gevolgtrekking gemaak dat TFC 'n effektiewe EL-instrument is. Verder kom die navorsing tot die gevolgtrekking dat TFC studente se leeruitkomste en ervarings positief beïnvloed.

1. INTRODUCTION

As an applied science, industrial engineering (IE) has a strong foundation in science and mathematics while also incorporating aspects of economics, management, and social sciences [1]. As such, a significant proportion of time and effort in the IE curriculum is allocated to teaching scientific content to IE students [2]. Teaching often occurs passively: the students listen to lectures and take notes [3]. However, this traditional approach usually limits students' opportunities for practical engagement with real-world scenarios. Felder and Brent [4] argue that there is often a gap between academic theory and practical proficiency. Incorporating experiential learning (EL) into industrial engineering curricula has proven to assist students in obtaining meaning from the content with which they engage [5].

Research has found that using classroom games to convey concepts in operations research and management sciences has recently gained significant interest [6]. One game that facilitates EL is The Fresh Connection (TFC). TFC is a sophisticated supply chain management business game that is designed to simulate the intricacies of managing a supply chain [7]. By immersing students in a realistic and dynamic business environment, TFC offers a compelling platform for EL, allowing students to develop critical-thinking, decision-making, and strategic-planning skills in a controlled yet engaging setting [8].

This research aims to determine the extent to which the use of TFC as an EL tool enhances IE students' understanding of the concepts taught in the supply chain management module of an undergraduate IE programme at a South African university. This is done by determining the extent to which the theoretical concepts illustrated in TFC align with the supply chain management learning outcomes in the undergraduate IE programme. Second, students' understanding of these concepts after incorporating TFC into the supply chain management module is assessed and reported.

For this study, a thorough comparison of TFC game content and the theoretical content covered in an undergraduate IE course's supply chain management module was conducted. Subsequently, the effectiveness of TFC as an experiential learning tool was assessed by evaluating 40 IE students who played six rounds of TFC as part of their supply chain management module participation. Over the course of the module, each round of gameplay was followed by a debrief session that was designed to reinforce learning and facilitate reflective observation. Students' understanding and retention of supply chain concepts was assessed through a group assignment and a quiz after the game rounds. This mixed-methods approach allowed for a comprehensive analysis of both the qualitative and the quantitative impacts of TFC on student learning.

This study addresses both theoretical and practical aspects of supply chain management education. Theoretically, this research provides empirical evidence supporting the integration of EL tools such as TFC into IE curricula, demonstrating how such tools could enhance traditional teaching methods and improve educational outcomes. Practically, the findings of this study highlight the value of incorporating business simulations in developing students' strategic decision-making and critical-thinking skills, which are essential for effective supply chain management and IE practices. By showcasing the positive impact of TFC on student engagement and learning, this study advocates for the broader adoption of EL techniques in engineering education, ultimately aiming to bridge the gap between academic theory and real-world practice.

2. LITERATURE REVIEW

Experiential learning (EL), often described as 'learning by doing', has become an increasingly significant pedagogical approach in engineering education. This literature review explores the implementation and impact of EL in engineering education.

The concept of EL in engineering education has gained interest over the past few years. The alignment between the goals of experiential education and the practical, problem-solving nature of engineering work drives this shift. Educators believe that incorporating EL at the undergraduate level could produce more innovative engineers who are better prepared for professional challenges [9].

Kolb's EL model, which includes four stages – concrete experience, reflective observation, abstract conceptualisation, and active experimentation – has been widely referenced in engineering education [10]. This model underscores the cyclical nature of learning, in which direct experiences are reflected upon,

conceptualised, and tested in new situations. Such a framework is particularly effective in engineering education, where students can directly apply theoretical knowledge to practical problems [10].

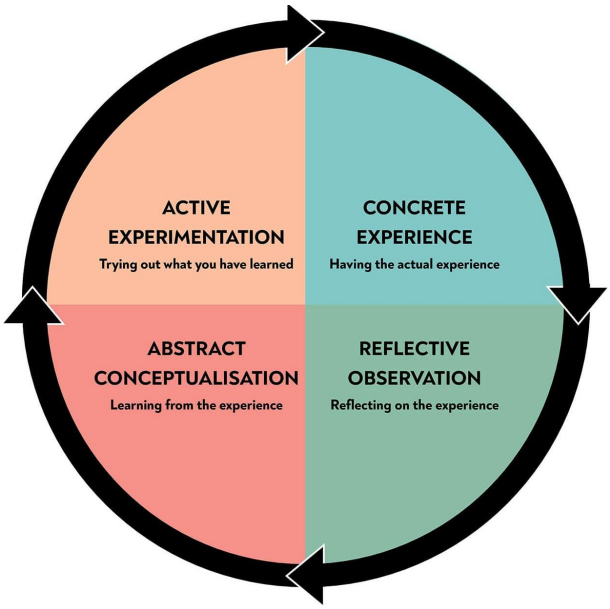

Figure 1: Kolb's experiential learning model [11]

Integrating EL, and specifically Kolb's experiential learning model, into engineering education has gained prominence recently, since traditional lecture-based teaching methods often need to be adapted to prepare students for the complexities of real-world engineering problems.

Using business simulations as a form of EL has proven particularly effective in supply chain management education. Business simulations provide a dynamic and interactive environment in which students can apply theoretical concepts to practical scenarios, bridging the gap between classroom learning and real-world application [8].

TFC is a widely recognised business simulation game that focuses on supply chain management. It is designed to engage participants in managing a virtual company. At the start of the game, the company's performance, measured by return on investment (ROI), has been experiencing a decline. Organised into four teams, participants play several simulation rounds, each representing six months of real time. During these rounds, participants are challenged to make strategic decisions in a simulated business environment, thus promoting their critical-thinking, teamwork, and decision-making skills. Participants face various realistic real-time challenges, with success hinging on their ability to understand and collaborate across functions, thus improving the company's ROI [7].

Despite the proven benefits of EL and business simulations, difficulties are associated with their implementation. One major problem is aligning the business simulation game's content with the theoretical curriculum to ensure that students can effectively integrate and apply their classroom knowledge [12]. In addition, the initial cost and resource requirements for implementing such simulations can be prohibitive for some institutions [8].

However, these criticisms do not diminish the overall value of EL and business simulations such as TFC. While it is true that simulations cannot fully replicate the intricacies of real-world supply chains, they provide a valuable experiential platform that enhances traditional learning methods. The benefits of improved engagement, critical thinking, and practical application outweigh the limitations. Moreover, as technology and educational tools continue to advance, the realism and accessibility of these simulations should only improve.

This study employs a mixed-methods research design and addresses the need comprehensively to evaluate the effectiveness of TFC as an EL tool in the supply chain management module of an undergraduate IE

programme at a South African university. The mixed-methods approach allows for a comprehensive analysis that combines quantitative and qualitative data. Creswell and Plano Clark [13] argue that

> *mixed-methods research combines the strengths of both quantitative and qualitative approaches, enhancing the overall validity and reliability of the findings.*

3. METHODOLOGY

For this study, elements of qualitative and quantitative research were combined. The content of TFC and the extent to which it aligned with the objectives and learning outcomes of an undergraduate supply chain management module were qualitatively assessed. Qualitative feedback from students on their experience of playing TFC was also enlisted. A quantitative approach was followed to determine students' performance during the game and their grasp of key supply chain management concepts. Quantitative data on students' performance in TFC, including their decision-making strategies and game scores, was collected to assess their practical application of theoretical knowledge. Quantitative data offers objective measures of learning outcomes, while qualitative data provides detailed insights into students' experiences and the contextual factors influencing their learning [13].

This research was conducted with all 40 (population sample) undergraduate IE students enrolled for the INGB318 (Supply Chain Management) module during the first semester of 2024 at NWU. This module is at NQF level 7. All the students participated in six rounds of TFC as part of their coursework.

Before the start of the game, each student was assigned to a group of four students, each of whom was assigned a specific role: Vice President (VP) of Purchasing, VP of Operations, VP of Sales, or VP of Supply Chain Management. Each role was responsible for decisions made in their area of the supply chain network, allowing each team member to make their own decisions; however, cooperation and communication were vital to making TFC a success.

After each round of the TFC game, debrief sessions were conducted to gather students' reflections on their experiences. These sessions also provided insights into their learning processes, the difficulties they faced, and the perceived value of the simulation. After completing all six rounds of TFC, the students were asked to complete a quiz to assess the extent to which critical concepts of SCM were conveyed to them by playing TFC. Last, as part of the group assignment, the students provided qualitative feedback on their engagement, satisfaction, and overall learning experience.

Descriptive statistics are provided to summarise the performance in TFC by analysing the round scores. The study concludes with a thematic analysis of the debrief sessions and feedback from the group assignment. This involved identifying, analysing, and reporting patterns in the qualitative data to gain deeper insights into students' learning experiences and perceptions of the TFC simulation [14].

4. RESULTS AND FINDINGS

This section first presents the assessment of the concepts conveyed in TFC with the learning outcomes of the undergraduate supply chain management (SCM) module. Then the impact of playing TFC on module learning outcomes, as assessed by the performance of each group's return on investment (ROI) metric, is presented. Finally, the quiz results that assessed students' experience of playing TFC are presented, whereafter a thematic analysis of students' learning experiences is discussed.

4.1. The Fresh Connection's alignment with supply chain management module learning outcomes

TFC is a comprehensive supply chain simulation providing hands-on management experience. Its alignment with the learning outcomes of the SCM module was assessed, and the results are displayed in Table 1.

Table 1: Assessment of TFC's alignment with SCM module learning outcomes

SCM Learning outcome	TFC Practical experience	Assessment of alignment	
		TFC integrates well with the SCM learning outcomes	Potential gap identified
Study Unit 1: Introduction to supply chain management			
Appreciate the significance of effective SCM in organisations.	TFC allows students to experience the impact of their decisions on the company's overall performance (ROI), highlighting the significance of effective SCM. The real-time feedback and end-to-end visibility offered by the simulation make the importance of efficient supply chain operations clear.	X	
Understand the concept of supply chain competitiveness and supply chain strategy.	TFC requires students to make strategic and tactical decisions to improve ROI and operational performance, which involves understanding the competitive positioning and strategic alignment of the supply chain.	X	
Identify and discuss global trends in SCM.	While TFC primarily focuses on operational and strategic decision-making in a single company's supply chain, the principles and challenges faced are reflective of broader global trends in SCM.	X	
Understand the challenges and opportunities in modern and future supply chains.	The dynamic environment of TFC, with fluctuating demand, supplier issues, and market conditions, exposes students to the challenges and opportunities present in real-world supply chains. Experiencing these scenarios helps students to understand the complexities of modern and future supply chains.	X	
Recognise and correctly use supply chain terminology.	The simulation uses industry-standard terminology, reinforcing students' understanding and the correct use of supply chain terms. Regular interaction with supply chain terminology in TFC helps students to become fluent in the language of SCM, fulfilling this outcome.	X	
Understand the function of the different elements of an effective supply chain.	TFC encompasses all the major supply chain elements – purchasing, operations, logistics, and sales – providing a holistic view of how these elements interact. Each student is also assigned a specific role, enabling them to understand each function and the correlation between these functions.	X	

SCM Learning outcome	TFC Practical experience	Assessment of alignment	
		TFC integrates well with the SCM learning outcomes	Potential gap identified
Appreciate the overall importance of information and information technology in a supply chain.	Using dashboards, real-time data, and analytics in TFC underscores the critical role of information and IT in managing and optimising supply chains. Through the simulation, students learn the value of information and IT in supply chain management, fulfilling this outcome.	X	
Study Unit 2: Supply chain network design			
Evaluate and design simple supply chain networks.	In round 5, students were allowed to change suppliers, effectively designing the supply chain network. Even though these decisions helped students to understand network design elements such as cost optimisation and strategic trade-offs, exposure to designing supply chain networks was limited.		X
Apply appropriate techniques for considering locations in a supply chain network.	Not included in the game design of TFC.		X
Understand the relevance of 'omni-channel' supply chain strategies and their impact on the structure and functioning of supply chains.	Not included in the game design of TFC.		X
Study Unit 3: Demand management			
Understand the importance and complexities of demand management in supply chain.	Students learn to manage demand fluctuations and align supply chain operations to meet demand effectively, fulfilling this outcome.	X	
Apply appropriate forecasting and demand management techniques and evaluate their effectiveness.	Forecasting techniques do not form part of gameplay, but to make decisions effectively, students could have used forecasting methods to determine demand.		X
Recognise contemporary approaches to managing supply and demand in supply chain networks.	Even though supply and demand should have been continuously managed in TFC, recognising contemporary approaches did not form part of gameplay.		X

SCM Learning outcome	TFC Practical experience	Assessment of alignment	
		TFC integrates well with the SCM learning outcomes	Potential gap identified
Study Unit 4: Inventory management			
Appreciate the role and importance of inventory.	TFC includes a detailed focus on inventory management principles, including what, how much, and when to order, directly aligning with inventory management study units. Through the simulation, students learn the role and importance of inventory, fulfilling this outcome.	X	
Discuss the major types of inventories, their costs, and their relationship to inventory decisions.	Through detailed reporting after each round, students are able to discuss the major types of inventories, their costs, and their relationship to inventory decisions.	X	
Understand the fundamental differences between approaches to managing inventory.	Students are encouraged to choose an inventory management approach and should therefore understand the differences between approaches (seeing how each approach has an impact on the ROI of the company).	X	
Apply appropriate techniques to manage inventory in a supply chain.	Through the simulation, students learn to apply inventory management techniques, fulfilling this outcome.	X	
Study Unit 5: Sales and operations planning			
Understand the concept of sales and operations planning (S&OP).	In TFC, students are involved in S&OP through decisions on service levels, production planning, and demand forecasting. For instance, setting safety stock levels and production intervals are critical aspects of S&OP. This aligns with the module's goal of understanding S&OP and how it coordinates different functions within the supply chain.	X	
Explain how S&OP coordinates sales, manufacturing, logistics, and marketing plans.	Continuous decision-making involves constructing and evaluating aggregate plans, which is central to S&OP.	X	
Construct and evaluate aggregate plans that employ different strategies to balance demand and supply.	Players need to balance production schedules with demand forecasts to minimise costs and meet service level agreements. This is seen directly in decisions related to inventory management, safety stock, and order deadlines. These activities help students to learn to construct and evaluate plans that balance supply and demand.	X	

SCM Learning outcome	TFC Practical experience	Assessment of alignment	
		TFC integrates well with the SCM learning outcomes	Potential gap identified
Explain yield management and its importance.	Although not explicitly termed 'yield management', TFC includes aspects of maximising resource utilisation and efficiency through careful planning of production schedules and inventory levels. Although these activities relate to the module's focus on understanding yield management, a potential gap is identified.		X
Study Unit 6: Supply chain performance measurement			
Understand the importance of supply chain performance measurement.	The simulation emphasises tracking key performance indicators (KPIs) such as ROI and service levels, highlighting their importance in decision-making.	X	
Explain the characteristics of good performance measurement and understand the impact of performance measures on behaviours and organisational culture.	Students learn to identify effective metrics that are timely, accurate, and relevant to their roles and the overall company performance.	X	
Critically evaluate supply chain performance measures.	The debrief after each round includes a critical evaluation of decisions and their impacts on performance metrics, fostering a deeper understanding of what makes performance measures effective.	X	
Identify the relationship between different supply chain elements and measures, and take appropriate action to improve overall supply chain efficiency and effectiveness.	The game illustrates how changes in one area (e.g., inventory levels) affect other areas (e.g., production efficiency, delivery performance), helping students to understand the interconnectedness of the supply chain.	X	
Select and develop appropriate supply chain strategies, and align the supply chain design to the chosen strategy.	Students are encouraged to select and develop a supply chain strategy before the start of the game, and to ensure that all decisions throughout the six rounds align with the chosen strategy.	X	

TFC integrates well with the learning outcomes of the SCM module, providing practical experience that aligns with the theoretical knowledge and skills outlined in the module outcomes. Through the simulation, students experienced the complexities and dynamics of SCM, reinforcing their understanding and appreciation of effective supply chain strategies and practices.

Areas identified as potential gaps (such as yield management, applying appropriate forecasting and demand management techniques and evaluating their effectiveness, evaluating and designing supply chain networks by applying appropriate techniques for considering their location, and understanding the relevance and

impact of omni-channel supply chain strategies) are in the minority, effectively aligning the SCM learning outcomes with TFC.

4.2. Impact of participation of The Fresh Connection on learning outcomes

The improvement in students' understanding and retention of SCM concepts was measured through participation in the TFC simulation, particularly through the game performance metrics (round scores of each team's ROI). The ROI round scores are presented in Table 2 and summarised in Figure 2.

Table 2: ROI round scores

Team number	ROI round 1 score	ROI round 2 score	ROI round 3 score	ROI round 4 score	ROI round 5 score	ROI round 6 score
Team 1	-0.90	2.71	2.31	3.55	4.25	4.79
Team 2	-4.47	-5.09	-0.83	1.16	2.34	-1.38
Team 3	-2.78	-0.79	-22.32	-16.71	-17.45	-13.28
Team 4	-3.60	-2.98	-19.50	-4.44	0.96	2.75
Team 5	-0.73	-2.52	-5.72	-6.37	-1.86	-1.57
Team 6	-1.26	-4.78	-1.04	2.20	4.04	-0.14
Team 7	-7.56	-3.26	-13.75	-0.16	1.10	1.62
Team 8	-1.90	-12.09	-6.83	-5.33	-16.49	-11.90
Team 9	-0.45	-1.46	-1.70	-1.40	-1.27	-7.84
Team 10	-1.09	-1.24	-22.81	-4.35	-3.55	-0.80

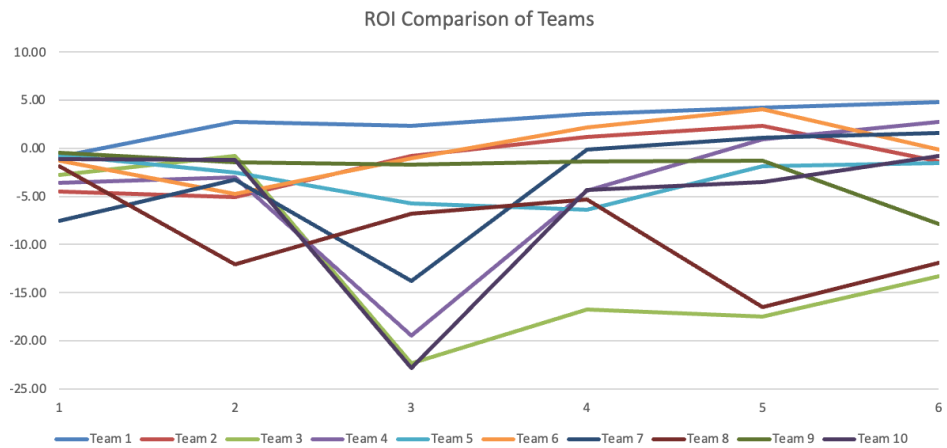

Figure 2: ROI comparison of teams through six rounds of TFC gameplay

Initially each team was assigned an ROI of -0.8, and the objective of the gameplay was to navigate the company towards profitability (positive ROI). Team 1 performed the best, as they had a positive ROI from round 2 onwards, and teams 1, 4, and 7 ended round 6 with a positive ROI, achieving the game's objective. Generally, most teams showed an improvement in the ROI results, confirming that the ROI improved by applying SCM knowledge and making the correct decisions in each round.

While the performance metrics were monitored, the assessment of the students did not rely on the ROI outcomes. Instead, the emphasis was placed on student engagement in decision-making processes and the overall learning experience. The students showed improved understanding and retention of supply chain concepts, which are discussed in section 4.3.

4.3. Student responses on playing TFC

The quiz results provided comprehensive insights into the effectiveness and reception of the TFC game as an experiential learning tool, assessing the extent to which critical concepts of supply chain management were conveyed to them by playing TFC. Figure 3 presents the essential findings and assessment of key game impacts. Each graph represents an element that was tested by means of the quiz.

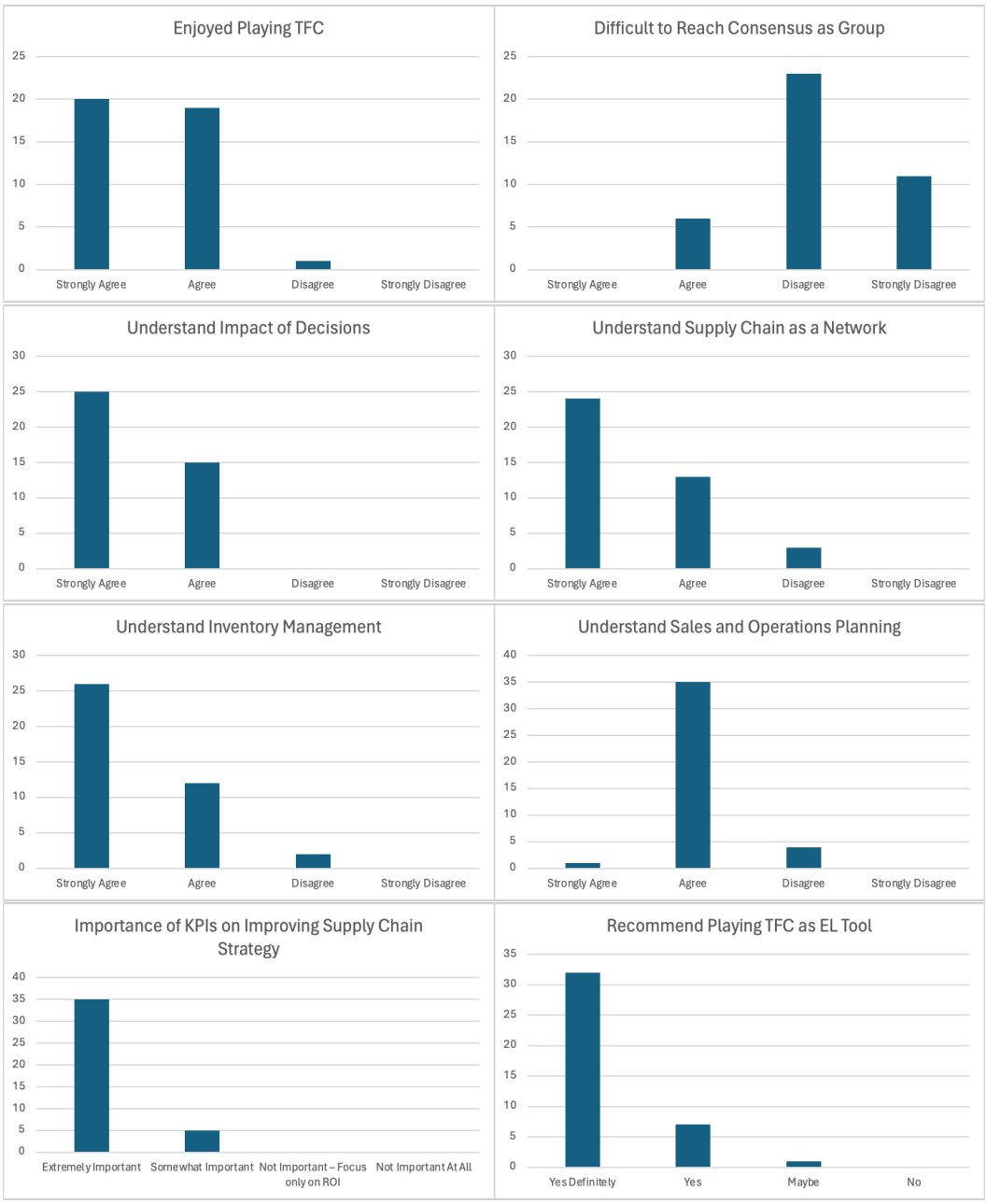

Figure 3: Assessment of key TFC game impacts

The feedback across the different roles highlights a generally positive reception, with significant agreement on the practical benefits of the game in understanding supply chain dynamics, the importance of KPIs, and the overall enjoyment of the game. Most participants recommended its inclusion in future courses, and emphasised its value as a practical educational tool.

4.4. Examine student learning experience through qualitative data

Qualitative feedback from the students was gathered through the video component of the group assignment, in which students were required to provide a comprehensive reflection on team contribution and essential lessons learned about their engagement, satisfaction, and the perceived value of the TFC simulation in their learning process.

Through thematic analysis, the qualitative feedback from all 40 students was analysed. A summary of the feedback and lessons learnt is provided in Table 3 below.

Table 3: Summary of qualitative feedback

Supply chain/TFC concept	Qualitative feedback
Importance of employing a unified strategy	It is crucial that all vice presidents (VPs) align on strategies and decisions. A collective strategy helps maintain a positive return on investment (ROI) and ensures effective decision-making.
Communication and cross-functional collaboration	Communication between departments is vital for organisational success. Effective communication and coordination lead to better decision-making, and ensure that changes in one area do not negatively impact others. Cross-functional collaboration and clear communication about overall strategy are essential.
Impact of small changes	Small adjustments in operational plans, even as minor as 1%, can have a significant impact on profits. These small changes should not be underestimated.
Teamwork and integration	Working well in a team and understanding the interconnectedness of different departments is crucial. Departments must integrate and follow a unified strategy rather than pursuing individual strategies.
Supplier relationships	Building strong relationships with reliable suppliers is essential for supply chain stability. Opting for high-quality suppliers over cheaper alternatives can positively affect production processes and the overall supply chain.
Strategic decision-making	Patience in decision-making is important. Taking things slowly to ensure profitability rather than rushing and risking losses is better. Aligning decisions with the overall supply chain strategy helps to achieve long-term goals, even if it involves short-term losses.
Continuous improvement	Balancing workforce size with production needs and focusing on continuous improvement and quality control is important for efficiency and effectiveness.

Students found TFC simulation engaging and enjoyable, highlighting the fun aspect of working in a team towards a common goal. The experience provided valuable insights into real-world business operations and the importance of teamwork and communication in achieving organisational goals.

The simulation was highly valuable in enhancing students' understanding of the complexities of business operations and the necessity of strategic alignment and effective communication. It provided practical lessons on the significance of small operational changes, the importance of supplier relationships, and the benefits of a collective strategy, contributing to a comprehensive learning experience.

Debriefing sessions were conducted after each round of the gameplay to capture reflections and insights on the learning experience and the challenges faced in each round. During these debriefing sessions, students were also given information about the next round, guiding their decision-making. The debriefing sessions were highly valued, as they allowed the students to learn from the decisions made by other teams and to receive collective feedback from both the lecturer and their peers.

5. DISCUSSION

The study's findings indicated that incorporating TFC simulation into the supply chain management module of an undergraduate industrial engineering programme significantly enhanced students' learning outcomes and overall educational experience.

The high levels of student engagement and enjoyment reported in the qualitative feedback highlighted TFC's effectiveness as an experiential learning tool. The students appreciated the game's realistic simulation of supply chain dynamics, which allowed them to apply theoretical concepts in a practical, interactive environment. The debriefing sessions after each round of the gameplay were particularly valued, as they facilitated reflective learning and allowed the students to understand the consequences of their decisions in the game. This aligned with the principles of experiential learning, which emphasise 'learning through doing' and reflecting on the experience.

TFC aligned well with most of the learning outcomes for the supply chain management module, providing practical hands-on experience that reinforced theoretical knowledge. The game effectively covered vital areas such as the importance of effective supply chain management, understanding supply chain competitiveness, and recognising supply chain terminology. However, some gaps were identified, particularly in supply chain network design and demand management. These gaps highlight the need for complementary teaching methods or additional simulation scenarios to cover these aspects comprehensively.

The quantitative data indicated that TFC significantly improved students' understanding and retention of supply chain management concepts. Most students reported that the game helped them to grasp the complexities of supply chain networks and the impact of decisions across different functional areas. This finding was consistent with previous research on the benefits of experiential learning and business simulations in education.

TFC fostered essential skills such as teamwork, strategic decision-making, and critical thinking. The students highlighted the importance of communication and collaboration in achieving a positive ROI in the game. The challenges of aligning decisions across different roles in the supply chain were seen as valuable learning experiences that prepared students for real-world scenarios in which cross-functional collaboration is crucial.

6. CONCLUSION

The Fresh Connection (TFC) has proven to be a valuable tool in industrial engineering education, providing engagement and measurable learning gains. The simulation's experiential learning approach successfully bridges the gap between theoretical knowledge and practical application, providing students with a deeper understanding of supply chain dynamics and the complexities of real-world business operations.

Key takeaways include:

- **Enhanced learning outcomes:** TFC significantly improved students' understanding and retention of supply chain management concepts.
- **Practical experience:** The simulation provided functional, hands-on experience, allowing the students to apply theoretical concepts in a realistic setting.
- **Teamwork and strategic decision-making:** The students developed essential skills in teamwork, communication, and strategic decision-making, which are crucial for their future careers in industrial engineering.
- **Positive student feedback:** Students' high engagement and enjoyment highlighted TFC's effectiveness as a teaching tool.

To enhance the effectiveness of TFC even more, it is recommended that pre- and post-gameplay assessments be implemented to evaluate students' understanding of supply chain concepts before and after participating in the simulation. This analysis would provide insights into enhancing students' comprehension and application of supply chain concepts following their experiential learning experience with TFC.

In addition, incorporating more explicit scenarios related to demand management and supply chain network design could address the identified gaps and provide a more comprehensive learning experience. Broader implementation is recommended by encouraging the use of TFC in other modules to assess its impact in different contexts. It is argued that TFC could be a foundation for experiential learning of other modules in the undergraduate IE course.

These recommended actions could further validate the findings and enhance the integration of experiential learning tools into industrial engineering education.

In conclusion, TFC's integration into the industrial engineering curriculum has substantially benefited student engagement, learning outcomes, and skill development. The positive feedback and measurable learning gains strongly support its continued use and further integration of experiential learning techniques in engineering education, ultimately preparing students more effectively for their future careers.

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