Exploring Student Learning and Sustainability Awareness through a Gamified Operations Management Challenge

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ABSTRACT

This study investigates the integration of gamification and Education for Sustainable Development (ESD) within an undergraduate Operations Management course. A structured, gamified, case-based activity known as the Ops Challenge – Kelantan Snack Factory Expansion was designed to engage students in applying plant layout and project scheduling techniques while incorporating sustainability considerations. The intervention was implemented over multiple phases, including theoretical grounding, gamified task execution, and a final competitive showcase. Adopting a qualitative research design, data were collected from approximately 300 students through individual reflections and analyzed using thematic analysis. The findings reveal that students developed meaningful awareness of environmental, economic, and social sustainability, particularly in relation to resource efficiency, cost optimization, and workplace safety. In addition, students demonstrated emerging systems thinking by recognizing the interdependence of operational decisions. The results further indicate that gamification significantly enhanced student engagement, motivation, and collaborative learning experiences. Team-based activities encouraged knowledge sharing and problem-solving, reinforcing both conceptual understanding and practical application of Operations Management tools. This study contributes to the growing body of literature on experiential and sustainability-oriented pedagogy by proposing the Gamified Sustainable Operations Learning (GSOL) Model. The model offers a structured and replicable framework for embedding sustainability into technical subjects, thereby supporting the development of future-ready graduates equipped with both analytical and sustainability competencies.

Keywords: Gamification in higher education, Operations Management education, Education for Sustainable Development (ESD), Experiential learning, Thematic analysis.

INTRODUCTION

The teaching of Operations Management (OM) in higher education continues to face challenges in fostering student engagement and bridging the gap between theoretical knowledge and practical application. Conventional lecture-based approaches often limit students' ability to contextualize analytical tools such as plant layout design and project scheduling within real-world operational environments [1].

In response, there has been increasing interest in adopting innovative pedagogical strategies, particularly gamification and experiential learning, to enhance student engagement and learning outcomes. Gamification introduces elements such as competition, challenges, and rewards to create interactive learning environments that promote active participation [2-3].

Simultaneously, higher education institutions are increasingly expected to embed Education for Sustainable Development (ESD) into curricula to develop graduates capable of addressing complex sustainability challenges [4]. However, the integration of sustainability into technical subjects such as OM remains relatively underexplored, particularly in developing country contexts.

This study addresses this gap by examining a gamified classroom intervention, the Ops Challenge – Kelantan Snack Factory Expansion, which integrates OM tools with sustainability considerations. The study aims to explore how such an approach influences students' learning experiences and sustainability awareness and propose the Gamified Sustainable Operations Learning (GSOL) Model at the end of the study.

LITERATURE REVIEW

Recent studies have also emphasized the importance of integrating multiple pedagogical approaches to enhance learning outcomes in higher education. The combination of gamification and sustainability-oriented learning has been shown to foster deeper engagement and critical thinking, particularly when students are exposed to real-world problem-solving scenarios [5-6]. Furthermore, collaborative and team-based learning environments play a crucial role in reinforcing knowledge construction and improving students' ability to apply theoretical concepts in practice. Despite these advancements, there remains a lack of structured frameworks that systematically integrate gamification, sustainability, and Operations Management education. This highlights the need for pedagogical models that not only engage students but also develop their capacity for sustainable decision-making in complex operational contexts.

Gamification has been widely recognized as a transformative pedagogical approach in higher education. It enhances intrinsic motivation and promotes active learning by incorporating game elements into instructional design [3]. Empirical studies suggest that gamified environments can significantly improve student engagement and participation, although their effectiveness depends on thoughtful implementation [5].

Operations Management education inherently benefits from experiential learning approaches that simulate real-world decision-making. Techniques such as case-based learning and simulations enable students to apply theoretical concepts in practical contexts, thereby improving critical thinking and problem-solving skills [1, 7].

ESD emphasizes the development of competencies that enable individuals to make informed decisions that consider environmental integrity, economic viability, and social equity [4]. While sustainability has gained prominence in business education, its integration into operational and quantitative subjects remains limited [6].

Although prior studies have examined gamification and sustainability independently, there is limited research exploring their combined application within Operations Management education. This study contributes to the literature by providing qualitative evidence of how a gamified, sustainability-integrated activity shapes student learning and awareness in a real classroom setting.

METHODOLOGY

This study adopts a qualitative research design to explore students' learning experiences and sustainability awareness following a gamified instructional intervention [8]. The participants consisted of approximately 300 undergraduate students enrolled in the Operations Management course (MGT345) at Universiti Teknologi MARA (UiTM), comprising Semester 4 Diploma in Business Studies students and Semester 5 Diploma in Banking Studies students during the October 2025 – February 2026 academic session.

The intervention, known as the Ops Challenge – Kelantan Snack Factory Expansion, required students to work collaboratively in groups to design a plant layout and develop a project schedule using PERT/CPM techniques, while integrating sustainability considerations into their decision-making processes.

Data were collected through individual student reflections, which provided insights into students' perceptions of their learning experiences and the integration of sustainability principles. The data were analyzed using thematic analysis, whereby responses were systematically coded into key themes, including environmental sustainability, economic sustainability, social responsibility, systems thinking, learning engagement and teamwork and collaboration.

The gamified learning activity was implemented in a structured, multi-phase format over several weeks to ensure progressive learning and sustained student engagement. The design of the activity aligned with course

topics and incorporated elements of competition, collaboration, and real-world problem-solving.

In Week 6, students were introduced to the topic of facility layout planning, followed by a detailed briefing of Activity 1: Plant Layout Challenge. The lecturer provided the problem scenario, constraints, and expected deliverables. Students were required to apply layout design principles while considering efficiency and sustainability factors.

In Week 7, the focus shifted to project management, particularly the use of PERT/CPM techniques. Students were then briefed on Activity 2: Project Scheduling Challenge, which required them to construct network diagrams and analyze project timelines.

This staged introduction ensured that students first acquired the necessary theoretical knowledge before applying it in a gamified context, consistent with scaffolding principles in active learning [7].

Between Weeks 8 and 13, students worked in groups to complete both activities in a competitive format. A total of 60 groups participated, each functioning as an "operations consulting team" tasked with solving the given case.

During this phase, students engaged in collaborative problem-solving, iterative improvement of layout and scheduling solutions and integration of sustainability considerations such as environmental, economic, and social.

The competitive element encouraged continuous engagement, accountability, and peer learning. Gamification principles such as goal orientation, time-bound tasks, and informal benchmarking between groups contributed to increased motivation and active participation [3].

The culmination of the activity took place in Week 14 through a structured in-class competition. All 60 groups presented their solutions, including layout designs and project schedules, to be evaluated based on predefined criteria such as accuracy, creativity, and sustainability integration.

To enhance motivation and recognition, groups were awarded Gold Award, Silver Award, and Bronze Award. In addition, small cash prizes were provided to top-performing groups. The competitive showcase created a high-impact learning environment, reinforcing both knowledge application and presentation skills.

This final phase reflects key elements of gamification, including reward systems and achievement recognition, which have been shown to enhance student engagement and learning outcomes [5].

The structured implementation of the Ops Challenge demonstrates how gamification can be systematically embedded into course delivery. By aligning weekly topics with staged activities and culminating in a competitive event, the approach promotes progressive knowledge application, sustained engagement over time and integration of sustainability into technical decision-making.

This model provides a replicable framework for educators seeking to incorporate gamified, sustainability-oriented learning in Operations Management and related disciplines

To conceptualize the implementation of the gamified intervention, this study proposes the 3-Phase Gamified Sustainable Operations Learning (GSOL) Model, as illustrated in Figure 1. The model outlines a structured pedagogical approach that integrates theoretical instruction, gamified application, and competitive evaluation to enhance student learning outcomes.

The first phase, Knowledge Foundation, involves the delivery of core theoretical content, including facility layout planning and project management techniques. This phase ensures that students acquire the necessary conceptual understanding before engaging in applied tasks.

The second phase, Gamified Task Execution, represents the core of the learning intervention. During this stage, students work collaboratively in groups to solve real-world problems through plant layout design and

project scheduling activities. Gamification elements, including competition, time constraints, and team-based challenges, are incorporated to enhance engagement. Importantly, sustainability considerations are embedded within this phase, encouraging students to integrate environmental, economic, and social perspectives into their decision-making processes.

The final phase, Competitive Showcase and Evaluation, involves the presentation and assessment of group outputs. Students' work is evaluated based on predefined criteria, and top-performing groups are recognized through awards and incentives. This phase reinforces motivation and provides opportunities for peer learning and knowledge sharing.

Collectively, the GSOL Model demonstrates how structured gamification can facilitate not only technical knowledge acquisition but also the development of sustainability awareness and higher-order thinking skills. The model offers a replicable framework for integrating Education for Sustainable Development (ESD) into Operations Management and related disciplines.

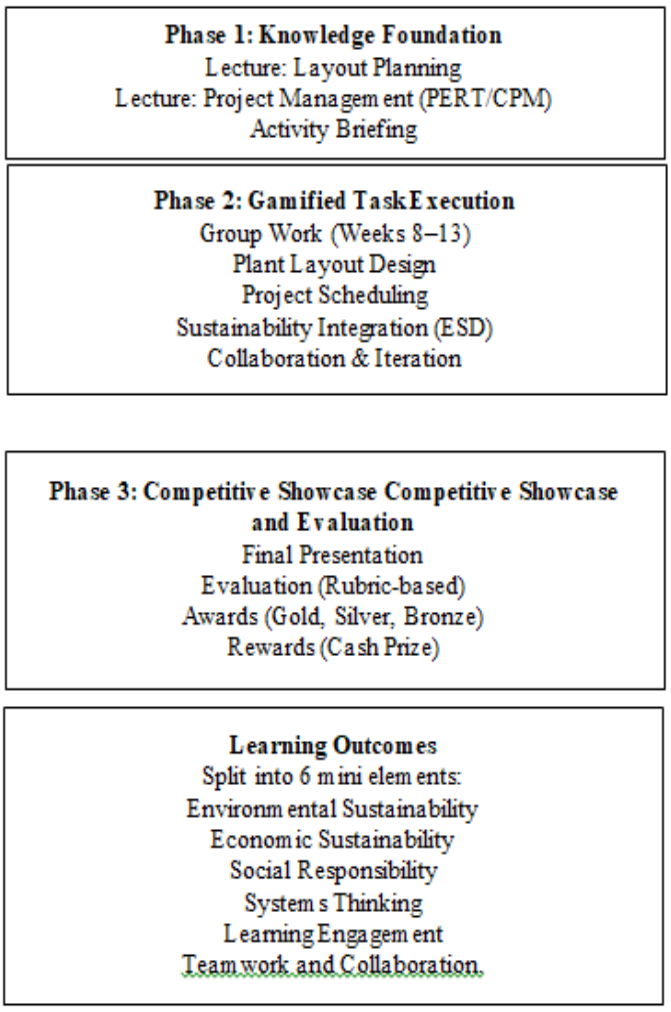

Figure 1. The 3-Phase Gamified Sustainable Operations Learning (GSOL) Model

FINDINGS

The findings indicate that students demonstrated a strong awareness of environmental sustainability, particularly in relation to resource efficiency and waste minimization. Students frequently emphasized the importance of optimizing workflow to reduce unnecessary movement and energy consumption.

"We arranged machines properly to reduce movement and save energy."

This suggests that experiential learning activities can effectively translate abstract sustainability concepts into

practical operational decisions, supporting prior findings by [6].

Students consistently linked operational efficiency with cost reduction, indicating an understanding of the economic dimension of sustainability.

"Better layout helps reduce cost and improve production efficiency."

This reinforces the notion that sustainability and efficiency are not mutually exclusive but are inherently interconnected within operations management [9].

Students also demonstrated awareness of social sustainability by considering safety and ergonomic factors in their designs.

"We made sure the working area is safe to avoid accidents."

This reflects an emerging recognition of the human dimension in operational decision-making, aligning with ESD principles.

Importantly, some students exhibited systems thinking by recognizing the interdependence between layout design, efficiency, and sustainability outcomes.

"One decision in layout affects the whole production process."

This indicates that the activity facilitated higher-order thinking skills, which are critical for sustainability-oriented decision-making.

The gamified nature of the activity significantly enhanced student engagement and motivation.

"This activity made learning more interesting and easier to understand."

This finding supports existing literature on the effectiveness of gamification in promoting active learning [3].

The findings also highlight the importance of teamwork and collaboration in enhancing students' learning experiences. Students frequently reported that working in groups enabled them to share ideas, evaluate alternative solutions, and make collective decisions.

"We worked together to decide the best layout."

This suggests that collaborative learning environments contribute to deeper understanding and improved problem-solving capabilities. Through group discussions and joint decision-making, students were able to critically evaluate different approaches and integrate sustainability considerations more effectively.

Therefore, this finding aligns with existing literature emphasizing the role of teamwork in active learning environments, where peer interaction facilitates knowledge construction and enhances learning outcomes. The gamified structure further strengthened collaboration by creating shared goals and a sense of accountability among group members.

In order the get the findings, the thematic analysis was conducted on student reflections to identify recurring patterns related to learning experiences and sustainability awareness. The analysis resulted in six key themes such as environmental sustainability, economic sustainability, social responsibility, systems thinking, learning engagement and teamwork and collaboration. These themes reflect the multidimensional learning outcomes achieved through the gamified activity, encompassing both technical and soft skill development.

The thematic analysis followed a systematic multi-step process adapted from [10]. First, all student reflections were carefully read multiple times to achieve data familiarization. Second, initial codes were generated by identifying meaningful patterns related to learning experiences and sustainability awareness. Third, similar

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codes were grouped into broader categories, which were then reviewed and refined into key themes. Fourth, themes were defined and named based on their conceptual relevance to the research objectives. To enhance consistency, coding was conducted iteratively, and representative excerpts were selected to support each theme. The analysis focused on identifying both dominant and less frequent patterns to ensure a comprehensive understanding of student responses.

Table 1. Summary of Thematic Analysis

Theme	Description	Frequency (Approx.)	Representative Quotes	Interpretation
Environmental Sustainability	Awareness of reducing waste, minimizing movement, improving energy/resource efficiency	High (≈70–80%)	"We arranged machines properly to reduce movement and save energy."	Students demonstrate practical understanding of sustainability through process optimization rather than abstract theory.
Economic Sustainability	Focus on cost reduction, productivity, and efficiency	High (≈65–75%)	"Better layout helps reduce cost and improve production efficiency."	Students strongly associate sustainability with efficiency and operational cost savings.
Social Responsibility	Consideration of safety, ergonomics, and worker well-being	Moderate (≈50–60%)	"We made sure the working area is safe to avoid accidents."	Students show emerging awareness of the human aspect of operations, though less dominant than economic/environmental themes.
Systems Thinking	Recognition of interdependence between layout, time, and outcomes	Moderate (≈40–50%)	"One decision in layout affects the whole production process."	Indicates development of higher-order thinking and holistic understanding of operations.
Learning Engagement	Increased motivation, enjoyment, and understanding through gamification	Very High (≈80–90%)	"This activity made learning more interesting and easier to understand."	Gamification successfully enhanced engagement and deepened conceptual understanding.
Teamwork And Collaboration	Group discussion, idea sharing, and joint problem-solving	High (≈70–80%)	"We worked together to decide the best layout."	Collaborative learning played a key role in reinforcing understanding and decision-making.

As shown in Table 1, the most dominant themes identified were learning engagement, followed by environmental sustainability and teamwork and collaboration. This indicates that the gamified structure was highly effective in enhancing student motivation while simultaneously facilitating the practical application of sustainability concepts. The frequency levels presented in Table 1 are approximate estimations based on the prevalence of themes observed in student reflections and do not represent statistical measurements.

The findings also reveal that students were able to connect operational decisions with both economic and environmental outcomes, suggesting a strong understanding of sustainability in practice. Although the theme

of social responsibility appeared less frequently, it still reflects an emerging awareness of workplace safety and human factors in operations design.

Additionally, the presence of systems thinking among student responses indicates the development of higher-order cognitive skills, where students recognized the interdependence of operational processes. Overall, the thematic distribution demonstrates that the gamified intervention successfully supported holistic learning by integrating technical knowledge, sustainability awareness, and collaborative skills.

Further analysis suggests a relationship between environmental sustainability awareness and systems thinking. Students who demonstrated a strong focus on resource efficiency and process optimization were also more likely to articulate the interconnected nature of operational decisions. For example, students who discussed minimizing movement and energy usage often also recognized how layout decisions influence overall production flow. Additionally, reflections from higher-performing or award-winning groups tended to exhibit more integrated thinking, combining technical accuracy with sustainability considerations, whereas other groups focused more narrowly on task completion. This indicates that deeper engagement with sustainability concepts may be associated with higher levels of cognitive complexity.

It is important to note that not all students demonstrated equally strong levels of systems thinking or sustainability awareness. While many responses reflected practical understanding, only a smaller proportion of students explicitly articulated complex interrelationships between operational variables. This may be attributed to differences in prior knowledge, group dynamics, or levels of engagement during the activity.

DISCUSSION

The findings of this study provide strong evidence that the integration of gamification and ESD can significantly enhance student learning in Operations Management. The results indicate that students not only developed technical competencies but also demonstrated increased awareness of sustainability principles, particularly in environmental efficiency, cost optimization, and workplace safety.

One key insight from this study is the role of gamification in sustaining student engagement over an extended period. Unlike traditional teaching methods, the structured competition encouraged continuous participation and active involvement. This supports previous findings that gamification enhances motivation and engagement when implemented with clear objectives and meaningful rewards [3].

While the findings support the effectiveness of gamification, it is important to acknowledge contrasting perspectives. Some studies argue that gamification may undermine intrinsic motivation if over-reliant on external rewards [11]. However, the findings of this study suggest that when gamification is embedded within meaningful, real-world contexts, such as the Ops Challenge, students reported sustained engagement and perceived relevance of learning activities. This indicates that the effectiveness of gamification depends on its design and alignment with authentic learning experiences.

Furthermore, the incorporation of sustainability elements enabled students to move beyond purely technical decision-making and consider the broader implications of their actions. This reflects the growing importance of integrating ESD into business education to develop responsible and future-ready graduates.

From a pedagogical perspective, the GSOL Model demonstrates how structured, phase-based learning can effectively combine theoretical instruction with practical application. The model ensures that students are adequately prepared before engaging in complex problem-solving tasks, thereby enhancing learning effectiveness.

Based on the findings of this study, several recommendations can be proposed to enhance teaching and learning practices in Operations Management and related disciplines. Firstly, educators are encouraged to integrate gamified and sustainability-oriented activities into their courses to promote active learning and increase student engagement. The use of structured frameworks, such as the Gamified Sustainable Operations Learning (GSOL) Model, can support systematic implementation and ensure alignment between theoretical

content and practical application.

In addition, incorporating collaborative and team-based tasks is essential, as these approaches foster peer learning, critical thinking, and problem-solving skills. From a research perspective, future studies should consider adopting mixed-method approaches to provide more robust empirical evidence and improve the generalizability of findings. Furthermore, the implementation of similar gamified models across different courses, institutions, and academic levels is recommended to evaluate scalability and broader applicability. Overall, integrating gamification and Education for Sustainable Development (ESD) into curriculum design can contribute significantly to the development of competent, engaged, and sustainability-conscious graduates.

CONCLUSION

This study demonstrates that the integration of gamification and sustainability into Operations Management education can significantly enhance student engagement and learning outcomes. The Ops Challenge provided a dynamic and interactive learning environment that enabled students to apply theoretical concepts in practical and meaningful ways.

The findings reveal that students developed not only technical competencies in layout design and project scheduling but also a deeper understanding of sustainability principles, including environmental efficiency, economic viability, and social responsibility. Additionally, the activity fostered higher-order thinking skills, particularly systems thinking, which is essential for addressing complex operational challenges.

The study also highlights the importance of collaborative learning, as teamwork and peer interaction played a critical role in enhancing students' problem-solving capabilities. The gamified structure further reinforced motivation and participation, creating a positive and engaging learning experience.

Overall, the proposed GSOL Model offers a practical and replicable framework for integrating ESD into technical subjects. It provides valuable insights for educators seeking to design innovative and impactful teaching strategies that align with the evolving demands of higher education and industry. This study highlights the importance of an innovative teaching learning approach in enhancing students' competencies in higher education. The integration of problem-based learning and experiential learning in the Innovation course encourages students to actively participate in the learning process and apply theoretical knowledge to practical situations.

This study highlights the practical implications of integrating gamification and Education for Sustainable Development (ESD) within Operations Management education. The findings suggest that structured, gamified interventions such as the GSOL Model can enhance not only student engagement but also the ability to apply sustainability principles in technical decision-making contexts. From an educational perspective, the model provides a scalable framework that can be adopted across disciplines to promote experiential and sustainability-oriented learning. These implications are particularly relevant for higher education institutions aiming to develop graduates equipped with both analytical competencies and sustainability awareness.

Limitation And Future Research

This study has several limitations that should be acknowledged. First, the use of self-reported student reflections may be subject to social desirability bias, where students provide responses, they perceive as favorable rather than fully reflective of their actual experiences. Second, the absence of a control group limits the ability to make causal comparisons between gamified and traditional teaching approaches. Third, while the competitive element enhanced engagement for many students, it may have also introduced pressure or anxiety for some individuals, potentially affecting their learning experience. These factors should be considered when interpreting the findings. This study is limited by its reliance on qualitative data from a single cohort, which may limit generalizability. Future research should incorporate mixed-method approaches and larger sample sizes to validate and extend these findings across different institutional contexts.

Contribution To Knowledge

This study contributes to the literature in three key ways which it provides empirical evidence on the integration of gamification and ESD within Operations Management education. Besides, it demonstrates how qualitative reflections can reveal deeper learning outcomes beyond traditional assessments. Lastly, it offers a practical and replicable teaching model for embedding sustainability into technical subjects.

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REFERENCES

1. Heizer, J., Render, B., & Munson, C. (2020). Operations management (13th ed.). Pearson
2. Deterding, S., Dixon, D., Khaled, R., & Nacke, L (2011). From Game Design Elements to Gamefulness: Defining Gamification. In Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments (pp. 9-15). ACM. https://doi.org/10.1145/2181037.2181040
3. Subhash, S., & Cudney, E. A. (2018). Gamified learning in higher education: A systematic review of the literature. Computers in human behavior, 87, 192-206.
4. Rieckmann, M. (2017). Education for sustainable development goals: Learning objectives. UNESCO publishing.
5. Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). Educational Research Review. Academia. Edu.
6. Michel, J. O. (2019). Sustainability in higher education. In Encyclopedia of sustainability in higher education (pp. 1670-1675). Cham: Springer International Publishing.
7. Prince, M. (2004), Does Active Learning Work? A Review of the Research. Journal of Engineering Education, 93: 223-231. https://doi.org/10.1002/j.2168-9830.2004.tb00809.x.
8. Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approach. Sage publications.
9. Lozano, R., Merrill, M. Y., Sammalisto, K., Ceulemans, K., & Lozano, F. J. (2017). Connecting competences and pedagogical approaches for sustainable development in higher education: A literature review and framework proposal. Sustainability, 9(10), 1889.
10. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa
11. Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. Psychological Bulletin, 125(6), 627–668. https://doi.org/10.1037/0033-2909.125.6.627