Gamifying Logistics: A Board Game Approach to Enhancing Student Motivation

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In this study, we developed an educational board game designed to provide students with experiential learning in both international and domestic logistics, and we analyzed changes in their attitudes toward logistics in terms of learning motivation, interest, and career aspirations after gameplay. The Department of Distribution and Information Engineering at the National Institute of Technology (KOSEN), Hiroshima College, is tasked with training engineers for the logistics industry. However, a significant proportion of its graduates do not enter logistics-related careers. This discrepancy may be attributed to negative public perceptions of the logistics sector, which are shaped in part by its demanding working conditions. These perceptions were anticipated to pose a greater societal issue by 2024, when revisions to logistics-related legislation were scheduled to take effect as "Logistics 2024 Issue". Concurrently, the global growth of e-commerce and the shrinking working population in Japan highlight the urgent need to establish a sustainable logistics network. However, building such a system requires not only advanced technological capabilities but also sufficient human resources. In the context of Japan's labor shortages, developing a robust logistics infrastructure has become increasingly difficult. Therefore, the objective of this study was to develop a game-based learning tool that could both facilitate understanding of logistics systems and promote a shift in awareness among future stakeholders, thereby contributing to long-term sustainability. The originally developed game, HEXATICS, is a backgammon-style board game for three to six players. Each player is responsible for importing distinct raw materials by sea or air, followed by domestic transportation to a warehouse. During gameplay, participants engage with the six key logistics functions—transportation, storage, cargo handling, distribution processing, packaging, and information management—through a combination of quizzes and interactive play. Results indicate that participation in the game increased students' interest in logistics, their willingness to learn more about the field, and their desire to pursue careers in logistics-related industries.

Keywords: *Logistics 2024 Issue, Student motivation, Student awareness, Serious game, Board game*

Introduction

Since 2019, a critical issue in Japan's logistics sector—commonly referred to as the "Logistics 2024 Issue"—has attracted widespread public and industry attention. This issue stems from the revision of labor regulations that limit the overtime hours of truck drivers, a measure intended to address long-standing concerns over working conditions. According to the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan is projected to face a shortfall of approximately 34% in domestic freight transport capacity (equivalent to 900 million tons) by 2030. Despite 84.5% of logistics companies recognizing the severity of the problem, only 54.3% have taken any action to address it.

The situation is further exacerbated by Japan's declining birthrate and aging population, which continue to reduce the available labor force. At the same time, the rapid growth of e-commerce has led to a surge in delivery demand. In 2022 alone, over 5 billion packages were delivered annually, with last-mile delivery being particularly labor-intensive and costly. As the e-commerce sector continues to expand, the burden on logistics infrastructure—especially the final leg of delivery—is expected to increase substantially.

In response, numerous studies have explored technological solutions to increase delivery capacity, such as optimizing delivery routes through hybrid models involving both trucks and drones (Wang et al., 2019). However, far fewer studies have examined strategies for reducing delivery volume itself, such as altering consumer behavior. Some efforts in this direction include ASKUL Corporation's campaign to spread orders over time and a social-issue film addressing the Logistics 2024 crisis. This film, centered on a fictional package bombing incident, highlights key issues such as corporate accountability, overwork, systemic failure, and personal responsibility. Many students who viewed the film reported reevaluating their own purchasing habits, suggesting that media can be an effective tool for shifting consumer awareness regarding logistics-related challenges.

In the field of education, board games have increasingly been introduced as pedagogical tools across various disciplines. As Matsumoto (2014) notes, board games that address social issues—referred to as "serious

games"—are used to promote learning through engagement and critical thinking. For instance, Sugiura and Kikkawa (2009) developed a board game for teaching environmental issues in university lectures, while Arita (2011) emphasized the value of such games for encouraging reflective thinking and social interaction. Zaitsu et al. (2011) found that students with higher game literacy derived greater educational benefits from a serious game focused on environmental topics. Meshitsuka et al. (2016) introduced a disaster education board game, detailing both its design and implementation. Within KOSEN (National Institute of Technology) institutions, several educational board games have been developed in recent years. Yamaguchi et al. (2023; 2024) created an English-learning board game through interdisciplinary student collaboration, aiming for commercial application in junior high school education. Similarly, Ogawa et al. (2024) developed a board game to teach students about shipping companies, and conducted pilot studies to evaluate its effectiveness in KOSEN lectures.

Although board games have been successfully used to address a range of social and educational issues, no educational board game has yet been developed specifically to teach logistics or address the Logistics 2024 Issue. This study seeks to fill that gap by introducing HEXATICS, a serious board game designed to educate students on logistics systems and promote awareness of related societal challenges.

Purpose

The purpose of this study is to develop a board game that facilitates logistics education for KOSEN students, implement it through gameplay, and analyze changes in their awareness of logistics before and after playing the game using a questionnaire survey.

Material and Methods

In this chapter, we introduce the board game HEXATICS (a combination of "HEXAGON" and "LOGISTICS"), developed for educational purposes and illustrated in Figure 1. The game's design incorporates a hexagonal structure to represent the six fundamental functions of logistics: transportation, storage, material handling, distribution processing, packaging, and logistics information systems. These functions form the core learning objectives of the game.

HEXATICS is a competitive board game in which each player assumes responsibility for managing the logistics operations of a fictional country. Players import raw materials from other countries and aim to complete specific products as their mission, simulating realistic international and domestic logistics flows. The game supports 3 to 6 players and is designed for participants aged 12 and above, given its moderate complexity. A typical session takes approximately two hours to complete; however, the playtime can be shortened to under an hour by streamlining certain gameplay processes.

HEXATICS consists of five sequential phases (Phases 1–5), as illustrated in Figure 2. Below is an overview of each phase:

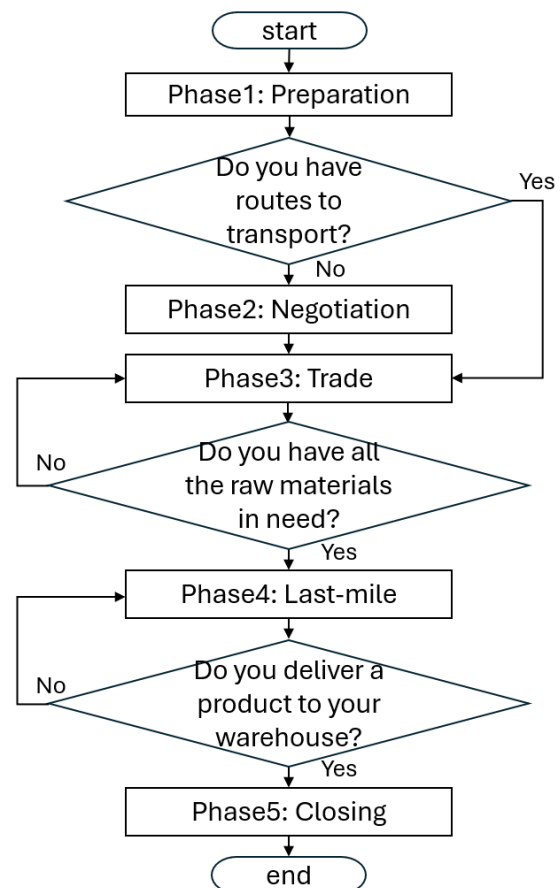Figure 1 Originally developed board game HEXATICS

Figure 2 How to play the board game HEXATICS

Phase 1: Preparation. Each player receives one continent board (Figure 3), along with 22 brown pieces, 30 blue pieces (Figure 4-a), and a random assortment of raw material and product pieces (Figure 4-b). A quiz piece (Figure 4-c) is also included for use in a later phase. The continent board represents the player's managed territory and serves as the platform for domestic land transportation. Blue pieces function as the in-game currency and are also used to construct air or sea transportation routes during Phase 3. These pieces may
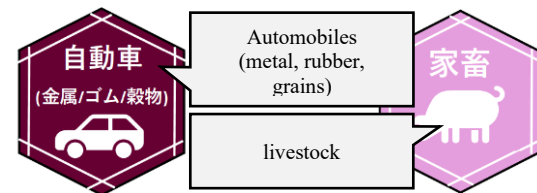
be stacked or aligned in sequence to represent transport paths between continents (Table 1). In total, there are 12 different product pieces, each created from specific raw materials (Table 2).
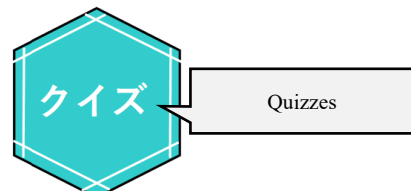

Figure 3 Continent board used in HEXATICS
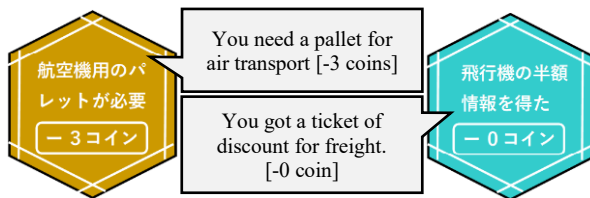
(a) Brown and Blue pieces

(b) Pieces of raw materials and products

(c) Quiz piece
Figure 4 Hexagonal pieces used in HEXATICS (translated to English)

Table 1 Features of transportation modes in trade

mode	sea	air
cost	low: 6 blue-pieces	high: 12 blue-pieces
speed	slow: 6 blue-pieces	fast: 1 blue-pieces
usage of blue-pieces	lining up	piling up

Phase 2: Negotiation. During this phase, players take turns negotiating with others who possess the raw materials they require. The goal is to establish sea or air transportation routes. Table 1 outlines the cost and characteristics of each transport mode: sea freight is more economical but slower, while air freight is faster but incurs higher costs in terms of blue pieces. The

negotiation phase was incorporated to enhance communication among participants. The capacity to comprehend the resources possessed by the other players and to attain mutually beneficial negotiation outcomes reflects a cognitive approach that is critical not only in the logistics sector but also in numerous other professional domains.

Table 2 Products and raw materials in HEXATICS

Products	Raw material in need for each product		
	1	2	3
Automobiles	Metal	Rubber	Grains
Toys	Plastics	Rubber	Wood
Ramen	Grains	Livestock	Vegies & Fruits
Furniture	Glass	Wood	Metal
Jam	Grains	Glass	Vegies & Fruits
Cameras	Livestock	Metal	Glass
Juice	Vegies & Fruits	Plastics	Wood
Clothing	Plastics	Livestock	Rubber
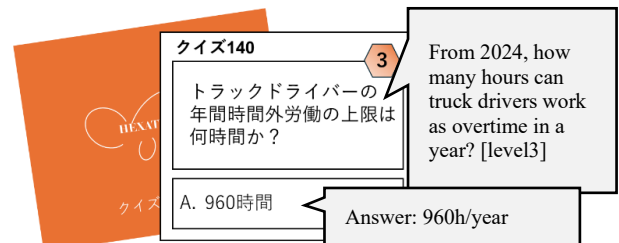
(a) Quiz Card
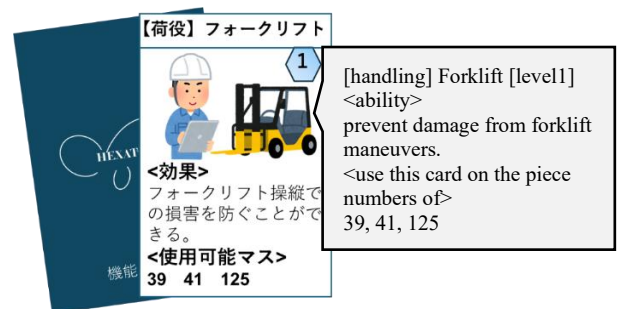
(b) Function Card
Figures 5 Cards used in HEXATICS (translated to English)

Phase 3: Trade. Once routes are established, players transport the necessary raw materials using ships or airplanes. Movement along blue-piece transport routes is determined by dice rolls. As players advance, they must follow the instructions indicated on the blue pieces where their transport stops. Some blue pieces are designated as quiz points (Figure 4-c). When a ship or airplane passes or lands on these, the player earns the opportunity to draw and answer a quiz card (Figure 5-a). The specific mechanics of quiz cards are explained after Phase 4.

Phase 4: Last Mile. In this phase, imported raw materials are moved by truck across the continent

board—from ports or airports to warehouses. During this domestic transport, the materials undergo four of the six core logistics functions: storage, distribution processing, packaging, and material handling, before being converted into finished products (Table 2). As in Phase 3, players can encounter quiz tiles on their land routes. If their truck stops on or passes a quiz tile, they draw a quiz card and may attempt to answer the question. Correct answers are rewarded with a function card (Figure 5-b). Both quiz and function cards are categorized into three difficulty levels (Levels 1 to 3). The quiz component consists of 140 questions, with difficulty levels varying according to response format and the degree of specialized knowledge required. For example, questions that can be answered with a simple "yes" or "no" are classified as Level 1, while those requiring specialized vocabulary are classified as Level 3. As participants encounter the quiz questions multiple times throughout the game, it is expected that those initially unable to answer Level 1 questions will gradually acquire the knowledge needed to correctly answer Level 3 questions by the end of the game. Function cards are used to resolve various logistics-related issues depicted on the blue tiles, excluding quiz points. Typically, resolving these issues would require players to spend blue pieces, but possessing a relevant function card allows them to bypass such costs. Thus, answering quizzes correctly and acquiring function cards contributes significantly to a player's success.

Phase 5: Closing. Players who successfully deliver a finished product to the warehouse receive bonus blue pieces based on the order of completion: 10 for 1st place, 8 for 2nd, 6 for 3rd, 4 for 4th, 2 for 5th, and 0 for 6th place. At the end of the game, the winner is determined by the total number of blue pieces in their possession. Function cards held at the end of the game may also be converted into blue pieces, influencing the final score.

Results and Discussion

The board game HEXATICS was implemented with second-year students from the Department of Distribution and Information Engineering at KOSEN, Hiroshima College (Figure 6). To evaluate its educational impact, students were asked to complete a logistics knowledge test and a questionnaire both before and after gameplay. A total of 41 participants took part in the study, with 38 valid responses collected from the pre-game questionnaire and 41 from the post-game questionnaire. According to the syllabus of National Institute of Technology, Hiroshima College and its Model Core Curriculum (MCC), participants possess a basic recognition of the terms "supply chain" and "logistics"; however, their current level of understanding does not enable them to articulate definitions or provide illustrative examples of these concepts. To develop their understanding, the board game was implemented as part of their departmental practice activities. The survey was administered using Microsoft Forms. Details of the test and questionnaire items are provided in Table 3.

Figure 6 2nd-year students playing HEXATICS

Table 3 A logistics knowledge assessment and student awareness and motivation questionnaire

1	What are the six main functions of logistics?
2	Are you willing to study logistics beyond regular lectures?
3	Do you have an interest in the field of logistics?
4	Would you consider pursuing a career in logistics industry?

Figure 7 presents the results of the logistics knowledge test, while Figure 8 illustrates changes in students' awareness and motivation regarding logistics before and after playing the game. The average test score increased by 4.41 points following gameplay, indicating an improvement in students' understanding of basic logistics concepts. Additionally, the standard deviation decreased by 2.19 points, suggesting a reduction in performance variability and a more consistent level of knowledge acquisition among participants. These findings suggest that playing HEXATICS effectively contributed to the students' foundational learning in logistics.

In terms of students' awareness and motivation regarding logistics, Figure 8-a illustrates that playing HEXATICS significantly increased interest in the field. Approximately 50% of students reported being "very interested" in logistics after the game, while an additional 30% indicated they were "interested." Figure 8-b shows a notable shift in students' willingness to learn logistics. Prior to playing HEXATICS, 54% of students indicated no desire to learn logistics, and 41% expressed only minimal interest. After the game, however, there was a 10% increase in students who reported a strong willingness to learn, and a 34% increase in those who expressed general interest. This indicates a clear decrease in reluctance and a corresponding rise in motivation to engage with the subject. Finally, regarding students' career intentions, the questionnaire revealed that before playing HEXATICS, approximately 75% of students had a negative view of pursuing a logistics-related career (Figure 8-c). After gameplay, this figure decreased to 41%, while the proportion of students who expressed a positive attitude toward working in logistics rose from 25% to 59%. In summary, the results suggest that playing HEXATICS has the potential to positively influence students' attitudes toward logistics. While this shift may not apply to every individual, the overall trend indicates a meaningful change in awareness and perception,

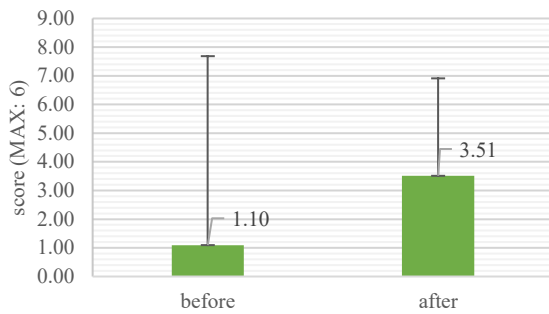supporting the potential of game-based learning to enhance interest and engagement in logistics education.
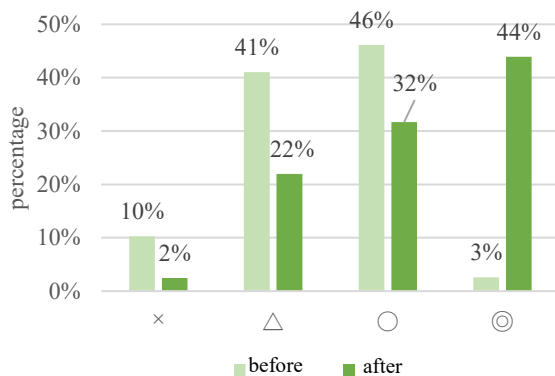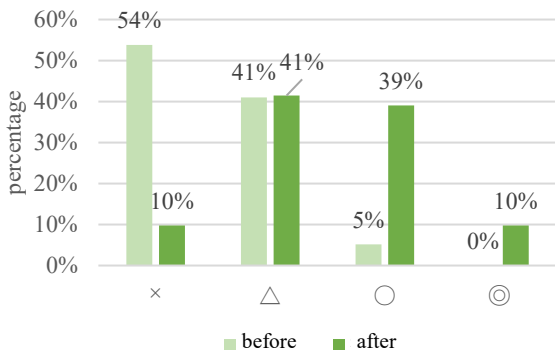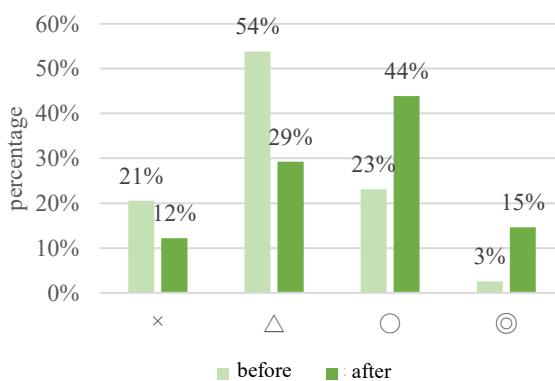

Figure 7 Result (the average and standard deviation) of the logistics knowledge test (before (n=39) and after (n=41))

(a) Interest in logistics

(b) Willingness to learn logistics

(c) Career intentions in logistics industry
Figure 8 Change in students' awareness and motivation on logistics (before (n=39) and after (n=41))
(×: strongly disagree, △: disagree, ○: agree, ◎: strongly agree)

Conclusions

In this study, we developed an original educational board game, HEXATICS, designed to facilitate learning about logistics. We conducted a survey to assess whether playing HEXATICS could influence students' awareness of logistics at KOSEN, Hiroshima College. Specifically, we examined changes in their willingness to learn, interest in the field, and perceptions of career opportunities before and after gameplay. HEXATICS accommodates up to six players, each managing logistics in a fictional country. Through gameplay, students encounter various logistics functions and related social issues, enabling them to acquire specific knowledge in an engaging format.

Our findings indicate that HEXATICS had a positive impact on students' attitudes toward logistics. We also assessed knowledge acquisition by testing students on the six core logistics functions—transportation, storage, cargo handling, distribution processing, packaging, and information management—before and after the game. Results showed that students retained key terminology typically taught in conventional lectures, and many reported enjoying the learning experience through gameplay. Remarkably, some students continued to talk about the game even six months later, suggesting that HEXATICS left a lasting impression.

Based on these outcomes, we are considering the integration of educational board games into formal instruction and are currently preparing HEXATICS for commercialization. Our goal is to contribute to logistics education globally by enabling a broader audience to engage with and deepen their understanding of logistics through this interactive medium. To support independent use, we have developed a rulebook and instructional video, making HEXATICS accessible for private and educational play. We hope these resources will encourage people of all ages, including children, to learn about logistics in an enjoyable and memorable way.

Acknowledgements

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