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A flexible web-based simulation game for production and logistics management courses

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ABSTRACT

This study develops a flexible simulation game environment called SIMPLE (Simulation of Production and Logistics Environment) in order to raise teaching effectiveness and improve classroom teaching in emerging production paradigms. Instructors can tailor SIMPLE by simply setting the appropriate parameters. SIMPLE can thus be adopted at various teaching stages to teach different major business concepts, such as inventory management, capacity management, pricing determination and negotiation, and information-sharing between players. Meanwhile, SIMPLE was employed in two courses to evaluate the degree of students' acceptance of using SIMPLE in classrooms. The results also showed that SIMPLE was generally well received by students.

1. Introduction

Instructors of decision sciences courses such as production management, logistics management, and supply chain management often are confronted with the challenge of continuously developing and adopting novel teaching methods to help students prepare for their professional careers. Additionally, instructors also are facing the challenge of motivating students with real-life scenarios in which several subjects are integrated within one study discipline. For example, determining the production quantities over time for a factory may involve at least the decisions of demand forecasting, resource allocation, machine scheduling, and inventory policy determination. Moreover, most universities are under sustained pressure to decrease instructional costs, even when most enterprises in industry prefer to recruit people who have multi-functional abilities in order to increase their market competitiveness.

To improve teaching effectiveness in these emerging production paradigms, new teaching aids are being proposed to help students gain a new understanding of real industries and enable them to employ the knowledge and theories that are obtained from classrooms in the real world. These teaching aids include gaming tools, which not only foster competition among students, but also bring excitement to the learning process. Instructors have successfully applied different games in class in recent years while teaching production management and other similar courses [21,17,1]. Additionally, games have been revealed to be very useful pedagogical methods for supplementing conventional teaching techniques.

Regarding the different roles of instructors and students when the game is adopted, some production management and other related course games are designed for the needs of a single course or certain teaching topic [9,11,15]. Therefore, when instructors use games to assist in teaching, they require different games based on the needs of the course [24]; students must learn the rules and determine the strategy of different games for different courses. The demand that is placed on preparation

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time of instructors is increased through game requirements, which threaten the instructor's willingness to adopt game-assisted instruction.

This study develops a flexible game environment called SIMPLE, which stands for SIMulation of Production and Logistics Environment. SIMPLE is a web-based object-oriented game environment that simulates various decision-making scenarios that often are observed in production, logistics, and supply chain management. The aim of this study is to build a flexible game environment as a teaching aid to increase the instructional effectiveness in production, logistics, and supply chain management and related courses. Meanwhile, SIMPLE can also be used as a test-bed to test/evaluate new rules, methods, and theories in a controlled, artificial environment.

2. Production/logistics game

In recent years, games have been proven to be an effective tool in supplementing traditional teaching methods [22,14,4]. Games are a goal-directed, challenging, and competitive activity that is conducted within a framework of agreed rules to provide a playful learning environment [1,8,16,17]. The use of games enhances the richness of learning and improves learning efficiency; games can provide experience in the application of theory and concepts as well as improve a student's capacity to think [20]. An additional goal is educating students in new methods of aggressive learning, which enables them to combine theory and practice to construct new concepts that are learned from course content in the classroom. Therefore, more and more instructors use the method of game playing to construct classroom situations so as to enhance the learning motivation of the students [22,23,18]. Especially, instructors in production management, logistics management, and other decision sciences courses adopt game-assisted teaching tools to simulate real enterprise situations so as to let students prepare for their professional careers.

The first (and best known) production/logistics game is the Beer Game, which was originally developed by the Massachusetts Institute of Technology (MIT) in the 1960s. The aim of the Beer Game is to reveal how people's decision patterns in production, logistics, and customer chains sometimes produce unexpected and undesired results. The game was first played on a board like a card game and later was transferred to a computerized environment. Several other games were developed after the Beer Game to challenge students' reactions and to develop their management skills. Several web-based games have now been developed and have been adopted not only in the classroom to facilitate learning, but also in other circumstances to stimulate research by bringing international competition and collaboration among students, instructors, and researchers. Table 1 shows several well-known web-based games in production and logistics management.

A special interest group for the development of games for production and logistics management was formed in the early 1990s. The Special Interest Group, under IFIP Working Group 5.7 on Integrated Production Management, seeks to encourage the development and application of simulation games for production management in education and industry. The group concluded that one of the lessons learned from applying games in teaching is the requirement of adopting different types of games. No single game can be successfully applied to all learning situations. Additionally, the group concluded that attention should be paid to motivating and enhancing the instruction of production and logistics management because of high

Table 1
List of the production and logistics simulation games.

Name of the game	Description	Decision Scope	Developer
MIT Beer Game http://www.beergame.mit.edu/	Beer production and distribution in a multi-stage distribution channel	Act as manufacturer, distributor, wholesaler, or retailer to determine production or ordering quantities	Massachusetts Institute of Technology, USA (1988)
Columbia Beer Game	Beer production and distribution in a multi-stage distribution channel	Act as manufacturer, distributor, wholesaler or retailer to determine production/order quantities (similar to MIT beer game but with stochastic customer demand)	Columbia University [6]
Hulia Game http://www.hulia.haifa.ac.il/Eng/hulia.html	Beer production and distribution in a multi-stage distribution channel	Act as manufacturer, distributor, wholesaler, or retailer to determine production or order quantities	The University of Haifa, Israel (2000)
Trading Agent Competition http://www.sics.se/tac	Online bidding on multiple markets simultaneously	Act as an agent to manufacture PCs, win customer orders, and procure components	Swedish Institute of Computer Science (2003)
Littlefield Technology http://www.littlefield.responsive.net	Manufacturing simulation in made-to-order assembler of electronic systems	Act as a manufacturer to determine utilization, queuing, scheduling, and inventory	Stanford University, USA (1996)
The Logi-Game http://www.moltho.dk	Simulation game of material flows in a distribution channel for bicycle industry	Act as manufacturer, wholesaler, or retailer to make manufacturing and inventory decisions	Technical University of Denmark
Supply Chain Game http://www.factory.isye.gatech.edu/research/	Production and distribution simulation in automobile industry, including manufacturers, transporters, and suppliers	Act as decision-maker in a competitive supply chain framework, such as a supplier or assembler	Georgia Institute of Technology

competition and globalization [24]. Therefore, a simulation game environment that can be played under different types of game scenarios while sharing a common fundamental infrastructure is needed.

In summary, this study develops a flexible game environment to achieve the following aims:

(1) to help students develop knowledge and application skills in various scenarios that are found in most production and logistics systems;
(2) to develop a configurable and flexible game environment to help instructors at multiple teaching stages;
(3) to develop a teaching aid for major production and logistics courses, and for interuniversity collaboration and competition;
(4) to develop an extendable game environment to support different industry scenarios that foster interactions among players;
(5) to develop an environment as a test-bed for production and logistics theories; and
(6) to help researchers utilize the game to analyze students' decision-making behaviors, and adopt the result as a teaching reference or for in-depth study of related learning behaviors and other research [2,19].

3. Simple design and implementation

3.1. Design concept

Based on the object-oriented concept, each of the game players was modeled as a conceptual unit, named the *basic unit*, to perform either production or logistic functions. To execute the function assigned to a basic unit, each game player responds to the data provided by the system.

The basic unit was modeled as an integrated circuit (IC) chip in which every pin of the IC serves as a functional channel for specific information or material flow, as shown in Fig. 1. The IC has built-in functions to perform production and logistics decisions, and can be activated fully or partially. The action of the basic unit can be triggered in several ways, based on the scenario of the game and the activated function of the unit. The line with an arrow in Fig. 1 shows the physical (material) flow, including raw material, manufacturing resource, and completed product. A cash flow is linked with every physical flow with a reversed direction. The line with a dot denotes information flow, in which the dot represents the primary receiving party (either this unit or another basic unit). Data can be supplied directly from another unit (played by another player or by the system) or created from the decisions that are made by the player, according to the game mode. Fig. 2 shows the interaction of supply and demand information between two basic units.

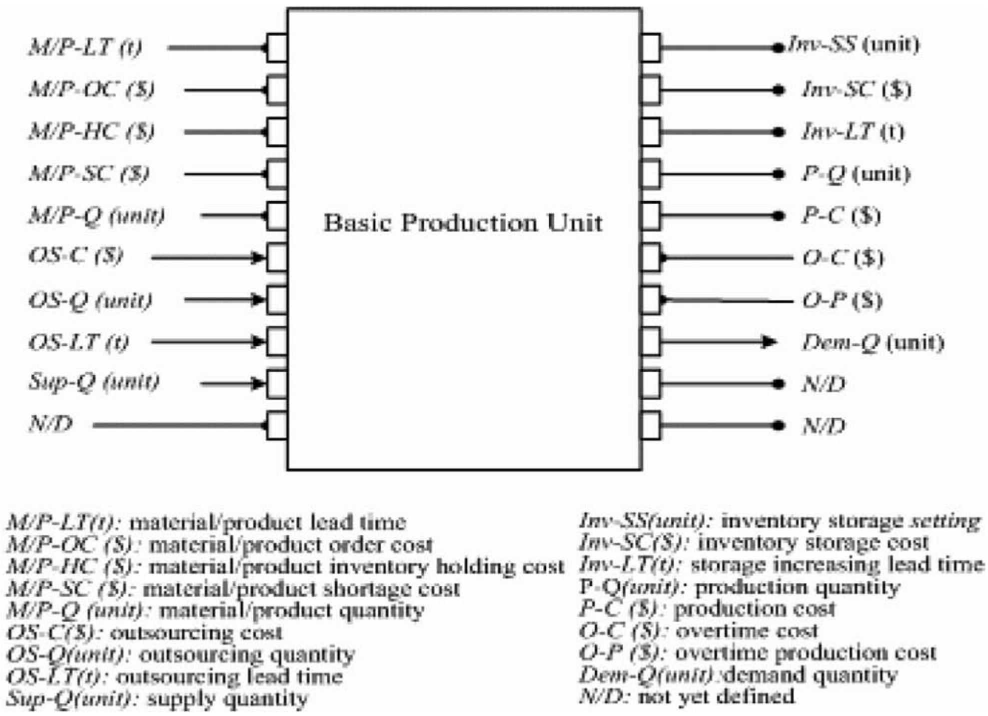

Fig. 1. The conceptual basic unit.

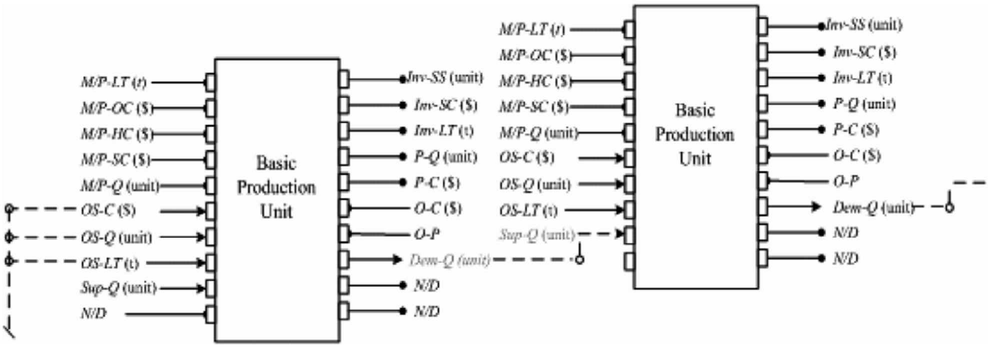

Fig. 2. Interaction of supply and demand (between basic units).

3.2. User accessibility

SIMPLE has three levels of user accessibility: (1) system manager, (2) game administrator, and (3) game player. The three-tier design of the user accessibility separates the functions of game management, configuration, and playing. The system manager has the authority to manage the server and database. Game administrators, who are generally the course instructors, can set up the game rules and parameters, which determine the game scope, such as the game mode, the value of the predetermined parameters for the game, and the information content provided by the system. Game players, generally the students, can only play the game that is configured by the game administrators.

3.3. Game scenarios

SIMPLE currently provides two different game scenarios, namely single-player single-tier and multiple-player multiple-tier.

3.3.1. Single-player single-tier scenario

Single-player means that the game has only one decision-maker, and players do not interact with other players. In a classroom, all students make their own decisions by responding to the same external information, such as market demand, which is set by the game administrator. Students then compete with each other according to their own "scores," which are determined by the costs that result from their decisions. This is the foundation of SIMPLE, and the main structure is shown in Fig. 3.

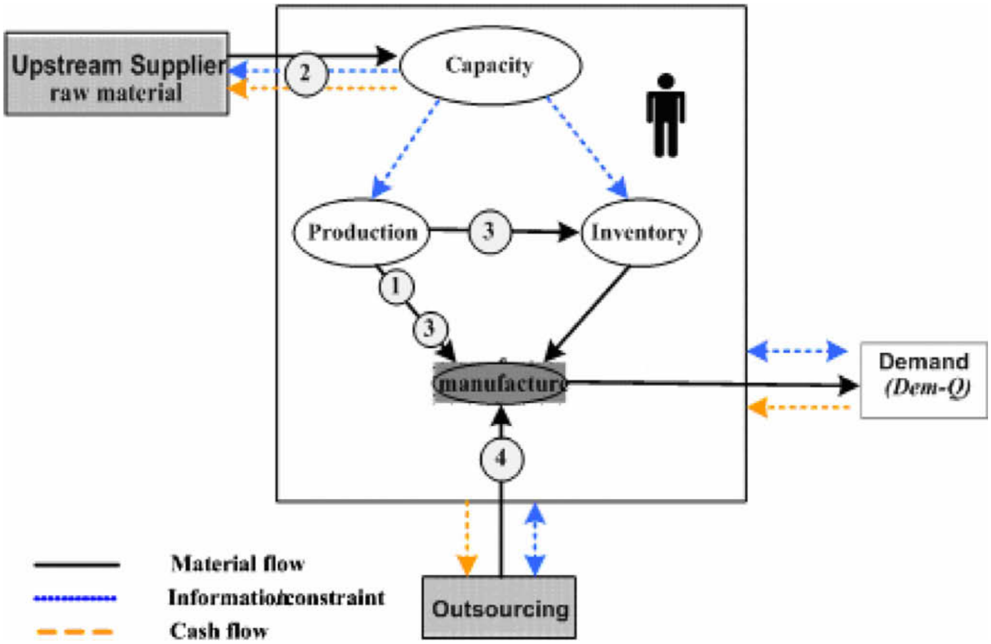

Fig. 3. The single-player single-tier scenario.

Fig. 3 defines the decision scope of a single-player, which represents a node in the supply chain; this node is called a *production unit* hereafter. Because the nodes produce/generate economic values that are not restricted by the physical product, every production unit can represent a manufacturer or a wholesaler. Any particular production unit that is controlled by a player can take one of three states/activities: capacity, production, or inventory. These concepts might have different meanings for different roles in a supply chain but are straightforward to generalize. *Production* is the main process in the production unit. For a logistics system such as a warehouse, "production" may resemble the associated packing/shipping activities. Production lead-time is a parameter in the game that is set by the game administrator. *Inventory* serves as a buffer to fulfill the demand. This concept can also be generalized to the role of a distribution center or warehouse, in which inventory refers to the items packed before the required shipping date. *Capacity* denotes the maximum production capability, which, in the SIMPLE environment, aggregates all production resources, such as labor, equipment, and space, into the production unit.

This study assumes the presence of at least one source of demand, which can be either deterministic or probabilistic. The shaded boxes in Fig. 3 denote the functions that are managed by the game administrator and have no capacity restriction. That is, the upstream material supply (such as raw material or assembly parts) and other resources (including manpower, equipment, and outsourcing) are always assumed to be sufficient and with given prices. Moreover, the game assumes that the player buys exactly the necessary quantities of raw material or parts, but has to determine the size of production capacity.

This production unit has four main decision components, which are numbered in circles in Fig. 3:

- *Make-to-order (MTO) production planning:* determine the number of units to produce in each time period in order to match demand. Producing more than the required demand (i.e., building up inventory) is forbidden.
- *Capacity management:* determine the maximum production capacity for production and storage.
- *Production planning/inventory management:* determine the number of units to produce in each time period. Inventory is permitted with pre-specified holding costs.
- *Outsourcing management:* determine the number of units to be outsourced; i.e., bought as completed goods from other sources. Outsourcing capacity is assumed to be unlimited. The outsourcing cost is a parameter of the game; i.e., the players are price takers.

3.3.2. Multiple-player multiple-tier scenario

This scenario involves multiple players in the system. Every player makes his own decision, as in a single-player game, to satisfy demand. The game administrator provides external demand information to simulate the requests from end-customers. As in the Beer Game, every tier is limited to one player. However, the number of tiers in the system is flexible and can be determined initially by the game administrator. Fig. 4 depicts an example of a two-tier game. Every player requests material from its upstream player; e.g., the downstream raw material request becomes the demand for the upstream player. Backordering (with or without penalty) and outsourcing (at a cost) are options that can be set by the game administrator.

Instructors can tailor SIMPLE by simply adjusting the game parameters, thus creating different games for various teaching stages and business concepts, including inventory management, capacity management, and information-sharing between players.

3.4. SIMPLE implementation

SIMPLE is implemented in the Java environment developed by Sun Microsystems. Java is chosen to be the programming since it can be developed and executed in a wide variety of computing platforms and is ubiquitous in web servers. The SIM-

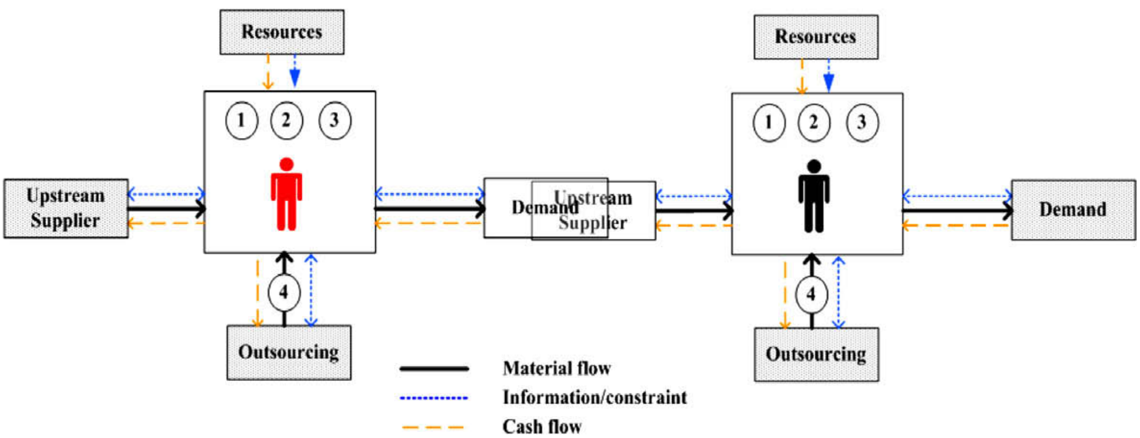

Fig. 4. An example of multiple-tier multiple-player scenario.

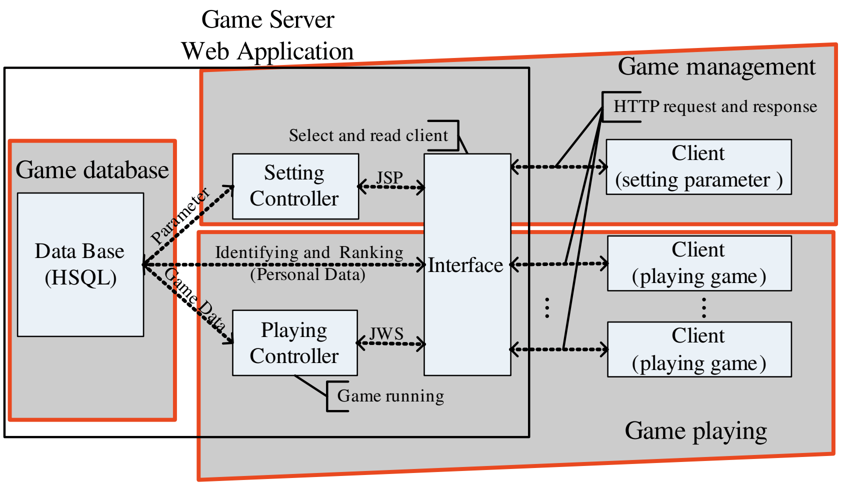

Fig. 5. SIMPLE architecture.

PLE architecture is designed as a client–server model, which is a dispersed system. This system utilizes many processors that are scattered around a network. Additionally, adding a new server or processor to the system, or upgrading an existing server, is very easy to do [7]. The game server and database are located at the server side, while the players are at the client side. Fig. 5 shows the architecture of SIMPLE.

The SIMPLE system can be roughly divided into three major parts: (1) game management, (2) game database, and (3) game playing. The following describes, respectively, these three parts:

(1) *Game management:* Java Server Pages (JSP) technology is used to create dynamic web content. The web pages are constructed by html codes embedded with Java programs. When a client sends a request to the game server through JSP web page, the request is sent by the JSP program and executed through Java Servlet. As a result, the corresponding response is then transmitted back to the client from the game server. The information and data that are exchanged between client and game server are based on Hyper Text Transfer Protocol (HTTP). A game manager can configure the game parameters through the above-mentioned process. Furthermore, it is possible to assign different paths for different game managers (usually for different courses) so that each manager can tailor his/her own game for his/her own players (such as students).
(2) *Game database:* The SIMPLE database is a relational database system managed by Hyperthreaded Structured Query Language (HSQL). All game history (for example, player's ordering decision and performance) and account information are recorded in the game database. The system manager can connect to the game database through JDBC driver to retrieve data for post-game analysis.
(3) *Game playing:* Game playing pages are displayed through the application of Java Web Start (JWS) technique to enable game players to start SIMPLE directly from the Internet using a web browser. In order to do so, the files of SIMPLE program codes are packed into a single Java Archive (JAR) file, and the "mime.type" file at the server side needs to be edited to include the appropriate definition of Java Network Launch Protocol (JNLP). Game players can play SIMPLE game from any web browser once connecting to the game server.

The system can be accessed through http://scmlab.nctu.edu.tw:8084/Esimplex/ (as shown in Fig. 6). SIMPLE is designed to be displayed in two languages, English and Traditional Chinese. The user guides for the player and administrator, respectively, are downloadable from this web page.

3.4.1. Game configuration

According to the two scenarios designed for SIMPLE, the game can be played under two different modes, Manufacturer Mode and Supply Chain Mode. Manufacturer Mode is designed for a single-player (corresponding to the single-player single-tier scenario). Supply Chain Mode is designed for several players to play the game interactively (corresponding to the multiple-player multiple-tier scenario). The number of players designed in Supply Chain Mode is unrestricted and is configurable by the game administrator through the game configuration pages provided.

Fig. 7 shows the game configuration page for the game administrator to set up the number of players who participate in a game, the type of players, and the name of every player. There are two types of players designed in SIMPLE: "General" and "Manufacturer." The difference between these two is that "Manufacturer" is equipped with production function; namely, it needs to arrange its capacity when playing each game. The game administrator can adjust the player setting to suit different teaching needs.

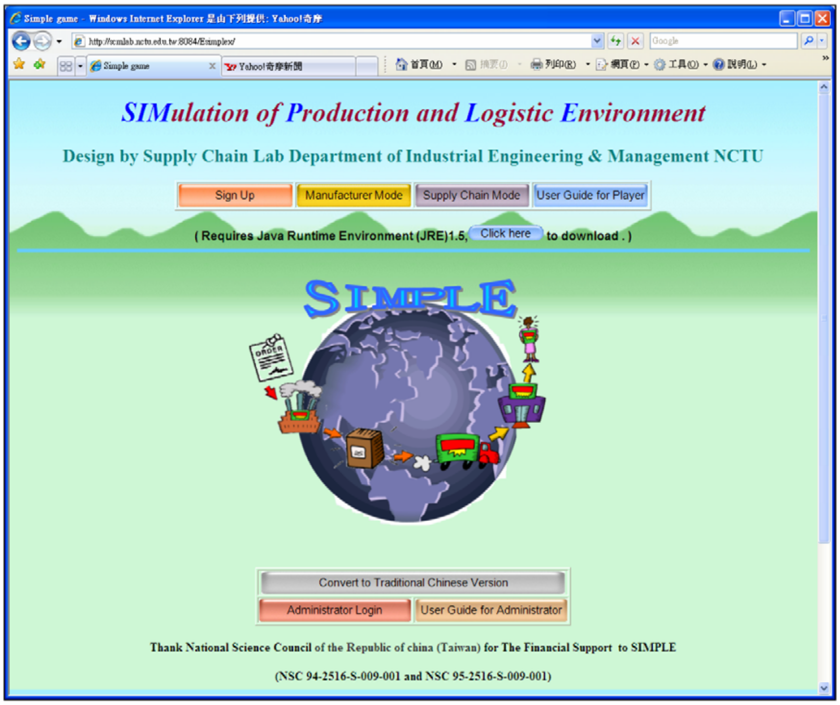

Fig. 6. SIMPLE access page (http://scmlab.nctu.edu.tw:8084/Esimplex/).

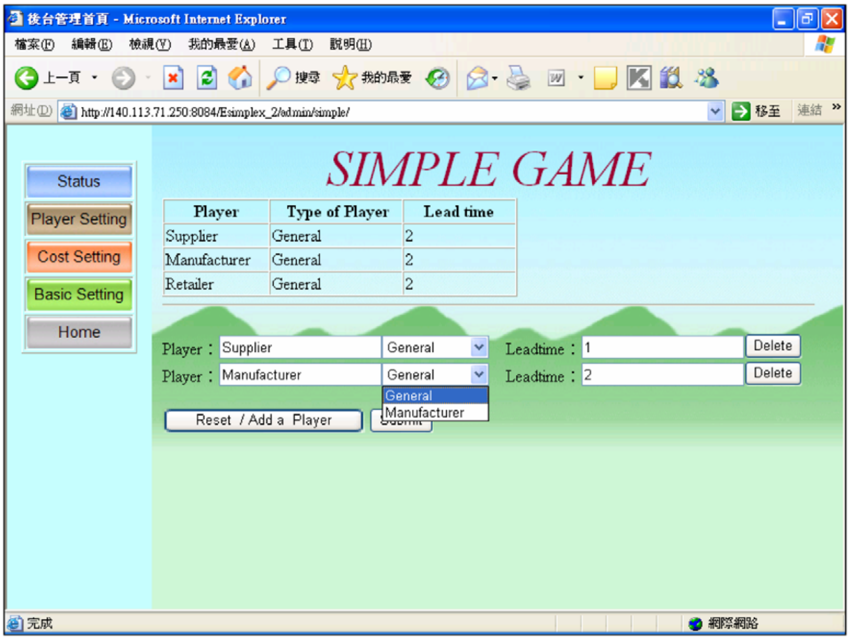

Fig. 7. Game configuration page – player setting.

Fig. 8 displays the web page designed for the game administrator to set up game parameters for different teaching objectives. The adjustable game parameters include the length of game duration, market demand, initial inventory, the information-sharing mechanism, storage and production capacity for manufacturers, and the cost structure that the system uses to evaluate performance of the player's decisions.

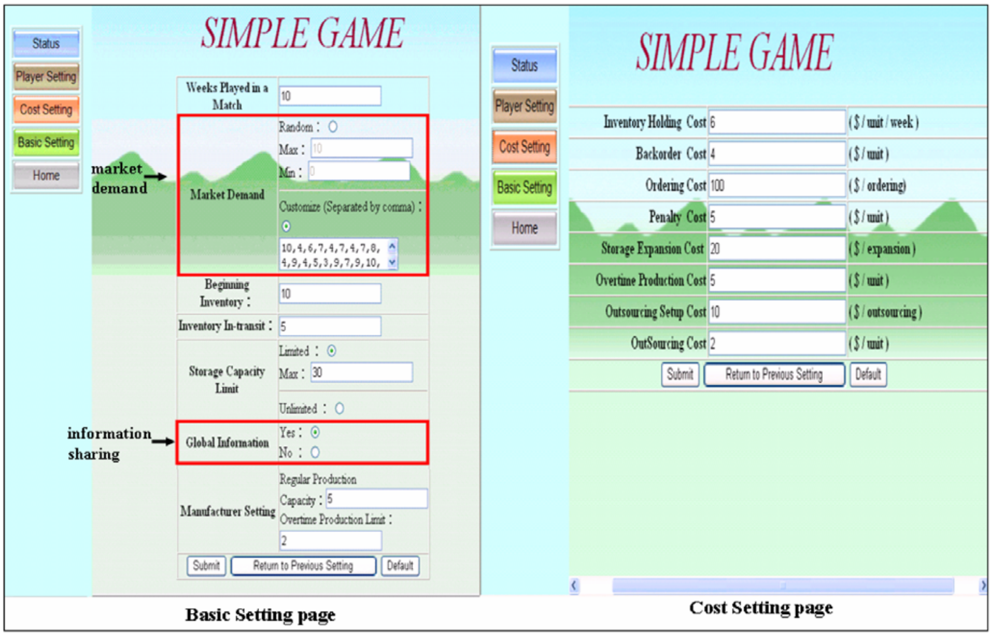

Fig. 8. Game configuration page – basic setting and cost setting.

3.4.2. Game playing interfaces

Fig. 9 shows an example of the player interface in SIMPLE. Depending on the game settings, the information displayed is slightly different for different game scenarios. However, the main structure remains the same. As shown in Fig. 9, three players play a three-tier supply chain game (i.e., under the Supply Chain Mode). Each player needs to determine his/her order quantity to satisfy upstream demand. The player interface provides players with their current inventory status, order and demand history, and prior-week decisions to help them make decisions efficiently and effectively. Each player can also find out if other players within the same game have made their decisions from the player interface provided. The interface under Manufacturer Mode shares the same structure as the one under Supply Chain Mode.

SIMPLE currently provides player interfaces in two languages, English and Traditional Chinese. When players are playing interactively (i.e., under Supply Chain Mode), they can choose their preferred displayed language. Fig. 10 shows the pages for two players who are participating in a three-tier supply chain game; while one player prefers to use English, the other chooses to work with the traditional Chinese interface.

3.4.3. Game results

Once a game is terminated, the game results are displayed in the form of various statistical charts and reports for players to check their performance. Fig. 11 provides several snapshots of the charts and reports that are provided by SIMPLE to display game results.

4. Application of simple

4.1. Description of the application

SIMPLE provides a flexible game environment to enable instructors to design appropriate teaching games by simply adjusting game parameters for different courses in various teaching stages. It can thus be employed to encourage students to use the course material that is learned from classes to develop game strategies and, furthermore, to internalize knowledge and become familiar with the course concepts. By appropriately adjusting game parameters, instructors can use SIMPLE to supplement traditional lecturing on various major business and operation concepts, such as the principle of inventory management, capacity management, production planning, forecasting, and cooperation and competition within a supply chain. This flexibility differentiates SIMPLE from currently available production games. The game management mechanisms of SIMPLE make it possible for instructors to design a series of games to simulate different situations within very quick setups. Fig. 12 illustrates the application concept.

Moreover, besides applying SIMPLE to assist curriculum activity, instructors can also utilize this game in pedagogy. For example, they can analyze students' decision-making behaviors from the game results that are stored in the database as a teaching reference or for in-depth study of related learning behaviors.

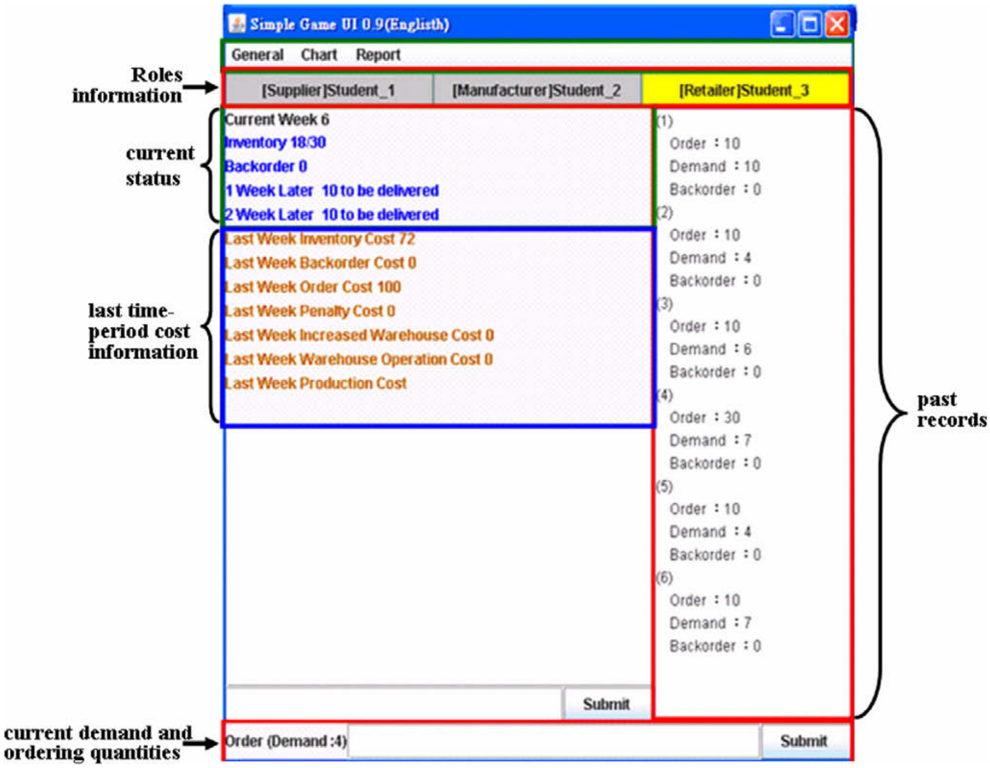

Fig. 9. The interface of Supply Chain Mode.

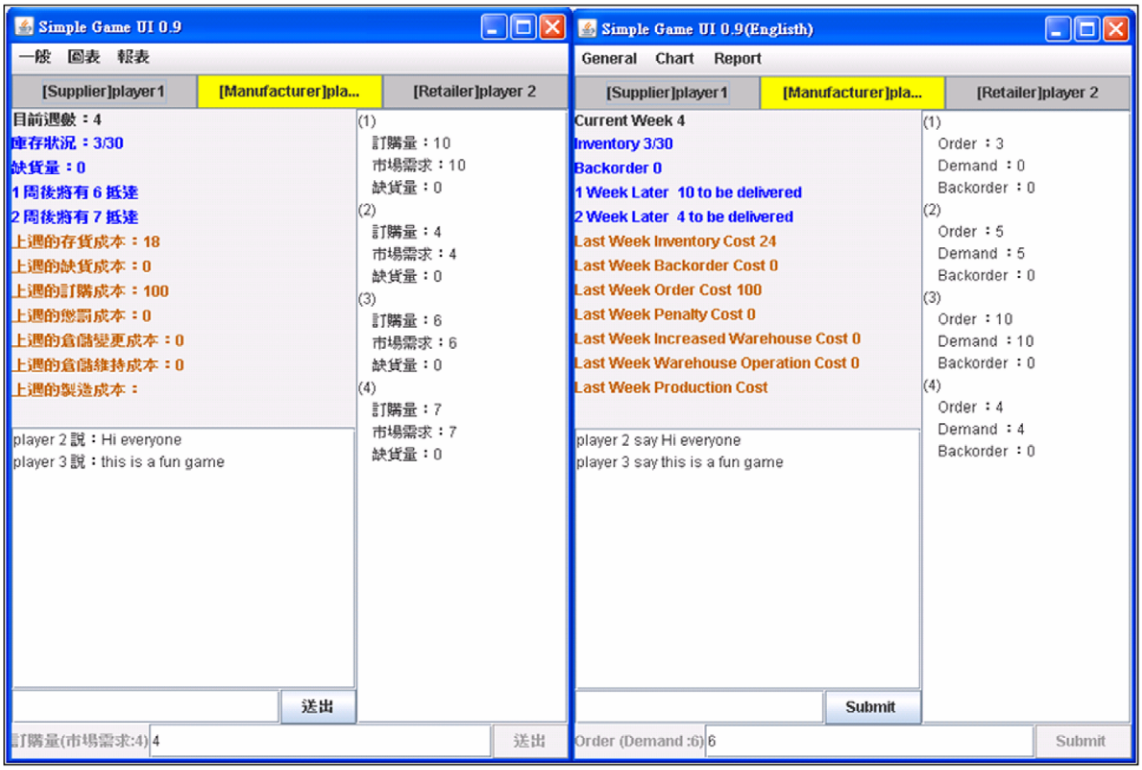

Fig. 10. Player interface displayed in English and traditional Chinese.

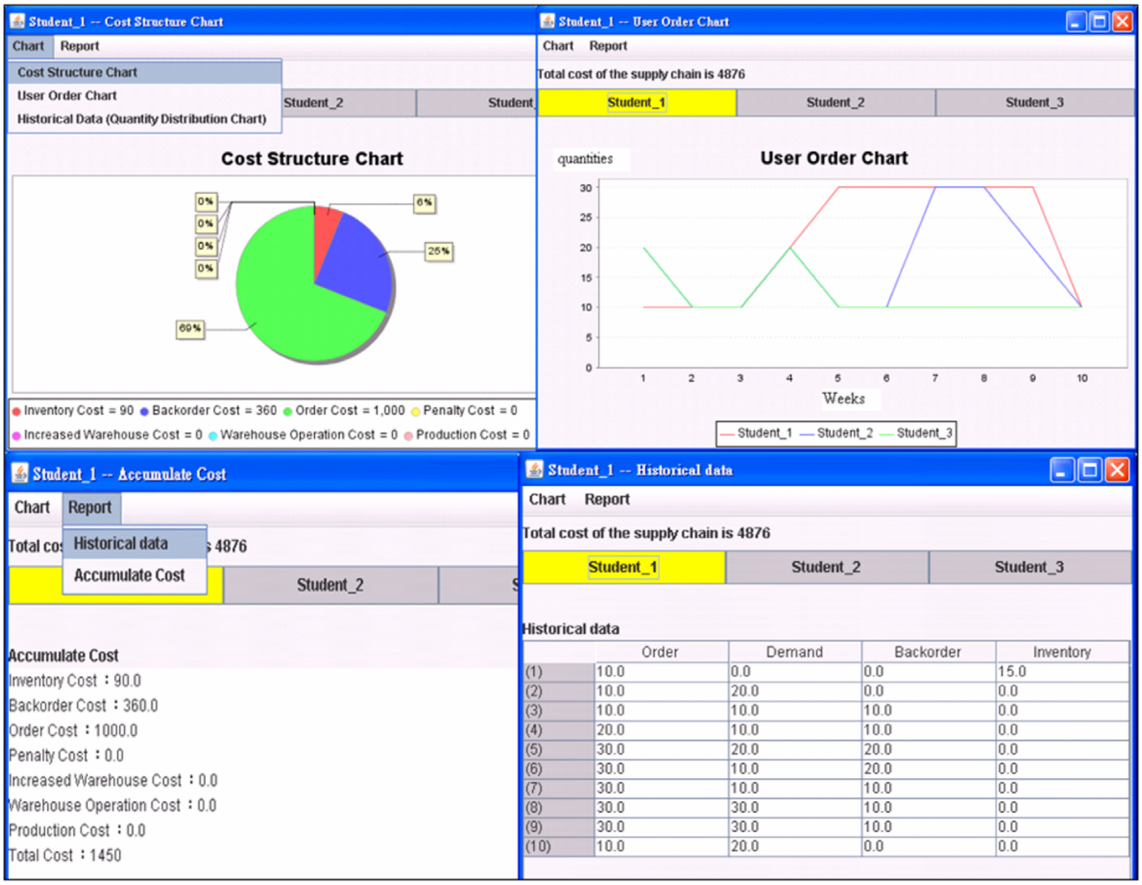

Fig. 11. Display of game results.

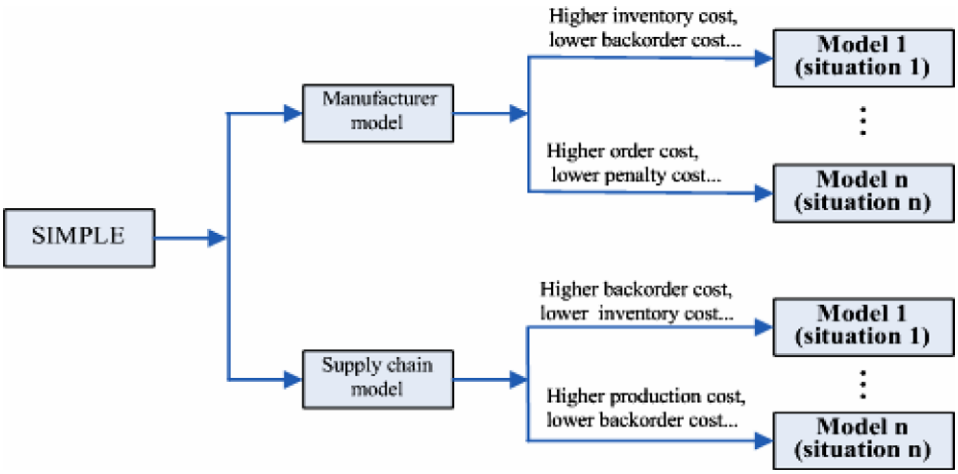

Fig. 12. Flexible and diversified models of SIMPLE.

SIMPLE can also be utilized as a platform to be shared with other universities to increase the collaboration and competition among students. Students can play SIMPLE individually or in groups through role-playing to experience the consequences that result from different applied strategies. Instructors can also adopt SIMPLE to create an inter- or intradepartment/university competition in order to encourage students to study and perform further research in related areas.

Furthermore, SIMPLE can be employed as a test-bed for production and logistics theories. As production and logistics research increasingly adopts simulation and game to verify theories [5,3,12,13,10], a simulation environment for production and logistics becomes a necessary tool for researchers for this purpose. A controllable environment enables students and instructors to observe and compare the performance of various approaches. This process enables students to benefit not only from learning and verifying theories in textbooks, but also from developing their own schemes that might lead to new theories and skills.

4.2. Application to courses

SIMPLE was employed in two courses to evaluate the degree of students' acceptance of using SIMPLE in classrooms. The two courses were production and operation management (POM) and supply chain management (SCM), which were opened in the Department of Industrial Engineering and Management at National Chiao-Tung University in Taiwan. Thirty-two undergraduate students in the POM course and 24 graduate students in the SCM course participated in this experiment.

In the POM course, students were grouped such that each group consisted of 3–4 students. The Manufacturer Mode of SIMPLE was introduced to the students. Each group of students acted as a "manufacturer" to interact with SIMPLE. The game was played for 20 simulated weeks twice, with a break in between. In the SCM course, we configured SIMPLE to simulate a four-tier supply chain. Each student acted as a member of the supply chain and interacted with each other via SIMPLE (namely, there were 6 supply chains that were operated by 24 students): the game was played for 25 simulated weeks twice, with a break in between. Toward the end of each activity, students completed an anonymous survey to collect data on student perceptions of SIMPLE. The questionnaire consisted of two components; the first part focused on student perception on the user interface design, while the second part focused on the students' learning experience. A Likert five-point scale, ranging from "strongly agree" to "strongly disagree," was adopted in the questionnaire.

Table 2 summarizes the students' responses regarding the user interface design. As shown in Table 2, most of the mean scores were above 3.6, which indicates that students generally agreed with the game user interface design. Meanwhile, it can be seen from the table that students were satisfied with the game transmission speed, but the displayed information needed to be further improved.

Table 3 summarizes the students' self-evaluations on their learning experience resulting from adopting SIMPLE in the corresponding course. It can be seen that most of the mean scores are over 4; the highest mean score was 4.42. Generally speak-

Table 2
Students' scores regarding SIMPLE's user interface design (total number of subjects in POM course: 32; total number of subjects in SCM course: 24).

Item	No. of strongly agree (score = 5)		No. of agree (score = 4)		No. of neutral (score = 3)		No. of disagree (score = 2)		No. of strongly disagree (score = 1)		Mean score	
	POM	SCM	POM	SCM	POM	SCM	POM	SCM	POM	SCM	POM	SCM
The instruction of the game is clear	6	0	9	15	16	9	1	0	0	0	3.63	3.63
The game displays an aesthetic screen design	9	3	15	16	8	4	0	1	0	0	4.03	3.88
The game displays adequate information to assist me in making decisions	7	1	15	12	10	10	0	1	0	0	3.91	3.54
The information and dialog boxes are displayed appropriately during the execution of this game	3	1	13	10	12	11	4	2	0	0	3.47	3.42
The download speed of the game is adequate	10	11	17	12	5	1	0	0	0	0	4.16	4.42
The response time of the game is short after entering each command	12	10	14	11	6	3	0	0	0	0	4.19	4.29
Generally speaking, the player interface is user-friendly	5	0	17	8	10	15	0	1	0	0	3.83	3.29

Table 3
Students' scores regarding their learning experience (total number of subjects in POM course: 32; total number of subjects in SCM course: 24).

Question	Mean (standard deviation)	
	POM	SCM
After playing the game, I will discuss with classmates about the game and the course material	4.00 (0.50)	4.38 (0.33)
When playing the game for the second time, I am involved in the discussion with teammates to work on appropriate game strategies	4.34 (0.48)	4.04 (0.65)
I think playing this game has enhanced my interest in this course	4.19 (0.71)	4.42 (0.34)
I got better understanding on the related course material after playing this game	3.60 (0.68)	4.38 (0.33)
I think if I play this game again, I will get a better result (i.e. a lower overall cost)	4.00 (0.50)	4.17 (0.49)
I discussed more with my classmates than what I did in usual class time	4.13 (0.61)	4.38 (0.77)
I think the game is interesting	4.19 (0.53)	3.71 (0.91)
I would like to play this game again	4.41 (0.55)	3.83 (0.75)

Table 4
A comparison of the total cost generated in the different rounds.

Course	Minimum cost	Maximum cost	Average cost	Standard deviation
POM				
Testing round	2132	16,586	7486	4718
1st round	2658	6896	5140	1749
2nd round	1306	2370	1812	346
SCM				
Testing round	4365	8936	6314	1587
1st round	1730	11,203	4994	3093
2nd round	752	4595	1873	1304

ing, students regarded themselves as having discussed more of the course material by playing SIMPLE and had a strong desire to play the game again.

From these results in Table 4, the average cost in the second round was smaller than those in the previous two rounds. From the viewpoint of assisting instruction, students are encouraged to explore the minimum cost by searching relevant theories, discussing with group members, and conducting experiments and reconsidering during a break after testing and first rounds in lectures. Meanwhile, the students desired to play the game "one more time" in order to reduce production costs even further.

5. Concluding comment

This study describes the concept, design, and implementation of SIMPLE, a flexible game environment that can be applied to various courses related to the decision sciences. Knowledge is acquired not only through class lecturing, but also through practice. Learners tend to develop the deepest understanding by combining the two methods. However, unlike students who, for example, study electronic design or mechanical systems, those who major in production and logistics (and related disciplines) do not have access to a laboratory environment. The lack of such a skill-developing environment means that the students cannot easily structure or connect the knowledge that is obtained in the classroom or implant what has been learned into their minds. SIMPLE was created to assist instructors in curriculum activities when teaching, for example, production management, inventory control, cooperation, and competition among multiple entities within a supply chain. SIMPLE's built-in flexibility enables instructors to fully control the required configurations when teaching various topics. However, all of the students asked the instructors aggressively after the class about the SIMPLE game design and about business administration strategy in the real world—these occurrences constitute proof of the students' interest in the SIMPLE Game. Meanwhile regarding the levels of students' scores and their learning experience, all of the students highly valued the content and tasks that were provided by SIMPLE. The students desired to play the game "one more time" in order to improve their scores—that is, in order to reduce production costs even further. In addition, in-depth interviews with the instructors of the two courses showed that they had a very high willingness to adopt SIMPLE in their courses and acquaint other instructors with SIMPLE. With appropriate course design, SIMPLE can be employed to help students develop internalized knowledge and applicable skills in various scenarios that are found in most production and logistics systems. Instructors can also utilize SIMPLE in pedagogy by analyzing students' decision-making behaviors from the game results that are stored in the database of SIMPLE. Furthermore, SIMPLE can be applied as a test-bed for production and logistics theories for the researcher in a related field.

6. Further work

We are extending the functions and scenarios that are provided by SIMPLE. In current version, the adjustment of game parameters is separated from game playing in order to make the control of classroom activities easier for instructors when using SIMPLE as a teaching aid. In the next revision, we are considering to appending a game mode to allow players adjust the game parameters during playing games when SIMPLE is used as a research tool.

Additionally, SIMPLE will be applied to various courses to analyze students' behaviors and to measure the effectiveness of teaching and learning by applying SIMPLE in classrooms. Supplementary SIMPLE-specific teaching plans will be developed to encourage the application of SIMPLE. Analyzing players' patterns and playing strategies in various situations is another interesting direction for further study.

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