Business game-based experimental active learning using a multiagent approach for management education

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***Abstract*—It is very difficult for students who do not have a business career or experience to understand business models or structures. In addition, business models from the student viewpoint remain largely within a model-based understanding, and students do not have practical opportunities to create an image of business uncertainty. Our goal is to provide an experimental learning environment beyond the level of the students' hypothetical thinking about uncertainty in business. We have developed a versatile participatory simulation environment as an active learning environment for the university classroom. We apply a multiagent-based approach to represent the uncertainty of the business environment. This paper introduces one of our active learning programs, the Croquette Factory Game, for understanding business interaction with uncertainty. We show that this program provides beneficial educational effects for students in understanding a business model with uncertainty.**

Keywords—active learning; participatory simulation; gaming simulation; business games; multiagent approach

I. INTRODUCTION

Various learning or teaching methods have been proposed and developed for the university classroom to encourage management education. Active learning and cooperative learning such as in-class activities followed by sharing what they have written in small groups have been the especial focus as a major learning method to encourage students' study. Presentations, debates, and role-playing activities by students are recently considered to be a typical active learning style. Though the term "active learning" has never been precisely defined in the educational literature, some general characteristics are commonly associated with the use of strategies promoting active learning in the classroom [1].

We propose an active learning technique for business education using a participatory simulation environment. Our learning environment can be used to supplement rather than replace lectures or previous active learning techniques. The goal of our research is to provide educational contents in the management science field in a participatory environment for the university classroom. As a typical participatory learning method using the Internet, we have been using business games. The students are organized into small groups of two to three and make certain decisions as a manager. Therefore, a student engaged in this type of active learning is assigned the same, single role in the game. This is a strict constraint considering the reality of a business situation.

From the viewpoint of real business, we need to create a business game environment that has more interactive functionality because there are various types of business agent in the real business world and they communicate with each other. In the process of business interaction, we sometimes face uncertainty. Therefore, we have expanded the existing business game environment and redesigned the participatory gaming simulation to represent business uncertainty. Uncertainty in business is very difficult to understand through business education. We have developed a business game as a type of active learning program: the Croquette Factory Game. This game involves business interactions among participants including an agent. We show that this program leads to beneficial educational effects and provides students with multiple views of business strategies.

The rest of the paper is organized as follows: First, we overview related research works in active learning using the participatory business simulation environment. Then, we describe the multiagent-based environment and see how it can be used in the active learning education environment. We also introduce the MAGCruise (Multi-Agent Gaming Cruise) Project in detail. We then describe our educational program and discuss the effectiveness as a proof of concept along with our proposal. We finally conclude our paper with a summary and overview of future works.

II. RELATED WORKS

A. Educational Frameworks for Digital Games

The educational model that is applied for online learning has been considered from the view of students' experience including flow experience. Kiiti [2] points out that one approach is to introduce online computer games in education, and computer games may create a new learning culture that corresponds better to students' habits and interests. On the

other hand, educational games should provide possibilities for reflectively exploring phenomena, testing hypotheses, and constructing objects.

The key to success is to reach a balance between fun and learning in a gameplay design model [3, 4]. The flow experience will give students a deep commitment to the educational game situation. This helps to focus the students' attention on the educational topic and discussion in feedback or the debriefing process in the classroom, as well as maximizing the effects of the education. We focus on these advantages of the educational game and aim to provide excitement in the classroom [5].

B. *Business Game Platform to Achieve Active Learning and Cooperative Learning*

As one of the active fields of online gaming in education, business games or business simulation has been considered and used as an effective way to engage students in Decision Support Systems (DSS) [6] .

Tanabu and Shirai [7] have been developing the Yokohama Business Game (YBG) as a system for the development and operation of business games. The YBG provides easy packaging of business game contents for business education. The main purpose of the system is to give an opportunity to experience management decision-making and to understand business models. The students participate in a business game as players who are managers of a company or shop. Some standard games are provided by YBG; furthermore, the faculty or the teacher can create new business models as a game designer. To develop one's own games on the YBG platform, it is not necessary to have any special skills in computer programming or operation. YBG provides domain-specific language to describe game scripts.

C. *Expanding the Business Game Platform to an Agent-based Gaming Platform*

YBG adopts the role-play game style and the players participate in the game as business managers. The role of the participants of the game in YBG should remain the same. On the other hand, as it is based on different roles, the MIT Beer Game [8, 9, 10] is a famous business game for understanding supply chain management. Kimbrough et al.[10] and Kwon et al. [11] focus on the MIT business game using an artificial agent. [10] have found that artificial agents are capable of playing the MIT Beer Game effectively, and are able to track demand, eliminate the bullwhip effect, discover optimal policies (where they are known), and find good policies under complex scenarios where analytical solutions are not available. [11] focus on multiagent collaboration and provide more flexible and extensible solutions to help address emerging uncertainties.

Based on these previous works, we focus on the computer-based business game platform where various types of players—agents and human beings—can play as a *hybrid* multiagent approach. This approach is good for representing the uncertainty of the business environment. The platform facilitates a full assessment of more complex business scenarios.

III. PARTICIPATORY GAMING FRAMEWORK FOR ACTIVE LEARNING

The term "cooperative learning" covers the subset of active learning activities that students do in groups of three or more, rather than alone or in pairs. Cooperative learning techniques generally employ formally structured groups of students assigned to complex tasks, such as multiple-step exercises, research projects, or presentations [1]. As a learning platform for active learning, we propose an multiagent-based participatory simulation, which can be mainly used for gaming education. The system structure of our proposed platform MAGCruise is shown in Figure 1 and Figure 2.

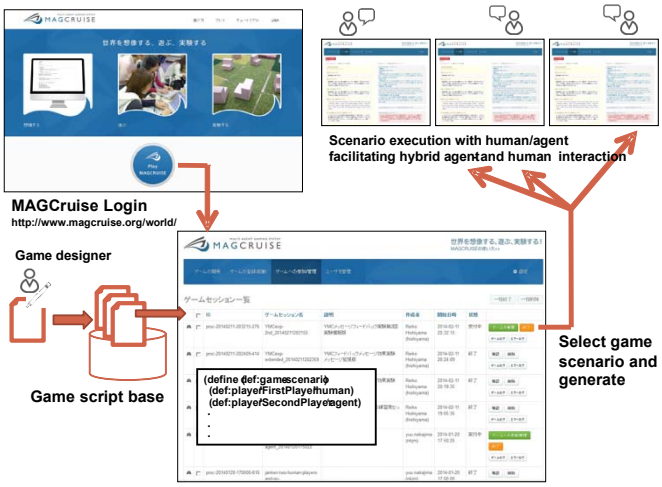

Fig. 1. MAGCruise (Multi Agent Gaming Cruise) system.

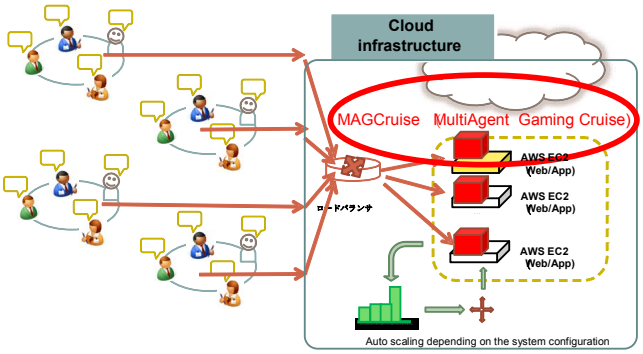

Fig. 2. MAGCruise system in the cloud computing environment.

MAGCruise users, who are teachers/students, do not need any special computer resources to use the system. Users can access the platform via a WWW browser and participate in the game session easily. Various types of business game scenario can be stored in the game scenario database. Thus, these are ready-made game scenarios. The teacher can select one of the

game scenarios according to their educational purpose and conduct their active learning class using the gaming simulation even though they do not have any educational contents. It is also possible to modify the ready-made scenario by hand to arrange what suits their educational purposes. As shown in Figure 2, MAGCruise is hosted as a cloud computing service. The system, which is on the EC2 service of AWS (Amazon Web Service*), is scalable if it is used for a large classroom, and the teacher can generate an instance of the game server according to the scale of the classroom. It is possible to select the auto scaling function to optimize the system resource. The gaming environment is automatically load-balanced according to the scale of the classroom. The teacher and students can create a new gaming scenario and store it as one of the gaming simulation contents. They can release and share their own original games with others openly in the cloud computing environment.

Our aim in focusing on an agent-based approach is to make it possible to conduct an platform where various types of role-players—agents and human beings—can play. In order to describe the various roles in the scenario, we have expanded a scenario description language *Q*[6] on the representational level of role behaviors and interaction among each role. The following (Figure 3) is an example of the scenario description of the game. In this description, the role of a farmer is played by an agent, and the roles of a factory and two shops are played by human beings.

As a relatively common occurrence for educational purposes, it is easy to switch the role from human to agent (or agent to human) by modifying the scenario script. If the teacher wants to give a single role to all the students in the class, he/she has only to modify the scenario: two shops are assigned to the agent in case of the scenario in Figure 3. An example of user interaction is shown in Figure 4.

```
(define (def:game-scenario)
  (def:ext-context Market)
  (def:ext-player 'Farmer 'agent Farmer)
  (def:ext-player 'Factory 'human Factory)
  (def:ext-player 'Shop1 'human Shop)
  (def:ext-player 'Shop2 'human Shop) )
```

Fig. 3. An example of the scenario description to define multiple roles.

In case of some previous studies on gaming simulation, student groups needs to be synchronized as the simulation progresses. For example, a round as a unit of the business game is synchronized by means of decision-making by all groups; the next round in the game begins only when the decision-making by all groups has been completed. A group sometimes has to wait for the other groups to submit their decision in case of YBG [7].

* Amazon Web Service, EC2. http://aws.amazon.com/.

```
(ui:request-to-input self:name
  (ui:form
    (to-string (<h4> ctx:roundnum "day: selling price ")
  self:name "    Make decision of today's selling price of the
  krokett, please    ")

    (ui:number "Selling price(krokett)" 'price (self:defaultPrices
  ctx:roundnum) (Min 50) (Max 200)))
```

Fig. 4. An example of the scenario description to define multiple roles.

As a viable alternative to this solution, the groups in this gaming system can make decisions asynchronously, in other word, the decisions of each group deal with events that happen asynchronously.

Figure 5 shows a screenshot of the game operation for the teacher. The game sessions of each student group are managed independently. Therefore, each group is released from the constraint of waiting for other groups' submission. This independency is provided as a function of the *Q*[6] processing system.

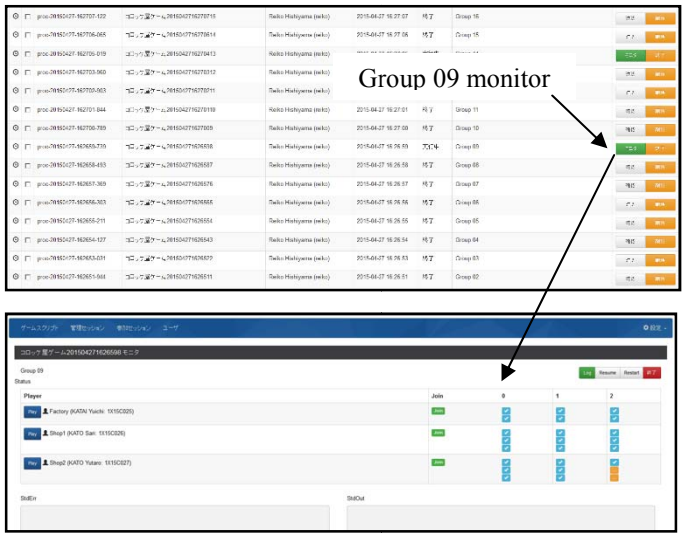

Fig. 5. An example of the scenario description to define multiple roles. The teacher can monitor the game progress status of each student group.

IV. Experimental Gaming in the Classroom

In order to evaluate our proposed platform, we developed an original business game called the Croquette Factory Game that can be made available for the education of first-year undergraduate students. This game scenario aims to understand three basic and important management flow functions, i.e., goods flow, money flow, and information flow, from the viewpoint of the various roles in the market.

We implemented the market model not only through a single role but also through three roles: shop, factory, and

farmer. This concept is dependent on the multiagent-based approach. In this regard, differences from the Bakery Game [7] and the MIT Beer Game [8, 9, 10] are that: 1) our game is organized by various types of human and agent role-mixed *hybrid* environments and 2) each player can communicate regarding exchange of goods, information, and money in the process of the game session.

The flow of the game scenario is shown in Figure 6. Three students comprise one group and each student has a different role: shop 1, shop 2, and factory. The "farmer" role is played by an agent.

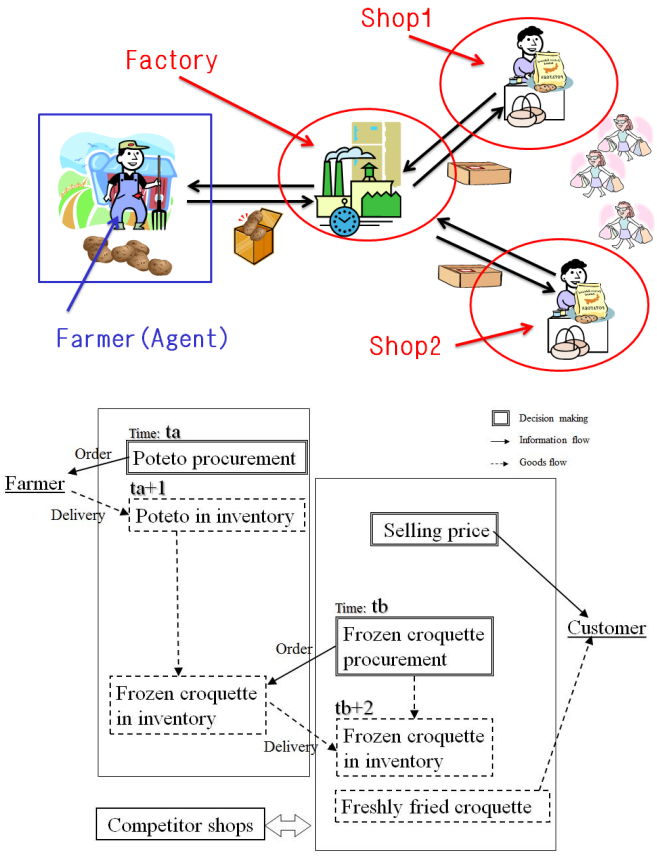

Fig. 6. Croquette Factory Game: A simple image of the market flow (above) and business model (below).

A summary of the scenario is as follows:

There are two croquette shops in a town. These shops sell freshly fried croquettes to customers. The croquette shops order frozen croquettes from the croquette factory. The factory delivers the frozen croquettes according to the order from the shops. It take two days from order to delivery of the frozen croquettes.

The factory orders potatoes from the potato farm in order to make the croquettes. The farmer delivers the potatoes according to the order from the factory. It takes one day from order to delivery of the potatoes.

A template of the communication process is as follows:

1) *Step 1: Ordering process*
   a) Decision-making of shop 1 and shop 2: ordering the frozen croquettes from the factory.
   b) Decision-making of the Factory: ordering potatoes from the farm.
2) *Step 2:Delivery process*
   a) Delivery of potatos from the farm to the factory.
   b) Delivery of frozen croquettes from the factory to shop 1 and shop 2.
3) *Step 3:Making frozen croquettes in the factory.*
4) *Step 4:Accounting deadline.*
   a) The accounting books are calculated for each role.

We implement intentions in about a combination of the supply chain management and basic accounting management.

We had 138 students in the class and this game was played twice by 46 groups. Each group comprised three students. After the game session, each team member received the game result data as a decision-making log. They analyzed it and discussed the successes or failures of their management from the viewpoint of management administration. We conducted a questionnaire survey consisting of six questions to evaluate our proposed system after the game session. The questions are organized as follows:

Q1: Did you become interested in the business game?

Q2: Could you create an image of the business management system?

Q3: Which is better for you for learning about business management: by lectures or by business simulation?

Q4: Have you ever learned business management through role-play experience in the classroom?

Q5: Do you want to participate in business simulation or business games again if you have an opportunity to attend this class ?

Q6: What were your strategies during the game? (This question was answered only by the students who played the "factory" role)

The result of questions Q1, Q2, Q3, Q4, and Q5 is shown in Figure 7. These questions were set to evaluate the effects of the education through the business simulation. The result of question Q6 is shown in Figure 8. This question was set to evaluate the effects of the scenario that has multiple roles. As described above, the game was conducted twice by 138 students. Questions Q1-5 were answered by 137 students, and Q6 was answered by the 81 students who experienced the "factory" role.

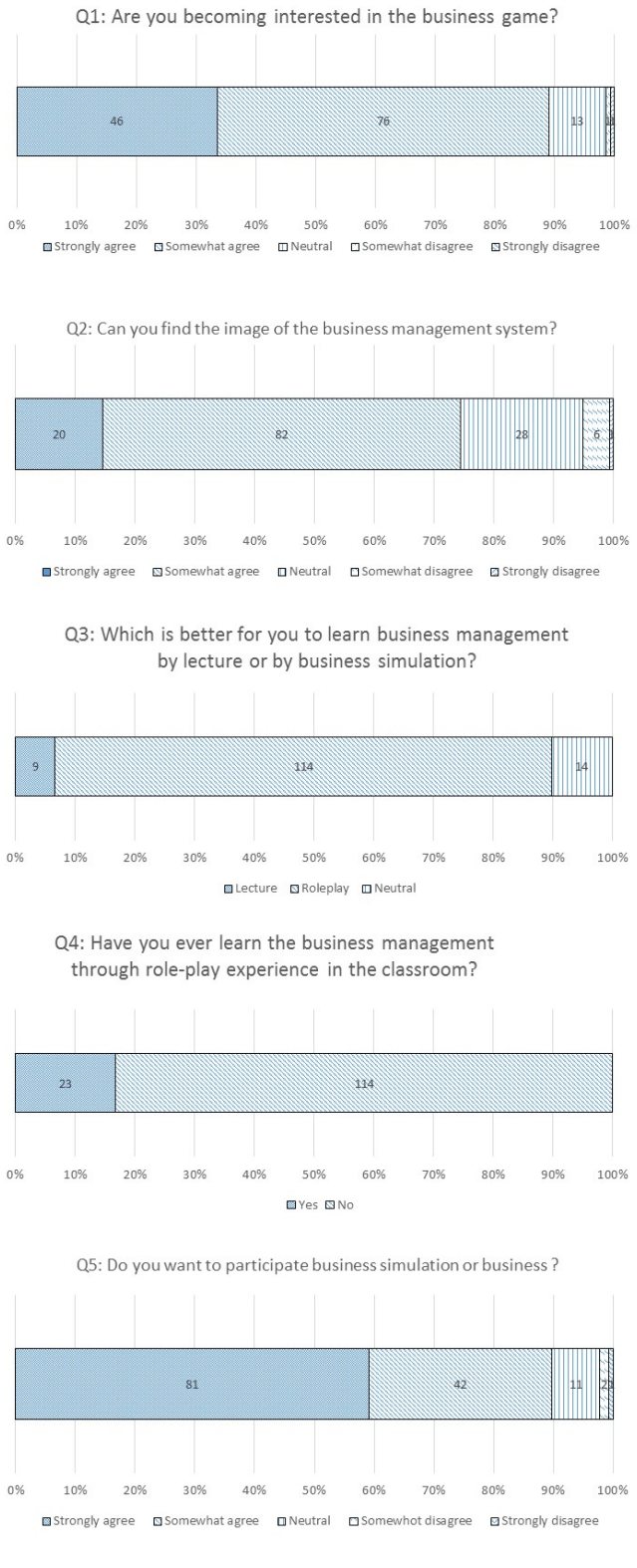

Fig. 7. An example of the scenario description to define multiple roles.

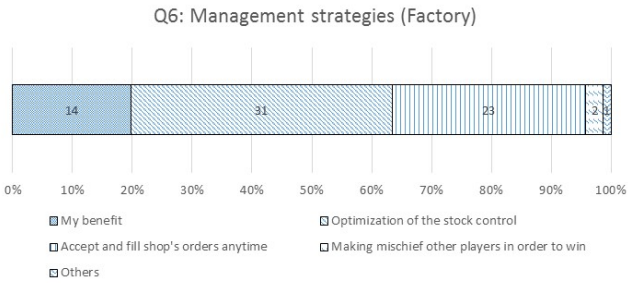

Fig. 8. An example of the scenario description to define multiple roles.

A. Basic Educational Effects

The result of Q1 showed that more than 90% of the students in the classroom were interested in business games through the experience in the classroom, and about 75% of the students could create a basic image of the business model as shown in the result of Q2. We found that the Croquette Factory Game gave an attractive experience and was successful in keeping the students from being bored in class.

According to the reports from the students after the class in conjunction with Q2, the following comments were common as feedback:

- *I understood the situation that the shop is allowed a few days for delivery if the factory does not have sufficient quantities of frozen croquette stocks.*
- *A lack of stock (or excess stock) and pricing control were dependent on the management decision in previous gaming terms. Predicting the future of the stocks, the number of customers, and pricing control is important for making better managerial decisions.*

The most difficult part of the business model, such as stock control or predicted numbers of customers with uncertainty, was well understood by introducing experiential, active problem-solving learning through the gaming simulation.

B. Traditional Lectures vs. Active Learning

To Q3, about 90% of the students in the class answered that active learning was better for learning business management. In business simulation, students participated in the market where everything happens in neat chronological order. In contrast to the lecture style, active learning enables students to become involved in the flow of management actions. In this regard, the students feel the benefit of understanding the timeline of the business.

On the one hand, according the result of Q4, most students have never had experience of active learning. Though multiple methods of learning have been proposed, various types of learning are not always provided in class. We assume that students seek novel experiences in the classroom.

To Q5, about 60% of the students answered that they strongly hope to attend the business game class again. This learning style was successful in arousing a feeling of curiosity in each student.

C. Giving Multiple Views in a Business Model

Q6 is a question for only those students who played the "factory" role. The gaming simulation was successful in providing some different perspectives on management actions. The students keep in mind not only benefit but also stock control. The factory had to maintain a global perspective in a business relationship among the shops as human players and the farmer as an agent to make a profit. According to the trend of answers to Q6, the students understood that benefits were brought about by concern for the other players.

V. Discussion

We found that the Croquette Factory Game gave an attractive experience and was successful in keeping students from being bored in class. The system resource in a cloud computing environment was sufficient for hosting all the student gaming groups. As mentioned above, we had 138 students as players and organized 46 groups. The system will be able to support classes that have more groups by generating instances of the gaming server. The number of instance increases should be planned in response to the number of groups.

As is clear from the result of Q4, most students have never had a chance to participate in a computer-based business game. Faust and Paulson [1] point out that the majority of college faculties still teach their classes in the traditional lecture mode. The result of Q4 provides clear evidence to support this point. As a cause of this situation, we assume that there is no environment for conducting computer-based business game education in schools or universities. In order to conduct computer-based active learning, the teacher has to prepare a computer-based educational environment and contents before starting the class. That is a significant hurdle to overcome for teachers in terms of computer skills and contents development costs. To solve these problems, a common computer-based gaming simulation environment should be effectively utilized as a shared infrastructure for a wide range of teachers openly. Our system will helpful in overcoming this problem. We are planning to develop various types of sample gaming simulation contents to be widely released.

The multiagent-based approach provided a multilateral perspective on the business situation. The game result showed differences among groups. These results teach students that a manager has to manage uncertainty effectively. Deepened studies will be achieved by setting up opportunities for students to report the results of their management as feedback.

VI. Conclusions

We provided a versatile participatory gaming simulation environment as an active learning method for the university classroom. We prepared an active learning program, the Croquette Factory Game, for understanding business interaction with uncertainty. We found that the game gives students an attractive experience and that a multiagent-based approach helps to give a global perspective in a business relationship among shops/factory as human players and a farmer as an agent player. We use a multiagent-based approach to represent the uncertainty of the business environment. As a result, they understand the business models well and succeed in creating an image of the uncertainty of business through dealing with the interactive behavior of the other players. As future works, we will develop other types of business simulation that involve interaction among various types of roles. For example, manager and business person as a human resource management game, or service provider and receiver as a service management game, will exploit the characteristics of games using a multiagent approach.

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