Facilitating Knowledge Acquisition with Surrogate Decision Maker Method in Business Simulation Game

Beiyu Yang¹ and Motonari Tanabu²

¹ International Graduate School of Social Sciences, Yokohama National University, 79-4 Tokiwadai, Hodogaya-ku, Yokohama
² Faculty of International Social Sciences, Yokohama National University, 79-4 Tokiwadai, Hodogaya-ku, Yokohama 240-8501 Japan

Abstract: Abstract: Knowledge acquisition is an important aspect in simulation game. However, most simulation game developers focus on not knowledge acquisition, but the game itself. Even though researchers focus on knowledge acquisition, their concern are the acquisition of game-related domain knowledge. Different types of knowledge can be obtained through various activities of simulation game in response to different purposes of these activities. Particularly, most simulation games have been computerized and widely utilized online. This indicates the availability of new method for knowledge acquisition. In this paper, we focus on knowledge acquisition in computer-supported simulation game with ICT mediated knowledge acquisition method. First, we categorize different types of activities and participants involved in simulation game, and clarify the relationship between different types of participants and activities. Then, we propose a new method for knowledge acquisition, by which participants can acquire knowledge from various gaming simulation activities. The proposed method is a computer-based numerical simulation with intelligent agent and human generated gaming data. After explaining the concept and definition of the method, we will see how the method can be used in different activities, and give some usages of the method in business simulation game, and suggest possible usage of the method for each type of activities. Finally, we discuss how ICT supported methods can facilitate knowledge acquisition in simulation game activities.

Key Words: Knowledge acquisition, Business simulation game, Surrogate decision maker method, Experiential learning, Debriefing, Game design

1. Introduction

Debriefing is perhaps the most important part of a simulation/game (Crookall, 1992)[1]. A debriefing is a time to reflect on and discover together what happened during game play and what it all means (Steinwachs, 1992). As Petranek, Corey and Black (1992) presented, Gillespie (1973) observes that games are not self-teaching and need a good debriefing session to assist students in reflecting on their behaviour and the purpose of the simulation. Crookall (2010) also pointed out that the learning comes from the debriefing, not from the simulation game itself, and debriefing is the processing of game experience to turn it into learning. Debriefing is generally categorized into two types: in-game debriefing in which the data can be processed to provide material for feedback during play (Crookall, 2010) and post-game debriefing which is an instructional process that is used after a game, simulation, role-play, or some other experiential activity for helping participants reflect on their earlier experiences to derive meaningful insights (Thiagarajan, 1992).

Simulation games have been computerized and widely utilized online in higher education and training in past two decades. It makes new debriefing methods available. The authors proposed a method, called surrogate decision maker (SDM) method, which aims at comprehensive debriefing. SDM method is a computer-based simulation in which decision-making data set yielded in simulation game is used as the decision input for the analytical model of same structure as the game, and a machine agent is substituted for a specific player. SDM method can be used both in in-game debriefing and post-game debriefing. In in-game debriefing, this method can be used to analyze future and past gaming environment such as market situations, and make player’s decision (what-if analysis, goal seek analysis, and sensitivity analysis, etc.). In post-game debriefing, SDM can be used to acquire knowledge about the game structure itself, to test the effectiveness of player’s model building during the game play, and to provide further opportunities where player can analyze another “as-if” world; these analysis might provide further understanding of the given game structure and real business structure.

SDM can be used for not only debriefing but also for other purposes, such as game design and testing of players’ decision-making strategy. Knowledge acquisition is an important aspect in simulation game. However, most simulation game developers focus on not knowledge acquisition, but the game itself. Even though researchers focus on knowledge acquisition, their concern are the acquisition of game-related domain knowledge. Different types of knowledge can be obtained through various activities of simulation game in response to different purpose of these activities. As mentioned above, most simulation games have been computerized and widely utilized online, therefore the current ICT readiness indicates new methods for knowledge acquisition.

In this paper, we focus on knowledge acquisition in
computer-supported simulation game with ICT mediated knowledge acquisition method. We categorize different types of activities and participants involved in simulation game, and clarify the relationship between different types of participants and activities in section 2. In section 3, we introduce SDM as a method of knowledge acquisition. The concept and definition of SDM is described. Participants can acquire knowledge from/for various gaming simulation activities by SDM method. In section 4, we will see how the method can be used in different activities. In section 5, we give some usage of the method in business simulation game, and suggest possible usage of the method for each type of activities. Finally, we discuss how ICT supported methods can facilitate knowledge acquisition in simulation game activities in the last section.

2. Activities in business simulation game

In business-related area, simulation games are mainly used for two purposes: business research and business education. The responsibility of different types of participants and the functionality of various activities correspond to these two purposes are different. Thus, it is needed to clarify these different types of participants and activities, and then we can strengthen the knowledge acquisition when using business simulation game in debriefing phases for each type of participants aimed to various activities.

2.1 Types of participants

In this section, we categorize participants who are involved in the business game into three types from both the educational and research point of view.

For the education, participants can be categorized into the following three types: instruction designer, teacher and learner. Instruction designer develop the game for a certain educational purpose together with game expert. Teachers then use the game in the class to create a simulation environment and facilitate the learners to obtain domain knowledge from the game play. Learners do experiential learning to acquire domain knowledge from/by game play and debriefing. This category is based on the usual discussion that simulation game is regarded as an educational tool.

However, we would emphasize another perspective, from which all of the participants are regarded as learners who acquire different types of knowledge through participating the game. From this perspective, participants can also be categorized into three types: game designer, game facilitator and game player. Game designers design the game not only for the players to learn, but also for themselves to do the research, for example, to modify the game model so that it can replicate the dynamics of target system. Game facilitators not only use the game to help the learners to learn, but they themselves can acquire knowledge from the facilitation and to do the research, for example, to explore the effective strategy. Game players cannot only obtain domain knowledge from playing the game, but also do their own research.

2.2 Types of activities

We define four types of activities in which participants are usually involved in simulation game: game model building, model characteristic exploration, decision strategy exploration, and domain knowledge acquisition. Game model building here include game model modification. Model characteristic exploration refers to finding or testing the game model characteristic to obtain knowledge about the model characteristic and find if it is correct or not. Decision strategy exploration is to explore the participants’ own strategy, it belongs to research area. Domain knowledge acquisition is for the player to acquire game-related domain knowledge.

2.3 Relationships between participants and activities

Figure 1 represents the relationships between different types of participants and activities. Instruction designer/game designer will be involved in first three types of the activities, teacher/game facilitator will be involved in model characteristic exploration and decision strategy exploration, and learner/game player the last three types of the activities.

The difference in relationships between activities and participants depend on the participants’ purposes. Accordingly, the concrete activities in which each type of participants takes part are also different. To make it clear, we show the activities and purposes of different types of participants in table 1.

Designers’ activity spans from modelling game, validating game to verifying game with the purpose of business research, for example, research on behaviour of player or market mechanism, and business education.

Facilitators’ activity is involved in tutoring, mentoring, coaching, instructing, educating, training, or teaching. The purposes are mainly business education and sometimes business research.

The players’ activities involve acquiring knowledge and skills. Such knowledge and skills involves decision-making, data analysis, communication, etc. The players’ purposes are given by the game, which include enjoyment and to win the game, that is, gaining experience, and learning-by-doing, or experiential learning. It may be confused because it deals with different layers, so we explain it separately from different points of view, that is, education and research.

From the educational point of view, one of the aims of all the three types of participants is to help learners to acquire domain knowledge. In figure 1, only player has direct relationship with one of the activities: domain knowledge acquisition. Thus, we don’t pay much attention on explaining it, but rather we’d like to give more attention to the research point of view.

The players do not only acquire domain knowledge for the learning purpose but also explore their own strategy for the research purpose, so the game player involves both domain knowledge acquisition and decision strategy exploration. The facilitators’ main purpose is not to help the players to learn, but they themselves can acquire knowledge from observation in the game play and debriefing to compare the players’ strategies with other players’ and explore their own strategy, and meanwhile, they can test the game model to explore the model characteristics to find the problems of the model and report to the designers. Designers design the game not only to create learning environment for the players, but they do their own research as well. They can test the model characteristics to find the problem and modify the game model and improve it, and they can also explore their own strategy.

Table 2 shows how participant can be explicitly, or directly, involved in different activities, which will make former discussion clearer. First, for game model building, the instruc-
Table 1  Purposes and activities by types of participants

| Activities                          | Instruction designer/Game designer | Teacher/Game facilitator | Learner/Game player |
|-------------------------------------|------------------------------------|--------------------------|---------------------|
| Validating game/model               | Validating game/model              | Tutoring/mentoring/coaching/ | Acquiring knowledge and skills |
|                                     | Verifying game/model               | instructing/educating/training/teaching | (decision making, data analysis, communication, etc.) |
| Purposes                            | Business research (behaviour of player, market mechanism) | Business education | Enjoyment and to win the game (experience) |
|                                     | Business research (behaviour of player, market mechanism) |                     | Learning by doing (experiential learning) |

Table 2  Participant-specific explicit involvements in each type of simulation gaming activities

| Game model building                  | Instruction designer/Game designer | Teacher/Game facilitator | Learner/Game player |
|--------------------------------------|------------------------------------|--------------------------|---------------------|
| Design the simulated world in which player will experience something similar to the designer’s experience or thought Modify the game model | Design the simulated world in which player will experience something similar to the designer’s experience or thought Modify the game model | Explore the game model | Explore the game model |
| Model characteristic exploration    | Test the game model                | Explore the game model   | Explore the game model |
| Decision strategy exploration       | Explore effective new strategy under the model | Explore effective new strategy under the model | Examine the existing possible strategy in gaming and real world |
| Domain knowledge acquisition        |                                    |                          | Acquire domain knowledge (learning objectives) |

designer/game designer designs the simulated and structured environment in which player will experience something similar to the designer’s experience or thought, and modify the game model based on their own testing result and the feedback. The teacher/game facilitator and the learner/game player are not directly involved in the activities, but they are indirectly involved in, and that will be discussed later. Second, for model characteristic exploration, the instruction designer/game designer can test the game model to find if there is any place that should be revised (that is, model validity). The teacher/game facilitators can explore the game model to acquire knowledge about the game model characteristic for themselves. The learner/game player can also explore the model to get knowledge about the game model characteristic. For decision strategy exploration, both the instruction designer/game designer and the teacher/game facilitator can explore effective strategy under the model. The learner/game player can examine the possible strategy in gaming and real world. For domain knowledge acquisition from educational perspective, the learner/game player can get knowledge that aimed to be acquired in the game (learning objectives).

Table 3 shows the implicit, or indirectly, involvements of participants in each type of simulation gaming activities. First, for game model building, since the instruction designer/game de-
signer are directly involved in these activities, so we omit the discussion in this table. The teacher/game facilitator can instruct the learners to play the game and give their feedback to help designer to modify the model. The learner/game player can play the game and give their feedback that helps designer to modify the model. Second, for model characteristic exploration, although the teacher/game facilitators are explicitly involved in the activity, they can also be indirectly involved in. That is, they can test the game model and find if there is any place that should be revised and report to the designer. No participant is implicitly involved in decision strategy exploration. Finally, for domain knowledge acquisition, the instruction designer/game designer can be implicitly involved in this activity by designing the simulated world to help learners learn. The teacher/game facilitator can be indirectly involved in the activity by understanding player’s behaviour and facilitating learners learn by simulation game. The learner/game player can learn “something” not aimed.

3. SDM method

3.1 Epistemology of simulation/gaming

Simulation and gaming is used in various fields not only as an educational tool but also as a research approach. In the context of which simulation/gaming is used as a research methodology for practical problem solving in policy science, for example, rather than training tools for developing decision making ability, the methodology of simulation/gaming could coincide with that of participatory paradigm, whereas participatory paradigm does not emphasize the ways of knowing by making a meta-critical comparison between critical subjectivity of experiences in a “simulated and structured” another world and that of the real world. Based on the characterization of gaming simulation by Arai (2004) and the epistemology of participatory paradigm, Tanabu (2011) characterized epistemology of simulation & gaming as subjectivity derived from a comparison between critical subjectivity of experiences in “simulated and structured” world and past experiences.

3.2 Importance of SDM method

Based on the above discussion on epistemology, simulation game can create a virtual environment, in which the researchers and the learners can get experience and knowledge that can be compared with their past experiences and used in the real world. However, from the perspective of knowledge acquisition, one game session provides only one situation, the experience and knowledge we can get from this one situation is limited. Therefore, in order to maximize the effect of one game session, it is useful to have a tool that can provide more situations for people to get more knowledge. SDM method is such kind of add-in. It is a computer-based simulation analysis tool. It can provide all kinds of possible situation by changing the parameters for the researchers and learners to get more experience and knowledge. Basically, it can be called what-if analysis.

3.3 Concept of SDM method

Computer based simulation that deals with social problems needs appropriate dataset as well as simulation model. When a game designer or researcher explores the decision strategy that meets a specific requirement under a given simulation game, it is usually hard for the explorer and computer agent to simulate complex, and sometimes unclear and irrational decision of human players. The surrogate decision maker (SDM) method was originally designed to carry out business simulations for the purpose of player’s strategy exploration.

The original SDM method refers a computer simulation that uses a dataset made by human players. The dataset consists of decision values of all decision items of all players of all rounds in a simulation game. The simulation model that yielded the dataset is used again in SDM simulation, however a part of the dataset, a series of decisions made by a specific player in most cases, will be replaced with the data that will be made by computer agent. By changing the decision data of a specific player, the explorer can examine various decision strategies under pseudo “game” situation that might take place.

The SDM was originally designed for the exploration of decision-making strategy, however it can be used also to game design such as model building and parameter fitting. Required the model modification, if the designer or researcher does not have enough knowledge of player’s decision strategies in advance, the SDM method will be used to design the game balance and examine it.

In the context of examining a specific decision strategy under given simulation model, changing data yielded by the human player causes interpretation problem. For example, in the simulation game in which the market share is calculated by the selling price every round, if some players were setting the selling price that is different from the original, all players might make different decision in the next round because the result of each decision is referred by the players in the succeeding rounds.

However, in the case of simulation game in which demand
is distributed by the selling price, if we assume that the demand for each player is influenced by the variation of players’ decision in selling price than that of total demand, we can interpret the result of SDM simulation by simple modification of total demand. Since, the demand for each player is usually calculated by dividing total demand proportionally in terms of decreasing function of selling price, we can modify the total demand so that the demand for all players other than the computer agent (that is also calculated by the modified total demand) is just same as that of gaming, by multiplying the original total demand by the coefficient that is calculated from the human generated dataset. This means that by using the method of SDM with demand modification, strategy explorers can interpret their SDM result into the original gaming situation.

Although to change the original dataset causes the impossibility of logical interpretation of SDM result and the method of SDM with total demand modification allows us to interpret the SDM result into the original situation, the authors observed that the SDM simulation without total demand modification could be used instead of the demand-modification SDM in most cases. The SDM simulation we will introduce later is simple SDM that does not modify the total demand.

4. SDM method in different types of activities

In section 2, we illustrated different types of participants and activities in simulation game. We also explain how participants can be involved in different types of activities. We assume SDM method can be used in these activities to achieve these purposes. The problem then arise will be how to use SDM method in gaming simulation. Debriefing is the most appropriate phase where SDM method can be applied.

4.1 Debriefing

According to Steinwachs (1992), a debriefing is a time to reflect on and discover together what happened during game play and what it all means. Debriefing, even without a facilitator, usually move of their own power through the three phases of description, analogy/analysis, and application. In the description phase, participants air their experiences and impressions, and also need to listen to the other participants and so be filled in on the whole picture. In the analogy/analysis phase, participants systematically examine the simulation game model as just played and as designed, identifying and exploring parallels with real-world situations. In the application phase, participants focus on the reality presented by the simulation game. As Petranek, Corey and Black (1992) presented, Gillespie (1973) observes that games are not self-teaching and need a good debriefing session to assist students in reflecting on their behaviour and the purpose of the simulation. Most instructors who use simulations and games move to the second level of learning by following the simulation with a session designed to help students reflect on their learning (Thatcher, 1990). Debriefing is the occasion and activity for the reflection on and the sharing of the game experience to turning it into learning (Crookall, 2010).

Debriefing consists of an oral discussion session in which students and teachers engage in a question and answer session designed to guide students through a reflective process about their learning. Coppard and Goodman (1979, p. 41) write, “According to many designers and facilitators, such discussion (debriefing) and analysis are the most important elements in gaming/simulation in terms of the learning process involved.” Thatcher (1990) argues convincingly that participants who can reflect on the game are in a better position to recognize what they learned in the game.

All these definitions of debriefing pointed out the importance and purpose of debriefing. However, some of them over emphasize the oral discussion, and will make people think that debriefing equals to oral discussion. It is incorrect or misunderstood. We should pay more attention on the essence of debriefing, reflection, rather than the method, oral discussion. In this sense, new method such as numerical analysis could also be considered as part of debriefing. We particularly appreciate analogy/analysis which means to systematically examine the simulation game model as just played and as designed, identifying and exploring parallels with real-world situations. According to the epistemology discussion, we can also find the importance of reflection and bridging the gap between the simulation world and the real world.

4.2 Debriefing forms

Debriefing is generally categorized into two types: in-game debriefing in which the data can be processed to provide material for feedback during play (Crookall, 2010) and post-game debriefing which is an instructional process that is used after a game, simulation, role-play, or some other experiential activity for helping participants reflect on their earlier experiences to derive meaningful insights (Thiagarajan, 1992).

Different combinations of in-game and post-game debriefing produce different debriefing forms. In figure 2, four debriefing forms are presented. In this figure, “R” stands for round, so R1, R2, ..., Rn refers to “round 1”, “round 2”, ..., “round n”. “D” stands for post-game debriefing. D1, D2, ..., Dn refers to the first, second, ..., n times in-game debriefing.

Form (1), (2), (3) and (4) respectively stands for: to do in-game debriefing after each game round, and to do post-game debriefing after the whole game play; to do in-game debriefing after several rounds of the game, and post-game debriefing after the whole game play; to do in-game debriefing after half of the whole game play, and post-game debriefing after the whole game play; to do post-game debriefing only and without in-game debriefing. These four forms cover all kinds of combinations of in-game and post-game debriefing for one game session.

Figure 3 presents the combinations of different game sessions. In figure 3, both session 1 and session 2 refers to form 4 of figure 2. It means to do post-game debriefing after the first game session and use the knowledge acquired from the debriefing to play the game again for higher level of activity, for example, exploring the strategy, examining simulation model. Although only one combination is listed in figure 3, we can combine all the four debriefing forms for different usage. SDM method can be used in all debriefing phase mentioned in above.

Different types of participants can use SDM method in different debriefing phases for various purposes. Table 4 represents how to use SDM method in different game stages by participant types for different game activities.

First, player can use SDM method both in in-game and post-game debriefing. If the player is a novice to the game, he/she has no knowledge about the game model, so in-game debriefing is unsuitable, or the facilitator should give them SDM simula-
tion model in this case. If the player has already had some knowledge of the game, then he or she can build his/her own simulation models. When using SDM method in in-game debriefing, the player can test the game model characteristic, or analyze the past market situation, predict the future market, and make his own decision and examine the possible strategy in gaming world. When using SDM method in in-game debriefing, the player can get knowledge that aimed to be acquired in the game (that is, learning objectives), and further, can get “something” acquired in debriefing for transfer the knowledge to the real world. Combining all of these information both get from the in-game and post-game debriefing together with the game experience, the player can give their feedback which helps designer to modify the model.

Second, facilitator can also use SDM method in both in-game and post-game debriefing. When using SDM method in in-game debriefing, the facilitator can analyze the market situation and understanding of player’s behaviour, and give advice to the player who has problem with making decision by himself or herself. When using SDM method in post-game debriefing, the facilitator can explore effective strategy under the model, test the game model to get knowledge about the game model characteristic and find if there is any place which should be revised and report to the designer, and give the players’ feedback to the designer to help designer to modify the model.

Last, designer can only use SDM method in post-game debriefing for game model modification, model characteristic exploration, and decision strategy exploration.

According to the discussion, we suggest that different participants can use different debriefing forms with SDM analysis to achieve their purpose.
In order to see whether the THM player can achieve the higher performance in profit, possible all combinations of price and selling price are tested. As to the experiment design, we just introduce one perfor- mance variable, profit, in this paper. More precisely, we focus our discussion on profit and its relationship with price and throughput.

The selling price of all players influences the customer demand for each player, which also influences the decision making of each player in production quantity and procurement quantity. That is, the higher selling price than others brings fewer customers, and conversely the lower selling price brings more customers. Thus under low selling price, player would expect more customers so that the player needs to set both production and procurement quantity at high level to meet the customer demand, otherwise the player would lose customer in the next round. On the other hand, under high selling price, the player needs to set them at low level to avoid loss of disposal because unsold bread must be disposed of. In terms of procurement, the player has to order enough quantity of frozen dough to ensure required production volume one day after the order-
We did SDM simulation for each combination of selling price and throughput. Number of all combinations of two values is $5151 (=101 \times 51)$. There were 11 possible decision makers, each of which was substituted by the computer agent respectively. Therefore, 56661 ($=5151 \times 11$) simulations were done for each of two data sets of gaming to see how SDM result varies depend on the gaming data.

Figure 4 shows profit for each throughput under some spe-
cific selling prices. The horizontal axis stands for the throughput, and each curve represents the relationship between profit and throughput under fixed selling price. Each marker corresponds to one SDM simulation and the figure was generated from 5151 SDM simulations with a fixed surrogate decision maker.

We can find from figure 4 that there exists unique optimal throughput that maximizes profit for any selling price. Moreover, we find the unique maximum value in the set of maximum profit for each selling price, that is, there exists the global optimal solution in profit. In this case, the global optimal solution is 105 of throughput and 850 of selling price.

From the viewpoint of the knowledge acquisition, we can find that simple THM strategy can be a good strategy if we set the appropriate throughput and selling price. When using THM strategy, it is important to find the optimal combination of throughput and selling price correspond to the given market.

Figure 4 shows just a set of SDM simulation results for a fixed surrogate decision maker, and because of the space limitation, we do not present all of the figures generated. But actually, we generate such figures for different surrogate decision makers, and can observe the existence of global optimal solution for other surrogate decision makers. Since a large number of figures show the same tendency, this implies some sort of credibility of SDM method.

5.2 Revised THM analysis

In the previous section, the computer agent has a predefined pair of values that is used for its decision, namely, selling price and throughput. The original notion of throughput-maintaining decision strategy is to keep the production and procurement volume constant, whereas selling price is not necessarily to be constant.

In order to increase the intelligence of SDM agent and explore the extensive applicability of throughput-maintaining strategy, in this section, we give another THM experiment example. We modify the previous THM simulation so that the SDM agent calculates the appropriate selling price to sell out the planned amount of the products. First, we assume that the elasticity of demand (number of customer visits) with respect to the selling price is known. This is to indicate that SDM agent can estimate the demand function based on the previous decision data, and also calculate the sell-out price. For SDM simulation in this section, the SDM agent estimates total demand and average selling price in order to estimate the demand function of next round, and calculates the sell-out price at which all the target amount of products can be sold with less shortage. The target sell-out amount of products is automatically determined by multiplying throughput by the sell-out coefficient of which value lies between 100% and 200%. Thus, the SDM simulation parameters are throughput and sell-out coefficient. The 200% of sell-out coefficient means 200% of throughput is expected to be sold out. In this case, the selling price must be lower than the price at which 100% of throughput is expected to be sold out.

Figure 6 is a result of the revised THM simulation with SDM methods.

Figure 5 shows profit for each throughput by different sell-out coefficients. The horizontal axis stands for the throughput, and each curve represents the relationship between profit and throughput by different sell-out coefficients. Each marker corresponds to one SDM simulation and the figure was also generated from 5151 SDM simulations with a fixed surrogate decision maker.

We can also find that there exists unique optimal throughput that maximizes profit for any selling price and exists the global optimal solution in profit. In this case, the global optimal solution is 100 of throughput and 115 of sell-out coefficient.

From the viewpoint of the knowledge acquisition, participants can find a characteristic of given model, and revised THM strategy would be effective, if throughput and selling price are appropriately decided regardless of sell-out coefficients. In this sense, the revised THM strategy is good. From the result of both experiments, we can conclude that THM strategy can be a good strategy. Note that the optimal combination of throughput and selling price varies depending on the given market data yielded by players.

The authors confirmed that a large amount of figures obtained from a series of SDM simulation with different surrogate decision maker show the same tendency. Due to the space limitation, we omit these figures. From the similar tendency among different surrogate decision maker settings, we can believe the credibility of SDM method.

Although the usage of SDM method cannot be fully encompassed, the two experiments present in this section can give us a chance to see the potential of SDM method as a way of analysis. Regarding table 4, it is also an example of how participants can use SDM method for model characteristic exploration and decision strategy exploration in post-game debriefing. Through the experiment, first, the participants explore the model characteristic of the Bakery Game, and then explore the effectiveness of simple THM strategy and revised THM strategy, and find that THM is a good strategy at least under this game model. For the other effect of SDM method, we will conduct other experiments in our future research and discuss in the following papers.

6. Conclusion

In this paper, we discuss how to facilitate knowledge acquisition with SDM method in business simulation game.

First, we emphasize the essence of simulation game, that is, knowledge acquisition, and introduce the recent development of the simulation game. Rather than from the game itself, knowledge can be acquired from debriefing.

Simulation games are now computerized and widely utilized online, which make new method for debriefing become available.

Second, we categorize activities and participants involved in simulation game into different types and clarify the relationship between different types of participants and activities.

Then, we propose a new method for knowledge acquisition, by which participants can acquire knowledge from/for various gaming simulation activities. The method is called surrogate decision maker method, which is a computer based numerical simulation with intelligent agent and human generated gaming data.

After explaining the concept and definition of the method, we illustrate how the method can be used in different activities for certain purpose.

Then, we give two examples of applying the method in business simulation game, and suggest possible usage of the method
Although we suppose SDM analysis can help participants acquiring knowledge, toward comprehensive debriefing and better reflection, there is no evidence to prove it now. In our future research, we’ll do such experiment that ask two groups of player to do debriefing with SDM method and debriefing without SDM method respectively, and compare their achievement in the game performance and test to see if SDM method is really useful for acquiring knowledge or not. Figure 6 is the illustration of one example of our future research. Different forms will be tested and compared in the future.

Due to the technique improvement nowadays, we can also use SDM simulator by cloud computing. Figure 7 presents the idea of our future research framework. We can see from the figure that SDM simulation can be implemented on BSAIC (Business Simulation Application Interface for Cloud), which is developed by Yokohama National University. The players can contact directly with BSAIC instead of simulation game. They can also contact BSAIC through using local SDM simulator and SDM simulator on cloud. By doing so, participants can easily and quickly collect data and do SDM analysis, which makes both in-game and post-game debriefing with SDM method, and particularly the in-game debriefing with SDM method that are considered impossible, to become realize.

Acknowledgments
This research is partly supported by Grant-in-add (23530430) from JSPS.

References
[1] Crookall D, 1992. Debriefing, Simulation & Gaming, 23, pp.141-142.
[2] Crookall D, 2010. Serious Games, Debriefing, and Simulation/Gaming as a Discipline, Simulation & Gaming, 41(6), pp.898-920.
[3] Thiagarajan S, 1992. Using Games for Debriefing, Simulation & Gaming, 23, pp.161-173.
[4] Arai K, 2004. Gaming Simulation, Journal of the Operations Research Society of Japan, 49(3), pp.143-147. (in Japanese)
[5] Tanabu M, 2011. Education for Business Intelligence, Communications of JIMA, 20(5), pp.243-250. (in Japanese)
[6] Steinwachs B, 1992. How to Facilitate a Debriefing, Simulation & Gaming, 23(2), pp.186-195.
[7] Petranek C. F., Corey S, and Black R, 1992. Three levels of
Learning in Simulations: Participating, Debriefing, and Journal Writing, Simulation & Gaming, 23(2), pp.174-185.

[8] Gillespie J. A., 1973. The game doesn’t end with winning, Viewpoints, 49, pp.21-27.

[9] Thatcher D. C., 1990. Promoting learning through games and simulations, Simulation & Gaming, 21, pp.262-273.

[10] Coppard L. C., Goodman F L, 1979. Urban gaming/simulation, Ann Arbor, MI: School of Education, University of Michigan.

[11] Shirai H, A., 2008. The Bakery Game: Consideration to University Programs Using Business Games, Yokohama Business Review, 29(3), pp.171-188.

Beiyu Yang

is now a doctor candidate of International Graduate School of Social Sciences, Yokohama National University, Japan. She received her master degree from East China Normal University, Shanghai, China, in 2009. She is now a member of the ABSEL and JASAG. Her research interests include gaming and simulation, business game, business simulation and experiential learning, and education with ICT-supported methods.

Motonari Tanabu

is a professor at Department of Business Administration, Yokohama National University, Japan. He received his Dr. Degree from Tokyo Institute of Technology in 1995. His research fields are in simulation and gaming, information systems, and management information systems. He is a member of the AIS, ACM, AOM, ISAGA and ABSEL. He is conducting research on business simulation modelling methodology for problem solving.