A Learning Support Method in Qualitative Simulation-based Economic Education

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1 Introduction

E-learning has been recognized as a promising field in which to apply artificial intelligence technologies[1][2]. We proposed an economic education support system, which helps users learn about economic dynamics based on qualitative simulation[3]. Our paper describes how our system should support end-users learning in the economic education. Existing study, such as [2], proposed the useful tools based on qualitative simulation for middle school students. The main aim of this paper is showing how students are intelligently supported based on their conditons. We show, in this paper, a method of supporting using an example of qualitative simulation in economic education.

The advantages of qualitative reasoning in education are as follows. Student knowledge is formed and developed through learning conceptual foundations. If there are any mechanisms in the (dynamic) system, the user can understand these mechanisms using qualitative methods. Generally, students also understand dynamic systems through qualitative principles, rather than through mathematical formula. In our study, we developed our approach in least formula and took learning by non-specialist users into consideration.

The feature of our study is that users can learn without teacher. Our goal is developing a system in which users can understanding economic dynamics through their self-learning. We consider an approach and system in which non-specialist naive and novice users can use our system based on simple input. The contribution of our paper is the integration of theory and shows an approach to support method for qualitative simulation-based education system.

2 Qualitative Simulation Primer

The simulation primer uses a relation model between causes and effects expressed as a causal graph. Each node of the graph has a qualitative state value and each arc of the graph shows a trend in effects.

Qualitative States on Nodes: In economics qualitative simulations, it is difficult to decide landmark values because there aren't conceptions for landmark in conditions of nodes. We provide three sorts of qualitative state values on nodes without fixed landmarks shown in the Table 1.

State Trends Changing on Nodes: We define state trends changing on nodes that indicate the time differential. Three types of qualitative values are given shown in the Table 2.

Table 1: Qualitative state

$[x(t)]$	Qualitative states
H	In the next step, $[x(t)]$ is higher than in the current step.
M	In the next step, $[x(t)]$ is lower or higher than in the current step.
L	In the next step, $[x(t)]$ is lower than in the current step.

Table 2: Qualitative changing state

$[\delta x(t)]$	Qualitative changing state
I	$[x(t)]$ is increasing.
S	$[x(t)]$ is stable.
D	$[x(t)]$ is decreasing

Direction of Effects of Arcs: The direction of effects of arcs is defined by state trends changing on arcs. We show the direction of the effect nodes as influenced by the cause nodes. Two sorts of qualitative values are given. $D(x, y)$ is the direction of the effects from node x to node y, as defined as follows. The directions are classified into two categories. $+$: When x's state value increases(decreases), y's state value also increases(decreases). $-$: When x's state value decreases(increases), y's state value increases(decreases).

Transmission Speed of Effects on Arcs: When node x is influenced by other nodes and changes to a qualitative value, node y changes the value simultaneously(with a one-step delay) in the definition of transmission speed $V_0(V_1)$.

Integration of Multiple Effects on Nodes: When there are multiple adjacent nodes connected to a node, the integration of multiple effects on nodes is defined as addition of changing state values among multiple nodes.

3 Supporting Procedure

Our system points out and displays when users make inconsistent relationships between nodes in making causal graph model. On the other hand, when users mistake about the rules of relationship between nodes, our system drops hints based on the relationship data reserved in the database.

Our system is intended for learners, such as elementary school students and junior high school students. Each student has each experience and knowledge concerned with economic activities. When such multiple users use our system, our system applies and decides how to support such users based on a process of users learning. When users construct a causal model, their behaviors are difference based on each user's ability. If users know about some factors and its relationships partially, they tell finishing work and pushes the Done button (in our system) when they finish making the causal graph. On the other hand, if users don't know about some factors and its relationships, they works stop for minutes without their reports. Thus, we decide conditions after making causal graph as: (a) After some operations, the operation stops for minutes, and (b) After some operations, the Done button is pushed.

When users don't operate in some minutes more than time in which a manager (teacher, mentor, ...) decides, our system judges (a). Our system asks whether users' operation finished or not. If users select a button in which his/her work finished, our system asks the four questions as pop-up window, that is Done, HINT, GIVE UP and NOT DONE YET. When users select the NOT DONE YET button, the users continues making causal graph model. When users selects the other buttons, our system check up a causal graph model constructed by users and decides how to support the users' leaning. We classify the following sets based on the causal model.

1. The graph doesn't have both arcs and nodes.
2. The graph has less nodes.
3. The graph is constructed as a partial model.
4. The graph has too many/superfluous nodes and arcs.

When the graph doesn't have both arcs and nodes, our system decides graph condition 1. When the graph has less number of nodes constructed by users than the number of nodes set up by a manager, our system decides graph condition 2. When the model has more number of nodes constructed by users than the number of nodes set up by a manager and its model consists of multiple partial graphs, our system decides graph condition 3. When the graph has more number of nodes constructed by users than the number of nodes set up by a manager, our system decides graph condition 4.

Our system supports users based on a causal graph model constructed by users. We define the following conditions based on a button pushed by users.

F: The user selects the DONE button.
H: The user selects the HINT button.
G: The user selects the GIVE UP button.

We show the 9 sets of users situations in the users' graph making. For example, when we show users situation (3, H), this means that the graph is partial and the users want to some hints. Our system basically support through four phases shown in the Figure 1.

First, users start making causal graph. The graph construction window has a field of making causal graph, the NOT DONE YET button and the DONE button. When users finish making simulation model, three buttons are provided, that is DONE, HINT and GIVE UP. However, we don't provide the DONE button at condition 1 to 3. Users can select HINT, GIVE UP and NOT DONE YET button at condition 1 to 3. Based on the option button selected by users, our system supports users based on our support algorithm. After supporting at condition 1 to 3, the users retry making or completing causal graph model. In case of condition 4, our system checks the relationships between each node with arcs rule which are referred from database files. If there are any inconsistencies, our system shows the correct rules to the users. After the model is renewed, our system tries conducting simulation based on initial values input by users.

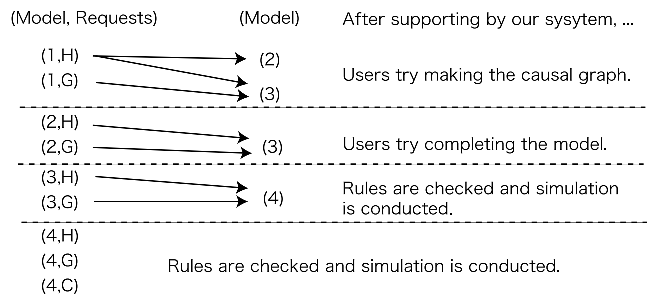

Figure 1: The Phase of graph making

Second, after users remake the causal graph model through our system's support, our system re-supports users based on the condition of model reconstructed by users. Users start making causal model and the users push the HINT button at condition 1. Our system shows some nodes, and users select the appropriate nodes from nodes shown by our system. After that, users restart making causal model and the users push the HINT button at condition 3. Our system drops hints as some relationship between nodes, the users use appropriate arcs based on the hints. Finally, our system checks the causal graph model based on the rules concerned with the relationship between each node. Users can try conducting an economic simulation based on the completed graph model.

4 Conclusion

In this paper, we proposed a support method of our e-learning support system based on qualitative simulation. In comparison existing education system using qualitative simulation, our system provide a simple input form in the simulation. When models and initial values are changed, users can know what influence its changing brings a result. Our system can be used without mentor, because users can input initial values easily in our system. Our system can be also a promising application as a self-learning system for a tele-education.

References

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