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Understanding Support System for Causal Relationship in Historical Learning

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Abstract: In historical learning, to grasp the causal relationship between historical events and to understand factors that bring about important events are significant for fostering the historical learning. However, some students are not able to find events that have causal relationships. The objective of this paper is to develop a support system for understanding the meaning of a causal relationship and making valid causal relation graphs in the historical learning. When events have a causal relationship, a state change in one event causes the other event. To consider these state changes are critically important to connect historical events. This paper proposes understanding scheme for grasping causal relationships between events by arranging state changes. Our system firstly asks students to arrange state changes of historical people according to the historical events, and then to draw the causal relation graph. The described state changes are indicated on the links in the causal relation graph. By observing the state changes on the links, students are not only able to check whether their causal relation graphs are correct, but also understand that state changes are important for grasping the causal relationships.

Keywords: Causal relationship, historical learning, historical thinking, state change

1. Introduction

Historical thinking skill is a reasoning skill to analyze and explain the historical events (Elder et al. 2012 & Ikejiri et al. 2012). This skill is important for inferring about events that will occur in the future (Lee, 2005 & Parkes, et al., 2014). Such skill brings us intrinsic knowledge for our future activities in many fields, such as politics, environmental issues, or architecture (Abbot et al. 1989). The skill should be learned through the historical learning. However, especially in Japan, students tend to memorize facts in historical learning and historical thinking skill is merely acquired.

Understanding the flow of the history and aware of the important factors that cause significant events in history are cornerstones for improving historical thinking. Important factors are estimated by the historical events that have causal relationships. What to regard important factors are different for individuals, so to discuss the differences is also meaningful. In order to discuss the important factors, one of the authors introduce a learning technique of having his middle school students draw graphs representing causal relationships, which we call a *causal relation graph*. This causal relation graph takes a form of a concept map (Chang et al. 2002), which basically consists of nodes representing historical events and links representing causal relationships. In implementing this technique, one of authors found that some of his students misconstrued the causal relation graph to signify a chronological time line rather than a causal relationship. The objective of this paper, therefore, is to develop a support system for understanding a causal relationship and drawing a valid causal relation graph in the historical learning.

When events have a causal relationship, a state change in one event causes the other event. This research defines the valid causal relation graph as the graph whose links correspond to the state change. To consider state changes is the key to create the valid causal relation graph. Therefore, this paper proposes understanding scheme for valid causal relationships between events by arranging state changes. Our system firstly asks students to arrange state changes of historical events, and then to draw the causal relation graph. The derived state changes are automatically indicated on the created links in the causal relation graph. By observing the state changes on the links, students are not only able to

check whether their causal relation graphs are correct, but also understand that state changes are important for grasping the causal relationships. Horiguchi et al. also focused on teaching causal relationships of historical events using pseudo-haptics of the tablet device (Horiguchi et al. 2016). However, this research only gives awareness information of incorrectness of causal relationships. In addition, it is difficult to define correct causal relationships, since there are various ways of understanding history. Our system encourages students to grasp the way to derive valid causal relationships, such as to consider state changes, by indicating derived state changes to the links in the causal relation graph.

2. Support of Creating Valid Causal Relation Graph of Historical Events

2.1 Valid Causal Relation Graph

Causal relationship graph represents the causal relationships of historical events and takes the form of a directed graph. Nodes correspond to the historical events and links show the causal relationship. Node at the bottom of the arrow is the cause of the node at the top of the arrow.

Assuming a valid causal relationship, state changes triggered by a cause event (*Event A*) can explain the emergence of the effect event (*Event B*) as shown in Figure 1. Therefore, if there are causal relationships between historical events, there is a state change that can explain it. As an example, Figure 2 is the causal relation graph that focuses the outbreak of peasant uprisings during the Muromachi period in Japan (1336-1573). The overview of this history is shown in Table 1 where underlined texts show the events occurred during this period. State changes between historical events in the causal relation graph is shown as messages on links. Consider the impact that the "formation of self-governing villages" had on other historical events. By the "formation of self-governing villages", the solidarity of the peasants got strengthened, which contributed to the "outbreak peasant uprisings," so clearly there is a valid causal relationship between "formation of self-governing villages" and "outbreak of peasant uprisings." On the other hand, the "development of a money economy" was not derived by "strengthening solidarity of the peasants," so there is no causal relationship between the "formation of self-governing villages" and the "development of a money economy."

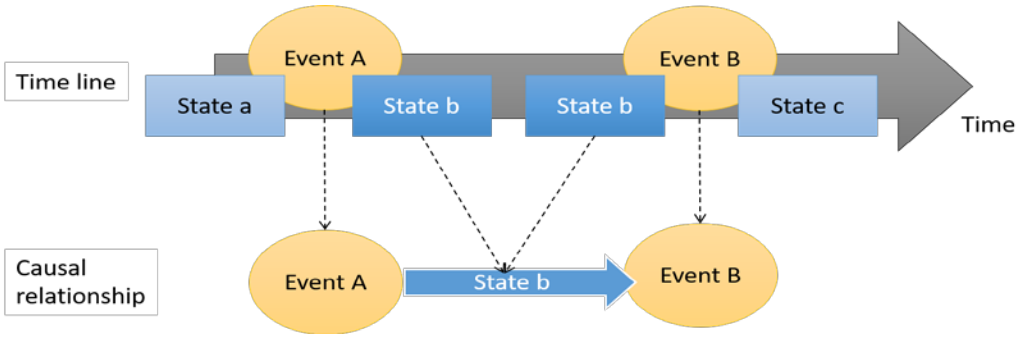

Figure 1. State change and causal relation

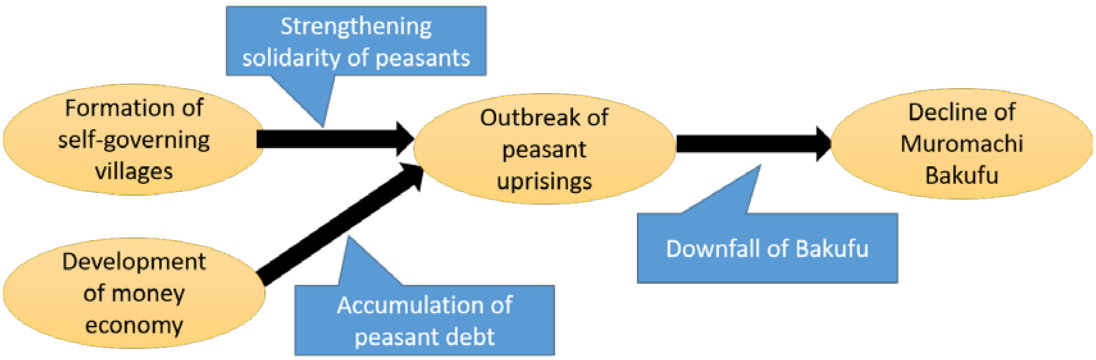

Figure 2. Example of causal relation graph with state change of historical text shown as Table 1

Table 1: Example historical text

During the mid-Muromachi period, the solidarity of the people strengthened due to the formation of self-governing villages. In addition to it, the rise of a money economy caused the peasants to accumulate debt. This led to frequent peasant uprisings and political demands being made to persons of authority in the Bakufu and palladium. Most of these demands were related to the peasants' desire for a virtuous government. These frequent uprisings weakened the Muromachi Bakufu, and Muromachi Bakufu was unable to effectively handle the situation.

2.2 Approach for Creating Valid Causal Relation graph

In order to support creating valid causal relation graph, students need to recognize the state changes by the historical events. Based on this assumption, this paper proposes the thinking process for creating a valid causal relation graph. Figure 3 shows the thinking process. Firstly, students read the historical text and understand its detail. Secondly, they grasp the state changes of historical people along with the historical events. Finally, they find the historical events that have causal relationships and create the causal relation graph by referring to the state change.

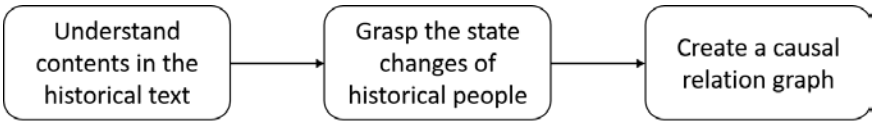

Figure 3. Thinking process for creating a valid causal relation graph

By following this thinking process, students are able to consider the state changes consciously. However, it is difficult to follow this step for students who are not trained to consider the state changes. In addition, even if they grasp the state changes, some of them are not able to reflect the grasped state changes to the causal relation graph. Therefore, this research proposes the system in which students are able to follow the thinking process in creating a causal relation graph. The system also gives awareness regarding to the state changes in creating causal relation graph. By creating the causal relation graph using the system, students are not only able to create a valid causal relation graph, but also to understand the necessity of grasping state changes in considering the causal relation.

The system provides the form for arranging state changes as *state transition map* in the step of grasping the state changes of historical people. The state transition map is proposed by our research group in which state changes of historical people along with the historical events can be organized (Kojiri et al. 2015). Figure 4 (a) shows the form of state transition map. In this map, circles on top show the historical events and vertical lines represent the timing that each events have occurred. Rows corresponds to the historical people's state changes. The blue squares correspond to the state change of the historical people after the events have occurred. Using this map, state changes that are occurred after the historical events have been organized.

Our system also provides the environment to draw a causal relation graph by considering the state changes. The state change which is occurred after the cause event is the trigger of the result event as shown in Figure 4 (b). So, our system displays the state changes after the cause event in the state transition map to the links in the causal relation graph so as to make students check the validity of their causal relationships.

3. System for Supporting Creation of Causal Relation Graph

We have developed a system for supporting students to create valid causal relation graph. The system consists of two subsystems: a state transition map generation support system and a causal relation graph generation support system. Figure 5 shows a screenshot of the interface for the state transition map generation support system. By selecting a previously covered history theme in the History Selection Area, a brief historical overview is appeared in the Text Display Area, and the student is allowed to create a state transition map in the State Transition Map Display Area. When the student clicks the intersection of a historical person and an event, the window for inputting the state change is appeared. In

the window, the student needs to input the type of state and selects the type of its change from “UP” and “DOWN.” When the state change is inputted, the blue square describing the state change is appeared in

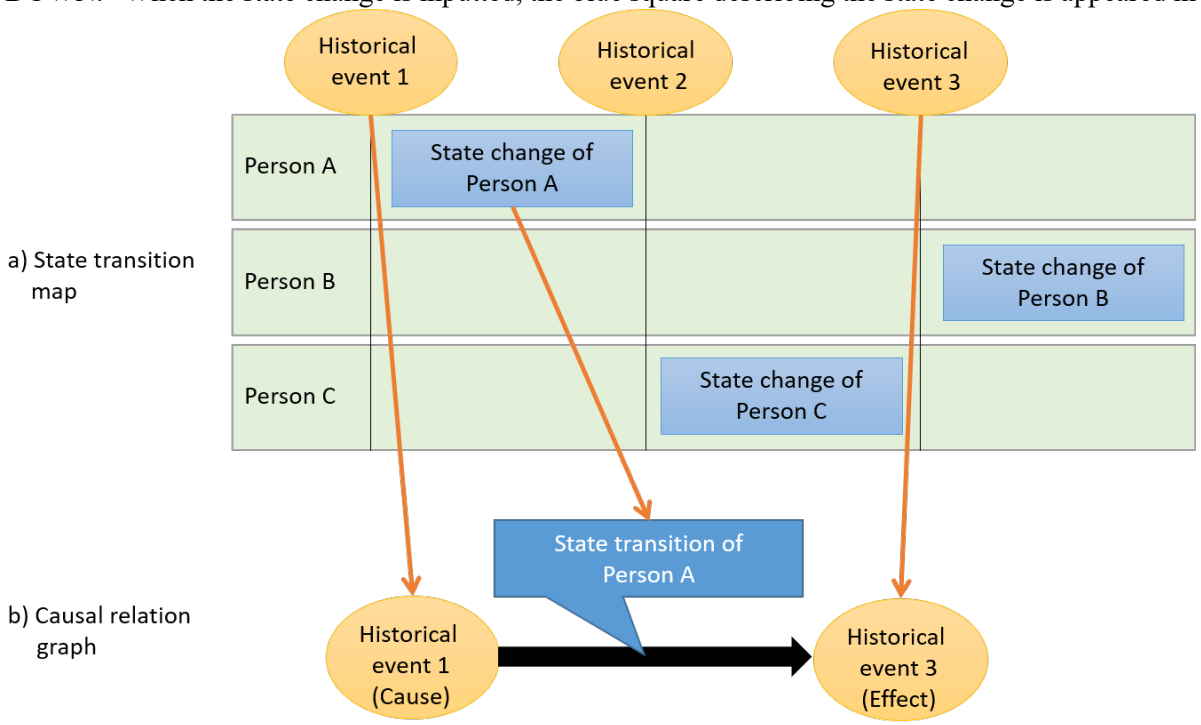

Figure 4. Relation between state transition map and causal relation graph

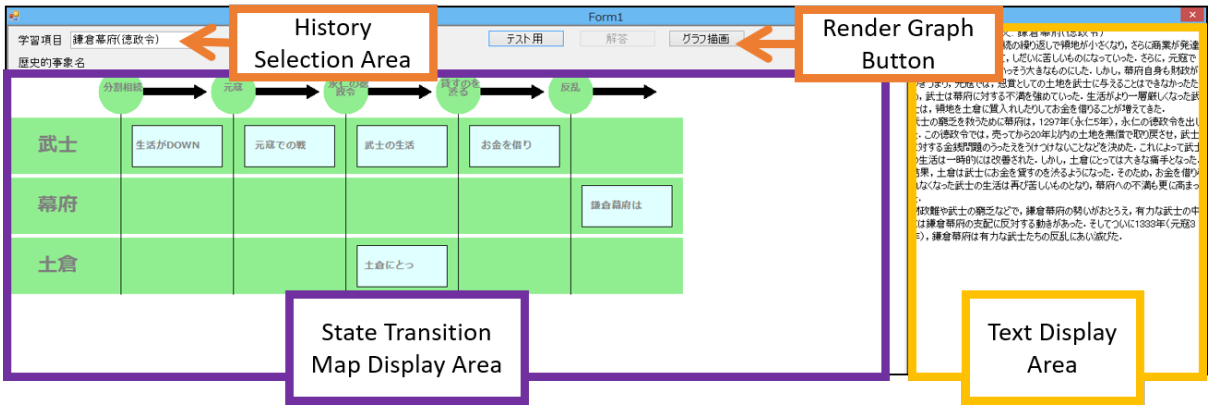

Figure 5. The interface for the state transition map generation support system

the State Transition Map Display Area. By clicking on the Render Graph Button in Figure 5, the system switches over to the causal relation graph generation support system.

Figure 6 shows a screenshot of the interface for the causal relation graph generation support system. Historical events are displayed in the Historical Event Display Area. The student can draw a causal relationship in the Causal Relation Graph Display Area by left clicking a cause event, right clicking an effect event, and then pushing the Render Button. State changes generated by a cause event are revealed by moving the cursor over the link as shown as Figure 6. Revealing the state changes in this way makes it obvious to the student whether a causal relationship is valid or not.

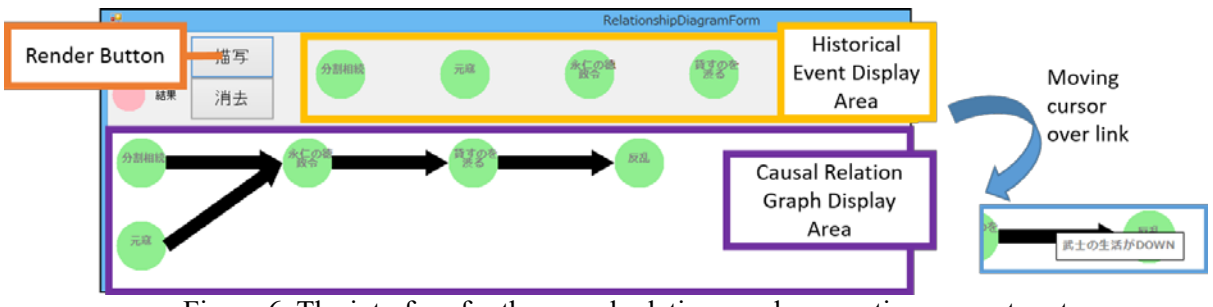

Figure 6. The interface for the causal relation graph generation support system

4. Experimental Trials

We conducted two trials to evaluate the validity of understanding state changes and the effectiveness of the support systems. As for the first trial, 5 university students (A-E) were recruited as subjects. As for the second trial, 8 middle school students (a-h) were subjects. As instructional materials, we have prepared an instructional video and several written passages on the theme "Transition from the Great Depression to World War II."

First, the students were instructed to read the history instructional materials and to draw a causal relation graph on the paper using a pen (causal relation graph 1). Next, we had them generate state transition maps using the state transition map generation support system. In the system, historical people and historical events of the state transition maps are given in advance. After that, they were allowed to modify their original graphs—causal relation graph 1—to create causal relation graph 2. And finally, the students created causal relation graphs using the causal relation graph generation support system (causal relation graph 3).

Tables 2 shows (i) whether the causal relation graphs were changed before and after generating state transition maps and before and after using the system and (ii) responses of the students on the questionnaire as to whether they had any experience in considering causal relationships in learning history. For (i), Y means that the students changed their causal relation graphs to the valid one and N means that they did not change them. In this experiment, no students changed the graphs to invalid one. For (ii), the students were asked to select one answer from given five options ranging from a definite "1. No" to a definite "5. Yes."

Table 2: Results: (i) causal relation graph changes and (ii) response of questionnaire

		University students					Middle school students							
		A	B	C	D	E	a	b	c	d	e	f	g	h
i	Change of causal relation graph from causal relation graph 1 to 2	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N
	Change of causal relation graph from causal relation graph 2 to 3	N	N	N	N	N	Y	N	N	Y	N	N	Y	N
ii	Have you ever considered causal relationships in the study of history?	4	4	5	2	3	3	2	5	2	5	3	1	2

According to the result, 7 out of 13 students made changes in total either after generating the state transition maps or after creating the causal relation graph. Among the university students, the change of the causal relation graph was observed after generating the state transition maps, while that was observed after creating the causal relation graph for middle school students. We would infer that such differences depend on whether the students could consider the meaning of deriving the state changes in generating the state transition map or not. That is, the university students inferred why they need to consider the state changes while creating the state transition map, but the middle school students did not. Therefore, the middle school students found the relations between state changes and causal relation when they were creating the causal relation graph.

Now look at 6 students who did not change the causal relation graphs. Among them, students H, c, and e answered 4 or 5 for (ii), which means they had experiences in considering the causal relationships in history. Such students were able to consider the state changes before the experiment and created the valid causal relation graph from the start of the experiment. Therefore, we would infer, that for the students who had never given much thought to causal relationships in the past, the proposed thinking process would be quite effective in helping understand the concept of causal relationships.

Next, we look at the number of created state changes on the state transition map in Table 3. The students A, E, b, and f derived less than 10 state changes. These students did not produce enough state transition maps. Among them, students except E did not change the causal relation graph. This finding would indicate that this thinking process and the system were not effective for students who are not able to derive the enough state changes. This is an issue that we must address in future work that to develop the support method to make students derive the state changes from the history text.

Table 3: The number of derived state changes in the state transition map

University students					Middle school students							
A	B	C	D	E	a	b	c	d	e	f	g	h
6	10	10	13	9	13	5	13	12	13	7	11	10

5. Conclusions

This study focuses on understanding the meaning of the causal relation in the history and creating valid causal relation graph. It proposes a novel thinking process that organizes state change in a way that helps students understand causal relationships. We also implemented a learning environment in which students are able to follow the proposed thinking process and are aware of the relations between state changes and causal relationships. The experimental trials demonstrated that the activities involved in producing state transition maps were effective in helping university students grasp causal relationships, while the system functions for creating causal relation graphs helped the middle school students understand causal relationships. The difference in responsiveness to the different learning levels of the two groups of student subjects. We also found that students who did not modify the causal relation graphs at all did not produce enough state changes in the state transition maps. For our next step, we need to come up with additional instructional aids for this kind of students who clearly did not understand the concept of state change.

In addition, we need further experiments to evaluate the effectiveness of the thinking process and the support system, since the number of the subjects in the experimental trials was small.

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