Semantically Enhanced Gaze-aware Historical Cartoons to Encourage Historical Interpretation

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Abstract: While it is desirable that learners tackle their learning activity by trying to read between lines and give an interpretation to lighten the background context of the knowledge, most of them merely focus on memorizing what is taught to improve their test scores. In this research, we aim to develop a learning support system that encourages learners to change their learning attitudes to active ones through performing historical thinking activities. Our approach is to focus attention on the potential of *historical cartoons* as learning materials. In this paper, we discuss the concept of an adaptive learning support method by utilizing semantically enhanced historical cartoons.

Keywords: Historical thinking, Historical cartoons, semantic representation, historical interpretation learning

1. Introduction

The importance of cultivating learning attitudes that enable learners to not only memorize fundamental knowledge but also give an interpretation to lighten the background context of the knowledge is widely shared. However, since teachers using traditional instructional methods are often obliged to unilaterally teach basic knowledge to learners, most learners fail to understand that rote learning (memorizing what is taught) is not an appropriate learning technique. Consequently, they tend to just acquire shallow knowledge without organization and feel bored with learning.

In history learning as well, the importance of cultivating 'historical thinking skills' that requires the abilities to read between the lines of historical events with considering historical background is known (Linda et al, 2012; Kenneth et al, 2000); For example, during "The Sino-Japanese War", the victory of Japan, which was still a little-known country in those days, resulted in the acceleration of the Chinese continent colonization by several western powers, ultimately leading to the rising of the imperialism era. Such kind of interpretation of historical events' background would be a desirable learning attitude among learners. However, most of them rather tend to focus on memorizing only names of battles, places, characters, events, etc., as a result of the lack of 'viewpoints' to give their historical interpretations to each event (Spoehr & Spoehr, 1994).

The objective of this research is to develop a learning support system whereby learners change their learning attitudes to active ones through performing historical thinking activities with given historical viewpoints as necessary for the historical events. To approach the objective, we use *historical cartoons*, which usually act as visual metaphor to illustrate historical interpretation, as learning materials so that learners perform historical thinking activities. In this paper, we propose an adaptive learning support method using historical cartoons with systematized semantic representation.

2. Design Philosophy of Historical Interpretation Learning

Illustration-based historical cartoons make it easier even for novice learners to intuitively understand the overviews of historical events in comparison with text-based historical literatures such as ancient documents and paleography. In the educational context, utilizing historical cartoons as learning materials has several pedagogical values. Cartoons, for instance, provide the learners with opportunities to gain insights into what people were thinking at that time, since they are often summarized and

encapsulate the social problems behind the historical events effectively based on the painters' keen eyes (Stradling, 2001).

In order to develop a learning support system which encourages learners' historical interpretation activities meaningfully, we employ a learning methodology proposed by Kuroda (Kuroda, 1986) based on the historians' activities to decipher painters' viewpoints represented as pictorial materials; the learning methodology has the following three phases: (1) _**fact understanding**_: grasp what each object depicted in historical cartoons symbolizes, (2) _**relation understanding**_: grasp what relationships among objects mean with giving careful consideration to the differences among them, and (3) _**integrated understanding**_: interpret the contexts of comprehensive historical backgrounds of the cartoons according to the painter's viewpoints at that time by integrating the fact and relation understandings at the phases (1) and (2).

3. Learning Activity Utilizing Semantically Enhanced Historical Cartoon

Figure 1 represents an overview of our learning environment using semantically enhanced historical cartoons and its internal semantic representation. In order to let learners perform historical thinking activities, the learning environment embeds the three learning phases introduced in the previous section, namely (1) _fact understanding_, (2) _relation understanding_, and (3) _integrated understanding_. Learners perform respective historical thinking activities at each learning phase in a cross-sectional manner as necessary. In the system, in order to support their activities adaptively, learning phase and content dependent _inquiries_ as stimuli are provided based on the semantics aware historical cartoons.

As far as the internal semantic information is concerned, we deal with the following four types of information: [a] contents of objects depicted in historical cartoons, [b] properties and relationships among objects, [c] artistic techniques called deformation used for strengthening painter's messages in the historical cartoons and [d] gaze-aware transparent areas of respective objects in order to capture what learners are gazing at. In this research, we intend to capture the learner's interests appropriatelty from learners' gaze behaviors using eye-tracking devices based on the correspondence between the information of [a] and [d], i.e.) the area of interest (AOI) regions on the objects in a historical cartoon. With respect to [c], Kuroda (1986) lays stress on the importance of artistic techniques illustrated in histrical cartoons for deciphering the background contexts of the events. This research refers to the following five techniques (Historical Society of Pennsylvania): (i) _symbolism_, (ii) _irony_, (iii) _analogy_, (iv) _exaggeration_, and (v) _inference_. In order for the system to generate learner-adaptive inquiries at respective learning phases, we utilize a Question Generation Framework proposed by Jouault et al. (2016), in which inquiries can be generated by using the question templates prepared in advance based on the semantic information of [c] and other semantic information of [a], [b] and [d] for supporting learners' historical thinking activities. Followings are the detailed explanations of each learning phase:

(1) _Fact understanding_: Transparent AOI regions are set on respective objects depicted in historical cartoons in advance to let the system recognize objects on which learners focus. In this phase, when the learner gazes at each AOI, the system dynamically generates inquiries (e.g., Q1 and Q2 in .1) based on semantic information and a question generation template: e.g., on the object (i) in Fig.1, the semantic information 'country is represented', 'coat is wore' and the historical cartoon technique '_symbolism_' are attached. According to the generated inquiries, learners try to grasp what each object symbolizes.

(2) _Relation understanding_: In this phase, the system infers the learner's interests on relationships based on his/ her gaze behaviors among objects at phase (1), and gives inquiries to prompt his/ her historical thinking about them. Question 3 in Fig.1 is an example of the generated inquiry based on the semantic information about a relationship between two objects (e.g., on the relationship between (i) and (ii) in Fig.1, the semantic information '(i) aims for (ii)' is attached as a type of [b] and the historical cartoon techniques, '_irony_', '_analogy_', '_exaggeration_', and '_inference_' are attached as a type of [c].) According to the inquiries, learners try to decipher painter's historical viewpoints depicted as relationships between objects.

(3) _Integrated understanding_: In this phase, learners attempt to interpret the context of comprehensive historical backgrounds of the cartoons by integrating the fact and relation understandings at the phase (1) and (2), e.g., at the time when "The Sino-Japanese War" occurred, Japan's ambition was to invade the Asian continent for expanding their power. Yoshikawa (2000) argues that the activities of micro-

level historical interpretation on backgrounds of each object depicted in historical cartoons contribute to enhancing macro-level historical interpretation activities. Although, it is difficult to provide content dependent inquiries adaptively to lead such interpretations due to the fact that learners' interpretation varies according to their interests, the system generates inquiries about the objects to which the learner has NOT given attention at phase (1) and (2) (e.g., Q4 and Q5 in Fig.1). The generated inquiries serve as scaffolding to foster learners' inclusive understanding activities for their fruitful interpretation activities.
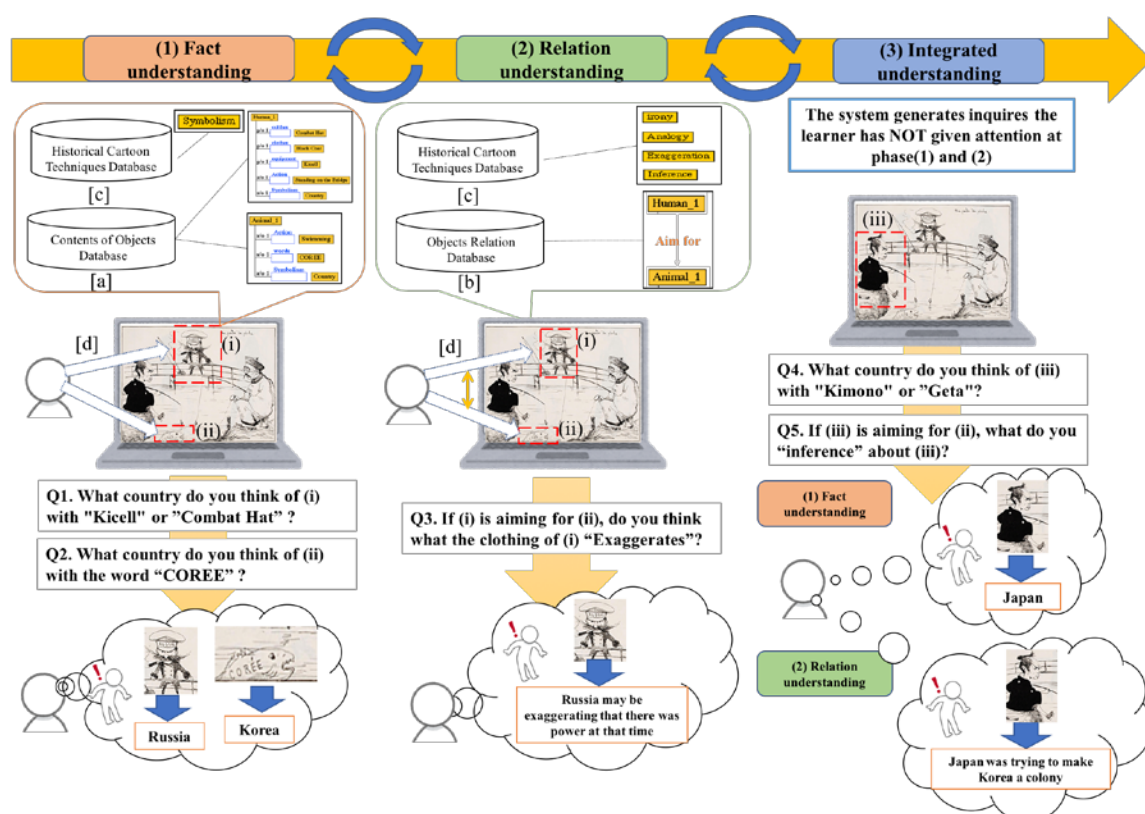

Figure 1. Overview of learning environment using semantically enhanced historical cartoons.

4. Conclusion and Future Works

In this paper, we designed an adaptive learning support method that allows learners to perform their historical interpretation activities using semantically enhanced historical cartoons. In future work, we will endeavor to implement a learning support system based on the proposed design in this paper.

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