

Designing and Evaluating Learning System for Collaborative Historical Analogy

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The application of historical causation to modern social problem solving is considered important in history education for high school. Additionally, a collaborative historical analogy is needed. In this study, we design a novel learning system that makes the combination of grouping students to maximize collaborative historical analogy and helps students to connect their historical analogies collaboratively. By integrating previous research on collaborative historical analogy, we designed an online learning system named the History Time Capsule that provides online collaborative writing spaces where students check the validity of their historical analogy and integrate their historical analogy collaboratively. As a result of an evaluation, this learning system achieved a certain result for grouping and collaborative historical analogy. Moreover, we propose some future works of devising a method or an algorithm that minimizes the variance among pairs and groups, better scripts for collaborative historical analogy, and so on.

Keywords: Analogy, Collaborative Learning, Grouping, History Education, Web Application

Introduction

Learning Historical Analogy

There has been growing interest in historical analogy. Staley (2002) insists that history provides not only information on the past but also alternative solutions to similar modern issues. There have been a few cases wherein American politicians have considered historical lessons when they frame diplomatic policies, which cannot be judged, based on individual experience (Abbott & Adler, 1989). Thus, learning history as the resource of analogy can aid in analyzing the reasons behind existing modern social issues and help us devise alternative solutions to confront them. Also in history education, the application of historical causations in solving modern issues is considered important. Indeed, the Ministry of Education, Culture, Sports, Science and Technology–Japan (2018) considers the fostering of the ability to apply historical knowledge to modern issues to be one important goal.

To help promoting the application of historical causation to modern problem solving, some researchers have developed effective learning methods. For example, Mansilla (2000) examined how students successfully apply historical causation to current issues. Ikejiri, Fujimoto, Tsubakimoto, and Yamauchi (2012) designed a competitive card game for high-school students studying world history. This research has revealed effective instructions for promoting the transfer of historical causation correctly: dividing information about causation into “problem,” “solution,” and “result,” using history to build an informed comparative base between both past and modern cases; recognizing contextual differences between them; and checking the validity of historical analogy made by students with each other in a group composed of two pairs. Moreover, Sumikawa and Ikejiri (2015) propose a mathematical framework estimating similarity between a present social issue and historical causation. Ikejiri and Sumikawa (2016) developed a web application, the History Time Machine, that help Japanese high-school students of world history to search for historical causation similar to authentic social issues and to transfer historical causation to authentic social issues appearing in recent news.

Collaborative Historical Analogy

While historical analogy is useful for confronting modern social issues, there are mainly two problems when it is used by one person. First problem of historical analogy made by one person is what each person thinks the similar historical event to the modern one is up to the person. Holyoak and Thagard (1980) showed a case in which some American politicians thought World War II was similar to the Gulf War and that they should intervene in the Gulf War, and other politicians thought the Vietnam War was similar to the Gulf War and that they should not intervene in it. Because modern social issues have complicated reasons, solutions to modern ones should be composed of some historical analogies from different viewpoints. Thus, the more different historical analogies there are in a group, the more collaborative historical analogy that we define as historical analogy connecting one's historical analogy from one viewpoint with another's historical analogy from different viewpoint will be promoted.

Second problem is that historical analogy made by one person often causes the misuse of analogy (Fisher, 1970). Ikejiri et al. (2012) proposed a learning method with a group composed of two pairs for preventing the misuse of analogy and showed that polishing a same historical analogy in a pair was effective for enhancing the quality of historical analogy. Thus, it is important to ensure that each pair is composed of two students that draw on a relatively similar history regarding historical analogy and that making students in each pair checking the validity of each historical analogy. This step should be done before connecting historical analogies from different viewpoints.

In sum, two steps are needed to promote historical analogy. The first step is checking the validity of each historical analogy in each pair composed of two students that each draw on a relatively similar history for historical analogy. The second is connecting one's historical analogy from one viewpoint with another's historical analogy from a different viewpoint in a group composed of two pairs that each draw on a relatively different history for historical analogy.

Problems in Previous Research about Collaborative Historical Analogy

There are some research studies that have helped enhance collaborative historical analogy. Ikejiri, Yoshikawa, and Sumikawa (2019) propose an algorithm that makes pairs composed of two students that each draw on a relatively similar history for historical analogy and groups composed of two pairs that each draw on a relatively different history for historical analogy. Moreover, Yoshikawa, Ikejiri, and Sumikawa (2019) developed an online system where students discuss their historical analogies in pairs and groups. We will explain these details in next chapter.

However, there are two challenges noted by previous research studies. First, there is no designed learning system integrating an instruction for prompting collaborative historical analogy with an online system (Yoshikawa et al. 2019) that has implemented the algorithm for grouping (Ikejiri et al. 2019). Second, there is no evaluation for high-school students with learning system high-school students. Addressing these problems may provide effectively learning collaborative historical analogy with high-school students in history classroom.

Purpose

In this study, we design and evaluate a learning system that promotes collaborative historical analogy. We address three research questions as follows:

RQ1: How is a learning system to promote collaborative historical analogy?

RQ2: Can our learning system make more ideal pairs and groups compared with attendance numerical order?

RQ3: To what extent high-school students create collaborative historical analogy with our learning system?

The next section summarizes three previous research needed to design a learning system. The History Time Machine that helps students to search similar historical events to modern social issues, an online system where students discuss their historical analogies in each pair and, for each group, an algorithm for grouping.

Preliminaries

The History Time Machine

The History Time Machine (Figure 1) was devised by Ikejiri and Sumikawa (2016). The History Time Machine preserves over 100 historical causations. The description of historical causation is composed of three sentences, "Problem," "Solution," and "Result." The following is an example.

Title: Bloc Economy

Category: diplomacy, commerce, community

Due to the 1929 economic crisis, many countries had to decide how to stabilize their economies. To reduce the effects of the crisis and stabilize their economies, the Great Powers decided to create closed economic spheres (bloc economic spheres) comprising colonies and friendly countries and centered on specific currencies.

Therefore, the conflicts between the blocs grew intense as other countries' goods were excluded; small- and medium-sized countries that relied on trade grew poor; and international affairs became unstable.

Each historical causation is assigned one or more categories from the following 13 categories; reign, diplomacy, war, production, commerce, study, religion, literature and thought, technology, popular movement, community, disparity, and environment. If historical causation is related to specific categories, these categories are tagged “1” and others are tagged “0.” Thus, feature vectors of all historical causations are created in advance, as shown in Table 1.

With History Time Machine, students explore daily web news that interests them (topics that include social issues), copy and paste the text. Next, students select categories related to the social issues of the news. Subsequently, the History Time Machine detects and provides similar historical events by counting the number of same categories attached to events if students push the search button (Sumikawa & Ikejiri, 2015). Sumikawa and Ikejiri (2015) assume that the more the same category is increased, the more similarity is also increased. For example, in Table 1, the number of the same categories between modern issue and History 1 is two, while the number of the same categories between modern issue and History 2 is one. So, the History Time Machine judges that History 1 is more similar to modern issue than History 2 in this case. After searching for similar historical events, students identify the similarity between the current social issues and historical causation and use the historical causation as a resource for considering the current social issues from a new perspective (Ikejiri & Sumikawa, 2016).



Figure 1. The interface of the History Time Machine

Table 1

The Example of the Vectors of Historical Causations

	reign	diplomacy	war	production	commerce	study	religion	literature & thought	technology	popular movement	community	disparity	environment
History 1	0	1	0	0	1	0	0	0	0	0	0	0	0
History 2	1	0	0	0	0	0	1	0	0	1	0	0	0
...													
Modern issue	0	1	0	0	1	0	1	0	0	0	0	0	0

Interactive System for Collaborative Historical Analogy

Figure 2 provides an overview of interactive system developed by Yoshikawa et al. (2019) including the History Time Machine for collaborative historical analogy. After collecting texts of news articles from a database, this system performs five steps: providing news and related historical events with the History Time Machine, creating feature vectors, making pairs and groups, creating collaborative writing spaces for pairs and groups, and archiving results of the discussion (Yoshikawa et al., 2019).

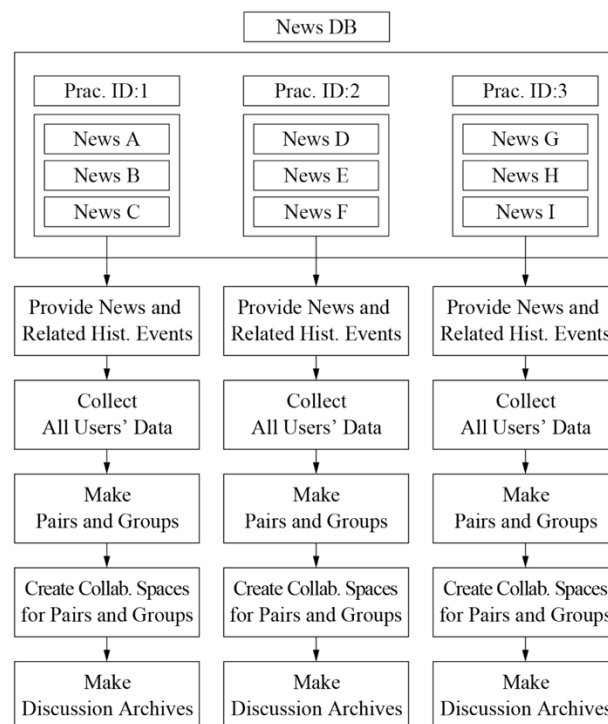


Figure 2. Overview of Interactive System in Yoshikawa et al. (2019)

Algorithm for Grouping

The algorithm for grouping in Ikejiri et al. (2019) creates feature vectors for all students based on the categories selected by them. This algorithm uses a “similarity score” that is calculated by counting the number of same categories between two feature vectors. These scores are automatically calculated in all combinations of the pairs formed from all students or all combinations of groups created from all pairs. In creating the groups, the feature vector of each pair is generated by adding each number of the category (ex. the feature vector of the pair is {1, 1, 0, 0, 1, 0, 1, 0, 0, 10, 0, 0, 0} if one student selects History 1 in Table 1 and the other student selects History 2 in Table 1) and used for the calculation of the similarity score. Based on the calculated scores, the pairs are created in descending order of similarity score or the groups are created in ascending order of similarity score. The experimental results prove that only this algorithm creates suitable groups compared with other popular-clustering algorithms (Ikejiri et al., 2019).

Design

For addressing RQ 1 of “How is a learning system to promote collaborative historical analogy?” we designed a novel learning system, “the History Time Capsule”. Figure 3 shows the overview of processes using the History Time Capsule. Once all students determine their discussions with the History Time Machine devised by Ikejiri and Sumikawa (2016) with some modern news, the History Time Capsule automatically makes ideal pairs and groups by using the algorithm of Ikejiri et al. (2019) with feature vectors based on the categories of historical causation selected by students. Then, students discuss with their partner or group members. While the interactive system is designed based on the interactive system developed by Yoshikawa et al. (2019), we additionally designed the interface and instruction for collaborative historical analogy. Figure 4 shows how students use the History Time Capsule for collaborative historical analogy. The details are as follows.

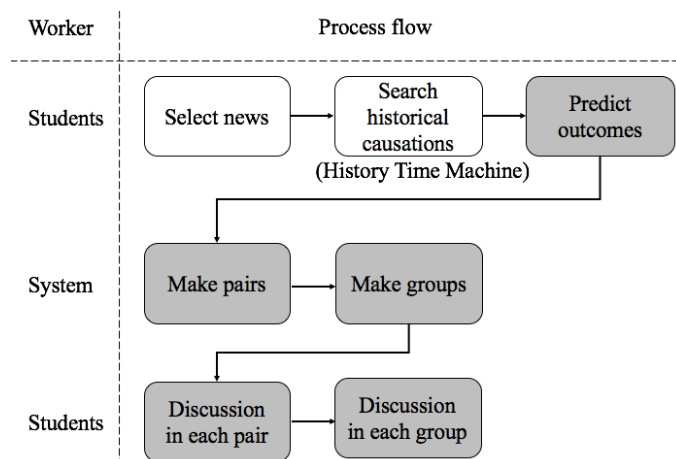


Figure 3. Overview of processes using the History Time Capsule
(The shadowed boxes in Figure 3 are newly designed processes for the main History Time Capsule)

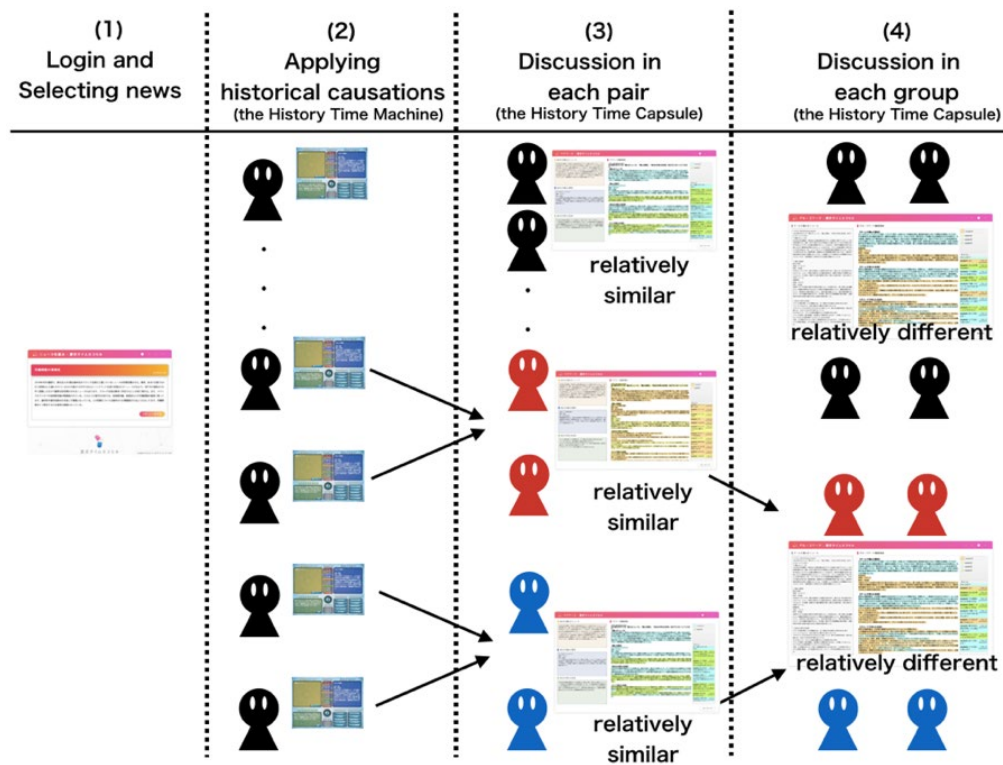


Figure 4. The image of processes using the History Time Capsule

(1) Login and Selecting news. Initially, each student logs into the History Time Capsule using their own accounts, and selects one piece of interesting news. Note here that we assume that the accounts and news are prepared by a

teacher in advance.

(2) Applying historical causations. Next, each searches for historical causations similar to the selected news using the History Time Machine (Figure 1). Students select categories that are related to the social issues in the news and search for related historical causations by clicking the search button. We expect students to identify the similarity between current social issues and historical causations and to use the historical causations as a resource for considering current social issues from a new perspective. From the search results, students predict what outcomes will be obtained by applying historical causations to social issues included in the news stories they have selected.

(3) Discussion in each pair. After all the students input their outcomes with the History Time Machine, pairs are automatically formed by this system. We expect that two students in each pair make use of relatively similar histories for historical analogy. Each pair collaboratively combines two documents about their outcome inputs imported from the History Time Capsule. In the online collaborative writing space, they communicate with each other in the chat box (Figure 5). We expect them to understand their historical analogies deeply and to check their validity. After finishing their combining, each pair submits the document and wait for the next grouping.

(4) Discussion in each group. After all pairs submit their documents, two pairs that make use of different historical analogies from each other are automatically paired off. We expect them to consider the current social issues from two different perspectives with the discussion imported from each pair work, leading them to check the validity of their historical analogies. Then, they communicate among them in the chat box. Finally, they integrate documents about their outcome collaboratively (Figure 6).

After each group submits the documents, each document is automatically archived as a web page that students can check anytime. We expect that students will reflect on or return to their predictions after a set period of time.

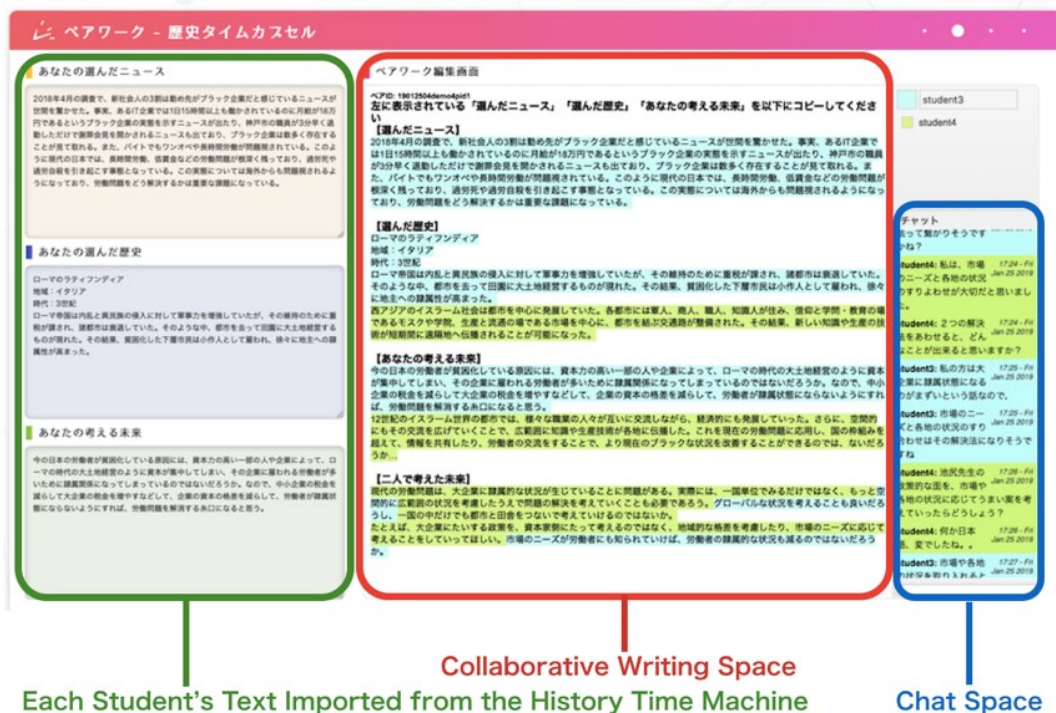


Figure 5. The interface of the History Time Capsule in a discussion in each pair



Figure 6. The interface of the History Time Capsule in a discussion in each group

Evaluation

Implementation with the History Time Capsule

We conducted lessons for 40 high-school students in Japanese public schools who learned world history to evaluate our learning system. The lesson was conducted on July 3rd and July 10th in 2018. All the students could use the desktop PC in both lessons. In the lesson (60 min) on July 3rd, the teacher explained the social issue of the Japanese labor problem and each student applied historical causation to the labor problem. All the data written by students was saved in the form of a Microsoft word file. In the lesson (60 min) on July 10th, the lesson started after each student opened the word file written about the solution of the Japanese labor problem on July 3rd. After all the students reviewed each solution with the History Time Machine in the last lesson, the teacher explained how to use the History Time Capsule. Next, all the students logged in the History Time Capsule and selected the news about the Japanese labor problem. They copied and pasted the data applying the historical causation with the word file made on July 3rd. After all the students input the data, pairing and groping was controlled by this grouping system. They discussed in each pair and wrote collaborative solutions to the problem by pair with the History Time Capsule in 15 min. Finally, they discussed their solutions in each group and wrote collaborative solutions to the problem in groups using the History Time Capsule in 20 min. Figure 7 depicts students learning this lesson. All the data describing their solutions written by students were saved in the History Time Capsule.



Figure 7. Lesson with the History Time Capsule

Evaluation Method

Analysis of Pairing and Grouping. This system aims at pairing students that draw on a relatively similar history and making a group composed of two pairs that each draw on a relatively different history for historical analogy. For addressing RQ 2 of “Can our learning system make more ideal pairs and groups compared with attendance numerical order?,” we calculate the similarity score with this system and compare between the case of lessons with the History Time Capsule and the virtual case of pairing and grouping in attendance numerical order. We assume that the similarity score in pairs is higher with the History Time Capsule and the similarity score in groups is lower with the History Time Capsule.

Analysis of Collaborative Historical Analogy. For addressing RQ 3 of “To what extent high-school students create collaborative historical analogy with our learning system?,” we first collected all the data of titles of selected history, key ideas of historical analogies written by each student, by each pair and by each group and created a list of these data. Next, we verified whether each group’s historical analogies included the key ideas connecting one pair’s key ideas with the other pair’s different ideas according to the definition of collaborative historical analogy in this study.

Result

Pairing and Grouping

The results of similarity scores in pairs and groups between the lesson with the History Time Capsule and the virtual case of attendance numerical order were as follows: the similarity score mean in pairs with the History Time Capsule was 2.5 ($SD = 1.05$) and the similarity score mean in pairs in the virtual case of attendance numerical order was 0.85 ($SD = 0.99$). The similarity score mean in groups with the History Time Capsule was 3.3 ($SD = 4.83$) and the similarity score mean in groups in the virtual case of attendance numerical order was 4.5 ($SD = 1.35$).

Subsequently, the results of a t -test to examine the scores in pairs with the History Time Capsule and in the virtual case of attendance numerical order confirmed a significant difference ($p < .05$). This shows that this learning system was effective in forming pairs composed of two students, making use of relatively similar histories for historical analogy. Otherwise, the difference between the scores in groups was not statistically significant. This is because of the inability to minimize the variance among the groups.

Collaborative Historical Analogy

Table 2 shows changing process of the key ideas of solutions written by each student, by each pair and by each group.

In Table 2, the red ideas refer to ideas made by pair A and the blue ideas refer to ideas made by pair B. In the column “The key ideas of solutions written by each group,” star marks for ideas with “red ideas & blue ideas” refer to collaborative historical analogies.

As a result of analysis, 60% of groups made collaborative historical analogies in implementation. For example, group 2 created a collaborative historical analogy. Student 2-A1 selected the historical causation of “Black slaves and the triangular trade” and created historical analogy including the key idea of a foreign worker. Student 2-A2 also selected historical causation for “Black slaves and the triangular trade” and created historical analogy including the key idea of foreign worker and dispatched workers. They combined historical analogies including key ideas of foreign worker, dispatched workers, and employee training after their discussion in the pair. On the other hand, student 2-B1 selected the historical causation of “Improvements in printing technologies” and created a historical analogy including the key idea of AI and ICT. Student 2-B2 selected the historical causation of “Christianity and learning” and created a historical analogy including the key idea of religion and common language. They combined historical analogies including key ideas of AI and ICT, a manual written in a foreign language and tolerance in religion after their discussion in the pair. Then, they integrated their proposed solutions to the Japanese labor problems as follows.

Improving efficiency by utilizing AI and ICT. Actively hiring foreign workers to reduce the burden on the mental and physical aspects of Japanese workers. At that time, understanding the differences of cultures and religions of each country. We think that a better society can be made by the entirety of Japanese society becoming tolerant of religious events, improving the skills of foreign workers by making manuals of foreign languages and having a problem directly addressed to workers by setting up opportunities for Japanese to work with foreigners.

In this case, the underlined part is the ideas connecting pair A's key idea of “employ training” with pair B's key idea of “manual written by foreign language.”

Discussion

Regarding RQ 1, we designed the History Time Capsule that aims at pairing students who make use of relatively similar history for historical analogy and also aims at creating groups composed of two pairs who make use of relatively different histories for historical analogy. On the basis of a similarity score, these aims were achieved.

Regarding RQ 2, we found that the similarity score in pairs was significantly higher with the History Time Capsule than in the virtual case of attendance numerical order. Otherwise, the difference between the scores in groups was not statistically significant, while the similarity score in groups was lower with the History Time Capsule than in the virtual case of attendance numerical order. We also found that the similar scores for groups were varied widely as follows: The score of group 1–4 was 0 points, the score of groups 5–6 was 1 point, the score of group 7 was 2 points, the score of group 8 was 5 points, the score of group 9–10 was 12 points. The inability to minimize the variance among the groups caused the no difference between the similarity scores with the History Time Capsule and in the virtual case of attendance numerical order. A future challenge is to minimize the variance among pairs and groups as much as possible.

Regarding RQ 3, we found that the History Time Capsule could partially promote collaborative historical analogy. Referring to Table 2, it can be seen that 90% of groups had the different pairs' ideas of historical analogies except group 9 and that 60 % of groups can create historical analogies connecting one pair's key ideas with the other pair's differing ideas in 20 min. This is so owing to the features of importing each students' ideas and pairs' discussions

Table 2

Changing Process of Key Ideas of Historical Analogies Written by Each Student, Each Pair and Each Group

ID	The Title of Selected History	The key ideas of historical analogies written by each student	The key ideas of historical analogies written by each pair	The key ideas of historical analogies written by each group
1-A1	Top-down modernization	• Manager	• Manager	• Manager
1-A2	Top-down modernization	• Human nature	• Human nature	• Human nature
1-B1	Boat route to India and domestic industry	• Law	• Law	★ Law & Manager
1-B2	The flourishing of the Islamic world	• Work environment		
2-A1	Black slaves and the triangular trade	• Foreign worker	• Foreign worker	• Foreign worker
2-A2	Black slaves and the triangular trade	• Foreign worker • Dispatched workers	• Dispatched workers • Employee training	• AI and ICT • Tolerance in religion
2-B1	Improvements in printing technologies	• AI and ICT	• AI and ICT	★ Employ training &
2-B2	Christianity and learning	• Religion • Common language	• Manual written by foreign language	Manual written by foreign language

			• Tolerance in religion	
3-A1	Top-down modernization	• Superior	• Superior and newcomer	★ Equal Relationship between Capitalist and labor & Revelation • Superior and newcomer
3-A2	Top-down modernization	• Superior and newcomer	• Revelation	
3-B1	Industrial Revolution and the division of labor	• Capitalist and labor	• Equal Relationship between Capitalist and labor	
3-B2	Industrial Revolution and the division of labor	• Capitalist	• Law	
4-A1	Labor union formation	• Labor union	(Nothing)	• Appropriate working time
4-A2	Labor union formation	• Work environment		
4-B1	Annexation of Ireland	• Appropriate salary	• Antidiscrimination	
4-B2	Strengthening of the serf system in Eastern Europe	• Compliance	• Appropriate working time	
5-A1	The United States becoming an industrialized country	• Foreign worker • Automation	• Foreign worker • Automation	★ Foreign worker & Automation & Hiring more labors • Results-oriented approach
5-A2	Monsoon trade	• Disparity		
5-B1	Rubber and plantations	• Hiring more labors	• Hiring more labors	
5-B2	Labor union formation	• Labor union		
6-A1	Académie française and the standardization of the national language	• ICT	• ICT • Referring foreign cases	• ICT • Referring foreign cases • Work environment High salary
6-A2	Fall of the Great Powers' regime	• Multilateral cooperation		
6-B1	New Deal policies	• Work environment • High salary	• Work environment • High salary	
6-B2	Artillery's invention	• Training		
7-A1	Factory Act	• Union	• Request for improvement & Union	★ Request for improvement & Automation • Law
7-A2	Factory Act	• Request for improvement		
7-B1	Persecution of Jews	• Power demand supply balance	• Automation • Law	
7-B2	Black slaves and the triangular trade	• Compellation to stop • prolonged work		
8-A1	United States' poverty problem	• Robot	• High salary	• Sharing ideas from various fields
8-A2	Sparta's policies	• Equalization		
8-B1	Coffeehouses	• Sharing ideas from various fields	• Surveillance & Sharing ideas from various fields	
8-B2	Factory Act	• Labor union • Law • Surveillance		
9-A1	Mass poverty and revolutions	• Request for improvement • Capitalist and labor	• Request for improvement • Law	• Request for improvement • Labor union
9-A2	Factory Act	• Labor union • Law		
9-B1	Factory Act	• Labor union	• Law	
9-B2	Factory Act	• Law		
10-A1	Mass poverty and revolutions	• Poor classes	• Poor classes & Law • Counseling Center	★ Committee of labor problem & Counseling Center • Law
10-A2	Factory Act	• Law		
10-B1	Factory Act	• Law	• Law & Committee of labor problem	
10-B2	Factory Act	• Committee of labor problem		

and groupings for enhancing collaborative historical analogy. However, four groups could not create a collaborative historical analogy. We think that there are two reasons: lack of time and insufficient scripts for collaborative historical analogy. For example, group 4 and group 9 showed that the activity time in each pair and in each group were insufficient for discussing and writing integrated historical analogies by analyzing the chat data. Furthermore, group 6 only enumerated each pairs' ideas and group 8 focused on odd pairs' ideas. These cases will be improved by giving more scripts for collaborative historical analogy.

In conclusion, we designed a novel learning system that partially promotes collaborative historical analogy. On the other hand, there is work for the future. First, a method or an algorithm that minimizes the variance among pairs and groups is needed. For example, even though they analyze the same historical event, a person finds different factors of causation from ones found by others according to his/her standpoint. Therefore, adding new data that reflects each student's historical analogy to the vector for grouping may be effective. Second, it is necessary to devise better scripts for collaborative historical analogy. For example, before discussion in each pair and each group, giving the prompt, "Let's start commenting on another pair's historical analogy critically" or "Let's think about whether your historical ideas can complement other's historical ideas" may promote connection between the historical analogies of pairs.

Redesigning the interface of the History Time Capsule is a future challenge. Third, a comparative experiment between groups with our system and without our one is needed to verify the effectiveness of our system from the viewpoint of collaborative historical analogy by analyzing the quality of the collaborative documents between them.

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