



Semiempty collaborative concept mapping in history education: students' engagement in historical reasoning and coconstruction

Manuel Lucero¹ · Manuel Montanero¹ · Carla van Boxtel²

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Abstract

There is abundant research on the use of concept maps in education. However, the most notable efforts have focused on learning outcomes as a consequence of individually constructed concept mapping for science concept learning. In the less explored field of history, some studies have found positive effects of collaborative concept mapping. However, student interaction has not been analyzed. This study employed quantitative and qualitative methods based on classroom discourse analysis to examine the extent to which students engage in historical reasoning and transactive interaction when they collaboratively complete a semiempty concept map, versus when they collaboratively write a summary, about 19th-century Western imperialism.

The participants were 20 secondary education students from two history classes with an average age of 16 years. Within each class, the students were randomly assigned to the different conditions: collaborative concept mapping and collaborative summary writing. Student interaction was analyzed at two different levels: the content level and modes of co-construction. The results show that the students in the semiempty concept mapping condition engaged significantly more in causal explanation and argumentation and used more historical and metahistorical concepts in their reasoning than the students in the summary writing condition. Interaction in the semiempty concept mapping condition included a much higher percentage of utterances which denoted the convergence and integration of the knowledge contributed by the partners in the dyad. This kind of transactive interaction not only reflected co-construction but also historical reasoning.

Keywords History teaching · Concept map · Collaborative learning · Secondary education · Discourse analysis

Introduction

In history lessons, students learn about historical phenomena that have shaped the development of the country and world they live in and that shed light on enduring issues. This is not about memorizing historical dates and chronology but about understanding and giving meaning. What were particular historical changes about, what were the causes and consequences of the changes, and how do people in the present give meaning to these changes? The development of a coherent mental representation of historical developments, such as modern imperialism or globalization, is, however, challenging for students. Historical concepts are often abstract. They are defined by many other concepts and do not have an agreed-upon definition (e.g., Husbands, 1996). Furthermore, historical understanding requires complex historical reasoning, which includes looking for multiple causes and consequences of historical developments and the analysis of individuals' motives and actions in a broader historical context (Stoel et al., 2017). Research in the field of history education has shown that students have difficulties constructing a historical reasoning. When constructing a historical explanation, for example, students overemphasize the role of human activity over the influence of structural causes and enabling conditions (Carretero et al., 1997; Seixas & Morton, 2012).

To improve historical reasoning and understanding of historical developments, it is important that students are not only exposed to historical reasonings in the textbook or by the teacher, but also have to reason historically themselves. To understand historical events, developments and phenomena, students themselves should actively situate historical events, persons and developments within a broader historical context, analyze connections between historical developments, use historical concepts and engage in historical argumentation. However, this is not characteristic of many history classes. Montanero and Lucero (2011), for example, showed that in Spanish classrooms, students hardly participated in the construction of historical explanations, especially with regard to why a particular cause brought about an effect. One way in which this deep processing and historical reasoning can be promoted is by using tasks in which students—after reading a text—individually or collaboratively produce visual-textual representations (Van Boxtel & Van Drie, 2018). History education scholars have discussed different types of representations in which relationships among components are organized in a spatial way, for example, an argumentative diagram (e.g., van Drie et al., 2005), causal map (e.g., Chapman, 2003), timeline (Prangmsma et al., 2008) or concept map (Nair & Narayanasamy, 2017; Tzeng, 2014; Van Drie & Van Boxtel, 2003). These representations focus students on key concepts, relations or features, and the graphical representation facilitates collaborative knowledge building.

The study we report here is about the potential of collaborative concept mapping to engage students in deep processing of a schoolbook text in order to improve their conceptual understanding of historical developments. We compared collaborative concept mapping with collaborative writing of a summary of a text in a history textbook. We mainly focus on the processes of interaction generated by collaborative concept mapping and summary writing. Research on collaborative concept mapping has paid relatively little attention to the nature of the collaborative processes activated by a collaborative concept mapping task. Most studies on collaborative concept mapping focused on the quality of the group products and individual test performance but not on the quality of peer interaction.

Historical reasoning and conceptual knowledge

Van Boxtel and Van Drie (2018) argued that historical reasoning contributes to the development of historical knowledge that is understood and can be applied in new situations. Historical reasoning “attempts to reach justifiable conclusions about processes of continuity and change, causes and consequences, and/or differences and similarities between historical phenomena or periods” (p. 151). Important components of historical reasoning are historical questioning, contextualization, argumentation, and the use of substantive (e.g., industrial revolution) and metahistorical concepts (e.g., change, cause, evidence, political). Students can develop, for example, a deep understanding of the Neolithic revolution when they formulate and answer questions about the causes and consequences of this wide-scale transition from hunting and gathering to agriculture and settlement. To answer these questions, they identify aspects of change, situate the transition in the context of climate change, among other things, and substantiate claims about causes and consequences with arguments based on historical sources. When reasoning about this historical development, students actively use substantive historical concepts, such as gathering and hunting, agricultural revolution, specialization and population growth, and vocabulary related to metahistorical concepts, such as change, economy, revolution, causes and long-term consequences. When engaged in such reasoning, students can develop a rich and well-organized representation of the Neolithic revolution.

Although research is still limited, some studies have shown positive effects of engaging students in historical reasoning, for example, in the context of inquiry-based learning, on students’ historical knowledge and understanding (e.g., Reisman, 2012; Stoel et al., 2017; Wissinger & De la Paz, 2016). Therefore, it is important to investigate which tasks are effective in engaging students in historical reasoning.

The potential of concept mapping

In general, a concept map consists of nodes, denoting concepts, and labeled lines, denoting the relationship between concepts. A meta-analysis by Horton et al. (1993) showed that the construction of a concept map has a positive effect on student achievement. Concept mapping not only enhances the understanding of abstract phenomena, but also enhances memory because the knowledge is better organized and, as a result, can be more easily retrieved (Novak & Cañas, 2006). Concept mapping has also been considered an effective task to summarize texts about complex issues. Haugwitz et al. (2010) compared the construction of concept maps and summaries in biology. They found that the group products in the concept mapping condition contained more valid propositions than in the summary writing condition. Furthermore, they found that students in the concept mapping condition obtained higher scores on an individual posttest.

While there is abundant research on the advantages of concept mapping to promote learning in science, our literature search did not locate any studies that have empirically replicated its role in history learning. When students work with textbooks, concept mapping seems to have the potential to engage students in historical reasoning activities and contribute to historical knowledge and understanding. Although an essay is a more common summary format in history education, a concept map format has several advantages: it can

prevent overloading verbal working memory, is easy to read, requires fewer grammatical decisions, signals the importance of a concept (as reflected in the number of links connected to it), makes propositional knowledge more accessible, and makes students less inclined to reproduce verbatim the source text (Haugwitz et al., 2010; Cañas et al., 2013; Kinchin, 2001).

As stated above, to date, previous research regarding concept mapping has provided consistent evidence of the positive effect on learning outcomes, particularly within the STEM fields. However, there is no consensus on the type of concept map that is effective. Some studies focused on the format of the concept map that needs to be constructed. Formats that required less elaboration (e.g., map corrections and semiempty concept maps) resulted in significantly better comprehension than other student-generated concept maps (Chang et al., 2002). Student-generated concept maps entail a high cognitive cost on the student's working memory, especially in students who are not experienced with concept maps, because these students find it very difficult to formulate self-explanations about the relationships between concepts (Kirschner et al., 2006). The use of semiempty concept maps, on the contrary, has resulted in significantly better recall of conceptual content (Wachter, 1993) with a relatively high effect size (0.59) and higher scores than other formats (Nesbit & Adesope, 2006). Wang et al. (2021) found that including predefined nodes helped students consider more factors and connections.

The potential of collaborative concept mapping

Collaborative concept mapping can scaffold the process of reasoning and knowledge integration. A concept map provides a graphical representation of concepts and relationships that facilitates the negotiation of meaning and construction of knowledge (Roth & Roychoudhury, 1993; Van Boxtel et al., 2002). While verbalizing ideas, students can refer to concept labels and conceptual relationships.

The question of what constitutes a productive interaction in collaborative learning groups can be answered from two different angles. On the one hand, taking a disciplinary perspective, an indicator of productive interaction is the extent to which students actively engage in disciplinary reasoning. In the context of history education, it is important to engage students in historical reasoning. The other important indicator of productive interaction in collaborative learning groups is the level of co-construction, that is, the extent to which collaborating students build on one another's contributions and are actively engaged with others' ideas (Berkowitz & Gibbs, 1983; Teasley, 1997). Examples are elicitation (e.g., questioning) and integration. Such interaction contributes to a deeper understanding (Novak & Cañas, 2006; Weinberger & Fischer, 2006; Wen et al., 2016).

In addition to the potential of collaborative concept mapping tasks to engage students in historical reasoning, collaborative concept mapping also has a high potential to provoke reflective and transactive discourse. Recent evidence suggests that one of the main difficulties of collaborative learning deals with students' tendency to develop pseudo-collaborative interactions, such as "copying", imposing or simply juxtaposing with little or no discussion (Montanero & Tabares, 2020). What remains unknown beyond such behavioral patterns is how to engage learners in a reflective process that leads them to review their own knowledge relating to the task, to negotiate with peers on strategies and decisions, and to integrate

the peers' inputs. Concerning this issue, it is considered important that learners negotiate a common solution. Efficient collaborative learning is rarely achieved solely by bringing together individual learners' contributions: a process of *collaborative knowledge building* is required (Roscoe & Chi, 2007).

The model of collaborative information processing (CIP) (Jorczak, 2011) distinguishes three phases of collaborative information processing that develop cyclically in the processes of negotiation and collaborative knowledge building: externalization, divergence and convergence. Externalization is the act of expressing representations of knowledge stored in memory, often through a symbol system such as language, in order to share it. In the divergence phase learners elaborate their initial own ideas, based on their prior knowledge, and compare them with those of their peers, in order to identify discrepancies. In the convergence phase learners negotiate and solve socio-cognitive discrepancies refining their mutual knowledge. The negotiation can lead to three types of consensus (Weinberger, Stegmann & Fischer, 2007): quick consensus (accepting the contributions of the learning partners), integration-oriented consensus (integrating and applying the perspectives of the learning partners by adding, clarifying and justifying) and conflict-oriented consensus (correcting the perspectives of the learning partners).

According to the MUPEMURE (MUltiple PERSpectives on MUltiple REpresentations) model (Weinberger et al., 2011), these negotiation and knowledge building processes are strongly influenced by the type of external knowledge representation tool used. In this regard, Tan et al. (2021) have pointed out that collaborative concept mapping is particularly effective to promote knowledge convergence processes, especially after an individual preparation phase. In an experimental study, they found that students were better able to present and negotiate their ideas. The interaction in the condition with individual preparation contained significantly more integration-oriented and conflict-oriented consensus statements and significantly more verification, clarification and positioning statements than interaction without individual preparation. These benefits are further increased if students are given the possibility to share and visualise the individual maps while elaborating the joint map (Farokhnia et al., 2019).

In the field of history education, some studies have found positive effects of collaborative concept mapping. For example, Nair and Narayanasamy (2017) conducted an intervention study in which fourteen-year-old students in Malaya collaboratively constructed concept maps over six weeks about the topic of nationalism. They found that students in the intervention group scored significantly higher on a knowledge test and a questionnaire on interest in history learning. However, the study did not provide information about the interaction students engaged in. Collaborative concept mapping was also part of the intervention study of Stoel et al. (2017), who investigated the effects of explicit teaching on students' ability to reason causally in history and their topic knowledge. Students constructed a concept map to categorize and connect causes. Because concept mapping was only a small part of a more comprehensive approach, it is not clear what the specific effect of concept mapping was. Furthermore, the study did not analyze intra-group interactions either.

Research questions

In short, in our review of related studies, we have identified the following gaps that need to be addressed. Firstly, most of the studies showing positive effects of collaborative concept mapping have been conducted within the STEM fields. However, historical knowledge and reasoning have their own distinctive characteristics that make it inappropriate to extrapolate the results from other fields of knowledge. From all of the characteristics that shape the idiosyncrasy of historical reasoning we should highlight the integration of narrative and multi-causal structures in the representation of historical phenomena; the combination of causal conditions, events and human intentions; and the use of a variety of historical and metahistorical concepts and perspectives. Understanding and interpreting historical events also requires knowledge of the specific historical context (e.g. time and place), and historical empathy. Consequently, all these specific aspects justify the importance of researching the effect of collaborative concept mapping on historical reasoning.

Secondly, it is likely that the nature and quality of the processes triggered by collaborative concept mapping are shaped by the type of knowledge representation, whether verbal or graphical, that learners use when discussing the content. Although many studies have focused on concept maps, it is noteworthy that there has been insufficient research that analyses the effects of concept maps in comparison with other widespread representational tools such as summaries, at least in terms of the historical reasoning processes triggered by peer discussion.

Considering the gaps, we seek to answer the following questions:

1. 1. To what extent do students engage in historical reasoning when they collaboratively complete a semiempty concept map versus when they collaboratively write a summary? What are the characteristics of argumentative and causal reasoning and the use of historical concepts and meta-concepts in both conditions? Does students' historical reasoning differ according to the external representations that are employed?
2. 2. To what extent do students engage in transactive interaction when they collaboratively complete a semiempty concept map versus when they collaboratively write a summary? What are the characteristics of collaborative discourse in both conditions? Do the divergence and convergence processes of knowledge differ according to the external representations that are employed?

We expected that collaboratively completing a semiempty concept map would result in more historical reasoning and transactive interaction than collaborative summary writing.

Method

Participants

The participants were 20 students from two Geography and History classes with an average age of 16 years (11 females and 9 males), all of whom belonged to the same charter school located in a town in Spain with 58,000 inhabitants and a middle-socioeconomic status level. They were taught by the same teacher at different time slots during the week (three one-

hour sessions of Geography and History per week). The school had two groups of students per grade. “Geography and History” is a compulsory and core national curriculum subject in Spain.

Within each class, the students were randomly assigned to the different conditions: semiempty collaborative concept mapping ($n=10$) and collaborative summary writing ($n=10$). Within each condition, students were randomly assigned to dyads.

We gained ethical approval for this study. At all times, the students were informed, and they consented to participate. Total confidentiality was guaranteed.

Collaborative learning tasks

Students completed two collaborative learning tasks preceded by a training session in both conditions. The tasks were about 19th-century Western imperialism. This topic is part of the mandatory topics for history and geography. Each semiempty concept mapping and summary writing task comprised an individual phase (construction of a concept map/writing of a summary) and a collaboration phase (construction of a joint concept map/written summary). We asked students to individually prepare because we assumed this would enhance questioning (because they would become aware of their knowledge gaps or misunderstandings during individual preparation) and discussion (because they would want to defend their concept map or summary). The collaboration phase started with showing each other the individually constructed concept maps or summaries.

Students in both conditions used the same texts. In the training session, we used a text titled ‘Imperialism in the 19th century’ (363 words). In the first intervention session, we used a text titled ‘Economic, political and demographic factors’ (406 words) and in the second session, a text titled ‘Ideological, cultural and scientific factors’ (480 words). The texts also included pictures, such as the historical artwork of the legendary meeting between Henry Morton Stanley and David Livingstone in Africa in 1871, the Suez canal in the age of imperialism and the colonial possessions.

The *concept mapping tasks* consisted of completing 3 moderately-directed semiempty concept maps with 19 (training session), 8 and 7 predetermined concepts and 12, 9 and 9 empty squares dealing with imperialism in the 19th century and related concepts, respectively. Because students were not familiar with concept mapping tasks and because the research showed positive outcomes of semiempty concept maps, we used semiempty concept maps (see Fig. 1). Students were asked to complete the concept maps with letters corresponding to different concepts/phrases that were part of the text they had read. The students had the text available when filling in the blanks. The task was presented to them as follows: “Before filling in the semiempty concept map, you must read the text. Then, please write the letters which correspond to the following ideas in the empty squares”.

The *summary writing tasks* consisted of writing a summary of the text. There was no word limit for the summary. The task was presented to them as follows: “Read the text, underline the information you consider important and take notes; write it in your own words”.

Procedure

A week before the intervention sessions, participants were trained during one 25-minute session on how to complete a concept map or write a summary using a text about imperialism

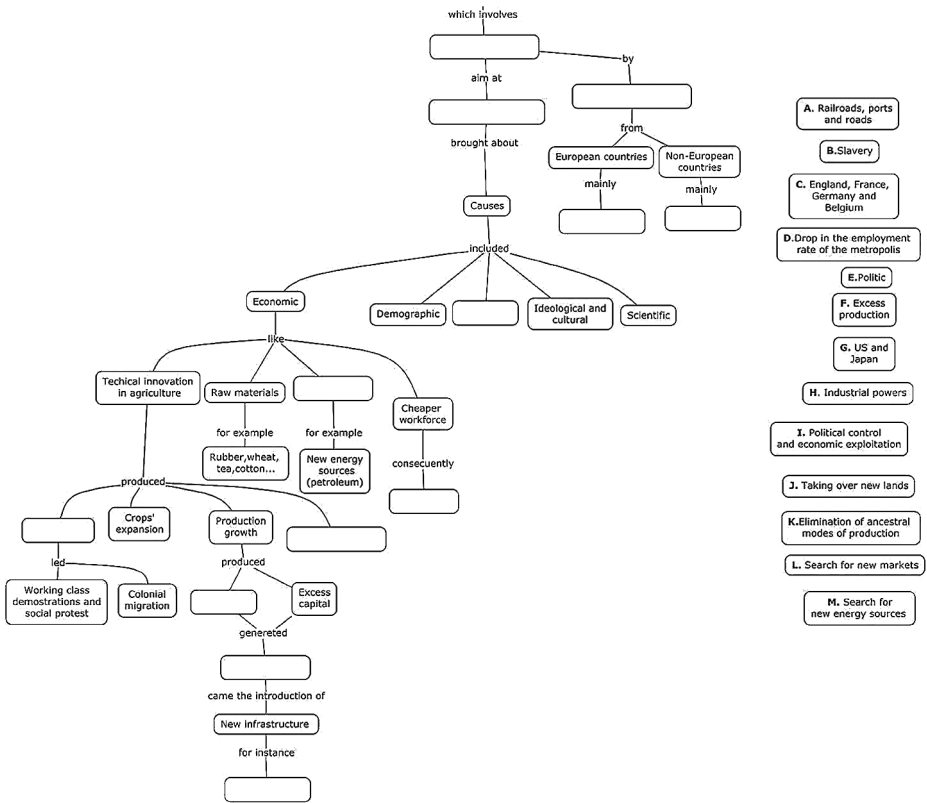


Fig. 1 Predetermined concepts and empty squares in semiempty concept mapping condition

in the 19th century. The concept mapping training session involved reviewing the components of a concept map: concepts, words or symbols enclosed in a circle, cross links (arrows connecting concepts to illustrate relationships between them), linking words; the concept maps' structure (hierarchical and propositional language units); and the processes that are involved: the selection, propositionalization, hierarchicalization and structuralization of key concepts (Chang et al., 2002). Each participant individually completed a semiempty concept map about "Imperialism" for practicing purposes (10 min). The summary writing training session addressed the steps required to write a summary: reading the text, highlighting important information and taking notes (minor details shouldn't be included); writing in their own words the main points of each section or paragraph using subheadings and, once the text has been actively reread, organizing the collected information in a coherent text (Brown & Day, 1983). Each participant individually wrote a summary of the text (10 min).

Then, the next week, in two consecutive lessons, the participants completed a concept map or wrote a summary from that week's readings (25 min).

Data analysis

To determine whether the conditions differed in the extent to which the collaborating students engaged in historical reasoning and coconstructive modes of collaboration, we analyzed the dyadic interaction. We audio-recorded, transcribed and coded the student interactions during the two consecutive collaborative learning tasks in 10 randomly chosen dyads: 5 in the semiempty concept mapping condition and 5 in the summary writing condition. Student interactions were analyzed on two different levels: on the content level (components of historical reasoning) and the level of modes of co-construction. The transcripts of the audio recordings were first segmented into turns and then into utterances: meaningful units limited between natural pauses in the speech. The utterance level is an appropriate unit for more detailed coding (Park et al., 2017). An utterance is defined as “a stream of speech with at least one of the following characteristics: (1) under one intonation contour, (2) bounded by pauses, and (3) constituting a single semantic unit” (Crookes, 1990).

Our coding scheme for historical reasoning (see Appendix 1) consisted of two dimensions. The coding scheme was based on the framework for analyzing the historical reasoning of Van Boxtel and Van Drie (2018, see also Van Drie & Van Boxtel, 2008). Because the texts and tasks in our study focused particularly on causal historical reasoning, the focus in our coding scheme was on causal explanation. We coded each utterance using the following mutually exclusive and exhaustive main components of historical reasoning: contextualization, argumentation, causal explanation and other (no historical reasoning). Each category was divided into subcategories (for example, different ways of contextualizing or explaining). Because students can use substantive and metahistorical concepts (such as cause, economic) while contextualizing or making causal connections, we also coded each utterance on the use of substantive and metahistorical concepts (for example, see Appendix 1).

Our coding scheme for the modes of co-construction (see Appendix 2) consisted of mutually exclusive and exhaustive categories that reflect transactivity. We distinguished three types of knowledge transactions between the students: elicitations, externalization and integrations (Teasley, 1997). Each of these categories was divided into subcategories (see Montanero & Marques, 2019).

To assess the quality of the coding scheme, first, a randomly chosen transcript was coded by the authors, and differences were discussed. This resulted in some minor changes in the coding scheme.

Second, two researchers (the first two authors) coded 548 utterances, representing 30% of the sample, to segment the transcript into utterances (the unit of analysis). Interrater agreement (Cohen's Kappa) reached 0.97. Third, after training, two researchers independently coded 390 utterances (21% of the sample). For the historical reasoning categories, Cohen's kappa was highest for the use of substantive concepts (0.87) and lowest (0.81) for the (sub)components of historical reasoning. For the modes of co-construction categories, interrater reliability on the level of subcategories was 0.81.

We used Chi-square nonparametric tests to compare the quality of the student interaction in the semiempty concept mapping and summary writing condition. Students were grouped by task, and chi-square analyses were performed to determine if the differences in the use of categories and subcategories (frequencies for all pairs in a condition taken together) were statistically and significantly different. The alpha was set at 0.01. Additionally, we compared differences in the length of interaction between both conditions.

Results

We present the results of our analysis of student interaction based on historical reasoning and modes of co-construction. We will use examples from the transcripts to illustrate differences between peer interaction in the two conditions (semiempty concept mapping and summary writing).

Number of utterances

Five dyads participated in each condition (semiempty concept map and summary). In total, we coded 1,788 utterances (taking the transcripts of the 10 dyads for the two tasks together). In the summary writing condition, students produced more utterances (1,141; 63.8%) than in the semiempty concept mapping condition (647; 36.2%). Thus, although all dyads worked for a total of two hours on the two tasks, the students produced more utterances in the summary condition.

Students' engagement in historical reasoning

Table 1 shows the number and percentages of utterances for each condition for the historical reasoning categories. In the summary writing condition, approximately one-third of all utterances were coded as historical reasoning. In the semiempty concept mapping condition, more than half of all utterances were coded as historical reasoning. In both conditions, students hardly engaged in argumentation. Chi-square analysis was performed to assess differences between the conditions on the main categories of historical reasoning.

For the main categories (contextualization, argumentation, causal explanation and off-analysis), Chi-square analyses revealed significant differences between the summary writing and the semiempty concept mapping condition ($\chi^2=420.31, p<.01$). Compared to the summary writing condition, students in the semiempty concept mapping condition engaged more in argumentation and causal explanation, while students in the summary writing condition engaged more in contextualization.

In addition, we found significant differences for the use of substantive concepts and metahistorical concepts ($\chi^2=10.97, p<.01$). In the semiempty concept mapping condition, students actively used substantive historical concepts and more metahistorical concepts more often.

The utterances that did not include a historical reasoning component were coded as off-analysis. We identified more off-analysis utterances in the summary writing condition than in the semiempty concept mapping condition ($\chi^2=420.31, p<.01$).

The following examples illustrate the differences we found between the two conditions. In the first example, taken from a concept mapping session, causal historical reasoning was very prominent. For example, "imperialism" is stated to be a consequence of "search for an international recognition" and the "search for strategic locations". All utterances were linked, forming a network and a single grid of causal and motivational relationships. The use of causal discourse markers (connectives and verbal signals, such as "derived from and "because") and motivational connectives ("in order to") in this excerpt stands out.

Additionally, in the same excerpt, student 1 built a historical context including information about a spatial and chronological frame of reference of the "Suez Canal". Contextu-

Table 1 Frequency and proportion of appearance of components of historical reasoning in the summary and semiempty concept mapping condition for each dyad and in total. The asterisks in the last row indicate where statistically significant differences were found in the frequency of appearance in the two tasks ($p < .001$)

Dyads	Components of historical reasoning	Summary writing	Semiempty concept mapping
Dyad 1	Contextualization	66(19.1%)	30(16.2%)
	Argumentation	0 (0%)	8(4.3%)
	Causal explanation	37(10.7%)	89(48.1%)
	Off-analysis	243(70.2%)	58(31.4%)
	<i>Subtotal</i>	<i>346 (100%)</i>	<i>185 (100%)</i>
	Substantive concepts	35(64.8%)	39(58.2%)
	Metaconcepts	19(35.2%)	28(41.8%)
	<i>Subtotal</i>	<i>54 (100%)</i>	<i>67 (100%)</i>
Dyad 2	Contextualization	29(18.7%)	22(22.9%)
	Argumentation	0(0%)	4(4.2%)
	Causal explanation	13(8.4%)	54(56.3%)
	Off-analysis	113(72.9%)	16(16.7%)
	<i>Subtotal</i>	<i>155 (100%)</i>	<i>96 (100%)</i>
	Substantive concepts	28(68.3%)	49(65.3%)
	Metaconcepts	13(31.7%)	26(34.7%)
	<i>Subtotal</i>	<i>41 (100%)</i>	<i>75 (100%)</i>
Dyad 3	Contextualization	60(28.7%)	14(15.6%)
	Argumentation	0(0%)	1(1.1%)
	Causal explanation	9(4.3%)	52(57.8)
	Off-analysis	140(67%)	23(25.6%)
	<i>Subtotal</i>	<i>209 (100%)</i>	<i>90 (100%)</i>
	Substantive concepts	26(66.7%)	26(48.1%)
	Metaconcepts	13(33.3%)	28(51.9%)
	<i>Subtotal</i>	<i>39 (100%)</i>	<i>54 (100%)</i>
Dyad 4	Contextualization	44(26.7%)	11(8.3%)
	Argumentation	0(0%)	1(0.8%)
	Causal explanation	22(13.3%)	69(51.9%)
	Off-analysis	99(60%)	52(39.1%)
	<i>Subtotal</i>	<i>165 (100%)</i>	<i>133 (100%)</i>
	Substantive concepts	25(73.5%)	32(50%)
	Metaconcepts	9(26.5%)	32(50%)
	<i>Subtotal</i>	<i>34 (100%)</i>	<i>64 (100%)</i>
Dyad 5	Contextualization	49(18.4%)	11(7.7%)
	Argumentation	0(0%)	0(0%)
	Causal explanation	22(8.2%)	59(41.3%)
	Off-analysis	196(73.4%)	73(51%)
	<i>Subtotal</i>	<i>267 (100%)</i>	<i>143 (100%)</i>
	Substantive concepts	41(73.2%)	24(49%)
	Metaconcepts	15(26.8%)	25(51%)
	<i>Subtotal</i>	<i>56 (100%)</i>	<i>49 (100%)</i>

Table 1 (continued)

Dyads	Components of historical reasoning	Summary writing	Semiempty concept mapping
Total	Contextualization*	248 (21.7%)	88 (13.6%)
	Argumentation*	0 (0)	14 (2.2%)
	Causal explanation*	102 (8.9%)	323 (49.9%)
	Off-analysis*	791 (69.3%)	222 (34.3%)
	<i>Subtotal</i>	<i>1141 (100%)</i>	<i>647 (100%)</i>
	Substantive concepts*	155 (69.2%)	170 (55%)
	Metaconcepts*	69 (30.8%)	139 (45%)
	<i>Subtotal</i>	<i>224 (100%)</i>	<i>309 (100%)</i>

alization is a key component of historical reasoning, and in this example, it was integrated into the causal explanation.

Example 1 Excerpt of a concept mapping interaction in which students build a causal explanation concerning imperialism. Each utterance starts on a new line.

1. Student 1: Colonial imperialism.
2. Student 1: The causes are economic, demographic and political.
3. Student 1: These political causes were derived from a search for international prestige.
4. Student 1: And to dominate strategic locations.
5. Student 2: I have added the same.
6. Student 2: Because it was very important at that time as all the great powers wanted to control most of the world.
7. Student 2: To be able to trade with many countries.
8. Student 2: After that,
9. Student 2: For example.
10. Student 2: One of the things that the great powers did to dominate strategic places was to create the Suez Canal and Gibraltar.
11. Student 1: I also agree with that.
12. Student 1: And I added the Suez Canal and Gibraltar.
13. Student 1: Because this canal was built in 1869 by Ferdinand de Lesseps.

In contrast, in Excerpt 2, from the summary writing condition, the students gave relatively few explanations in causal terms. They made use of up to 10 utterances to contextualize the event. More concretely, different types of contextual comments were distinguished: temporal comments and social frames of reference, including knowledge of social activity such as socioeconomic, sociopolitical, and sociocultural aspects of life. Additionally, it can be seen how the organization of ideas showed a high degree of disconnection. Most ideas were not linked.

Example 2 Excerpt of a summary writing interaction in which students build a contextualization in the context of interpreting and dating the causes of imperialism.

1. Student 1: I wrote “imperialism”.

2. Student 1: In the economy, they needed raw materials, energy sources and new markets [...].
3. Student 2: OK!
4. Student 2: I'll read you mine.
5. Student 2: Raw materials, energy sources and new markets to sell their surpluses needed.
6. Student 2: The colonies supply the raw materials they needed.
7. Student 2: The industrial powers, the Europeans sought the territories where they could invest them.
8. Student 2: The colonies were territories for the settlement of surpluses.
9. Student 2: The process of exploration of the planet that began in the 15th century is completed throughout the 19th century.
10. Student 2: Racism.
11. Student 2: The African David Livingstone is famous in England in the 19th century for his expeditions.
12. Student 2: He was the first European to see Victoria Falls.
13. Student 2: He disappeared for three years searching for the sources of the Nile.
14. Student 2: And was found by the journalist Henry Morton.
15. Student 2: They explored together.
16. Student 2: But in 1872 they separated.
17. Student 2: And Livingstone decided to stay in Africa.

Collaboration and modes of co-construction

Focusing on the types of transactivity, Chi-square analyses revealed significant differences between the conditions ($\chi^2=393.68$, $p<.001$). Students in the summary writing condition used more elicitation (36.8% summary; 12.4% concept map) and less externalization (22.2% summary; 41.9% concept map) and integration (18.1% summary; 45.3% concept map) than students in the concept mapping condition.

From the analysis of the subcategories of transactivity, Table 2 shows that, in the summary writing condition, the dyads expressed most of the utterances directed at eliciting behavior: managing his or her participation in the activity, dictating sentences mechanically, and inquiring about their agreement with an idea. Regarding the externalization of ideas, one of the most commonly used strategies was “signaling”, which means that the idea was taken verbatim from the text or from the concept map without any level of paraphrasing. Very frequently, the contributions of the students did not reflect the elaboration or clarification of ideas, but instead, they repeated the same information related to a specific idea.

Regarding the strategies aimed at integrating the participants' contributions to the task, in both tasks, students contributed many evaluations, mostly expressions of agreement. However, in the semiempty concept mapping condition, students reelaborated much more on the ideas of their peers. It is worth noting that 23% of the utterances verbalized by the students in the summary task were coded as off-analysis because these utterances were related to the mechanical processes of content repetition previously dictated by one of the members of the pair.

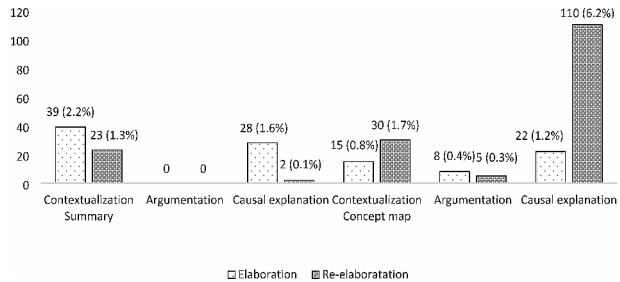
Table 2 Frequency and percentages for transactivity categories in the summary writing and semiempty concept mapping condition for each dyad and in total. The asterisks in the last row indicate where statistically significant differences were found in the frequency of appearance in the two tasks ($p < .001$)

Dyads	Transactivity categories		Summary	Semiempty concept map
Dyad 1	Elicitation	Management	46(13.3%)	15(8.1%)
		Instruction	67(19.4%)	1(0.5%)
		Questioning	22(6.4%)	4(2.2%)
	Externalization	Signaling	50(14.5%)	42(22.7%)
		Elaboration	10(2.9%)	12(6.5%)
		Doubt	14(4.0%)	9(4.9%)
	Integration	Evaluation	54(15.6%)	31(16.8%)
		Re-elaboration	13(3.8%)	71(38.4%)
		Off-analysis		70(20.2%)
Dyad 2	Elicitation	Management	28(18.1%)	3(3.1%)
		Instruction	36(23.2%)	0(0.0%)
		Questioning	4(2.6%)	0(0%)
	Externalization	Signaling	6(3.9%)	48(50.0%)
		Elaboration	16(10.3%)	18(18.8%)
		Doubt	11(7.1%)	0(0%)
	Integration	Evaluation	14(9%)	13(13.5%)
		Re-elaboration	7(4.5%)	14(14.6%)
		Off-analysis		33(21.3%)
Dyad 3	Elicitation	Management	18(8.6%)	3(3.3%)
		Instruction	37(17.7%)	0(0%)
		Questioning	15(7.2%)	0(0%)
	Externalization	Signaling	21(10.0%)	34(37.8%)
		Elaboration	14(6.7%)	4(4.4%)
		Doubt	13(6.2%)	7(7.8%)
	Integration	Evaluation	22(10.5%)	19(21.1%)
		Re-elaboration	16(7.7%)	22(24.4%)
		Off-analysis		53(25.4%)
Dyad 4	Elicitation	Management	22(13.3%)	8(6.0%)
		Instruction	29(17.6%)	2(1.5%)
		Questioning	7(4.2%)	7(5.3%)
	Externalization	Signaling	25(15.2%)	45(33.8%)
		Elaboration	15(9.1%)	5(3.8%)
		Doubt	5(3.0%)	2(1.5%)
	Integration	Evaluation	22(13.3%)	31(23.3%)
		Re-elaboration	16(9.7%)	31(23.3%)
		Off-analysis		24(14.5%)
Dyad 5	Elicitation	Management	22(8.2%)	21(14.7%)
		Instruction	58(21.7%)	2(1.4%)
		Questioning	10(3.7%)	7(4.9%)
	Externalization	Signaling	26(9.7%)	32(22.4%)
		Elaboration	20(7.5%)	8(5.6%)
		Doubt	8(3.0%)	13(9.1%)
	Integration	Evaluation	26(9.7%)	26(18.2%)
		Re-elaboration	15(5.6%)	34(23.8%)
		Off-analysis		82(30.7%)

Table 2 (continued)

Dyads	Transactivity categories		Summary	Semiempty concept map
Total	Elicitation	Management*	136 (11.9%)	50 (7.7%)
		Instruction*	227 (19.9%)	5 (0.8%)
		Questioning*	58 (5.1%)	18 (2.8%)
	Externalization	Signaling*	127 (11.1%)	201 (31.1%)
		Elaboration	75 (6.6%)	47 (7.3%)
		Doubt	51 (4.5%)	31 (4.8%)
		Evaluation*	138 (12.1%)	120 (18.5%)
	Integration	Re-elaboration	67 (5.9%)	172 (26.6%)
		Off-analysis*	262 (23%)	3 (0.5%)

Fig. 2 Frequency and percentage of elaborations and re-elaboration in contextualizations, causal explanations and argumentations



The following example illustrates the process of co-construction of a summary. Both students contributed to the summary. Student 1 read his summary about the causes of imperialism. It should be noted that they took ideas (see utterances 2 to 7 in Example 3) quite literally from the texts without any level of reelaboration. The utterances are more or less ‘copied’ from the textbook (see Example 4). The excerpt also contains expressions of management (utterance 9), agreement (utterances 8, 10, 12, 15 and 17) and operation (utterances 13, 16 and 19). Utterances 22 and 24 are examples of repeating content while dictating or writing. Students in the summary writing condition produced more of this type of utterance.

Example 3 Excerpt of a summary writing interaction in which students they built a summary of the causes of imperialism.

1. Student 1: OK.
2. Student 1: In my summary, I have written, causes.
3. Student 1: Imperialism was justified with different arguments.
4. Student 1: The economic cause is perhaps the main factor.
5. Student 1: I wrote “Imperialism.
6. Student 1: In the economy, they needed raw materials, energy sources and new markets.
7. Student 1: And in the Industrial Revolution, they needed resources to strengthen their power thanks to their technical, organizational and economic superiority.
8. Student 2: OK.
9. Student 2: Let’s write yours, shall we?
10. Student 1: OK!
11. Student 2: The first thing you said, can you dictate it to me please?

12. Student 1: Yes.
13. Student 1: Imperialism was justified with different arguments.
14. Student 2: With different arguments?
15. Student 1: Yes!
16. Student 1: You can write “the main factor” in brackets.
17. Student 1: OK!
18. Student 2: Economic, what did you write?
19. Student 1: They needed raw materials, energy sources and new markets.
20. Student 2: Need for raw materials....
21. Student 1: Energy sources.
22. Student 2: Energy sources.
23. Student 1: And new markets.
24. Student 2: New markets.

Example 4 Excerpt from the textbook about the causes of Colonial Imperialism.

Causes.

Imperialism was justified with different arguments. The economic cause, perhaps the main factor, has several aspects. On the one hand, the industrial powers needed raw materials, sources of energy and new markets to sell their surpluses. The Industrial Revolution provided Europeans with the means to assert their power over humanity as a whole through their technical, organizational and economic superiority [...].

Student interactions of the dyads that made concept maps contained more corrections and precisions. In this condition, students constructed causality more frequently, accompanied by utterances in which they expressed previous knowledge or implicit information on the relationship. Let us see an example of this type of explanation (example 5):

Example 5 Excerpt from the interaction of a dyad constructing a semiempty concept map.

1. Student 1: Population increases due to birth rate and reduction of death rate.
2. Student 2: On the contrary.
3. Student 2: There was an increase in the birth rate because in the colonies and metropolis, the number of people increased.
4. Student 1: No.
5. Student 2: Do you know what birth rate and death reduction are?
6. Student 1: Yes, I do.
7. Student 2: It depends on how many people there are....
8. Student 2: So more people are born and less people die.
9. Student 1: Because of that.
10. Student 1: First, it is the increase in the population and then the increase in the birth rate and the reduction in the death rate.

Collaborative historical reasoning

To assess to what extent student interaction reflected collaborative historical reasoning, we conducted a combined analysis of the main components of historical reasoning and indicators of a higher level of transactivity, such as externalization in terms of elaboration and integration of the contributions to the task through the reelaboration of the partner's idea. Regarding elaborations (Table 2), the dyads in the summary writing condition tended to externalize more elaborations while contextualizing the historical content and deploying more causal explanations than dyads in the semiempty concept mapping condition, but these differences were not statistically significant. However, students in the semiempty concept mapping condition expressed more utterances of the reelaboration type (corrections and precisions) in the different components of historical reasoning. The differences were statistically significant ($\chi^2=503.73, p < .001$).

Excerpt 6, made up of 22 utterances, represents an example of the co-construction of historical reasoning (a causal explanation) in the semiempty concept mapping condition. In utterance 1, student 1 starts establishing a cause-consequence relationship between two ideas: political developments and imperialism. Student 2 agrees (utterance 2), and this agreement is followed by up to 6 reelaborated utterances in an attempt to justify the student's decision (utterances 3 to 8). All of these utterances relate to economic, demographic and political factors, contributing to a multicausal explanation. Furthermore, in utterances 14 to 22, student 2 adds to this explanation with more elaborations while contextualizing the historical content. Different types of knowledge are used to contextualize this particular period of imperialism, such as knowledge about socioeconomic developments and characteristics of a location (utterances 15, 17 and 18).

In utterance 16 ("in the Suez document it says that more than 18,000 ships sailed there"), student 2 refers to information in one of the sources in the textbook to support his argumentation. This contribution includes information that was not provided in the concept mapping task itself.

Example 6 Excerpt of a coconstructed historical reasoning (causal explanation) using different social modes of co-construction in the semiempty concept mapping condition.

1. Student 1: Now we have political causes.
2. Student 2: I agree.
3. Student 1: Political because the economic one has more to do with production,
4. Student 1: Demographic factors have to do with the increase in population.
5. Student 1: And then the political one has more to do with conquest.
6. Student 1: About why they wanted the territories.
7. Student 1: So, political ones derive from the search for international prestige.
8. Student 1: And I have written the need to dominate strategic places.
9. Student 2: Ok, me too.
10. Student 1: So that's why it would be political.
11. Student 2: For the fact of dominating more land and having more conquests.
12. Student 1: Of course.
13. Student 1: It was in the countries' interest.
14. Student 2: It was in their interest to have more territories, conquests and more places.

15. Student 2: For example, the Suez Canal and Gibraltar.
16. Student 2: In the Suez document, it says that more than 18,000 ships sailed there.
17. Student 2: Well, that is in 2005.
18. Student 2: But previously oil was transported through it.
19. Student 2: So, that is why the countries had that conflict.
20. Student 2: Right?
21. Student 2: Because it was in their interest to have that canal in order to be able to transport oil.
22. Student 2: And it also provoked tensions and conflicts.

Excerpt 7 represents an example of students' reasoning in the summary writing condition. Whereas dyads in the semiempty concept mapping condition coconstructed more causal explanations by reelaborating the participants' contributions, in the summary writing condition, there were very few episodes in which the students collaborated in the reelaboration of the causal relationships, either by correcting or by reformulating in other words an idea expressed by the interlocutor. In excerpt 7, only one utterance could be categorized as such (utterance 17), where student 1 added "and cheaper workforce" to the utterance of the partner. The contributions of David Livingstone do not add much to explain the colonial expansion of European countries. Student 1 mentions the Suez Canal, the raw materials, energy sources and markets for their manufacturers. These are not truly discussed but dictated to write the summary (see utterances 16, 17, 18, 21, and 23).

Example 7 Excerpt of coconstructed historical reasoning using different social modes of co-construction in the summary writing condition.

1. Student 1: Political causes.
2. Student 1: The Suez Canal had a great power of expansion and was the perfect place to settle the territories they had conquered.
3. Student 1: In the 19th century, there was a process of exploration and at the beginning of the 15th century.
4. Student 1: Afterward, David Livingstone was a great explorer and advocate of slavery's abolition and racism.
5. Student 1: in 1869....
6. Student 1: Previously, he had been lost, and nothing was known about him.
7. Student 1: Stanley went in search of him.
8. Student 1: And he found him in Ujiji.
9. Student 1: But he couldn't take him back to Europe.
10. Student 1: So he stayed in Africa.
11. Student 1: And in 1872, they went their separate ways.
12. Student 2: Yes, I've practically written the same.
13. Student 1: Let's see, I'm going to write it down.
14. Student 2: Let's write mine and then what you have written.
15. Student 2: Mine is more detailed.
16. Student 1: We should write down what "raw materials, energy sources and markets were used by the powers in order to get money".
17. Student 2: raw materials and cheaper workforce.

18. Student 2: Also, do write down, “at the same time the colonies were markets for their manufactures”.
19. Student 1: And cheaper workforce?
20. Student 2: Yes.
21. Student 2: And then “at the same time, the colonies were markets for their manufacturers”.
22. Student 1: Ok.
23. Student 1: “Europeans were looking for large territories in order to get more money”.
24. Student 2: Ok.

Discussion

As we have already seen, there has been extensive research on the use of concept maps over the last 30 years. However, the most notable efforts have focused on learning outcomes as a consequence of individually constructed concept mapping for science concept learning (Molinari, 2017). Since epistemic content is a very relevant variable in this type of research, one should be very cautious about generalizing findings to other domains (Haugwitz et al., 2010). Distinguishing features of the study that we presented are that we examined the quality of student interaction (instead of learning outcomes) and focused on the school subject of history.

We expected that collaborative concept mapping (using semiempty concept maps) would result in more historical reasoning and transactive interaction than collaborative summary writing. Our analysis of the interaction in both conditions confirmed this hypothesis. This finding is consistent with what is predicted by the MUPEMURE model (Weinberger et al., 2011). According to this model, there is a reciprocal effect between the type of representations and collaboration. The way learners interact with each other is affected by the type and quality of the external representation.

The students who collaboratively wrote a summary produced more utterances. However, most of these utterances did not reflect historical reasoning, but rather consisted of dictating sentences from one of the summaries, which the partner merely repeated and copied. Regarding the first research question, we found that the students in the summary writing condition focused on a superficial historical contextualization. The transcripts (e.g., excerpt 2) showed that their comments mainly concerned information about the physical location, the temporal sequence of events or historical figures, with little relevance for the construction of a (causal) historical reasoning. Students hardly created an appropriate historical context (see Wineburg, 1998) to interpret modern imperialism. Knowledge of social activity, such as socioeconomic, sociopolitical, and sociocultural aspects of life, was mentioned but without inferring information beyond what the texts provided. No attempt was made to explain the influence of these contextual conditions on the colonized peoples' thoughts or behavior. On the contrary, the students in the semiempty concept mapping condition engaged significantly more in causal explanation and argumentation and used more historical and metahistorical concepts in their reasoning than the students in the summary writing condition. These results are not in line with some previous studies that focused on the learning outcomes in other subjects. For instance, Fechner (2009) did not find significant

differences in learning outcomes between students who collaboratively wrote a summary and students who collaboratively constructed a concept map in chemistry.

Regarding the second research question, we found that the interaction in the semiempty concept mapping condition showed a higher level of transactivity than in the summary writing condition. Interaction in the semiempty concept mapping condition included a much higher percentage of utterances denoting the convergence and integration of the knowledge contributed by the partners in the dyad. According to the collaborative information processing (CIP) model developed by Jorczak (2011), we can conclude that the pairs who wrote a summary jointly did not, in general, go beyond the initial phase of knowledge externalization. Students showed a typical pattern of copying, imposition, or juxtaposition of contributions, which is usually described by teachers as the main risk of collaborative learning activities (Montanero & Tabares, 2020). On the other hand, the transcripts of the verbal interactions that took place during the completion of the concept map showed numerous cyclical processes of revision of one's own representations, negotiation of discrepancies, and integration of the partner's input. These are convergence processes, which are often resolved by *quick consensus building* (learners accept contributions of their peers without further modifications or comments) but also through *integration-oriented consensus* (involving clarifications and justifications) and, to a lesser extent, *conflict-oriented consensus* (when the interlocutor's contributions are explicitly corrected). These last interaction segments are considered indicators of high-quality interaction (Stegmann et al., 2007).

One of the categories in our coding scheme targeting different types of transactivity is re-elaboration. It is precisely this category that can be regarded as an indicator of collaborative historical reasoning, because the interaction includes both historical reasoning and co-construction. Students who completed a semiempty concept map produced up to five times more re-elaborations of causal relationships than the students who wrote a summary. Many of these re-elaborations involved justifications in which students explained how a historical condition or event contributed to a later event (causal relations) or what the intentions of historical characters and collectives were when carrying out actions that were relevant in the historical course of events (motivational relations). Sometimes, the discussion around these explanations caused students to resort to the reference texts to justify their reasoning. It is striking that this did not occur in any of the groups that prepared the summary.

There are two reasons that may explain the more collaborative interactions of those students who completed the semiempty concept map. First, the exclusively verbal and linear nature of a summary may not reflect clearly enough the macrostructure of the reference text, especially when students were not able to identify the most important ideas and articulate them adequately, making comprehension and discussion difficult (van Dijk & Kintsch, 1983). On the contrary, the concept map provided a very explicit hierarchical representation of the content's macrostructure. This graphical representation enhances the processing of concepts and ideas (Armbruster & Anderson, 1984), as well as the discussion about the relationships among them.

Second, according to cognitive load theory, a relatively complex task such as constructing a summary from long text, when so many ideas must be considered simultaneously, generates an intrinsic cognitive load in the working memory, which may be excessive for students with little experience in such a task (Kirschner et al., 2006). This difficulty also affects the construction of multiple external representations (MERs), such as self-generated concept maps (Molinari, 2017). It goes without saying that one problem with concept maps

is they have no practiced conventions for reading order. English text is always read left to right, top to bottom. After an eye fixation on a node, the reader must decide the next node (or link label) to jump to. This constant low-level decision-making while reading concept maps imposes significant cognitive load when the students are not used to work with them. Another problem when reading concept maps is it's much easier to forget which nodes have already been visited, so the reader often wastes eye fixations on needless revisitation of nodes. Nevertheless, completing a semiempty concept map might have provided scaffolding that freed up sufficient cognitive resources to enable reasoning about the relationships between ideas. The incomplete concept map in our study focused students on key components of historical reasoning. Many of the ideas that students had to provide to complete the map referred to an intention, an event, or a context (social, economic, political, cultural), which was interpreted as a cause or consequence of other events related to the historical phenomenon of imperialism. As the transcripts of the paired discussion activities clearly showed, this may also have facilitated the construction of self-explanations in which students tried to justify these causal and motivational relationships. In general, therefore, it seems that with the summary task the students limited themselves to externalizing ideas and knowledge about the historical phenomenon, with little elaboration. In contrast, completing the concept map stimulated *reflective knowledge-building* processes (Roscoe & Chi, 2007) that focused mainly on causal reasoning. An analysis of the verbal transcripts revealed that such processes frequently involved the identification and correction of errors through causal justifications and arguments referring to the source on which the map was based.

However, more research is needed to determine the effect of semiempty maps. We need to be cautious because students were asked to complete the semiempty concept maps with letters corresponding to different concepts/phrases that were part of the text they had read. This somehow could undermine the effect of the concept mapping task.

Further research is also needed to investigate whether these findings are still present with similar complex tasks, that is, whether the task of completing a semiempty summary would result in similar advantages as the task of completing a semiempty concept map. Future research could also focus on the use of student-generated concept maps in the context of history education. Another open question that should be explored in future research has to do with the degree of cognitive effort generated by each type of task. Completing a semiempty concept map entailed an effort of knowledge retrieval from memory that was not very intense, since the information that students had to provide was very limited and they also had the possibility of consulting the reference text. The well-known *retrieval practice effect* has shown that students who use processes involving the mental effort of retrieving information from memory to answer questions or perform a certain task significantly improve their learning with respect to those who, for example, are allowed to reread the text (Karpicke & Blunt, 2011; Lechuga et al., 2015). When comparing concept mapping with a free recall task (similar to summary writing), several recent studies have found better learning outcomes in both tasks, but only when students do not have access to the text (Blunt & Karpicke, 2014; Ortega et al., 2019). The verbal records of the arguments identified in our work show that students sometimes based their reasoning on fragments that they had read literally in the text, with little elaboration. It is possible that, had this resource not been accessible to them, the need to retrieve knowledge from memory to complete the map would have involved them more actively in the reasoning and justification of their answers.

In future research, we, therefore, intend to compare the task of completing a map or a mutilated summary, individually and collaboratively, with and without the possibility of consulting the reference text. In this way, it would be possible to confirm whether the collaborative completion of an incomplete map constitutes a task that is truly adjusted to the competences of this student profile, with the aim of achieving an optimal balance between the cognitive load it entails and the cognitive effort it demands.

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Consent for publication All authors agreed to publication of the article in its current form.

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Authors and Affiliations

Manuel Lucero¹  · Manuel Montanero¹ · Carla van Boxtel² 

✉ Manuel Lucero
mlucero@unex.es

Manuel Montanero
mmontane@unex.es

Carla van Boxtel
C.A.M.vanBoxtel@uva.nl

¹ Facultad de Educación y Psicología, Universidad de Extremadura, Badajoz, Spain

² Research Institute of Child Development and Education, University of Amsterdam, Amsterdam, The Netherlands