History Learning with Textual or Visual Tasks: Student Dialogue

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Abstract: Multimodal representations are representations containing a combination of text and schemas and/or pictures. According to the Cognitive Theory of Multimedia Learning such representations can be powerful learning tools. The study described here approaches this theory from the domain of history in co-construction tasks. In an experimental study, the dialogues of pupils who co-constructed either textual representations or multimodal representations integrated in a timeline were compared. The participants were 12 to 14-year-old pupils in pre-vocational secondary education who worked in dyads on a series of four history tasks. Dialogue protocols of the taped student conversations for one of these tasks were analysed. The results show that integrated multimodal representations do – to some extent – lead to more discussion about domain content as well as about procedural issues than working with textual representations.

Theoretical framework

Multimodal representations combine two or more modes of representation, for example, a verbal text with one or more types of visualisation (i.e., schematic and/or depictive). While there has been a fair amount of research on the effects of learning with multimodal representations – in particular visualisations presented with texts – there has been less research on the learning processes that occur when using multimodal representations in tasks. This study sheds light on differences in the learning process between multimodal and verbal tasks at the level of task content.

There is a large body of research on learning with multimodal representations (Ainsworth, 1999; Larkin & Simon, 1987; Mayer & Chandler, 2001; Schnotz, 1993). In these studies multimodal representations are seen as cognitive thinking tools – tools for remembering, thinking, and problem solving (Jonassen, Reeves, Hong, Harvey, & Peters, 1997) – and the focus is primarily on the learning outcomes that these representations produce. These outcomes are explained by Dual Coding Theory (Paivio, 1991), Cognitive Theory of Multimedia Learning (Mayer, 2001) and/or Cognitive Load Theory (Kirschner, 2002; Sweller, Van Merriënboer & Paas, 1998). In recent research, two topics related to learning with multimodal representations have gained attention, namely: 1) the effects of constructing different forms of multimodal representations on learning processes and outcomes, and 2) the learning and interaction processes that are provoked and supported by the construction of multimodal representations by the learners themselves. We will first elaborate on these topics below.

Cox (1999) argues that constructing external representations can be beneficial for learners. Several studies have shown positive learning effects for one specific type of task in which a multimodal representation is constructed, namely a concept map (e.g., Horton, McConney, Gallo, Woods, Senn, & Hamelin, 1993; O’Donnell, Dansereau, & Hall, 2002; Van Boxtel, Van der Linden, & Kanselaar, 2000). Concept maps are diagrams that indicate interrelationships between concepts and represent conceptual frameworks within a specific domain of knowledge (Novak, 1990). In order to construct a concept map, students have to think about and describe both concepts that are instrumental to a specific situation and the relationships between those concepts. By doing this, concept mapping helps students focus on the macrostructure of the content, stimulates elaboration and can provide multiple retrieval paths for accessing knowledge.

The higher level of activity required from students in construction of representations leads to different learning processes. According to Bodemer, Ploetzner, Bruchmüller, and Häcker (2005), students often remain rather passive when they only have to look at a multimodal representation. The researchers argue that active integration of textual and pictorial information by the students themselves is essential for successful learning. They conducted an experimental study in which the students had to relate textual and pictorial information about the working of a tire pump by actively dragging and dropping captions into a drawing of a tire pump on a computer screen. This active integration significantly improved learning. Van Meter and Garner (2005) give examples of tasks in which students construct visual representations, such as organizing or sequencing, given component pieces of a representation.

These ideas about the level of activity and active integration of representations led to an experimental study that was conducted to assess the value of active construction of multimodal representations of historical phenomena (Prangsma, Van Boxtel, & Kanselaar, 2008). Students constructed or completed multimodal representations for different historical phenomena and developments in the Early Middle Ages along with a coordinating timeline. Then, the learning outcomes of pupils who co-constructed textual representations were compared with learning outcomes of pupils who co-constructed multimodal representations integrated in a timeline. Results showed that working on multimodal representations integrated in a timeline led to higher learning outcomes than co-constructing textual representations. The differences in the content of the discourse of collaborating students in these two conditions were assumed to have contributed to this outcome.

Studies on the construction of multimodal representations in collaborative settings that include discourse analysis give some insights into the learning *processes* with multimodal tasks (Bodemer, Ploetzner, Bruchmüller, & Häcker, 2005; Suthers & Hundhausen, 2003; Van Boxtel, Van der Linden, Roelofs, & Erkens, 2002). These studies showed that multimodal representations can facilitate discourse – or articulation – at the content level, thus encouraging the use of domain-specific language, and ultimately knowledge building. Discourse analysis in these studies has focused on the communicative functions (Suthers & Hundhausen), on the activities in the software (Bodemer et al.), on procedures and task management (Erkens, Jaspers, Prangsma, & Kanselaar, 2005), and on topic content (Fischer, Bruhn, Gräsel, & Mandl, 2002; Roth & Roychoudhury, 1994; Van Boxtel, Van der Linden, & Kanselaar, 2000; Van Drie, Van Boxtel, Jaspers, & Kanselaar, 2005).

Problem Definition

This study examines whether collaborative construction and completion of multimodal representations can encourage students to describe and explain historical phenomena using historical concepts. It looks at student dialogues and concentrates primarily on what actually occurs at the content-related level, as this is where pupils most obviously work on acquiring the building blocks of a domain. Through verbalisation of the thought processes, light can be shed on the processes involved in learning with multimodal representations.

The main question is: What are the effects of the collaborative completion and construction of integrated multimodal representations versus textual representations on the content of the student dialogue? The study compares the learning processes of pupils who co-constructed either textual representations or multimodal representations integrated in a timeline. The multimodal representations used joined historical concepts, phenomena and relations (i.e., the components of a chronological-conceptual frame of reference).

On the basis of the literature one would expect the student dialogues to be different for different types of tasks (i.e., textual versus integrated multimodal) in several ways. The pupils who co-construct integrated multimodal representations that combine pictures, diagrams and text in a timeline should elaborate more on the (domain-specific) content of the tasks than pupils who co-construct textual representations, because the information in the visual elements needs to be verbalised and then related to the verbal information given to them (Teasley & Roschelle, 1993). In turn, verbalising knowledge and information about abstract historical phenomena and the relations between them should be easier when learners can make use of multimodal representations because it gives learners a common referent: They can point out parts of the representation they are constructing to indicate what they are referring to, and the task product provides a joint workspace that visualises what knowledge has already been co-constructed.

Method

Participants

The participants in this study were pupils (aged 12 to 14) from six different first-year classes in three different pre-vocational secondary schools, with one history teacher for each school. The majority of Dutch pupils in secondary school (some 60%) attend this school type. The language proficiency of these pupils is relatively low. History as a school subject is part of the compulsory curriculum for only the first two years for these pupils, so there is little time for developing a chronological frame of reference.

Twenty dyads (40 participants) were selected from the total sample ($N = 143$) for the discourse analyses: 10 from the Text condition, and 10 from the Timeline condition. The dyads were randomly selected from all dyads from the final sample for which a full set of recordings was available.

Setting and procedure – experimental tasks

All participants in both the Text and the Timeline condition were given an individual knowledge pre-test. The test consisted of three parts that were administered separately. Part 1 asked pupils to write down everything they knew about the Early Middle Ages in a concept map. Part 2 consisted of 8 open items, including both textual and multimodal questions. Part 3 consisted of 18 multiple-choice items. Interrater reliability for the open items on 74 randomly chosen tests was .89 (Cohen's kappa). Low prior knowledge resulted in low homogeneity (Cronbach's alpha = .31) of the pre-test. Scores for the multiple-choice section were used to divide the participants into dyads with contiguous ability ranges (i.e., low+intermediate, intermediate+high) and intermediate dyads to ensure both sufficient symmetry to enhance relations, and asymmetry to keep the dialogue going. The pre-test scores of the two conditions were very similar. The Text condition scored 12.13 (SD = 2.56; N = 30), whilst the Timeline group scored 11.79 (SD = 3.32; N = 24). A t-test indicated that the conditions did not differ significantly from each other ($t(52) = .43$, $p = .67$).

Working in pairs, participants carried out four tasks on the Early Middle Ages (the period of 500 to 1000 AD in Western European history) during three consecutive history lessons. In each task, the participants started out by reading a short text (i.e., circa two pages with important historical concepts, such as 'Roman Empire' and 'manorialism', printed in a bold typeface. Dyads were encouraged to use the main concepts in their answers. The texts remained available throughout all tasks. The texts (of which there were four, see further) included appropriate illustrations that were not actively used in the construction task that followed, but were provided to improve basic understanding of the text for both conditions.

The tasks in the Text condition consisted of open questions, fill-in-the-blanks and ordering sentences. The tasks in the Timeline condition involved text, diagrams, and pictures, and the separate task products had to be integrated in a timeline the size of two sheets of flip chart paper (approximately 60 cm x 140 cm). The representation forms of the Timeline tasks were matched to the task-specific content based on the taxonomy by Lohse, Biolsi, Walker, and Rueter (1994): (1) process diagram (decline of the Roman Empire), (2) network chart (effects of the fall of the Roman Empire), (3) structure diagram (manorialism), and (4) cartogram (spread of Christianity and Islam)..

The tasks used in the Timeline condition were designed according to Mayer's (2003) principles for multimedia learning. According to these principles students learn more when words and pictures are combined (multimedia effect), when extraneous material is excluded (coherence), and when words are placed near a corresponding picture (spatial contiguity). Figure 1 shows an example of Task 2 in the Timeline condition. This is the task for which the dialogue analyses are reported on in this paper.

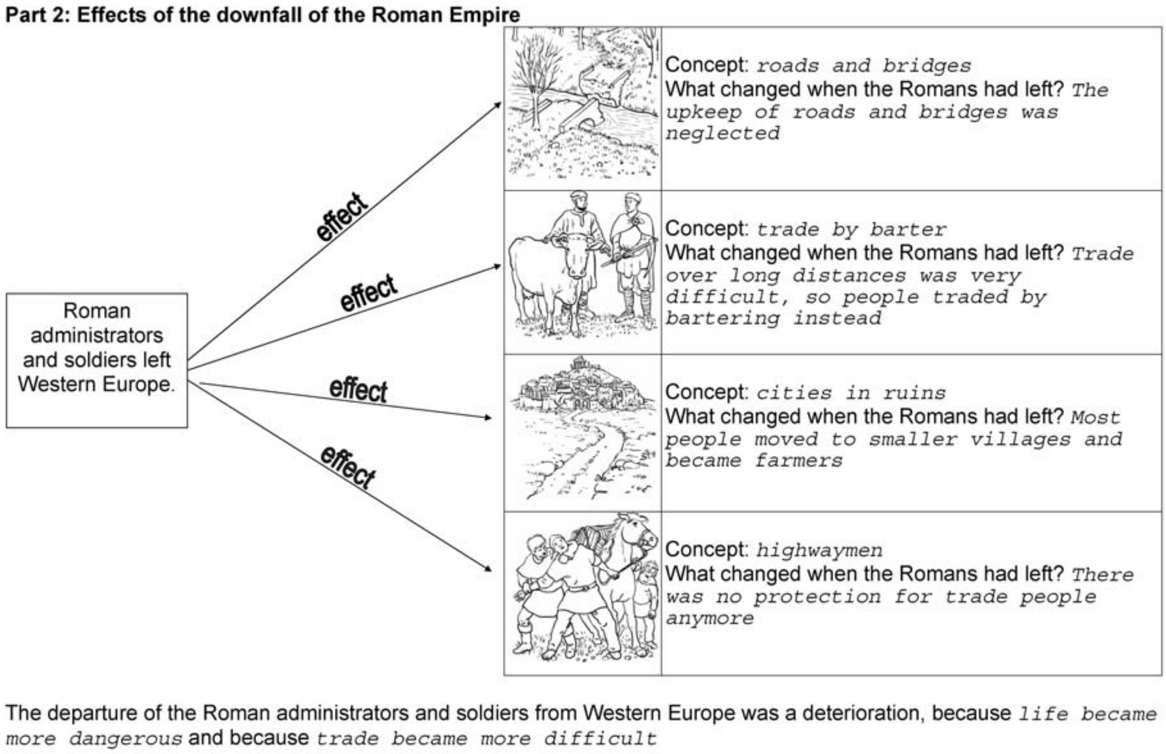

Figure 1. Example of a completed task sheet for Task 2 in the Timeline condition.

Dialogue Analysis

The analyses of differences between the dialogues in the two conditions focused on a single task (Task 2). This task – about the effects of the fall of the Roman Empire – was chosen because the participants had had one task to get used to working together and to get accustomed to the type of task and setting. For each of the 20 dyads selected, the dialogues were transcribed, coded and analysed with utterances as the unit of analysis. All tasks consisted of two phases: an initial reading phase and a production phase. The initial reading phase was the same for all conditions. Dyads were given the text and instructed to read it out to each other to ensure they actually read the text. After reading the text, the dyads were given the task assignment, which was the starting point for the second phase. The dialogue of the first phase was excluded from the analyses.

Participant dialogues were recorded, transcribed, coded and analyzed in several steps, taking the utterance as the unit of analysis. First, the utterances were coded for their basic topic: Content, Procedural, Social or Other (see Table 1). Passages read out from the text, the instructions, or the answer sheet were coded as 'Read out'. The category Other included utterances by others (e.g., the teacher) and unintelligible utterances. The analyses focused on the domain-specific content of the discourse. A distinction was made between core and auxiliary Content utterances. Core content coding was based on an exhaustive list of phenomena and relations (historical propositions) based on the task text. Auxiliary content coding was assigned to utterances referring to task content, but without an explicit description or reasoning. In addition, the total number of concepts and the total number of different concepts were tabulated.

Table 1: Examples of the dialogue coding categories.

Code	Examples	Description/Explanation
Procedural utterances	"It's your turn now." "Do you have sticky tape?"	E.g., collaboration, partner behavior, spelling
Social utterances	"Are you going to the party on Friday?" "You know who called last night?" "Who did she kiss?"	Utterances irrelevant to the task
Content utterances by subtype:		
Core content	"There was little trade" "When the Romans left, bridges collapsed"	Statement about historical phenomenon, or relating phenomena to each other
Auxiliary content	"Trade" "Viking boats are cool"	Reference to content without explicit description or reasoning
Read out content	"What happened here?"	Statement that is read out from the text or answer sheet
Read out procedural	"Look at the five pictures"	Statement that is read out from the instructions

Interrater reliabilities between two coders were calculated for four randomly chosen dialogue protocols (two from each condition, totalling 1060 utterances). Cohen's kappa was .74 for coding the main topic (Procedural, Social, Content, Read out) whilst agreement was 82.80 %. For the Content coding level (Core vs. Auxiliary) agreement was 86.40 %, and Cohen's kappa was .76. Agreement for counting the total number of concepts was 82.40 %, and Cohen's kappa was .78.

Results

Differences Between Text and Timeline in Task 2 Dialogue Utterances

Task 2 student dialogues in the Text condition were compared to those in the Timeline condition. In the Text condition the mean duration of the analysed dialogues was 19.43 minutes (SD = 8.90) and in the Timeline condition 19.42 (SD = 5.79). The durations did not differ significantly between conditions ($t(17) = .004$, $p = .997$ (two-tailed)). Hence, all dialogue results report frequencies of utterance categories.

Table 2 shows the means and standard deviations for the dialogue frequencies in both conditions. On the whole, the Timeline group talked significantly more than the Text group, as shown by an independent samples t-test for the total number of utterances. This difference seems to be attributable to all three main topics – procedural, social, and content utterances – though only procedural utterances and social utterances show significantly higher frequencies for Timeline condition than for the Text condition. There is no significant difference for the number of content utterances.

Table 2: Means and standard deviations for the frequencies of the dialogue variables in Task 2: Comparison between conditions.

		Mean		*SD*		*t*	*df*	*p*
		Text	Timeline	Text	Timeline			
Total number of utterances	**	85.00	160.60	45.05	68.22	-2.92	15.60	.00
Procedural utterances	**	18.80	54.90	13.36	28.44	-3.63	18	.00
Social utterances	*	17.20	40.30	18.64	33.12	-1.92	14.18	.04
Content utterances		49.00	65.40	22.16	26.23	-1.51	18	.07
Core content		17.20	16.70	9.77	10.22			
Auxiliary content	*	25.70	43.80	11.35	24.02	-2.15	12.83	.03
Read out content		6.10	4.90	3.78	2.81			
Read out procedural	**	1.00	3.00	1.70	1.70	-2.63	18	.01

Core content utterances + auxiliary content utterances + read out content = content utterances. Read out procedural utterances are a subset of procedural utterances.
Text: $N = 10$ dyads. Timeline: $N = 10$ dyads.
*: Timeline > Text at $p < .05$; **: Timeline > Text at $p < .01$.

Taking a closer look at the content utterances shows that the two conditions have elicited roughly the same number of core content utterances, and similar amounts of content were read out from the task text and task sheet. Yet, even though there was no significant difference between the two conditions for the number of content utterances, the Timeline condition shows a significantly higher frequency for auxiliary content utterances. This suggests that the multimodal representations do encourage content talk, but not to name things or refer to them very specifically. Table 3 shows a typical example of pupils discussing what text should be written on the task sheet to describe a picture of Viking raids in Task 2 in the Timeline condition. The columns show the alternation between the two pupils in the dyad (Speaker), a translation of the utterances, the main topic (procedural, social utterances or content), and the subtopic (read out, core content, or auxiliary content). A clear example of an auxiliary utterance in this excerpt is "No, the bottom one, the village", in which the pupil refers to a picture without being explicit. The auxiliary utterances in this excerpt, such as 'What does that say' and 'That's because', seem to lead up to more explicit statements (i.e., core content utterances) about historical phenomena described in the task text. The auxiliary utterances often include deictic expressions, such as 'that' and 'it'.

Table 3: Excerpt from a dialogue on Task 2 in the Timeline condition.

Speaker	Utterance		Topic		Subtopic
1	"Here, that's finished, Wesley, well done"		Procedural		
2	"Now you do another sentence"		Procedural		
1	"Oh, let me think"		Procedural		
2	"No, write"		Procedural		
1	"What does that say?"		Content		Auxiliary
2	"Just that the Vikings travelled around"		Content		Core
1	"No, the bottom one, that village"		Content		Auxiliary
2	"That's because"		Content		Auxiliary
1	"Um, OK but it needs something after it"		Content		Auxiliary
1	"The Vikings plundered"		Content		Core
1	"With fifteen exclamation marks after it"		Social		
2	"Oh yeah"		Social		
1	"That makes the sentence a bit longer, that's a question mark idiot"		Social		
2	"Like this"		Social		

The Timeline group also read out significantly more procedural information from the task sheet and instructions. This is not surprising, as the instructions for the Text condition were more concise.

Concept use in the two conditions

Analysis of the use of historical concepts used within the content-related utterances (core and auxiliary) showed no differences between the Text and Timeline conditions in the total number of concepts used, nor for the number of different concepts. Closer inspection of the data did not reveal differences between conditions in the choice of specific concepts. Table 4 shows the results for the concept use in the dialogue.

Table 4: Means and standard deviations for the concept scores of the dialogues in Task 2: Comparison between conditions.

	Mean			SD	
	Text	Timeline		Text	Timeline
Total number of concepts	27.70	24.00		16.57	10.74
Total number of different concepts	9.00	7.30		2.26	2.36

Conclusions and implications

The effects of multimodal representation tasks in a timeline (Timeline) and of textual tasks (Text) in a collaborative setting were examined. It was assumed that working with multimodal representations in a timeline would result in different dialogues and learning outcomes than working with textual representations would. In addition, the study explored whether different types of multimodal tasks resulted in differences in the dialogues.

The first research question investigated the effects of the collaborative completion and construction of integrated multimodal representations versus textual representations on the (domain-specific) content of the student dialogue. The results of the dialogue analysis of one out of four tasks showed that the multimodal group (Timeline) talked more in general, and produced more procedural utterances in particular than the textual group (Text). This is not surprising since the multimodal timeline task required more organisation and coordination compared to the textual task. Whilst the textual version of the task involved fill-in-the-blank sentences, ordering sentences, and answering a summary question, the multimodal timeline version of the task – completing a causal network chart – required choosing relevant pictures and discarding irrelevant ones, adding concepts and captions to the pictures chosen, relating visual and textual information, linking the elements to the previous task on the timeline, as well as answering the summary question. Van Boxtel, Van der Linden, and Kanselaar (1997) found a comparable difference between tasks. They compared a concept mapping task on electricity concepts with a poster task in which students had to use the same concepts to explain the working of an electric flashlight. In their study, the concept mapping task elicited significantly more talk about the concepts than the poster task did. Their explanation – that the poster task elicited more writing and drawing activities – is in line with the suggestion by Bennett and Dunne (1991) that tasks that require more physical activities are more likely to elicit less abstract talk: “for tasks which combine both action with abstract demands, talk related to action continues to dominate” (p. 113). Still, in the study presented here, the tasks with multiple representations asked for more physical activities, such as selecting and gluing pictures, which resulted in more procedural utterances, but not in fewer content utterances – about abstract historical phenomena and the relations between them – in comparison with the less physical tasks with only textual representations.

The Timeline group also talked more about topics not related to the task (social utterances). The nature of the multimodal timeline task – which involved more physical activity than its textual counterpart – might have made working in the classroom more turbulent, making it harder for pupils to concentrate on the task, thus eliciting more distraction and the tendency for more social utterances. This did not, however, detract from content related discussion. Also, pupil concentration may have been influenced by the fact that for many dyads this particular task was spread out over two non-consecutive lessons, and by the fact that these pupils are not used to working in groups for an entire lesson – although these circumstances were the same for the pupils in the textual condition. Restarting their work could require a certain amount of coordination (i.e., catching up on what has intervened) which could be achieved through social talk. The value of social talk in group work has been confirmed by Chen, Lee, Chu, Wang, and Jiang (2005), although it has to be noted that their research was done in a different cultural setting (Asian as opposed to Western European).

On the whole, the results do not strongly support the idea that the extra step of visualisation in the multimodal condition provokes and supports more extensive discussion of core content than in the textual condition. Co-constructing a multimodal representation in a timeline did not seem to invite more core content utterances, nor did it elicit the use of more or more different concepts. However, the results do indicate that auxiliary talk about the content – i.e., talking about content without making clear statements – was encouraged by the multimodal timeline task. It seems that learners often describe pictures in very general terms in auxiliary utterances – including non-specific referents such as ‘this’ and ‘that’ – because there is a tangible common point of reference, so they can afford to be less explicit. From that point of view, the multimodal representations have a deictic role (i.e., pointing to a picture or schema or to a part of it; see Suthers, Girardeau, & Hundhausen, 2003) that does not occur in the textual condition. At the same time, it might also be difficult for learners – considering their educational level – at this level to use abstract concepts to describe concrete pictures, and as a result the learners keep using everyday instead of domain-specific language.

If referring to visual elements and talking about core concepts is so important, then future research should focus on how we can encourage learners to perform these activities. In addition, future research could focus on the role of deictic properties of multimodal representations in face-to-face collaborative learning.

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