Instruction of digital reading strategies based on eye-movements modeling examples

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Abstract

During the last decade several studies have proposed and tested different instructional methods for teaching digital reading strategies to young students. In this study, we have tested the effectiveness of a program combining eye-movements modeling examples (EMME) and contrasting cases to instruct ninth grade students how to plan, evaluate and monitor their digital reading. EMMEs are videos that display a dot representing the eye-movements of a model and an oral transcription of her thoughts while answering a specific question in a hypertext. Students in the EMME condition obtain higher comprehension scores in a post-test performed one week after the instruction, as compared to a control group that have received a control instruction using written case examples. Students working with EMMEs also spend more time reading the main digital document, but they don’t differ in terms of visits and time to relevant and irrelevant pages. Our study suggests that EMMEs can be used to foster literacy strategy instruction.

Keywords: digital literacy; eye-movement modeling examples; contrasting cases; hypertext navigation; text comprehension; high school education.
Introduction

Digital reading is becoming ubiquitous in schools, as students are increasingly encouraged to access the Internet to gain information relevant for their subjects (OECD, 2015). Online documents, such as web pages, are connected to other documents via hyperlinks, which allow students to access topically related information to expand their understanding of a topic. But not all available hyperlinks in a web page may lead to relevant information to fulfil the student’s specific learning goal. Thus, efficient digital reading requires that students constantly self-regulate their digital reading, to strategically manage their reading purpose (‘Do I know what I have to learn?’), assess the relevance of the available links and the web pages visited (‘Is this link connected to a web page relevant for my learning goal?’), and to integrate information from multiple pages (Afflerbach & Cho, 2009; Brand-Gruwel, Wopereis & Walraven, 2009; Rouet, 2006; Salmerón, Strømsø, Kammerer, Stadtler, & van den Broek, 2017). As young students are still developing and automatizing complex text comprehension processes, such as identifying main ideas or making inferences, correctly understanding a text may not leave enough cognitive resources to properly engage in self-regulation during digital reading (Salmerón, García, & Vidal-Abarca, 2018; Segers, 2017). Thus, such strategic processing must be promoted through specific instruction.

This study presents and assesses an innovative technique for the instruction of digital reading strategies based on a combination of video modeling and contrasting-cases. Before the description of the study, we review the literature on the instruction of digital reading strategies in adolescents.
Instruction of digital reading strategies

During the last decade several studies have proposed and tested different instructional methods for teaching digital reading strategies to students in primary and secondary education (see Table 1 for a review of their main characteristics and results). In general, these programs share many features of traditional reading comprehension instruction, such as ensuring a correct understanding of the task, monitoring current understanding, or activating prior knowledge. What is unique to digital reading programs is the emphasis on how to articulate navigation across pages through hyperlinks to support comprehension and to avoid distraction.

-Insert Table 1 here-

Four main instructional methods have been used in the literature, including direct instruction (Kuiper, Volman & Terwell, 2008, 2009; Kuo & Hwang, 2014), different types of scaffolds (Argelagós & Pifarré, 2012; De Vries, van der Meij & Lazonder, 2008; Fesel, Segers, De Leeuw, & Verhoeven, 2016; Walraven, Brand-Gruwel, & Boshuizen, 2010), work in pairs (De Vries et al., 2008; Fesel et al., 2016; Kuiper et al., 2008, 2009), and modelling (Hagerman, 2017; Kroustallaki, Kokkinaki, Sideridis, & Simos, 2015). Overall, the studies suggest that the different programs can be used to effectively teach digital reading comprehension to young students. However, the conclusions based on these studies should be taken with caution, as many of them suffer from different methodological limitations (see Table 1, column ‘Comparison’). Most of the studies lacked a control group, or simply used a ‘waiting list’ group as a control (see table 1). Only the recent study by Hagerman (2017) used a control group that received alternative training. The absence of a
proper control group in most of the studies doesn’t allow to test to what extent the proposed program is better than a simplest instruction or mere practice. Another limitation is that only a few studies used an objective measure of students’ digital reading strategies (see Table 1, column “Navigation”), and therefore they mostly relied on performance measures to assess the effectiveness of the programs.

To overcome these limitations, we conducted a study that used a pre-post design, with a control group that received alternative training. We also collected students’ log-files to assess their navigation behavior before and after the instruction. Specifically, we tested the usefulness of video modeling in supporting the instruction of digital reading strategies to adolescents, following the recent work by Hagerman (2017). Although the use of video modeling is rather recent in the field of digital reading, it has been applied in the literature in several other domains.

**Video modeling to support instruction**

High school students often use instructional videos on websites such as YouTube for informal learning, to learn how to mix clothes well, or how to solve a problem situation in an online game. Instructional videos are also important in formal teaching, including master classes, case videos, or tutorials (Spires, Hervey, Morris & Stelpflug, 2012). One of the advantages of instructional videos is that they can be used at any time, and can be seen repeatedly. Instructional videos allow modeling an expert strategic behavior, which makes them an adequate technique for the instruction of strategies. The effectiveness of such instructional videos, in which an expert models, through explanation and implementation, the procedure to solve a complex task, has been generally tested through the lenses of the
social theory of learning (Bandura, 1986). Learning by modeling has been used in many areas, such as mathematics, reading, or writing (for a review see van Gogh and Rummel, 2010). This type of learning does not merely involve watching a video. Bandura (1986) concludes that effective modeling learning requires four conditions: 1) the student must pay attention to the relevant behavior of the model, 2) she/he must elaborate the information in his memory, 3) she/he must be able to reproduce the modeled behavior, and 4) she/he must be motivated to practice the modeled behavior. These conditions must be taken into account in the instructional design of any program that includes video modeling. For example, in the case reading strategies, the model verbalizes the mental steps necessary to carry out the strategy, with the aim that the student pays attention to the relevant behavior to be modeled. However, it is not always possible to verbalize all the mental steps involved in the expert use of complex cognitive strategies, as the verbalized thoughts and the actual behavior may be desynchronized. For example, while an advanced reader thinks "I'm going to quickly scan sections of the web page to decide if this page contains information relevant to my study goal," at the same time it she/he is moving its eyes along the page, for example, quickly reading the statements, hyperlinks and images presented.

The technique of modeling examples from eye movements (EMME) allows to jointly model in a video the experts’ thoughts that guide a strategic behavior, as well as her visual inspection during the application of this strategy. This instructional technique has been mostly applied to visual procedural tasks, such as medical diagnosis (Gegenfurtner, Lehtinen, Jarodzka, & Säljö, 2017; Jarodzka et al., 2012), fish locomotion patterns (Jarodzka, van Gog, Dorr, Scheiter & Gerjets, 2013), problem-solving task (van Gog, Jarodzka, Scheiter, Gerjets & Paas, 2009), or geometric problems (van Marlen, van
Wermeskerken, Jarodzka, & van Gog, 2016). Recently, EMMEs have also been applied to teach reading strategies, specifically the integration of text and graphics (Mason, Pluchino & Tornatora 2015, 2016). For example, Mason et al. (2016) provided a group of 7th grader students a three minute video of a model’s eye-movements, while she was reading an illustrated text. The model read the text, and subsequently move her attention from the text to the information in the picture. In a post-test task, participant’s eye-movements were recorded while reading a different illustrated text. The control group didn’t saw the EMME. Students in the EMME condition showed more integrative visual processing, e.g. they showed more transitions from relevant parts of the graphic to the corresponding text segments. They also scored higher in deep comprehension questions.

Research has shown that EMMEs can be effective for instructing strategic knowledge, but they don’t always improve students’ performance (for a review see de Koning, & Jarodzka, 2017). Visualizing the model’s gaze can guide students’ attention to relevant behaviors (condition 1 for effective modeling, Bandura, 1986). But according to Bandura’s theory (1986), to fully get advantage of a model, students must also elaborate on the modeled information. A fruitful technique to induce students’ information knowledge elaboration and transfer are contrasting-cases (Schwartz & Bransford, 1998). In this task students compare cases about the information or procedure to be learned. To facilitate the comparison, the cases are designed to change just in a few features, while keeping a similar structure. Few studies have applied this technique to the field of text literacy (Braasch, Bråten, Strømsø, Anmarkrud, & Ferguson, 2013; Beitzel & Derry, 2009). Braasch et al. (2013) aimed to instruct young students to evaluate information from multiple documents. The authors first explained the expert strategies, and then presented students with pairs of
written cases, which described the strategies taken by two fictitious students while they read a set of documents on a conflicting issue. One of the students applied the strategies explained by the researchers, and other used less sophisticated ones. Students discussed in pairs which of the students would perform better, and explained why. In the post-test, students individually read a set of multiple documents and wrote to write an essay about the issue. Students in the experimental group better ranked the relevance of the documents, and included more information from relevant documents in their essays, as compared to the control group that received no training. In sum, contrasting cases may induce students’ to reflect and to elaborate on what is displayed in the EMMEs.

**Goals of the study**

Our study tested a program using EMMEs with contrast-cases scenarios to instruct complex literacy strategies. Such program represents an innovative approach in digital literacy as it combines contributions from observational learning (Bandura, 1986) and transfer of learning (Bransford & Schwartz, 1998). Such combination would allow young students both to focus their attention on the relevant aspects of strategic knowledge used by the model, and to further elaborate on the strategies to be able to transfer them to scenarios different from that used during training. In addition, in our study we have wanted to overcome some of the methodological limitations of the previous works on the instruction of digital reading strategies. Specifically, we have used a pre-post design with a control group that received alternative training, and a fine grained analysis of students’ navigation based on log-files of their actual navigation. Thus, in our hypotheses we not only focused on the potential effects of instruction on comprehension, but also on the effects on navigation behaviors:
Hypothesis 1: students in the EMMEs group obtain higher comprehension scores in a post-test question-answering task than those in the control group.

Hypothesis 2: students in the EMMEs group navigate more efficiently in a post-test question-answering task than those in the control group.

Method

Participants

One hundred and one 9th graders (3rd year of secondary education in the Spanish system) from three different high schools from two major cities in Spain took part in the study (mean age 14.5, SD = 0.8; 65% female). On average, students have used computers for 5.5 years (SD = 2.3), and only 5.8% didn’t have a computer at home. They claimed to use the Internet for entertainment purposes “Once or twice a week”, and read Wikipedia articles “Once or twice a month”. Two entire classes from each school participated in the study. Within each school, classes were randomly assigned to the experimental and control groups. 16 students lacked completed data because technical problems in their outputs or because they didn’t attend the three sessions of the program. Only students with complete data (N= 85) were included in the analyses, 41 in the experimental group and 44 in the control group. The study was approved by each school board, who listed the study as an academic task for the students.

Materials

Instruction
The instruction included there phases: modeling, practice, and reflection. Modeling included an explanation of self-regulation strategies that have been proved useful in the literature (Coiro & Dobler, 2007): planning (e.g. setting a purpose and developing a mental plan), evaluate the search of information (e.g. anticipating where a reading choice may lead, and adapting how to read the text depending on the relevance of the information: scanning or deep reading) and monitoring (e.g. evaluating the relevance of the choice made), and prior knowledge activation.

The practice phase differed between the two groups. The experimental group (EMME group from now on) worked with a contrasting cases task in which dyads of students evaluated and discussed EMMEs. EMMEs displayed different digital reading strategies used by secondary school students from a previous study (Salmerón, Naumann, García, & Fajardo, 2017). They presented a dot representing the students’ eye-movements, and an oral transcription of the students’ thoughts while answering a specific question (Figure 1).

We edited six pairs of short EMMEs, each pair ranging from 8 min 4 sec – 9 min 21 sec. Each pair showed two different students answering the same question while reading a Wikipedia document on the French Revolution (the same hypertext and questions used in the pre-test). One of the students used mostly reading strategies that were identified as optimal strategies in the modeling phase, while the other used less optimal strategies. The whole class first practiced with a pair of EMMEs, with a discussion lead by the researchers. Afterwards, dyads worked independently with the rest of EMMEs. After watching a pair of
EMMEs, students’ dyads discussed to respond to the questions “Which student is more likely to answer correctly and why?” The practice phase in the control group differed only in the type of material used to prompt the discussion. Instead of using EMMEs, participants in the control group received written case examples that described the reading strategies used by different students.

Finally, in the reflection phase students were provided with specific formative feedback that informed them about the strategies displayed in the EMMEs/written cases, and were requested to reflect on their performance (Nicol & Macfarlane-Dick, 2006).

**Hypertexts**

In the pretest, we used a hypertext on the topic “French Revolution”, adapted from a textbook (Tapia, 2004). The main document contained 1,878 words, four sections distributed across 13 subsections, and 48 embedded links. In the in post-test, we used a hypertext about “Pollution” elaborated from a textbook (López, 2003), with a length of 1,917 words, four sections distributed across 13 subsections, and 56 embedded links.

**Comprehension questions**

For each hypertext we constructed six open-ended comprehension questions to assess students’ comprehension. Three retrieve questions demanded readers to select specific pieces of information from a relevant linked page, while three integrate questions required them to connect pieces of information through inferences within relevant linked pages (or within the main document and linked pages). Questions were corrected using a rubric of 0 (incorrect), 0.5 (correct but incomplete) or 1 (correct and complete). Two researchers corrected 10% of the responses, reaching acceptable interrater reliability, Cohen’s $\kappa = .79$.
and .72, for the “French Revolution” and “Pollution” topics, respectively. Disagreements were resolved through discussion.

**Prior knowledge questionnaire**

We constructed two questionnaires of ten multiple-choice questions about the topics “French Revolution” and “Pollution”. Questions were developed to assess students’ knowledge of introductory information about the topics. Questions were validated by two teachers with ample experience in each of the respective subjects, but they had questionable internal consistency: $\alpha = .59$ and .50, for the “French Revolution” and “Pollution” topics, respectively.

**Procedure**

The study lasted three 1-hour sessions that took place in three consecutive weeks (see overview in Figure 2). In the first session students completed the prior knowledge questionnaire about the “French Revolution” and then they responded to the hypertext comprehension questions on the same topic. In the second session, students received the digital reading strategy training. Finally, in the third session students completed the prior knowledge questionnaire about “Pollution” and then responded to the hypertext comprehension questions on that topic. Students were encouraged to apply the digital reading strategies they had learnt during training to perform the task.

-Insert figure 2 here-

**Design**
We used a between subjects factorial design with intervention (EMME or control) as between groups variable, and time of testing (pre-post test) as within variable. Relevant dependent variables included students’ scores in the comprehension questions at pre and post tests, as well as navigation indices. Those included: a) visits to relevant pages (number of visits to pages which included relevant information to answer a particular question, averaged by question), b) visits to irrelevant pages (number of visits to pages which didn’t include relevant information to answer a particular question, averaged by question), c) time in main page (time spend in the main page, averaged by question), d) time in relevant pages (time spend in relevant pages, averaged by question), and e) time in irrelevant pages (time spend in irrelevant pages, averaged by question).

Results

Preliminary analyses

To ensure that groups had comparable characteristics before the instruction, we first compared students’ prior knowledge on the topics used at the hypertext of the pre and post tests (Table 2). Groups didn’t differ in their level of prior knowledge on the topics French Revolution (pre-test): \( t(83)= 1.44, p = .15 \), and Pollution (post-test): \( t< 1 \). In addition, we compared students’ navigation indices and comprehension scores at the pre-test. At that point, groups didn’t differ in their visits to relevant and irrelevant pages (both \( ts < 1 \)), nor in their reading times (main document, relevant pages, and irrelevant pages) (all \( ts < 1.08 \)). Finally, students from the EMME and control groups scored similarly in the comprehension questions at the pre-test, \( t < 1 \).

-Insert table 2 here-
We also performed Pearson correlations between the measures at the pre-test, to confirm the validity of our navigation indices (Table 3). As expected, comprehension scores were positively correlated with time in relevant pages and visits to relevant pages. There was also a lower but significant positive correlation between visits to irrelevant pages and comprehension. Prior knowledge was only related to reading times of the main page. In sum, participants who were more active visiting pages and spending more time in relevant pages scored higher at the comprehension questions at pre-test.

-Insert table 3 here-

**Main analyses**

To control for the potential confounding effects of school and class, we explored the effects of instruction on comprehension and navigation by means of linear mixed models. We included condition (EMME and control) and time (pre-post test) as fixed factors, and school and class as random factors. To test our hypothesis 1, we run a first model with comprehension scores as dependent variable. Results showed non-significant main effects of condition, $F(1, 2.84) = 5.96, p = .10$, and time, $F(1, 156.95) = 1.17, p = .28$, and a significant interaction, $F(1, 156.95) = 4.21, p = .04$. Planned contrasts with Bonferroni correction indicated that students in the EMME and control groups didn’t differ at pre-test ($p = .61$), but they differed at post-test ($p = .02$). Supporting our hypothesis 1, students at the EMME group outperformed those in the control group only at post-test (see descriptive data in Table 2).

To test hypothesis 2 we performed a series of models with the navigation indexes recorded. A model for time in main page showed no main effect of condition, $F(1, 2.84) =$
1.21, \( p = .32 \), and a main effect of time, \( F(1, 156.95) = 19.42, p < .01 \). On average, students in the post-test spend less time reading the main page than in the pre-test (Table 2). This effect was qualified by a significant interaction, \( F(1, 156.95) = 4.00, p = .04 \). Planned contrasts with Bonferroni correction indicated that students in the EMME and control groups didn’t differ at pre-test \( (p = .63) \), but they differed at post-test \( (p = .04) \). Specifically, students at the EMME group spend more time reading the main page than the control group at post-test (Table 2). Follow up linear mixed models with reading times in relevant and irrelevant pages indicated no effects of condition (both \( F \)'s < 1), time \( (F(1, 156.95) = 2.34, p = .13 \) and \( F(1, 156.95) = 1.24, p = .25 \), for relevant and irrelevant pages, respectively), or their interaction \( (F < 1 \) and \( F(1, 156.95) = 1.43, p = .23 \), for relevant and irrelevant pages, respectively). Similarly, linear mixed models for the navigation variable visits to relevant and irrelevant pages indicated no effects of condition \( (F(1, 2.84) = 1.45, p = .27 \) and \( F < 1 \), for relevant and irrelevant visits, respectively), time \( (F(1, 156.95) = 1.51, p = .22 \) and \( F < 1 \), for relevant and irrelevant visits, respectively), or their interaction \( (F < 1 \) and \( F(1, 156.95) = 2.92, p = .09 \), for relevant and irrelevant visits, respectively). In sum, navigation data provide only weak support of our hypothesis 2, as students in the EMMEs condition only differed from the control group in that they spend longer time reading the main Wikipedia document.

**Conclusions**

The present study has tested the effectiveness of an intervention combining EMMEs with contrast-cases scenarios to instruct digital reading strategies to young students. To measure the effectiveness of our program, we have used a methodologically sounding design, including pre-post test and a control group that has received an alternative training.
In addition, we have measured not only students’ performance but also a fine grained analyses of their navigation during the question-answering tasks.

Results from our study confirm that an instruction using EMMEs and contrasting cases can be effectively used to train digital reading strategies. Compared to an instructional control group that uses written case examples, students who work with EMMEs improve their comprehension scores in a post test that used testing materials from a topic different from that used in the instruction, and that was performed one week after the instruction. The visual cues that are provided by EMMEs may serve as an attentional guide to learn the self-regulation strategies modeled, which may ultimately improve students’ comprehension.

Students’ discussion of contrasting case scenarios may have supported students’ identification and elaboration of the strategies. By discussing different cases, students identify what is unique for each strategy, and what is task dependent. This type of processing favors transfer of knowledge, which allows students not only to memorize the strategy, but also to apply it in learning tasks different from the ones used during instruction (Bransford & Schwartz, 1998). This explains how students in the experimental group, who have been trained to use digital reading comprehension strategies in the learning scenario of ‘The French Revolution’ during the first two sessions, could efficiently use such strategies in a different untrained scenario (‘Pollution’) at post-test.

Unexpectedly, EMMEs combined with contrasting cases have a rather modest impact in improving students’ navigation, as captured by our navigation indices. Concurring with prior research (Fessel et al., 2016; Kuo & Hwang, 2008), our instructional
program produce an increase in reading times of the main document during the question-answering task. However, this effect is not selectively manifested in increased times for relevant pages or in decreased times for irrelevant pages. Similarly, EMMEs don’t impact students’ selection of relevant and irrelevant pages by means of text embedded links. Why EMMEs only produce an effect on the reading times in the main page, but not on the visits and times for relevant and irrelevant pages? Previous studies suggest that young students fail to efficiently articulate scanning and deep reading in online question-answering tasks (Salmerón et al., 2017). For example, Kuiper et al. (2008) have found that 5th grader students spend less time reading and more time scanning in complex tasks than in simple fact-finding tasks. EMMEs make an explicit and visually salient argument that reading online requires not only to quickly scanning information, but also a deep and slow reading of the text potentially relevant for the students’ goal. Students in the EMMEs group may have realized that point, as evidenced by the longer reading times in the main Wikipedia document. Other relevant navigation measures, such as visiting relevant pages, or quickly abandoning irrelevant ones, may not be so easily well conveyed in EMMEs. Evaluating the relevance of hyperlinks demands that students engage in inferential processes, to link the currently read information from a main document to the information expected to be found in the linked page (Salmerón, Cañas, Kintsch, & Fajardo, 2005). Two factors may have limited the effect of our intervention. First, mastering these processes may require extensive practice in a long-term intervention (Argelagós & Pifarré, 2012). Second, the format used may not be appropriate in this case. Relevance evaluation processes are modeled in our EMMEs via the audio, which represents the model’s concurrent thoughts (cf. Hagerman, 2017). Previous studies have reported that audios in EMMEs may be even detrimental (van Gog et al., 2009), as students may find it difficult to attend both to the model’s eyes and to
their thoughts, that always come a few seconds after the visual information (as the eyes move faster than the time required to present the modelled thoughts). In sum, modeling thoughts in EMMEs may not be useful to convey abstract processes, such as inference making to evaluate the relevance of hyperlinks.

Limitations and instructional applications

Our study comes with certain limitations. The EMMEs used incorporate both visual cues and audio information, reflecting both where the reader was looking at and what she was thinking at that moment. In future research the effectiveness of EMMEs to foster literacy instruction should be analyzed by assessing individually each component of the EMME, separating the visual information (eye-movements), from verbal information (models’ thoughts) (cf. van Gog et al., 2009). Another element which effect could be explored separately is the formative feedback that students receive after the contrasting cases. Formative feedback has been shown to be a powerful tool to encourage students’ learning and to promote certain strategies by allowing students to compare their performance in a given task with some desired standard of performance (Hattie & Timperley, 2007; Shute, 2008).

Our study adds to the current efforts to extend the use of EMMEs from procedural learning tasks to complex literacy contexts (Mason et al., 2015, 2016). As EMMEs allow conveying reading strategies solely by using visual cues, they may particularly useful to support students that may struggle by receiving instructional information in verbal form. EMMEs could be considered as a complementary technique in existing programs in this learning context, based on other instructional methods such as direct instruction or
scaffolding (Argelagós & Pifarré, 2012; De Vries et al., 2008; Fesel et al., 2016; Kuiper et al., 2008, 2009; Kuo & Hwang, 2008; Walraven et al., 2010). Notwithstanding, this technique not only increases the possibilities of individualization of the task for each student, but also reduces the teacher’s load, as videos can be consulted at any time, and can be seen repeatedly without cost to the teacher. Finally, introducing a video-based instruction allows the school to be brought closer to the real context of the students. As such, implementing EMMEs with contrasting cases in schools might help to decrease the digital divide between the worlds of adolescents in school and outside of it (Buckingham, 2007), which might have positive impacts on general learning motivation and commitment.

**References**


Jarodzka, H., Balslev, T., Holmqvist, K., Nyström, M., Scheiter, K., Gerjets, P., & Eika, B. (2012). Conveying clinical reasoning based on visual observation via eye-


Table 1

*Main characteristics of the previous studies aimed at instructing online reading strategies to young students*

<table>
<thead>
<tr>
<th>Study</th>
<th>Students</th>
<th>Instructional support</th>
<th>Navigation</th>
<th>Comparison</th>
<th>Outcomes for instructional group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuiper, Volman and Terwell (2008)</td>
<td>5th grade</td>
<td>Direct instruction, work in pairs</td>
<td>Task time</td>
<td>No control group or pre-post test.</td>
<td>NA</td>
</tr>
<tr>
<td>Kuiper, Volman and Terwell (2009)</td>
<td>5th grade</td>
<td>Direct instruction, work in pairs</td>
<td>Not reported</td>
<td>Pre-post test, but not control group.</td>
<td>Higher learning of assignments' topic and of web literacy knowledge.</td>
</tr>
<tr>
<td>Kuo and Hwang (2014)</td>
<td>5th grade</td>
<td>Direct instruction</td>
<td>Search and reading time, number of pages visited</td>
<td>Pre-post test, but not control group.</td>
<td>Higher task performance and browsing times.</td>
</tr>
<tr>
<td>De Vries, van der Meij and Lazonder (2008, exp. 2)</td>
<td>5th-6th grade</td>
<td>Scaffold (Support worksheets), work in pairs</td>
<td>Not reported</td>
<td>No control group or pre-post test.</td>
<td>NA</td>
</tr>
<tr>
<td>Walraven, Brand-Gruwel, and Boshuizen (2010) (condition 1).</td>
<td>9th grade</td>
<td>Scaffold (Support worksheets)</td>
<td>Not reported (*)</td>
<td>Pre-post test, but not control group.</td>
<td>Better relevance evaluation of web pages</td>
</tr>
<tr>
<td>Walraven, Brand-Gruwel, and Boshuizen (2010) (condition 2).</td>
<td>9th grade</td>
<td>Scaffold (Mind map)</td>
<td>Not reported (*)</td>
<td>Pre-post test, but not control group.</td>
<td>Better relevance evaluation of web pages</td>
</tr>
<tr>
<td>Argelagós and Pifarré (2012)</td>
<td>7th-8th grade</td>
<td>Scaffold (WebQuest)</td>
<td>Number of relevant/irrelevant pages visited</td>
<td>Pre-post test, control group (no training).</td>
<td>Select more relevant web pages, Score higher in inquiry questions</td>
</tr>
<tr>
<td>Fesel, Segers, De Leeuw, and</td>
<td>6th grade</td>
<td>Scaffold (Mind mapping),</td>
<td>Reading time</td>
<td>Control group (no training).</td>
<td>Higher comprehension and reported strategy use.</td>
</tr>
<tr>
<td>Study</td>
<td>Grade</td>
<td>Intervention</td>
<td>Control Group</td>
<td>Findings</td>
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<tr>
<td>Verhoeven (2016)</td>
<td></td>
<td>modeling, feedback, work in pairs</td>
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<tr>
<td>Kroustallaki, Kokkinaki, Sideridis, and Simos (2015)</td>
<td>5th-6th grade</td>
<td>Modeling (Teacher)</td>
<td>Control group (no training).</td>
<td>More relevant information included in their responses</td>
<td></td>
</tr>
<tr>
<td>Hagerman (2017)</td>
<td>9th grade</td>
<td>Modeling (Video), work in pairs</td>
<td>Control group performed online inquiry tasks without training.</td>
<td>Information from more web pages, and higher integration, in their essays.</td>
<td></td>
</tr>
</tbody>
</table>

(*) Only a small subsample of students used think aloud protocols.
Table 2

Means and standard deviation (in brackets) by condition and time

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
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<th>Post-test</th>
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<tbody>
<tr>
<td></td>
<td>EMME</td>
<td>Control</td>
<td>EMME</td>
<td>Control</td>
</tr>
<tr>
<td>Prior topic knowledge</td>
<td>3.60 (3.57)</td>
<td>2.56 (2.96)</td>
<td>1.43 (2.05)</td>
<td>1.11 (1.38)</td>
</tr>
<tr>
<td>Comprehension scores</td>
<td>4.51 (2.89)</td>
<td>4.31 (3.18)</td>
<td>4.91 (2.82)</td>
<td>3.03 (2.64)</td>
</tr>
<tr>
<td>Visits to relevant pages</td>
<td>0.84 (0.71)</td>
<td>0.79 (.67)</td>
<td>1.02 (0.64)</td>
<td>0.87 (0.66)</td>
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<tr>
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<td>0.85 (0.99)</td>
<td>0.99 (0.94)</td>
<td>1.05 (1.38)</td>
<td>0.62 (0.77)</td>
</tr>
<tr>
<td>Time in main page</td>
<td>74.34 (23.39)</td>
<td>75.96 (29.32)</td>
<td>62.93 (27.26)</td>
<td>50.61 (23.21)</td>
</tr>
<tr>
<td>Time in relevant pages</td>
<td>18.30 (16.87)</td>
<td>17.85 (15.41)</td>
<td>16.98 (13.47)</td>
<td>12.64 (13.81)</td>
</tr>
<tr>
<td>Time in irrelevant pages</td>
<td>9.23 (9.05)</td>
<td>11.66 (10.97)</td>
<td>9.37 (9.99)</td>
<td>8.20 (8.69)</td>
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</table>
Table 3

Zero-order correlations between condition and measured variables in the pre-test

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<th>Variable</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<tr>
<td>2. Comprehension scores</td>
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<td>-</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3. Visits relevant pages</td>
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<td>.80**</td>
<td>-</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4. Visits irrelevant pages</td>
<td>-.03</td>
<td>.24*</td>
<td>.30*</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Time in main page</td>
<td>.30*</td>
<td>.14</td>
<td>.13</td>
<td>.24*</td>
<td>-</td>
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<td></td>
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<tr>
<td>6. Time in relevant pages</td>
<td>.22</td>
<td>.74**</td>
<td>.87**</td>
<td>.24*</td>
<td>.13</td>
<td>-</td>
<td></td>
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<tr>
<td>7. Time in irrelevant pages</td>
<td>.08</td>
<td>.15</td>
<td>.29*</td>
<td>.77*</td>
<td>.25*</td>
<td>.27*</td>
<td>-</td>
</tr>
</tbody>
</table>

Note. *p < .05, **p < .01.
Figure caption

Figure 1. Screen capture of an eye-movement modeling example.

Figure 2. Overview of the procedure used in the study.
Crisis económica

En las primeras etapas de la Revolución, la economía francesa no pasaba por buenos momentos. La normalización del socio era la razón de la situación de la economía rural, sector responsable entonces de dos tercios de la riqueza de Francia. Los años 1787 y 1788 se caracterizaron por desfavorables condiciones meteorológicas que causaron en muchos años una crónica crisis de alimentos, algo común en el antiguo sistema feudal. La escasez de alimentos condujo a una escasez de precios y con esto llegó una grave agitación política y el descenso social de los grupos más desbarajados.

Con todo, muchos historiadores han dado más peso como causa económica de la revolución no a la crisis agraria, sino a la crisis fiscal por la que pasaba el estado francés. Así es sabido que desde hacía años la hacienda francesa era incapaz de recaudar con sus impuestos los cantidades que se gastaban.

Desarrollo de la Revolución

Los Estados Generales

Los Estados Generales eran organismos políticos que representaban por separado a los tres estamentos del Reino: la nobleza, la Iglesia y el pueblo.
<table>
<thead>
<tr>
<th>Session 1</th>
<th>Session 2</th>
<th>Session 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control group</strong></td>
<td><strong>Experimental group</strong></td>
<td><strong>Experimental group</strong></td>
</tr>
<tr>
<td>· Prior knowledge questionnaire on “French Revolution”</td>
<td>· Modelling of self-regulation strategies</td>
<td>· Prior knowledge questionnaire on “Pollution”</td>
</tr>
<tr>
<td>· Hypertext comprehension questions on “French Revolution”</td>
<td>· Text-based contrasting cases</td>
<td>· Hypertext comprehension questions on “Pollution”</td>
</tr>
<tr>
<td></td>
<td>· Formative feedback</td>
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