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 tpes 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).

-Insert figure 1 here-

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 *t*s < 1), nor in their reading times (main document, relevant pages, and irrelevant pages) (all *t*s < 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 Fs < 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

Afflerbach, P., & Cho, B. (2009). Identifying and describing constructively responsive comprehension strategies in new and traditional forms of reading. In S. Israel & G. Duffy (Eds.), *Handbook of reading comprehension research* (pp. 69–90). Mahwah, NJ: Erlbaum.

Argelagós, E., & Pifarré, M. (2012). Improving information problem solving skills in secondary education through embedded instruction. *Computers in Human Behavior, 28*(2), 515–526. doi: 10.1016/j.chb.2011.10.024

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall, Inc.

Braasch, J. L., Bråten, I., Strømsø, H. I., Anmarkrud, Ø., & Ferguson, L. E. (2013). Promoting secondary school students' evaluation of source features of multiple documents. *Contemporary Educational Psychology, 38*(3), 180–195. doi: 10.1016/j.cedpsych.2013.03.003

Bransford, J. & Schwartz, D. (1999). Rethinking transfer: A simple proposal with multiple implications. *Review of Research in Education, 24*, 61–100. Retrieved from: http://journals.sagepub.com/doi/abs/10.3102/0091732X024001061

Brand-Gruwel, S., Wopereis, I., & Walraven, A. (2009). A descriptive model of information problem solving while using internet. *Computers & Education, 53*, 1207–1217. doi: 10.1016/j.compedu.2009.06.004

Beitzel, B. D., & Derry, S. J. (2009). When the book is better than the movie: How contrasting video cases influence learning. *Journal of Educational Computing Research*, 40, 337–355. doi: 10.2190/EC.40.3.e

Buckingham, D. (2007). *Beyond technology: Children's learning in the age of digital culture.* Cambridge: Polity Press.

Coiro, J. (2011). Predicting reading comprehension on the internet contributions of offline reading skills, online reading skills, and prior knowledge. *Journal of Literacy Research*, *43*(4), 352–392. doi: 10.1177/1086296X11421979

Coiro, J., & Dobler, E. (2007). Exploring the online reading comprehension strategies used by sixth-grade skilled readers to search for and locate information on the Internet. *Reading Research Quarterly*, *42*(2), 214–257. doi: 10.1598/RRQ.42.2.2

de Koning, B. B., & Jarodzka, H. (2017). Attention guidance strategies for supporting learning from dynamic visualizations. In R. Lowe & R. Ploetzner (Eds.) *Learning from Dynamic Visualization* (pp. 255–278). Springer International Publishing.

de Vries, B., van der Meij, H., & Lazonder, A. W. (2008). Supporting reflective web searching in elementary schools. *Computers in Human Behavior*, *24*(3), 649–665. doi: 10.1016/j.chb.2007.01.021

Fesel, S. S., Segers, E., De Leeuw, L., & Verhoeven, L. (2016). Strategy training and mind-mapping facilitates children's hypertext comprehension. *Written Language and Literacy, 19*, 131–156. doi: 10.1075/wll.19.2.01fes

Gegenfurtner, A., Lehtinen, E., Jarodzka, H., & Säljö, R. (2017). Effects of eye movement modeling examples on adaptive expertise in medical image diagnosis. *Computers & Education*, *113*, 212–225. doi: 10.1016/j.compedu.2017.06.001

Hagerman, M. S. (2017). Disrupting students' online reading and research habits: The LINKS intervention and its impact on multiple Internet text integration skills. *Journal of Literacy and Technology*, *18*(1), 105–156. Retrieved from: http://www.literacyandtechnology.org/uploads/1/3/6/8/136889/jlt_v18_1_hagerman.pdf

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81–112. doi: 10.3102/003465430298487

Jarodzka, H., Balslev, T., Holmqvist, K., Nyström, M., Scheiter, K., Gerjets, P., & Eika, B. (2012). Conveying clinical reasoning based on visual observation via eye-movement modeling examples. *Instructional Science, 40*(5), 813–827. doi: 10.1007/s11251-012-9218-5

Jarodzka, H., van Gog, T., Dorr, M., Scheiter, K., & Gerjets, P. (2013). Learning to see: Guiding students' attention via a model's eye movements fosters learning. *Learning and Instruction, 25*, 62–70. doi: 10.1016/j.learninstruc.2012.11.004

Kroustallaki, D., Kokkinaki, T., Sideridis, G. D., & Simos, P. G. (2015). Exploring students' affect and achievement goals in the context of an intervention to improve web searching skills. *Computers in Human Behavior, 49,* 156–170. doi: 10.1016/j.chb.2015.02.060

Kuiper, E., Volman, M., & Terwel, J. (2008). Students' use of Web literacy skills and strategies: searching, reading and evaluating Web information. *Information research*, *13*(3), 5. Retrieved from: http://www.informationr.net/ir/13-3/paper351.html

Kuiper, E., Volman, M., & Terwel, J. (2009). Developing Web literacy in collaborative inquiry activities. *Computers & Education*, *52*(3), 668–680. doi: 10.1016/j.compedu.2008.11.010

Kuo, F. R., & Hwang, G. J. (2014). A five-phase learning cycle approach to improving the web-based problem-solving performance of students. *Educational Technology & Society*, *17(1),* 169–184. Retrieved from: http://www.jstor.org/stable/jeductechsoci.17.1.169

López, T. (2003). *Ciencias de la tierra y medioambientales*. Madrid, Spain: Santillana.

Mason, L., Pluchino, P., & Tornatora, M. C. (2016). Using eye-tracking technology as an indirect instruction tool to improve text and picture processing and learning. *British Journal of Educational Technology*, *47*, 1083–1095. doi: doi.org/10.1111/bjet.12271

Mason, L., Pluchino, P., & Tornatora, M. C. (2015). Eye-movement modeling of integrative reading of an illustrated text: Effects on processing and learning. *Contemporary Educational Psychology*, *41*, 172–187. doi: 10.1016/j.cedpsych.2015.01.004

Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in higher education, 31*(2), 199–218. doi: 10.1080/03075070600572090

Organisation for Economic Co-operation and Development (OECD). (2015). Students, Computers and Learning. Making the Connection. OECD Publishing. Retrieved from http://dx.doi.org/10.1787/9789264239555-en.

Rouet, J. F. (2006). *The skills of document use: From text comprehension to Web-based learning*. Mahwah, NJ: Erlbaum.

Salmerón, L., Cañas, J.J., Kintsch, W. & Fajardo, I. (2005). Reading strategies and hypertext comprehension. *Discourse Processes, 40*, 171–191. doi: doi.org/10.1207/s15326950dp4003_1

Salmerón, L., García, A., & Vidal-Abarca, E. (2018). The development of adolescents' comprehension-based Internet reading skills. *Learning and Individual Differences, 61,* 31–39. doi: 10.1016/j.lindif.2017.11.006

Salmerón, L., Strømsø, H. I., Kammerer, Y., Stadtler, M., & van den Broek, P. (in press). Comprehension processes in digital reading. In Paul van den Broek et al. (Eds.) *Learning to read in a digital world.* John Benjamins.

Salmerón, L., Naumann, J., García, V., & Fajardo, I. (2017). Scanning and deep processing of information in hypertext: An eye-tracking and cued retrospective think-aloud study. *Journal of Computer Assisted Learning, 33,* 222–233. doi: 10.1111/jcal.12152

Schwartz, D. L., & Bransford, J. D. (1998). A time for telling. *Cognition & Instruction, 16,* 475–522. doi: 10.1207/s1532690xci1604_4

Segers, E. (in press). Children's hypertext comprehension. In E. Segers & P. van den Broek (Eds). Developmental perspectives in written language and literacy: In honor of Ludo Verhoeven. John Benjamins.

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research, 78*(1), 153–189. doi: 10.3102/0034654307313795

Spires, H. A., Hervey, L. G., Morris, G., & Stelpflug, C. (2012). Energizing project-based inquiry: middle grade students read, write, and create videos. *Journal of Adolescent & Adult Literacy, 55,* 483–493. doi: 10.1002/JAAL.00058

Tapia, J. (2004). *La Revolución Francesa* [The French Revolution]. Retrieved from http://ntic.educacion.es/w3//eos/MaterialesEducativos/bachillerato/historia/revfran/index.htm

Van Gog, T., Jarodzka, H., Scheiter, K., Gerjets, P., & Paas, F. (2009). Attention guidance during example study via the model's eye movements. *Computers in Human Behavior*, *25*(3), 785–791. doi: doi.org/10.1016/j.chb.2009.02.007

Van Gog, T., & Rummel, N. (2010). Example-based learning: Integrating cognitive and social-cognitive research perspectives. *Educational Psychology Review, 22*(2), 155–174. doi: 10.1007/s10648-010-9134-7

Van Marlen, T., van Wermeskerken, M., Jarodzka, H., & van Gog, T. (2016). Showing a model's eye movements in examples does not improve learning of problem-solving tasks. *Computers in Human Behavior*, *65*, 448–459. doi: 10.1016/j.chb.2016.08.041

Walraven, A., Brand-Gruwel, S., & Boshuizen, H. P. (2010). Fostering transfer of web searchers' evaluation skills: A field test of two transfer theories. *Computers in Human Behavior*, *26*(4), 716–728. doi: 10.1016/j.chb.2010.01.008

Table 1

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

Study	Students	Instructional support	Navigation	Comparison	Outcomes for instructional group
Kuiper, Volman and Terwell (2008)	5th grade	Direct instruction, work in pairs	Task time	No control group or pre-post test.	NA
Kuiper, Volman and Terwell (2009)	5th grade	Direct instruction, work in pairs	Not reported	Pre-post test, but not control group.	Higher learning of assignments' topic and of web literacy knowledge.
Kuo and Hwang (2014)	5th grade	Direct instruction	Search and reading time, number of pages visited	Pre-post test, but not control group.	Higher task performance and browsing times.
De Vries, van der Meij and Lazonder (2008, exp. 2)	5th-6th grade	Scaffold (Support worksheets), work in pairs	Not reported	No control group or pre-post test.	NA
Walraven, Brand-Gruwel, and Boshuizen (2010) (condition 1).	9th grade	Scaffold (Support worksheets)	Not reported (*)	Pre-post test, but not control group.	Better relevance evaluation of web pages
Walraven, Brand-Gruwel, and Boshuizen (2010) (condition 2).	9th grade	Scaffold (Mind map)	Not reported (*)	Pre-post test, but not control group.	Better relevance evaluation of web pages
Argelagós and Pifarré (2012)	7th-8th grade	Scaffold (WebQuest)	Number of relevant/irrelevant pages visited	Pre-post test, control group (no training).	Select more relevant web pages, Score higher in inquiry questions
Fesel, Segers, De Leeuw, and	6th grade	Scaffold (Mind mapping),	Reading time	Control group (no training).	Higher comprehension and reported strategy use.

Verhoeven (2016)		modeling, feedback, work in pairs			
Kroustallaki , Kokkinaki, Sideridis, and Simos (2015)	5th-6th grade	Modeling (Teacher)	Not reported	Control group (no training).	More relevant information included in their responses
Hagerman (2017)	9th grade	Modeling (Video), work in pairs	Not reported	Control group performed online inquiry tasks without training.	Information from more web pages, and higher integration, in their essays.

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

Table 2

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

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

Table 3

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

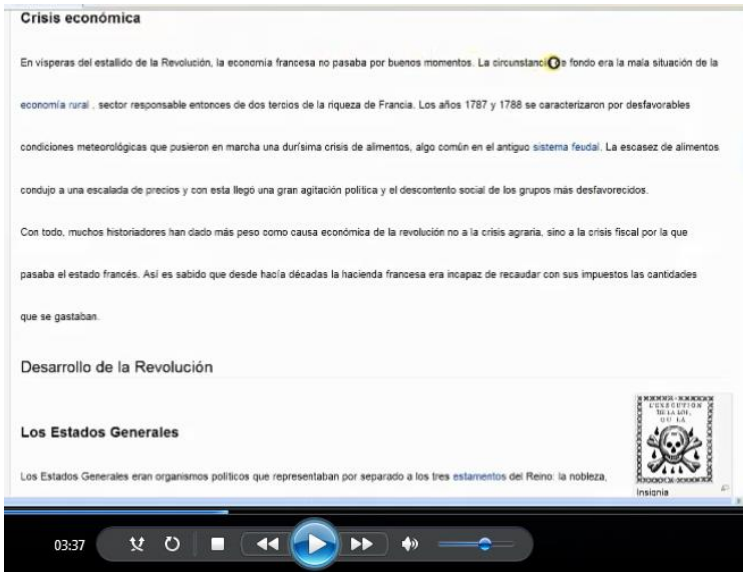
Variable	1	2	3	4	5	6	7
1. Prior topic knowledge	-						
2. Comprehension scores	.09	-					
3. Visits relevant pages	.16	.80**	-				
4. Visits irrelevant pages	-.03	.24*	.30*	-			
5. Time in main page	.30*	.14	.13	.24*	-		
6. Time in relevant pages	.22	.74**	.87**	.24*	.13	-	
7. Time in irrelevant pages	.08	.15	.29*	.77*	.25*	.27*	-

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

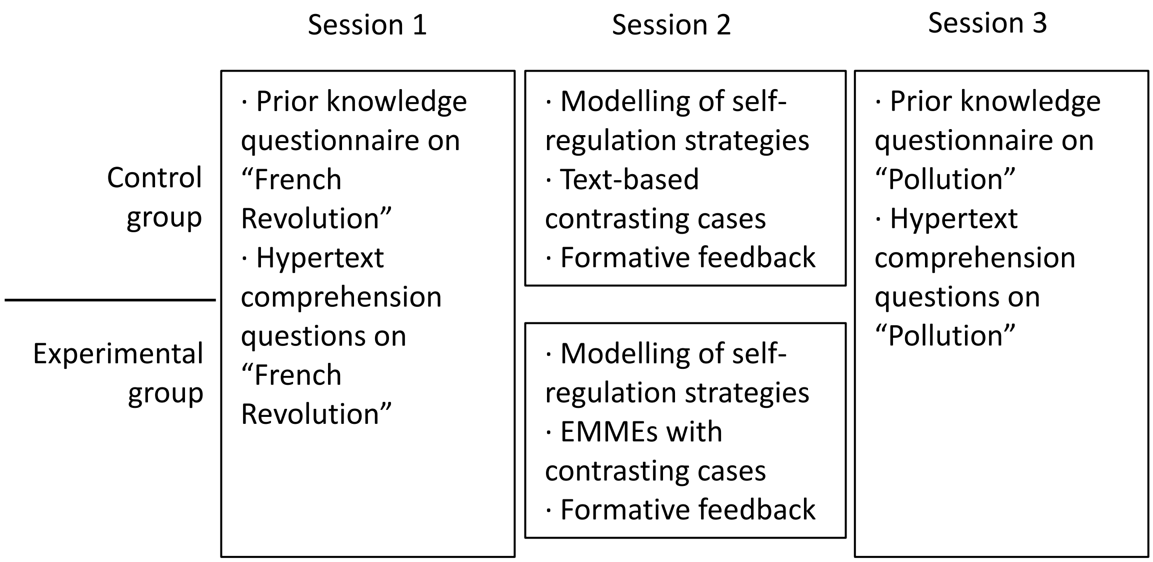
En vísperas del estallido de la Revolución, la economía francesa no pasaba por buenos momentos. La circunstancia de fondo era la mala situación de la economía rural , sector responsable entonces de dos tercios de la riqueza de Francia. Los años 1787 y 1788 se caracterizaron por desfavorables condiciones meteorológicas que pusieron en marcha una durísima crisis de alimentos, algo común en el antiguo sistema feudal. La escasez de alimentos condujo a una escalada de precios y con esta llegó una gran agitación política y el descontento social de los grupos más desfavorecidos.

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 décadas la hacienda francesa era incapaz de recaudar con sus impuestos las 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,


Session 1
Session 2
Session 3
Control group
Experimental group
· Prior knowledge questionnaire on "French Revolution"
· Hypertext comprehension questions on "French Revolution"
· Modelling of self-regulation strategies
· Text-based contrasting cases
· Formative feedback
· Modelling of self-regulation strategies
· EMMEs with contrasting cases
· Formative feedback
· Prior knowledge questionnaire on "Pollution"
· Hypertext comprehension questions on "Pollution"