Instructional effectiveness of a computer-supported program for teaching reading comprehension strategies

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A B S T R A C T

This article examines the effectiveness of a computer-based instructional program (e-PELS) aimed at direct instruction in a collection of reading comprehension strategies. In e-PELS, students learn to highlight and outline expository passages based on various types of text structures (such as comparison or cause-and-effect) as well as to paraphrase, self-question, and summarize. The study involved 1041 fourth-grade elementary students from 21 schools distributed in three regions in central Chile. Participant teachers integrated this program into the Spanish language curriculum, instructing their students during thirty sessions of 90 min each during one school semester. Pretest-to-posttest gains in reading comprehension scores were significantly greater for students instructed with this program than for students who received traditional instruction ($d = .5$), with particularly strong effects for lower-achieving students ($d = .7$). The findings support the efficacy of direct instruction in specific learning strategies in a computer-based environment.

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1. Introduction

This study evaluated the effectiveness of a computer-supported program for teaching reading comprehension strategies. The program included visual cognitive strategies such as highlighting key ideas and using graphic organizers to organize information based on types of text structures, and verbal strategies such as paraphrasing, self-questioning and summarizing. Does direct instruction using a multiple-strategy program embedded in a software application improve reading comprehension? This was the main research question that guided this study. The strategies embedded in the software application were specially developed and selected to meet the curricular standards and requirements of 4th grade elementary students.

2. Strategy-based comprehension instruction

A learning strategy is defined as the set of actions carried out by a learner during learning which are intended to improve knowledge acquisition (Dole, Nokes, & Drits, 2009). Cognitive strategies for reading comprehension support readers' efforts to select, organize, interpret and understand text (Vellutino, 2003). Reading comprehension strategies can be grouped into levels according to the cognitive processes they support. One scheme, proposed by Román and Gallego (1994), includes strategies for information acquisition (e.g., text underlining, text coloring, or reading aloud); for information coding (e.g., self-questioning, paraphrasing, sequencing, diagrams, conceptual maps, or graphic organizers); for information retrieval (e.g., mental imaging, abstracting, or problem solving); and for information processing support (e.g., making schedules or forming study groups). In the SOI model, Mayer (2008) suggests that learning strategies can be classified in terms of three different cognitive processes: select — paying attention to relevant information; organize — building a coherent structure; and integrate — connecting incoming information with existing relevant knowledge activated from long-term memory.

Reviews of research on cognitive strategy instruction indicate that there is sufficient research evidence to encourage the idea that cognitive and metacognitive strategies can improve reading comprehension and that they can be taught effectively (Mayer, 2008; Pressley & Woloshyn, 1995; Vellutino, 2003). A research study by the RAND Reading Study Group (RAND, 2002) in the United States summarized a series of findings on what works for comprehension instruction. The following findings were particularly relevant for the present study: (1) Enhancing reading fluency has a significant effect on word recognition but moderate effect on reading comprehension. (2) Instruction on specific learning strategies and monitoring mechanisms has proved effective in fostering reading comprehension. (3) Low-achieving students benefit particularly from explicit teaching of comprehension strategies. (4) Curricular integration of comprehension strategies into specific content domains, such as history and science, further develop reading comprehension. (5) Finally, teachers should dedicate more time and offer more support to students in the classroom, particularly in primary and upper elementary grades, to teach specific reading comprehension strategies.

Focusing specifically on reading comprehension instruction and its relation with learning strategies, Raphael, George, Weber, and Nies (2009) reviewed research since 1980s, separating research on instructional approaches in three main stages: (1) individual strategy research, (2) frameworks for multiple strategies, and (3) coherence in comprehension instruction. The first stage had its origins in research carried out during the 1980s and early 1990s. This brought together cognitive psychologists, educators, linguistics and others interested in cognitive mechanisms to improve reading comprehension. The second stage had its origins in research on individual strategies, but investigating sophisticated models that integrate multiple comprehension strategies. The third and current stage, according to these authors, has focused on research whose object of study has moved beyond the individual classroom, integrating networks of teachers within schools or groups of schools. It examines coherence in literacy curriculum, studying factors, and conditions and processes that make a literacy program successful.

Research on teaching individual strategies has focused mainly on identifying those strategies that proficient readers use, on how to teach and evaluate those strategies, and their impact on reading comprehension (Raphael et al., 2009). A research survey by the National Reading Panel (2000) in the United States identified the following single strategies that seem to be effective and show potential as teaching methods: metacognitive mechanisms for comprehension, collaborative learning, graphic organizers, questioning, and summarizing. On the other hand, research on multiple-strategy instruction has built on research on individual strategies but also considers that learning takes place in complex settings, and that knowledge is socially constructed, dialogical and interactive in nature (Raphael et al., 2009). Consequently, the approaches or frameworks developed during this stage sought to integrate different individual strategies to improve reading comprehension in classroom activity settings. Some well-known and researched multiple-strategy approaches are Reciprocal Teaching (Palincsar & Brown, 1984), Concept-oriented Reading Instruction (Guthrie et al., 2004), Survey, Question, Read, Recite and Review (McDaniel, Howard, & Einstein, 2009) and collaborative reasoning (Clark et al., 2003).

In general, empirical evidence demonstrates that multiple-strategy instruction integrated into the curriculum can work well in schools and can improve reading comprehension over students instructed with traditional methods (RAND, 2002). For example, in a review of 16 studies on reciprocal teaching, Rosenshine and Meister (1994) concluded that this approach enhances reading comprehension, with significant score gains by students trained with reciprocal teaching. In the case of collaborative reasoning, Reznitskaya et al. (2009) studied the effects of this approach on the distribution of participation, student argumentation quality, use of rhetorical moves and their impact on argument construction, and variety of questions used by students; they found improvement in argumentative and communication skills. Finally, regarding concept-oriented reading instruction, in several quasi-experimental studies; the conclusion was that the experimental groups in comparison with the control groups achieved a significant gain in reading comprehension (Guthrie et al., 2004; Guthrie et al., 2009).

3. E-PELS: a multiple-strategy instruction program for reading comprehension

An important new issue addressed in this study concerns whether cognitive strategies for reading comprehension can be taught effectively within a computer-based system that systematically uses direct instruction and practice. The computer-supported multiple-strategy program was named e-PELS ("Programa de Entrenamiento en Lectura Significativa" or "Program in Deep Reading Comprehension"). The basic idea to develop e-PELS was taken from Román (2004) who designed a paper-based instruction program in reading comprehension built upon a set of information processing learning strategies that included underlining, paraphrasing, self-questioning, text structure and conceptual maps. Based on this idea, we developed a software application that embedded similar strategies, but replaced conceptual mapping by the use of interactive graphic organizers; additionally, we included summarizing and conceptualizing strategies. This new application took advantage of our previous work on the development of interactive graphic organizers. A first version of e-PELS was developed with a more primitive interface than the one used in this study and tested with a small group of fourth-grade students.

The following three figures show e-PELS in use. The instructional activities encouraged teachers and their students to work on each strategy sequentially and systematically with different short texts. In general, they started by reading the text on the computer screen or projected on the whiteboard when a data projector was in use. Thirty short texts were provided with e-PELS, but teachers were free to incorporate new ones. If some words were not understood, teachers used the word-box functionality to define the respective word in a dialogical process, asking students to derive its classification (e.g., verb or adjective), its synonyms, examples and the best definition found in a dictionary. Following this process, students were asked to highlight key ideas and use them to paraphrase the original text, as illustrated in Fig. 1. Next, students worked on identifying the type of text at hand (i.e., narrative, informative, news and poems) by choosing and completing the visual schemes provided (see Fig. 2). After they have finished with this strategy, students were asked by their teachers to choose one or two graphic organizers to identify the main arguments in the text, by using cause-and-effect relationship, comparison-and-contrast, sequence or pro-and-con structures (see Fig. 3). Naturally, this process took more than one class, and this is the main reason to have allocated thirty 90-min sessions to work on all strategies during one school semester, as indicated in Table 2

Fig. 2 shows the text structure strategy being used; in this case, the structure corresponds to an informative text. E-PELS provides four different text structures that can be used according to the type of text being analyzed in a learning activity.

Fig. 3 shows a differences and similarities interactive graphic organizer that has been completed for the organization of ideas and arguments from a written text. In the large vertical rectangles, the two elements under comparison must be written (e.g., butterflies and