Review

A review of using eye-tracking technology in exploring learning from 2000 to 2012

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ABSTRACT

This study aims to disclose how eye-tracking technology has been applied to studies of learning, and what eye movement measures have been used for investigations by reviewing studies that have employed the eye-tracking approach. A total of 81 papers including 113 studies were selected from the Social Sciences Citation Index database from 2000 to 2012. Content analysis showed that eye movements and learning were studied under the following seven themes: patterns of information processing, effects of instructional design, reexamination of existing theories, individual differences, effects of learning strategies, patterns of decision making, and conceptual development. As for eye-tracking measurements, the most often used indices were temporal measures, followed by count and spatial measures, although the choice of measures was often motivated by the specific research question. Research development trends show that the use of the eye-tracking method has proliferated recently. This study concludes that the eye-tracking method provides a promising channel for educational researchers to connect learning outcomes to cognitive processes.

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Contents

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1. Introduction

In educational research, a considerable number of studies have been devoted to the processes and outcomes of learning (e.g., Posner, Strike, Hewson, & Gertzog, 1982; Schnotz, Vosniadou, & Carretero, 1999). Traditionally, the interview procedure based on the think-aloud protocol has been the most important and frequently used technique to probe cognitive activities during learning (LeCompte & Preissle, 1993; Mintzes, Wandersee, & Novak, 1999). However, such a method often suffers from validity issues. For this reason, educational researchers are seeking various research methods developed in different academic domains in the hope of presenting the process of learning from different angles (Anderson, 2007). Among various techniques, the eye tracking method, which has been intensively used by psychologists to study basic cognitive processes during reading and other types of information processing (Rayner, 1998, 2009), has just started to attract attention from educators in recent years. This method is valuable due to its capacity to recode online cognitive activities, and therefore, it is certainly a promising tool for tracking the cognitive process of learning.

As mentioned, the use of eye tracking technology in educational research has been growing in recent years, but most studies have been conducted in psychology related fields. Consequently, what learning issues have been explored by the technology, and how different eye movement measures can inform us about cognitive activities during learning are still not easily assessable by educators. A systematic analysis of the eye movement studies related to learning would allow educators to better understand how the eye tracking technology could be and has been used. Therefore, in the current work, by carrying out an extensive literature review, we have made an attempt to examine how the eye movement studies in psychology are related to studies of learning in the domain of education. A bridging framework is then established to illustrate the relationship.

2. Literature review

2.1. Learning & cognitive development

The paradigm shifts in the theories of learning, moving from behaviorism emphasizing observable behaviors to cognitive perspectives embracing mental activities, have had a tremendous influence on educational practice. Early cognitive psychologists such as Piaget and Vygotsky proposed that cognitive development undergoes active changes in cognitive structures. Based on such a viewpoint, learning is thought to bring about cognitive development (e.g., Ginsburg & Opper, 1988; Phillips & Soltis, 2009). The cognitive position on learning is further strengthened by many modern neurocognitive studies showing the flexibility of the human brain, and the effect of learning on the change in brain structure (e.g., Galván, 2010; Goswami, 2008; Lee et al., 2010). In sum, supported by both cognitive and neurocognitive studies, learning manifests itself in not only the acquisition of new information, but also the development of perception, social cognition, language, mathematical thinking, causal/scientific reasoning, psychomotor skills, problem solving skills and strategies, and conceptual knowledge (Anderson, 2009; Goswami, 2008). Accordingly, when learning becomes a subject to be examined, one may find that the foci of discussions are actually related to different aspects of human cognitive development. For that reason, the topics of learning discussed in this review study include various aspects of cognitive development as defined previously.