The Effectiveness of a Metacognitive Strategy during the Learning Process on Subject Matter Retention, Visual Attention, and Cognitive Allocation

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Introduction

A primary interest of teaching metacognitive strategies is to improve reading comprehension (Baker, 2002; 2008). Metacognition is an information process defined as "cognition about cognition' or 'thinking about thinking" (Flavell, 1979, p. 906). Practicing metacognitive reading strategies can positively change students' learning performance (Block & Parris, 2008; Peirce, 2003). Metacognition is an unobservable complex construct involved in an individual's affective and motivational states (Lai, 2011; Schraw & Moshman, 1995). Learners may not be easily aware of their cognitive knowledge and learning process monitoring, which results in difficulties to reflect the actual behavior during cognitive process without precise measurements (Veenman, Prins, & Verheij, 2003). Thus, assessment of metacognition has been a challenge for psychologists and educators.

Eye-tracking technology has been extensively used to explore moment to moment cognitive processes in reading comprehension (Raney, Campbell, & Bovee, 2014; Rayner & Raney, 1996). Measuring eye movement behaviors is one of the most precise methods to understand cognitive process (Rayner & Raney, 1996). Eye movement behaviors, such as fixation duration and fixation counts, can provide important evidence to reflect the cognitive process in a natural reading environment (Brunyé, Drew, Weaver, & Elmore, 2019). Recording eye movement behaviors can directly reflect the cognitive process involved in reading comprehension (Mason, Pluchino, & Tornatora, 2015).

The Survey, Question, Read, Respond, Recite, Record, and Review (SQ5R) strategy is a metacognitive activity that was proposed by Pauk (1984). The SQ5R strategy is purportedly an effective reading comprehension strategy (Lapp & Flood, 1986; Silberstein, 1994). Utilizing SQ5R can help learners become aware of learning and enhance the user's ability to monitor their behavior, and ultimately reach higher levels of thinking (Sangcharoon; 2010). However, there is a lack of evidence exploring the effectiveness of SQ5R metacognitive strategy through the use of eye-tracking measurements.

Purposes and Objectives

The purpose of this research was to investigate the effectiveness of a metacognitive strategy (SQ5R) based on the eye-movement reading behaviors during the learning process. Specifically, this experiment was to compare differences in eye-movement behaviors (fixation duration, fixation counts, and fixation duration percentage) before and after watching SQ5R metacognitive strategies video.

Theoretical Framework

This research was guided by the information processing theory. Miller (1956) used short-term memory and long-term memory to describe the information process. Short-term memory is fundamental cognitive processing of holding chunks of information (Miller, 1956). By utilizing metacognitive strategies, learners could store a portion of information into their long-term memory (Rayner, Pollatsek, Ashby, & Clifton, 2012). By implementing the information processing theory, the evidence of metacognitive information processing benefits were described in this research.

Methods

This quasi-experimental study involved a pre-test and a post-test of students at Texas Tech University Fall 2018. Participants read four passages (mitosis, meiosis, tracheophytes, and

bryophytes) presented on a computer monitor while their eye movements were recorded by Tobii Pro Eye-tracker software. Forty participants (N=40) were randomly assigned to a specific combination of two different reading passages. The intervention was a video that discussed how to use the SQ5R metacognitive strategy. Within the design, participants experienced eye-calibration, reading passage one, taking the pre-test, watching the intervention video, reading passage two, and taking the post-test. Key elements in each passages were identified as areas of interests (AOIs). The operational measures of visual attention and cognitive allocation were the average of fixation durations and average of fixation counts on AOIs of each passages. Fixations were operationalized as "eye movements that stabilize the retina over a stationary object of interest" (Duchowski, 2007, p. 46). Fixation duration was the time that participants' spent fixated on AIOs. Fixation count was the number of fixations on AIOs. Fixation duration percentage means were the period of time on AOIs account for the time period on the entire passage. Paired t-tests were conducted to examine the differences in participants' eye-movement behaviors (average fixation duration, fixation frequencies, and fixation duration percentage) before and after watching the SQ5R metacognitive strategies video.

Results

The results of pre-test and post-test scores indicated that students retained more information after they had been taught the SQ5R metacognitive strategy. The average of pre-test scores was 22.79 out of 100 points (M = 22.79; SD = 26.94), the average of post-test scores was 54.35 out of 100 points (M = 54.35, SD = 32.34). There was a significant difference between pre-test and post-test scores, $t_{(39)}$ =-4.67, p<.05. Students spent more time (in seconds) on the second passage (M =141.92, SD = 63.69) processing information after the intervention compared to the first passage (M =71.95, SD=22.30). There was a significant differences of average fixation duration (Seconds) on AOIs, $t_{(39)}$ =-3.91, p<.05, before intervention (M = 6.64, SD = 3.29) and after the intervention (M =10.79, SD = 6.65). The average fixation counts (frequencies) before the intervention was 28.03 (SD = 11.38), after the intervention, the average of fixation counts was 52.03 (SD = 39.36); there was a significant difference between them, $t_{(39)}$ =-4.94, p<.05. The fixation duration percentage on AOIs before the intervention was 11.35%, which increased to 19.86% after watching the video. Students spent more time on the second passage on both AOIs and entire passage, which indicated that students spent more time using the SQ5R strategy and retained more information.

Conclusions and Recommendations

In conclusion, students spent more time on the key elements of the passage (AOIs) to process information in deep levels after they watched the SQ5R metacognitive strategies video. This study provided the evidence of effectiveness of the SQ5R upon students' reading comprehension improvement. If students can be trained with metacognitive strategies, they will apply the reading strategies in their learning process to improve their performance. This study contributes relevant insights into the importance of metacognitive strategies and their relationships to reading comprehension. Given the role eye-tracking might play in future research developments on education instruction, researchers should utilize the records of eye-movements to better design instructional materials or procedures to increase reading comprehension. We believe future educators should adopt more metacognitive strategies to improve instructional effectiveness as reading is fundamental to learning.

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