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Effects of integrating dynamic concept maps with Interactive Response System on elementary school students' motivation and learning outcome: The case of anti-phishing education

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ABSTRACT

This study aimed to investigate the effects of integrating dynamic concept maps with Interactive Response System (IRS) on elementary school students' motivation and anti-phishing learning outcome. In the quasi-experimental design employed, 130 fifth-grade students were divided into three groups: the control group (traditional image-text), experimental group I (static concept maps), and experimental group II (dynamic concept maps). The results showed that the use of dynamic concept maps with IRS during anti-phishing education significantly increased students' learning self-efficacy when their initial self-efficacy was already high. For learners with low initial self-efficacy, the use of traditional image-text with IRS helped increase post-test self-efficacy. Learners' achievement in the dynamic concept maps group was significantly higher than that of the traditional image-text group. The findings suggest that the use of dynamic concept maps with IRS in the classroom has a positive impact on students' learning process. In addition, when implementing such strategies, it is important to consider students' initial self-efficacy.

1. Introduction

1.1. Concept map and Interactive Response System (IRS)

In the learning process, the provision of a learning framework can help students understand contents; if such a framework can also organize and integrate knowledge, it could further promote more meaningful learning. David Paul Ausubel (2000) suggested that meaningful knowledge can assist in problem solving and reflection, as the meaning of learning is formed by connecting the acquired knowledge with past experience. When the two cannot be connected, teachers might assist learners by providing a simple conceptual framework (David P Ausubel & Fitzgerald, 1961). “Concept maps” are knowledge maps constructed through the logical and systematic summarization and organization of complex knowledge. “Concept” refers to perceived regularities or records, which can be labeled with words or signs (e.g., +, -) (Novak, 1990). Concept maps are comprised of boxes (concepts) connected with labeled arcs, representing the relationships (i.e., propositions or node-link-node triads) between different concepts (Safayeni, Derbentseva, & Cañas, 2005). When learners try to understand concept

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maps, they need to identify first the top-tier concept node and then connect it to the meaning of various nodes below (Blankenship & Dansereau, 2000; Novak, 1990). Concept maps are visual representations formed by integrating texts and images; they are capable of promoting understanding during the learning process (Richard E. Mayer & Moreno, 2003). In presenting the sequence of concepts and the relation among structures and hierarchies using meaningful narrative methods (Novak, 1984, 1990; Safayeni et al., 2005), concept maps can therefore promote meaningful learning (Novak, 2010; Stoica, Moraru, & Miron, 2011; Taşkin, Pepe, Taşkin, Gevat, & Taşkin, 2011).

However, learners who have not used concept maps might have difficulty in understanding them, which can subsequently affect their learning motivation (Blankenship & Dansereau, 2000; Tsai, Lin, & Yuan, 2001). Chandler and Sweller (1992) pointed out that the split-attention effect in reading materials should be considered. In other words, educators should prevent learners from focusing their attention on the search and organization of information. Meanwhile, the use of concept maps should be combined with appropriate teaching/learning strategies.

To design concept maps with greater support features, researchers started integrating them with different guiding methods to assist learners in consolidating their knowledge structure. Examples include using directional arrows to show the learning sequence (Cañas & Novak, 2010) and the step-by-step guiding method for representing maps in sequence (Jamet, Gavota, & Quaireau, 2008). Nesbit and Adesope (2005) reported that using methods with clear visual cues or guiding effects can help learners new to concept maps understand their meaning; they can also assist students with low learning achievement in organizing and consolidating knowledge.

Therefore, the present study proposes that concept maps in educational materials should have clear “visual guiding effects” that can reduce learners’ split-attention effect during the reading process. Given the above, to assist learners in synchronized integration of concept maps and node information to achieve meaningful learning (Chandler & Sweller, 1992) and learning outcomes (Nesbit & Adesope, 2005), we used dynamic concept maps, where the initial representation of a single concept node or connecting line for visual guidance is followed by a gradual representation of the entire concept map through superposition.

The Interactive Response System (IRS) is a learner-centered interactive teaching/learning technology. It is a small-scale, portable electronic voting device that learners can use to answer on-screen multiple-choice questions (MCQs) shown by their teachers. The IRS is an anonymous voting tool used in class (Nocente & Belostotski, 2009) that makes use of infrared or radio frequency (RF) wireless communication technologies to transmit students' answers to the USB receivers on teachers' computers; the class's answer distribution is then displayed through the computer's projector. Richard E Mayer (2001) pointed out that combining teaching/learning strategies with appropriate teaching technologies could enhance learners' attention span. Richard E Mayer et al. (2009) later highlighted that learners are more reluctant to work if they are not immersed in the learning environment, particularly when understanding learning materials and classroom tests. Studies have confirmed IRS′ positive effects on learning, which includes enhancing learning commitment (Hoekstra, 2008), stimulating learning interest (Prather & Brissenden, 2009), and maintaining learning attention (Lantz & Stawiski, 2014).

Concept maps have been applied widely in practical teaching. In classroom environments, concept maps are often used as a teaching/learning strategy, whereby after the content has been taught, concept maps are designed to guide learners to draw concept maps, followed by practice drawing and evaluation of the correctness of the maps (Chiou, 2008; Redford, Thiede, Wiley, & Griffin, 2012). In online learning environments, concept maps are more often used as learning tasks. For example, after acquiring the knowledge in class, learners may use the online learning system to create concept maps and thus consolidate their understanding as well as develop problem-solving capabilities (Hwang, Kuo, Chen, & Ho, 2014); alternatively, learners may complete their learning tasks by voluntarily constructing concept maps through online games (Charsky & Ressler, 2011). In terms of integrating concept maps with teaching/learning technologies, systems have been developed with concept map functions for mobile devices, where learners can use mobile devices to construct concept maps during class activities (e.g., outdoor butterfly watching), thus addressing gaps in the application of concept maps (Hwang, Shi, & Chu, 2011; Hwang, Wu, & Ke, 2011). The learning effects of integrating dynamic concept maps with IRS have been investigated (Chen & Sun, 2014). The current research proposes that although using dynamic concept maps marginally reduces the split-attention effect, combining the maps with appropriate IRS could help learners become more interested in learning activities. Therefore, the present work aimed to help learners better understand the knowledge concept framework related to their questions by presenting dynamic concept map voting questions through IRS in classrooms, to reduce the split-attention effect while helping learners focus on the learning environment for optimal effectiveness.

1.2. Effects of concept maps and IRS on learning motivation and achievement

Pintrich and De Groot (1990) proposed that learning motivation can be examined from three perspectives, namely, expectancy, value, and affective components. As students' beliefs about learning efficacy significantly determine their learning performance, and influence their confidence that tasks will be completed and that they have the necessary capabilities to complete them (Wigfield & Eccles, 1992), the present study investigated learning motivation from the perspectives of intrinsic value beliefs and self-efficacy. Self-efficacy denotes individuals' confidence in their own problem-solving and task completion capabilities. It comprises result expectation and efficacy expectation (Bandura, 1977); the former is the belief that certain behaviors ensure certain results, whereas the latter is the belief in oneself to complete those behaviors and obtain those results. Further, intrinsic value belief is at the level of devotion and interest in individuals when they perform a task (Pintrich & De Groot, 1990; Wigfield & Eccles, 1992). Learners’ relevant past experiences can affect their intrinsic value beliefs