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Effects of an online problem based learning course on content knowledge acquisition and critical thinking skills ☆

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ABSTRACT

This study investigated how the online problem based learning (PBL) approach employed in an online learning environment influenced undergraduate students' critical thinking skills (CTS) and content knowledge acquisition. The pretest–posttest control group design was used in the study. The subjects included the students who were enrolled at the Department of Primary School Mathematics Teaching in Anadolu University Education Faculty. Subjects attended to Computer II course in 2008 spring. Experiment group attended the online PBL course whereas the control group attended the online instructor-led course. Each group consisted of 20 students. Data collection tools consisted of a multiple choice content knowledge acquisition scale and the Watson–Glaser critical thinking skills test. The results of two-way mixed design ANOVA indicated that learning in the online PBL group did not have a significant effect on the content knowledge acquisition scores. It was also revealed that learning in the online PBL group had a significant effect on increasing the critical thinking skills.

1. Introduction

Today's working conditions have required fundamental changes in the profiles of work power, which basically stemmed from the rapid change and transformation in the nature of information. For societies to survive in this competitive world, they need to equip individuals with skills to conduct research, use and transform information, think critically and reflectively, and make higher order decisions. In addition, technological changes along with the changes in the workplace have made critical thinking abilities more important than ever before. In this regard, the instruction designed to assist students' critical thinking focuses on skills that are applicable across different domains of knowledge and the disposition to use these skills (Halpern, 1999). The report of the National Commission on Excellence in Education, A Nation at Risk (1983) sounded an alarm regarding insufficient and ineffective attempts to foster higher order thinking skills in schools including critical thinking and problem solving. The Secretary's Commission on Achieving Necessary Skills (1991) regarded higher order thinking competencies as complementary for productive workplaces including critical thinking, decision making, problem solving and reasoning. In short, the ability to understand and use information is emphasized rather than merely possessing it (Richardson, 2003). In this respect, it is crucial for teacher candidates to have these higher order thinking and problem solving skills along with the ability to cooperate and work effectively within a team. Thus, integration of constructivist approaches such as problem based learning (PBL) into the instructional endeavors carries utmost importance (Yaşar, 1998), as constructivism represents how people deal with real-life problems in society by working with peers to make effective thoughtful decisions, take the initiative and solve problems (Jonassen, 1997).

1.1. Problem based learning (PBL)

Different definitions of PBL in the literature address three basic principles to differentiate PBL settings from those that are not implementing the PBL. First, it is necessary to have a problem to trigger learning. Second, PBL is not an instructional technique in isolation; rather, it is a holistic approach involving interaction of several learning approaches and methods. Third, PBL is almost always

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student-centered. These principles offer the opportunities to actively process information, trigger prior knowledge, have a meaningful content, and research and organize information (Kocaman, Okumuş, & Bahar, 2003).

PBL is based on several learning approaches. For instance, Schmidt (1993) maintains that PBL is based on information processing theory, in which learning requires learners to participate actively in the process of retrieving, constructing, and using information; and relate new information with their prior knowledge. Norman and Schmidt (2000) explain PBL through a constructivist viewpoint where information is acquired and general principles are learnt during problem solving practices to be used for similar future problems. Hoffman and Ritchie (1997) consider PBL as 'a student-centered strategy that has significant contextualized, real-world, ill-structured situations while providing resources, guidance, instruction and opportunities for reflection to learners as they develop content knowledge and problem solving skills' (p. 97). As indicated in the definition, students have an active role in solving a real-life problem. Learning occurs when learners reflect on their learning, while instructors serve as guides and facilitators. In this respect, instructors do never offer the ready response for a problem (Barrows, 1996; Gallagher, 1997; Stepien, Gallagher, & Workman, 1993). They have a direct influence on the success of the process. More specifically, they exert the direct influence to attract students' attention whereas they have an indirect influence in increasing achievement (Dolmans, Wolfhagen, & Scmidt, 1994). Proficiency in providing guidance carries utmost importance in this regard. While providing guidance and facilitating the process, they are supposed to sustain the functionality of the group and lead the group to learning objectives (Abacıoğlu, 1998).

PBL activities are designed in a way that is possible for instructors to offer guidance for ill-structured and complicated problems (Gallagher, Stepien, & Rosenthal, 1992). Such problems require learners to adopt higher order thinking skills such as critical thinking. Barrows (1985) summarizes the features of ill-structured problems. First of all, sufficient information to understand the problem is more than the information provided in the problem situation. Second, new information about the problem situation can change the definition of the problem. Third, different perspectives are necessary to interpret information. Finally, there is no definite and single solution for the problem.

Ill-structured problems are similar to those that learners are supposed to solve in their real lives in which the definition of the problem is not clear and some features of the problem are not provided. Particularly the information directing learners to the solution is not provided within the problem situation. Since they are not limited to common classroom situations, the solutions are not predictable. Moreover, resorting to different disciplines can be necessary to solve the problem. As they are similar to real-life problems, student motivation is generally high (Jonassen, 1997).

It has been maintained in the literature that PBL positively influence learning outcomes along with learners' higher order thinking skills such as creative thinking, problem solving, logical thinking and decision making. For instance, Elshafei (1999) compared the Calculus achievement levels of second graders in five different high schools and 15 different classes where PBL and traditional instructional methods were implemented. Findings indicated that students in PBL settings did prefer this method and had higher levels of achievement. In addition, it was revealed that students in PBL settings had better solutions for given problems in comparison to those who were in traditional classroom settings. Kaptan and Korkmaz (2000) investigated the influence of PBL on problem solving skills and self-efficacy levels of in-service teachers. Findings revealed that the experimental group which was exposed to fundamental science activities through PBL had higher self-efficacy and logical thinking scores than the control group. Deveci (2002) explored the influences of PBL in social science classes on students' attitudes, achievement levels and retention grades all of which were found to be higher in PBL settings. Yaman and Yalçın (2005) investigated the effects of PBL on creative thinking skills of teacher training students through a pretest–posttest control group design, which revealed that the PBL group had higher scores in creative thinking measures in comparison to the control group. Similar to above studies, several researchers claimed that PBL had a positive influence on problem solving and critical thinking skills (Gallagher, 1997; Hmelo, 1998).

1.2. Critical thinking skills (CTS)

Critical thinking has been the focus of several current implementations in educational settings. Thinking is based on relating and drawing conclusions on notions and events, and involves a variety of different cognitive processes such as implicating, problem solving, examining, reflecting and criticizing. Thinking begins with a physical or psychological inconvenience stemming from lacking the solution for a problem whose solution becomes the objective for an individual. Higher order thinking skills like critical thinking, creative thinking and problem solving are considered necessary skills for 21st-century individuals. Thus, it is necessary to examine these notions objectively, scrutinize on the contents of these skills, and elaborate on the ways to equip individuals with such skills. Problem solving involves cognitive, sensory and psychomotor domains which helps instructors to resort to a large variety of contexts and materials. However, it was maintained that the most valid and reliable way to equip individuals with problem solving skills is to integrate it with creative thinking and decision making (Kalaycı, 2001).

As a non-controversial claim, critical thinking entails awareness of one's own thinking and reflection on the thinking of the self and others. In this regard, metacognition is defined as thinking about thinking, a skill originating early in life when children first become aware of the mind. However, metacognition does not always develop to the extent that we would like (Kuhn & Dean, 2004). The construct of metacognition can be examined within a developmental framework during which the metacognitive skills become more powerful and effective gradually as they operate increasingly under individuals' conscious control. Thus, improving metacognitive awareness of what to believe and how to know; and employing metacognitive control on information processing strategies are important developmental and educational goals.

Critical thinking involves critical implication and discussion, which has a crucial role in activating problem solving and decision making processes (Chaffee, 1994). Critical thinking is a constructivist analysis process to examine what is going on in our environments. This analysis system can be used to define problems, take actions towards an aim, make decisions and conduct retrospective evaluations. In order to define, describe, measure and evaluate the critical thinking process, it is necessary to understand indicators of CTS. Several researchers provided the literature with comprehensive classifications in this regard. For instance, the Watson–Glaser classification of CTS involves defining a problem, determining possible solutions and strong assumptions, drawing valid conclusions regarding the solution and evaluation these conclusions (Demirtaşlı-Çıkrıkçı, 1996; Kaya, 1997). Such skills are

- Inference: Defining a problem involves selecting the most appropriate information piece leading to the solution. Making decisions regarding the credibility of assumptions based on the information provided within a text is an inference process.