Creative and Critical Thinking Skills in Problem-based Learning Environments

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Abstract
Creative and critical thinking skills are the abilities, which can sometimes be used interchangeably in definition. In fact, they have different constructs because they differentiate in outcome of human behaviours. Also one of today's requirements is that individuals should approach everyday problems by using both competences. So, one of the helpful tool for development of creativity and critical thinking skills proposed is problem-based learning environments in classrooms. In this study, problem based approach including philosophy; general characteristics of it, role of teachers and students in problem-based learning environment, and its uniqueness over other learning approaches is explained by considering advantages and limitations. Then, problem-based learning is discussed with regard to instructional design perspective in a scientific manner. Finally, the study is aimed to explain when PBL grounded in development of instructional strategy as a fruitful approach; instructional strategies, methods and techniques are differentiated in creativity and critical thinking skills.

Keywords
problem-based learning, creative thinking, critical thinking, instructional design

Nowadays, the main point of education is not to teach reading, writing or arithmetic, but it is to teach how to use thinking skills such as not only creativity

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(Rhodes, 1961; Runco, 2014), but also qualified problem solving skills (Segal, Chipman & Glaser, 1985), scientific and technological literacy skills (Lawless & Brown, 2015; Tortop, 2013) because these are the skills that are required for sustainability and lifelong education in addition to basic education. So these skills should be reflected on educational programs implementing for gifted and average ability students. In the lifelong process, it is possible to say that learners are faced with many real life problems (Augustine, 2011; Maker, 1982; Tortop, 2013). The goal is to guide learners to become skilled in acquiring application qualification.

Many learners have not grasped the meaning of thinking as an objective of learning and education, and thus questions, which require thinking, are challenging. In modern world, to increase students' capacity for problem solving and critical thinking is presented as a goal of education in all fields (Olszewski-Kubilius & Thomson, 2015; Paul & Elder, 2012). Learning directly associates with activity; whilst indirectly with thinking and verbal communication. Development of thinking can be an outcome in this process. Hence, thinking in the big perspective compensates knowledge, skill, process and attitudes (Lai, 2011).

Critical and Creative Thinking Skills

Creative Thinking Skills

Creative thinking can be defined as the entire set of cognitive activities used by individuals according to a specific object, problem and condition, or a type of effort toward a particular event and the problem based on the capacity of the individuals. They try to use their imagination, intelligence, insight, and ideas when they face to such situations. In addition, they try to suggest an authentic and new design, generate different hypotheses, solve the problem with the help of discovering and finding new applications (Glass, 2004; Young & Balli, 2014) whereby each individual realizes his/her knowledge deficits and tries to bridge this gap while obtaining new viewpoints by looking at the problem from multiple perspectives with the help of making unusual connections and taking risks based on their insights to produce alternative solutions toward the problem or situation with great patience and determination.

Generally, creative thinking is correlated to critical thinking, and problem solving. Actually, there are three dimensions of creative thinking as synthesising, articulation and imagination having the following qualities (Aslan, 2007; Rhodes, 1961; Sternberg, 2009)

- *Synthesising*: This dimension includes various activities such as getting benefit from analogous thinking, deducing original result from small parts, presenting novel and authentic suggestions to the solution of the problem.

➢ *Articulation*: It involves forming the old and new knowledge or expanding the current knowledge with the help of the new one, constructing unusual relationship to produce authentic solutions and making thoughts concrete with the help of imagination and use of the materials.

➢ *Imagination*: This dimension is consisted of constructing relationship between valid and reliable thoughts, presenting flexible ways of thought with the help of imagination, to come up with different insights during idea producing process.

Based on the dimensions of the creative thinking, its general characteristics can be listed as the following (Gilhooly, Ball & Macchi, 2015; Kember & Leung, 2009; Liu, He & Li, 2015);

➢ Flexibility
➢ Authenticity
➢ Multiple thinking
➢ Wondering
➢ Thinking fast and independent
➢ To be open to criticism
➢ Rationalism
➢ Being suspicious
➢ To come up with different solutions
➢ To realize and define the problem
➢ To suggest possible solutions

The conjecture that only particular types of people can be creative is demoded thanks to educational developments because creative thinking is not merely based on art-based activities such as dance, music, drama,...etc., as previously assumed. In recent years, creativity has been valued as universal capability that it can be applied in everyday situations. It is interpreted as capability of human intelligence instead of a subject. Sternberg defines creativity as an imaginative action fashioned so as to produce outcomes which are both original and of value (Craft *et al.* 2006; Sternberg, 2003; as cited in Robson, 2013). Also novelty is necessary rather than originality meaning that "someone's idea does not have to remark thinking that has never been thought before by anyone". This thinking should be new for that individual, not necessarily for society as a whole.

According to a set of skills, creative thinking is distinct from analytical and practical thinking. Choices and critical evaluations, however, are made by participants and observers as a part of creativity process. Wright (2010) also points out that creativity integrates both problem setting and problem-solving skills with meaningful solutions (cited in Robson, 2013). In addition, according to Newbill and Baum (2012) for today's technology-driven, problem-riddled world, creative and critical thinking skills are vital for students who are faced with

situations. In this purpose, idea generation, reflective judgment, self-regulation and attitude-disposition, which are both intuitive and teachable, are needed.

For instance, in the idea generation phase, children can have an opportunity to look at their idea from various perspectives and expand them on a theme. In reflective judgement, analysing, synthesising, evaluating ideas from the idea generation phase become utilized as consistent with higher order thinking ability. It expands participant's creative thinking ability beyond their comfort zone. While in self-regulation phase monitoring and reflecting on progress and product are valued, during attitude disposition part, someone present idea while others not only listen but also add to the idea (Newbill & Baum, 2012).

Critical Thinking Skills

Richard Paul (1988) defines critical thinking as reaching to the conclusion according to the objectives and knowledge, while Norris (1985) mentions it as students' application of previous knowledge and changing it after valuation process (as cited in Demirel, 2012). Generally, critical thinking is a kind of ability to look at events, conditions or thoughts with a careful eye and making comments, decisions, studying on the reliability and validity of the knowledge according to standards of logic and the mind (Seferoglu & Akbıyık, 2006). This higher order thinking ability provides the opportunity to reason the existed knowledge or situation to correct the mistakes and complete deficits in order to reach appropriate situations (Howard, Tang & Austion, 2015; Watson & Galser, 1980).

Indeed, critical thinking skills involve identification and analysis of informational sources for credibility, indicating previous knowledge and making connections and deducing to conclusions (Thurman, 2009). Shortly, the general characteristics of critical thinking can be listed as the following;

- Reasoning and suspecting
- Looking at situations from multiple perspectives and dimensions
- To be open to changes and innovations
- To look at thoughts without prejudices
- Being open minded
- Thinking analytically
- Paying attention to details

Advantages of critical thinking;

- People who are critical thinkers think freely and independently
- People don't behave without thinking
- Individuals can state the problem explicitly (Demirel, 2012).

In educational perspective both critical and creative thinking skills should be developed because in each branch of area, to analyze a discussion, to make

inferences from meanings and comments, to make extensive and comprehensive reasoning and to judge toward assumptions are some competences through which every individual can evaluate what they see, hear or learn. (Samli, 2011). Also, creating clear and convincing presentations should be one of the capabilities of the learners. As an illustration, how many individuals could ask if 2+2 = 4 consistently, or in which mathematical sets? Can negative words be understood as positive in the case of rhetoric speech? Why is there distributive property of multiplication over addition but not that of division? How frequently *"What is the reason behind…?"* type of questions are asked or encouraged to be asked?

What is PBL?

Problem Based Learning (PBL) is defined as a pedagogical approach which uses cases and problems as departure points in order to accomplish the intended learning objectives (as cited in Pijl-Zieber, 2006; Tortop and Ozek, 2013). Actually, it is one of the most innovative instruction methods in the history of education in which an authentic or ill structured problem is presented to students to embed them into the learning process by building new knowledge onto the previous one in order to solve the problem itself. Students' problem solving, self-directed, collaborative learning skills and motivation levels are aimed to be developed during the problem solving process (Hmelo-Silver, 2004).

Constructivism (Piaget, 1970), discovery learning (Bruner, 1961), experiential and inquiry-based instructions (Dewey, 1910) are some of the approaches that have been proposed throughout educational psychology framework. Even problem-based instruction (Barrows & Tamblyn, 1998) is one of them. In fact, logic of knowledge and psychology of knowledge unites under the roof of discovery. Even if they can be seen as a minimally guided and pedagogically equivalent approach (Barrows & Tamblyn, 1998), their applications are different. As stated by Albanese & Mitchell (1993)'s study, PBL students receive better score during clinical performance because PBL provides hypothetical-deductive method of reasoning and an opportunity to practice skills.

In addition, PBL challenges students to solve authentic problems in information rich settings. They can construct their own solution that contributes to the most effective experience such as method, process and epistemology of discipline. However, some opponents state that all problem-based searching make working memory force a heavy demand. High working memory load does not lead to accumulation of knowledge in long term memory because working memory becomes used to search for problem solution so that it cannot be used to learn. Also the aim should be teaching of discipline by inquiry rather than as inquiry. Finally it is indicated that some participants who trained in PBL cannot

acquire forward directed reasoning but retain backward directed reasoning pattern. It can delay development of forward reasoning pattern.

Creative and Critical Thinking Skills in Instructional Design

Thus far, the definitions and qualities of both critical and creative thinking skills are discussed. What can be said about their role in instructional designs with respect to general elements of an instructional design process?

Table 1. Creative and Critical Thinking Skills with Instructional Design Dimensions

Instructional Design Construct	Dimensions	Reason
Learner Analysis	Creative Thinking Skills (Different solutions toward different problems)	To determine the needs for which instruction is the solution
	Critical Thinking Skills (Looking at events and conditions skeptically)	
Context Analysis	Organized teaching and learning environment in school climate	To select instructional strategy, method and technique
Organization of Instructional Objectives	As consisted with learner and context analysis	To write measurable objectives for target instruction by considering learner and the context
Development of Instructional Strategy	*Creative Thinking Skills*: Brainstorming, Problem solving, case study, project, *PBL*, demonstration, role playing	Thought development & analytical thinking
	Critical Thinking Skills: Questioning, discussion, *PBL*, project	Thought development & analytical thinking
Implementation Process	Instructional delivery in the classroom environment	
Assessment Techniques	Formative by performance assessment or authentic	Multiple thinking & solution, looking at problem from different perspectives, encourage higher order thinking skills

Instructional systems are described as learning environments including many elements in the process of supporting learning activities. Learning theories and educational philosophies are the supported elements in an instructional system. Instructional systems provide the framework for development process of the fruitful learning environments. An instructional design process has several

dimensions as illustrated in Table 1. It begins with the analysis of target learners to determine the needs of them. Then, context is analyzed to be able to select accurate instructional strategy, method and technique. Measurable objectives are written by considering outcome of learner and the context analysis. By using these objectives, instructional strategies are developed to promote the learners' analytical thinking. However, if the aim is to help the learners improve their creative thinking skills, instructional strategy should be selected from the set of demonstration, problem based learning or role-playing activities. If it is to help them improve critical thinking skills, instructional strategy should be selected from the set of questioning, problem based learning or discussion activities. After the delivery of instruction, assessment techniques of objectives might also be one of the formative assessment techniques so that not only product but also process itself might be evaluated. According to Table 1 it can be highlighted that problem-based learning approach can be integrated into instructional strategy order to foster both critical and creative thinking skills.

Besides aforementioned instructional design dimensions, many researches and studies also reveal the effect of PBL on these thinking skills with the pros and cons. For instance, Batdı (2014) applied a meta-analysis study with 90 studies had been made in national and international field between the years 2006 to 2013, 19 theses and 6 articles, in which pre-test and post-test experimental design had been applied. And he found problem-based learning approaches were more effective when compared to traditional teaching techniques. On the contrary, there are some studies, which highlight non-significant effects of PBL. Temel (2014) worked on 49 pre-service teachers in chemistry to compare the effects of PBL and direct instruction on their critical thinking dispositions and perceptions of problem-solving ability. According to research results of pre-test-post-test control group design, PBL and direct instructional method did not have different effects on the critical thinking dispositions of pre-service teachers and they had different effects on their perceptions of problem-solving ability. In addition, Choi, Lindquist and Song (2014)'s quasi-experimental non-equivalent group pre-test post-test design study was aimed at exploring the effect of PBL. In this study, first-year 90 nursing students, who had been recruited from two different junior colleges in two cities in South Korea, were exposed to 16 weeks PBL instruction. The findings pointed out only positive trends apart from significant difference between teaching methods due to the fact that it was discussed as a small underpowered study.

Furthermore, through the context of effect of PBL on creative thinking skills, Ulger and Imer (2013) studied determining the effect of PBL approach on seventy-two 7th grade students in their visual arts education. It was a quasi-experimental pre-test post-test research design in which the students randomly

assigned to experimental and control groups. In experimental groups, the students were exposed to 9-week PBL experience whereas control group students were taught demonstration, lecture and question answer method in that time. It was shown that PBL method has a significant effect on students' creative thinking ability in the visual arts education.

Conclusion

This paper attempts to highlight differences between creative and critical thinking skills and the reinforcement of problem-based learning on them. It has also attempted to discuss how instruction in the classroom can be designed to support both skills. By the same token, using PBL as a mean depends on the usage of cases and everyday problem in which learners have an opportunity to discover new knowledge onto their prerequisite knowledge in order to solve the problem. Hence, they participate in an active process to create innovative solutions toward the problem through their experiences.

By welding together creative and critical thinking skills in PBL; multiple thinking skills, to come up with different solutions and suggesting possible solutions indicate creativity whereas reasoning and suspecting skills, thinking analytically, looking at ideas without prejudices point out critical thinking. Creative and critical thinking complete to each other and production of qualified innovations and sustainability of education.

To conclude, if we want to raise the learners who might be the possible young scientists of the future, both skills need to be developed critically in the instructional design process. Namely, it should not be forgotten that learner and context analysis, organization of instructional objectives, development of instructional strategy or assessment techniques become distinct in the instructional design step with regard to critical and creative thinking skills under the problem based learning approach.

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