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The effects of the development of metacognition on project-based learning

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Abstract

This article revises the effects of the metacognition development on project-based learning by giving different cases for the graduate level students (n=86) at the innovation and entrepreneurship courses. The objective of the article is to understand clearly and deeply how metacognitive learning methodologies affect the learning process and outcome. As a result, cases in which everyday challenges, such as social, economic, cultural, and environmental are solved develop better environments for the development of metacognition due to the fact that the highest 'meta-level' of cognition is implicated. In the project-based learning, by solving different problems it is possible to develop creative ideas while improving highly developed skills.

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Keywords: metacognition; development; project based learning; metacognitive skills; learning process.

1. Introduction

According to Flavell (1999) metacognition is not only knowledge about the nature of people as thinkers but also knowledge about the nature of a variety of cognitive tasks. In addition it can be said that metacognition is about possible strategies that can be utilized for the solution of different tasks. Moreover metacognition includes managerial skills for monitoring and regulating one's cognitive activities.

It can be said that there is an increase in metacognitive abilities with age and experience (Biggs, 1987; James, 1998), and where previous knowledge is insufficient, learners have the tendency to adopt surface level approaches (Ramsden, 1997). It is claimed that in the traditional academic environment, there are obstacles linked with "pushing" abstract theory too far beyond the "commonsense" approach to the subject adopted by most students (Entwistle, 1981). Such developmental limitations, together with the motivational shortage can be a limitation of learning to mainly surface-level awareness throughout the undergraduate years. Thus, students are let to "missing the point" about complex sustainability-related issues. A proper definition of both terms is required in order to show the difference between cognition and metacognition. Cognition is the mental process through which the user establishes this mental model whereas metacognition considers the mindful engagement of the user in a task, including the knowledge and control the user has over his cognitive processes (Lopez, 1997).In addition it also deals with awareness, observation, reflection and analysis which is needed to become an independent learner.

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It can be said that metacognition has a complex structure therefore it would be suitable to identify metacognitive skills. According to Gorrell et al., 2009, metacognitive skills are:

- Evaluation (or criticality of sources or task success).
- Metamemory (a person's knowledge and awareness of his or her memory usage).
- Metacomprehension (an awareness of the extent to which a task is understood).
- Monitoring (the assessment of progress through a cognitive task).
- Planning (appropriate structure is assigned to the task).
- Schema training (the generation of a cognitive framework to help understand the task).
- Transfer (the ability to transfer strategies to tasks other than the one on which they were learned).

Another point which needs to be mentioned is that according to Harvey and Knight (1996) the essence of quality in education is "Transformation".In other words, a "critical ability" students have of evaluating and developing knowledge for themselves. So, in order to understand metacognitive skills it is important to understand the features of transformative learning:

- Critical transformative learning represents an integrative approach.
- Assessment is to be the focus of the learning experience.
- The students should be supported and challenged into risk taking ventures to wrestle with their profession in new and creative ways.
- The students are able to articulate why a different approach is to be taken in different contexts, and decide on which aspects of the concept are relevant to a particular context.

It can be said that this leads to metacognition: knowledge, awareness and control of one's own learning. (Bowden and Marton, 1998). It can hardly denied that employers are looking for graduates with a potential to transform organizations. The completion of such a task requires skills that surpass disciplinary knowledge, into their application of problem solving in different domains. One of the most criticized and insufficient parts of universities by employers is that they are not always make a good job of fostering the skills" (Harvey and Knight, 1996). Under discussion is essentially a case of fragmentation. A good example of this would be the lack of transformed knowledge. In order for learning to occur It is necessary to focus on the relations within the content fields and between content and context. Hence curriculum development should be about establishing a balance between the "professional and disciplinary frameworks of knowledge" (Bowden and Marton, 1998).

According to Peters (2000) and Rivers (2001) metacognitive skills are important in the development of independent learners. Peters (2000) sees metacognitive skills as something which enables learners to self-manage and evaluate their own thinking and learning. Rivers (2001) reports that students' self-directed learning behavior is associated with students' regular estimation of their academic performance, their approach to learning, and how this compares with that of other learners and with the teaching styles used.

The development of independent learning in children aged three to five years was examined in a study. According to Anderson et al. (2003) there are a number of metacognitive and self-assessment skills underlying independent learning. These include:

- ability to speak about own and others' behaviors;
- monitors progress and seeks help appropriately;
- negotiates when and how to carry out tasks;
- is aware of feelings and others;
- is aware of own strengths and weaknesses;
- can speak about how they have done something or what they have learned;
- can speak about planned activities; can make reasoned choices and decisions;
- engages in independent cooperative activities with peers;
- initiates activities;
- finds own resources without adult help;
- develops own ways of carrying out tasks; and
- plans own tasks, targets and goals.

It is necessary to add that any organization including higher education institutions can only succeed, if it represents the shared values of the stakeholders (Senge et al., 2000).Seeing quality as the transformation of students is one way higher education institutions can follow in order to meet the requirements or needs of the steakholders, (Harvey and Green, 1993).When this is achieved in others words when students are transformed, it is beyond the

providers' basic expectation of "value for money".In addition it meets the requirement of "excellence" from students, satisfies the "fitness of purpose" for a competent service to employers, and serves as a clear evidence of motivation in staff through "consistent" policies. As it can be seen, interpretation of quality as transformation is of high importance to the development of educationally-oriented models to quality in higher education.

Furthermore, it might be said that what was defined as independent learning has become a priority in both educational and employment contexts (Cotton, 2001). In our continuously changing world, there is an integral need for students to develop as independent learners to enable them to cope with the demands of the changing curriculum and structure of higher education and to meet the expectations of employers (Cotton, 2001). In addition to the things said above it is also true that contemporary challenge for higher education comes from the demands of political leaders for access for a greater share of the country's population to meet the demands of the new economy. The situation is worsened by the thought that the skills and attitudes young people bring to their roles as employees and citizens are insufficient (Newman, et al., 2004).While characterizing the independent learner, apart from a range of attributes, skills and propensities, it is essential to take the ability to self-assess into consideration.

In general terms, high level of self-awareness and the ability to monitor one's own learning and performance are demanded by self-assessment skill. Self-assessment is associated with metacognitive awareness and skill, which is described as "thinking about thinking, being aware of the learning process and employing that in new learning" Reid (2001). Metacognitive skills have been described by Vockell (2004) as: "learners' automatic awareness of their own knowledge and their ability to understand, control and manipulate their own cognitive processes". The particular skills referred to under the metacognition banner include: metamemory: awareness of memory systems and strategies to manipulate memory for optimal efficiency; The information about our own memory is a part of what is known as metamemory; a term used by Falvell (1971) as knowledge and awareness of memory. According to Chua (2008) metamemory is the knowledge of our own memory that affects our own behavior and action. Besides that, metamemory is seen as one's beliefs, awareness, and assessment about one's own memory and others' memories (Beck, 2004; Troyer and Rich, 2002).Kelemen (1998), on the other hand, described metamemory as the ability to predict future memory performance for recently learned information. Control and monitoring processes are the main components of metamemory (Nelson and Narens, 1990).Based on cognitive psychology, metamemory includes four components:

- factual knowledge,
- self monitoring,
- memory self-efficacy,
- memory-related affect (Rudolf and Jellemer, 1996; Hultsch et al., 1987).

One of the best predictors of academic achievement and other cognitive performances is metamemory (Sinkavich, 1994, 1995; Geddie et al., 2000; Rawson et al., 2002).

- metacomprehension: This can be defined as the ability to know what has and has not been understood and to apply strategies to increase understanding;
- self-regulation: the act of self-monitoring and estimating and adapting learning in light of experience and feedback (Vockell, 2004).

Furthermore it is worth mentioning the study conducted by Kevin Downing and Flora Ning and Kristina Shin

This study is based on data from the Learning and Study Strategies Inventory (LASSI) and the Course Experience Questionnaire (CEQ).This study extends previous work by examining differences in metacognitive development and learning experience between two groups of students from the beginning to the end of their first 15 months as undergraduates in two knowledge-similar programs. Consequently, this study confirms significant differences in metacognition and learning experience between students taking first-year building and construction courses, which have adopted a problem-based approach to learning, and those taking similar building and construction courses in a non-PBL (Problem Based Learning) environment.

Hacker (1998) stresses the importance of learning more about thinking and broadens the concept further. The author identifies a difference between cognitive tasks (remembering things learned earlier that might help with the current task or problem) and metacognitive tasks (monitoring and directing the process of problem solving). Another important issue, the role of learners' beliefs about thinking is emphasized by Cornoldi (1998) . Brown (1987) supports this viewpoint and agrees that metacognition requires the thinker to utilize and describe the process of mental activity. According to Allen and Armour-Thomas (1991) metacognition is best defined by acknowledging that it is both knowledge about, and control over thinking processes. Hacker (1998) who divides metacognition into three types of thinking; namely, metacognitive knowledge (what one knows about knowledge), metacognitive skill (what one is currently doing), and metacognitive experience (one's current cognitive or affective state). Marchant

(2001) provides a good summary statement and argues that whilst cognition focuses on solving the problem, metacognition focuses on the process of problem solving.

Solving problems often requires undergraduate students to understand how their mind functions, and identify not just what they know, but how they perform important cognitive tasks, such as remembering, learning and problem solving. Given the emphasis on the processes of learning in PBL approaches, rather than merely knowledge-based outcomes, it is logical to expect more significant metacognitive development from undergraduates engaged in PBL when compared to those who learn through non problem-based approaches, which do not always require the same reflective performance. There are a number of ways to evaluate metacognition. One of the most popular methods currently in widespread use is through the use of questionnaires. This method requires students to report their perceptions about their thinking and problem-solving skills and strategies. One of the generally accepted things is that most students who struggle at university could improve their performance noticeably if they understood the learning process better.

That learning is more effective when engaged in thinking about the process of learning, thinking, and problem solving has been asserted by Weinstein and Palmer(1988). As a result of her work in the field of strategic learning at the University of Texas at Austin, Weinstein (1987) developed the LASSI which is now the most widely used learning inventory in the world. The LASSI measures student's perceptions of their study and learning strategies and methods. In other words, it is a measure of the students thinking about their thinking or metacognition.

Biggs (1999) suggests that the aim of undergraduate education is to assist students to develop the functioning knowledge which allows them to integrate the academic knowledge base (declarative knowledge), the skills required for that profession (procedural knowledge), and the context for using them to solve problems (conditional knowledge). According to Hmelo et al. (1997), PBL by its unique nature requires a different way of using knowledge to solve problems, and it is this "functioning" knowledge that involves the metacognitive processes identified above.

That students' perceptions of their learning experience are positively associated with PBL curriculum has been demonstrated by previous work. For example, an early study by Sadlo (1997) used the CEQ (Ramsden, 1991) in order to compare traditional subject and problem-based curricula in six schools in various countries. The author found that students who received a problem-based curriculum reported higher scores in the CEQ scales than those who received traditional curriculum.

First point of this study is the problem statement. A massive transformation can be witnessed not only of the higher educational institutions themselves but also that one of the students. This change is fostered by becoming aware of metacognitive skills and how these skills transform the student into an independent learner. In addition students, who learn in a problem based learning environment are in the position of meeting the demands of a new economy.

In this study the main purpose is to analyzes critically and deeply the effects of the metacognition development on project-based learning.

Second point is the research question. There is one research question in this study; What are the effects of metacognition development on project-based learning?

This question is crucial to understand the role of metacognition in transforming learners. In addition it to comprehend how this transformation of learner and higher educational institution meets the demands of the employers. It makes some highly useful suggestions about how the university system should be organized in such an environment. According to research conducted in this field it can be said that the effect of the metacognition development on project based learning nurtures the industry with individual learners, in other words with problem solving prospect employees.

The purpose of this study is to show that metacognitive skills are the underlying skills which enable the learner to transform into an independent one. In addition, this transformation is crucial to meet the requirements of the industry. That is why higher educational institutions should base their curriculum on project based learning. By using PBL universities are enabled to meet the requirements of the industry which in this case is qualified human resources. This paper explores the effects of the development of metacognition in project based learning.In other words, how it affects the institution, the learner and the employer.

The effects of the development of metacognition on project based learning have been observed in two different courses for six week by using phenomenological analysis as a research method. To analyze the difference, at the entrepreneurship and innovation courses, two different programs have been preferred. In the first one, project-based approach is used in the curriculum in which the participants have actively solved different problems and cases. In the second, however, teaching and learning methodology is more traditional.

2. Method

In this study 12 different research questions in the semi-structured interviews were answered by 86 graduate level students taking entrepreneurship and innovation courses. The collected data were analyzed in Atlas-ti 7 to make

depth study. Data analyses were completed using Atlas-ti as well as manually coding the individual transcripts. In total, 23 transcripts were imported into Atlas-ti as well as read thoroughly and repeatedly by the author.

3. Result

The results show that most (86%) participants agree that the project-based learning environment by solving different problems in cases is much better (32%) than traditional environment. As most (81%) of the participants point out that their awareness is markedly improved (68%) in the training comparing to those of the participants in the traditional courses. As a result, cases in which everyday challenges, including social, economic, cultural, and environment are solved in the projects develop better environments for the development of metacognition due to the fact that the highest 'meta-level' of cognition is implicated. In the project-based learning, by solving different problems it is possible develop creative ideas while improving highly developed skills. According to the findings above the following results might be expected.

Typically, graduate courses are a continuation of the content and structure found in undergraduate courses. However, the structure of graduate courses needs to be designed to allow students learn how to be independent thinkers and to take charge of their own learning. With globalization, courses offered in the traditional format do not always prepare individuals to be competitive, and consequently may have little value or relevance to students after they graduate. Hence, the mass customization of courses (Williams and Mistree, 2006) that will allow students to identify and develop selected competencies should be advocated. However, designing and creating learning environments which empower students to learn how to learn is not an easy task. When students enter learning environments, most learners want quick answers to questions they already have (Ifenthaler, 2012a; Pirnay-Dummer et al., 2012). Thus, students tend to like to be provided with simple recipes and scripts – because they seem to be of more practical value at the time. That is why project based learning and creating an environment for this kind of learning to take place violates this quasi-need because the aim is to bring about conceptual change (Vosniadou, 2007). Clearly, it can be said that there is need to explore further the effectiveness of scaffolding and feedback of learning. Educators should become increasingly aware of the need and expectation for students to develop non-technical skills (such as independent learning) in order to exploit educational resources and meet the demands of the employment market (Cassidy and Weinberg, 2005). Because of this, there should be an emphasis in educational research on understanding non-technical skill development and how best to design learning environments which cultivate the development of both technical and non-technical skills. Transformative learning can only take place in an institution as a result of commitment by the staff that sees their view of quality as "Perfection" being fully addressed by the institution. Thus, it is seen that achievement of transformative learning in an institution fully meets all of the stakeholders' expectations of quality. These arguments are also consistent with previous research, which found that metacognitive activity was related to learning (Pintrich and DeGroot, 1990; Schmidt and Ford, 2003).

Needless to say those individuals with greater metacognitive activity may be more likely to monitor and adapt their behavior to create a more positive learning environment.

In order to conclude it might be said that problem-based activities place students in unfamiliar and challenging situations which demand that they not only think about the task or problem solution, but also the processes by which they might arrive at that solution. Consequently, their awareness of the processes of learning is likely to be heightened and this awareness can be regarded as a developing skill which is later transferable to other situations and problems.

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