Investigating Predictive role of Critical Thinking on Metacognition with Structural Equation Modeling

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ABSTRACT

The purpose of this study is to examine the relationships between critical thinking and metacognition. The sample of study consists of 390 university students who were enrolled in different programs at Sakarya University, in Turkey. In this study, Critical Thinking Disposition Scale and Metacognitive Thinking Scale were used. The relationships between critical thinking and metacognition were examined using correlation analysis and the hypothesis model was tested through structural equation modeling. In correlation analysis, critical thinking and metacognition were found positively. The model demonstrated fit ($\chi 2$= 1014.86,df=551, p=.00, RMSEA=.038, GFI=.99, AGFI=.99, CFI=.99, NFI=.99, IFI=.99, RFI=.99, SRMR=.008). According to results metacognition was predicted positively by critical thinking. Results were discussed in the light of literature.

Keywords: *Critical thinking, Metacognition, path analysis*

INTRODUCTION

Critical thinking is a thinking method that involves cognitive procedures such as reasoning, analyzing, and evaluating. That thinking process consists of critical thinking, efficient problem solving and making a decision was stated by McPeck (1983). Concrete and abstract thinking processes is covered by critical thinking in order to reach a conclusion about specific pro-visions that are in balance with same sense and scientific evidences. It was stressed by Black (2005), Kuhn and Dean (2004) and Schroyens (2005) that critical thinking happens when indivuduals practice higher order thinking skills or strategies. Ennis (1985) described that critical thinking as reflective thinking stresses on determining what to do or what to believe. Bruning et al. (2004) defined reflective thinking as a reflective action in which the purpose is to comprehend the source of a problem. Moreover, the aim of critical thinking is to critisize the information, providing us to make meaningful decisions. Individual who apply critical thinking not only practise daily life ability of defining, summarizing, retrieving, analyzing, and synthesizing information (Gomez & Gomez, 2007), but also properly decide relevance and reliability of information received from the developing world. Five stages of critical thinking were described by Lynch et al., (2002). The first stage is “confused fact-finders” and referred to elemantary pupils particulary attending the classroom. Lynch et al., (2002) defined the second stage of critical thinking as named a “biased jumper” or a student who quickly comes to decision and then searching for promoting evidence.“Perpetual analyzer” is the third stage of critical thinking .Individuals in this level are not able to prioritize knowledge or find and support the solutions. The fourth stage is labeled “pragmatic performer”.The indivuduals investigate the evidence independently and draw a conclusion. The last stage of critical thinking acquisition is labelled the “strategic revisioner” (Lynch et al., 2002). That the leading supporter of the subject-specific view lays emphasis on the information of a

specific subject as the main component of critical thinking was stated by McPeck (1983). Neverthless, McPeck informs the funtions of abilities and features in the process. It is pointed out by McPeck (1983) that educating about critical thinking includes both "teaching how," which refers to methods or abilities, and "teaching to," that refers to tendecies. These abilities are dependent on a particular subject, and are not possible to be movable to other subjects. Excellent critical thinker was identified by Sternberg (2003) as a perfect problem manager; but, indivuduals sholud be instructed to shift the problem-solving skills so students learn in school to their daily real lives activities. Clever thinkers have the original skills to produce new opinions, analytical skills to decide if they are benficial ideas, and the useful skills to determine how to practise the ideas and to convince others people's the importance of their ideas.

Metacognition

Metacognition was initially introduced by John Flavell in the beginning of 1970s and he indicated that metacognition includes both watching and organizing elements. According to the definition of Flavell (1979) metacognition is knowledge and cognition about cognitive phenomenon. After this definition many researchers (Braten, 1992) started to investigate metacognition and regarded it as a multi-dimensional concept. Generally, researchers (Brown, 1987; Flavell, 1987; Metcalfe & Shimmura, 1994; Schraw 1994) assumed metacognition as a two-dimensional concept: knowledge about cognition (metacognitive knowledge) and regulation of cognition (metacognitive regulation). Reflection on learning experiences can expand metacognitive knowledge which can be defined as the knowledge, awareness, and deeper understanding of one's own cognitive processes and products. Encompassing a bunch of activities that enable students to control their learning can be regarded as regulation of cognition (Gourgey, 1998; Hartman, 1998). Even though several regulatory skills have been described in the literature, three basic skills are considered as important: planning, monitoring, and evaluation (Jacobs & Paris, 1987).

It is extremely important to teach metacognitive skills in educational system, because they helps students develop higher order thinking process and improve their academic success (Flavell, 2004; Larkin, 2009). Because of the impact of metacognition in higher order thinking processes, its importance has increased day to day. Therefore, learning environments and teaching strategies, that put emphasis on metacognitive knowledge and regulation considering the higher order thinking process, have been designed. According to the studies which investigated learning environments and teaching strategies, there are strong relationships between teaching metacognitive strategies and progress in students' higher order thinking process (Kramarski, Mevarech & Arami, 2002; Schraw, 1998). Van der Stel and Veenman (2010) and Dignath and Buttner (2008) stated that metacognition has been conceptulized one of the most relevant predictors of accomplishing complex higher order thinking process. The conditions that develop higher order thinking process should be determined before creating learning environments and teaching strategies which support the development of students' metacognitive skills. According to Jacobs, Paris (1987) and Wittrock (1983) the use of metacognition seems to be associated with academic achievement and it improved learning outcomes. Furthermore, Watkins and Hattie (1992) indicated that higher achieving students were more likely to use strategies compatible with their own motivational states than lower achieving students. In this regard, teaching methods and learning environments based on the principals, creating the proper conditions, can be easily designed (Hacker, Dunlosky and Graesser, 1998).

The Present Study

Recently studies have indicated that two of the most important internal motivational factors that correlate to higher order thinking process are critical thinking and metacognition (Arslan, 2014; Arslan & Akın, 2014 ; Arslan ,Akın, & Çitemel, 2013;Arslan & Cardak,2012; Choy and Cheah , 2009; Coutinho et al. 2005; Kogut,2005; Kuhn and Dean, 2004; Magno,2010; Orion and Kali, 2005; Schroyens, 2005). Despite these findings, there has been limited empirical research that directly examines individual differences in the use of metacognition and critical thinking. Hence, the aim of study is to investigate the relations with the critical thinking and metacognition.

METHOD

Participants

Students volunteered to study. Students who do not wish to participate in the study were excluded from the research sample and stated their status before the study. The confidentiality of data in the research is explained to the students.

Necessary permissions were obtained from the authorized institutions and teachers before applying the scales. The students who participated in the study were informed about the purpose of the study.

Correlation and structural equality modeling were used in data analysis. Participants of the study were 390 university students (209 (54%) were female and 181 (46%) were male in Sakarya University, Turkey. Their ages ranged from 18 to 25 years and the mean age of the participants was 21.6 years.

Measures

Critical Thinking Disposition Scale (Akın, et al.,2013).

Critical Thinking Disposition Scale is a 11-item self-report scale using a five-point Likert scale (1= strongly disagree 5= strongly agree).

This scale has two sub-scales: reflective scepticism (seven items) and critical openness (four items). Results of confirmatory factor analysis have demonstrated that the items loaded on two factors.The results of confirmatory factor analysis indicated that the model was well fit (x^2=53.24, df= 40, RMSEA=.040, NNFI=.96, CFI=.97, IFI=.97, and SRMR=.048).

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For reliability of the Turkish version of the CTDS internal consistency coefficient was calculated. The Cronbach's Alpha internal consistency of the scale was as .68 for reflective scepticism, .75 for critical openness sub-scale, .78 for whole scale. The corrected item-total correlations of CTDS ranged from .25 to .61.

Metacognitive Thinking Scale (Arslan & Akın, 2015).

Metacognitive Thinking Scale. Metacognitive Thinking Scale is a 12-item self-report scale using a five-point Likert scale (1= strongly disagree 5= strongly agree).

This scale has two sub-scales: metacognitive knowledge (five items) and metacognitive regulation (seven items).

Results of confirmatory factor analysis have demonstrated that the items loaded on two factors. Results of confirmatory factor analysis demonstrated that the two-dimensional model was well fit (x2= 124.39, sd= 45, RMSEA= .061, NNFI=.96, NFI= .96, CFI= .97, IFI= .97, RFI= .94, GFI= .96, SRMR= .054).

RESULTS

Descriptive Data and Inter-correlations

Table 1 shows the means, descriptive statistics, inter-correlations, and internal consistency

coefficients of the variables used.

Table 1. Descriptive statistics and inter-correlations of the variables

Variables	Reflective scepticism	Critical openness	Metacognitive knowledge	Metacognitive regulation
Reflective scepticism	1			
Critical openness	.59**	1		
Metacognitive knowledge	.60**	.58**	1	
Metacognitive regulation	.64**	.71**	.57**	1
Mean	25.8	15.5	20.3	27.7
Sd	4.0	2.6	2.9	3.9

**$p < .001$

Table 1 show that there are significant correlations between the critical thinking and metacognition.

Subscales of the critical thinking; reflective scepticism correlated positively with metacognitive knowledge (r = .60;), metacognitive regulation (r = .64); critical openness correlated positively with metacognitive knowledge (r = .58;), metacognitive regulation (r = .71).

The means of the variables ;Reflective scepticism=25.8, Critical openness=15.5; Metacognitive knowledge=20.3; Metacognitive regulation=27.7. The standart deviation of the variables; Reflective scepticism=4.0; Critical openness=2.6; Metacognitive knowledge=2.9; Metacognitive regulation=3.9.

To test the hypothesis model critical thinknig would be associated positively metacognition and structural equation modeling (SEM) was used. Using SEM is a measure of the relationship between the dependent variables and the independent variables.

Structural equality modeling can also be performed as causal analysis of causal modeling at the same time. The results of testing whether critical thinking has a direct effect on metacognition is presented in Figure 1.

Schemas are very important for the researcher to explain his thoughts about the relationships between variables.The purpose of the analysis is to test a model or to test a set of models that are related to each other.In this model, each observed or hidden variables are independent or independent variable.

After the model was determined, the parameters of the model were estimated using the sample data.The predicted sample was used to create the covariance matrix. For each of the parameters in the model, if an original numerical solution exists, the model is defined.

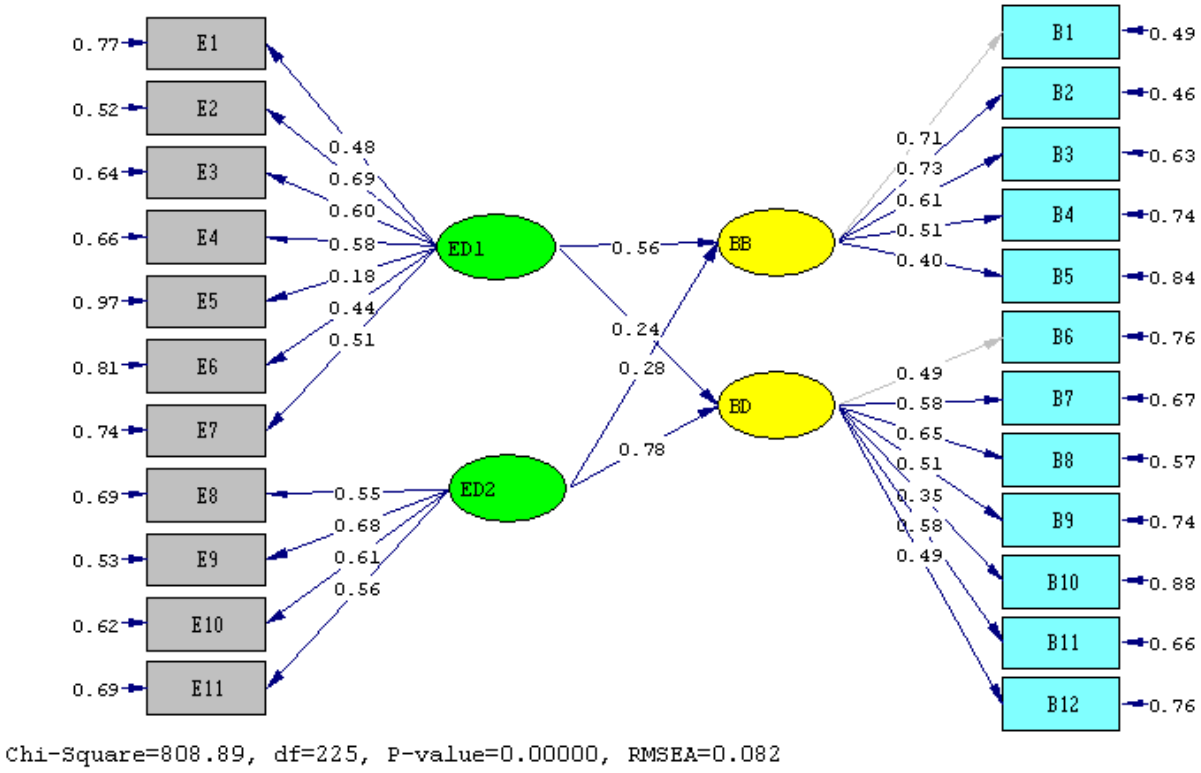

Figure 1. Path analysis between critical thinking and metacognition

ED1: reflective scepticism,ED2: critical openness,BB: metacognitive knowledge, BD: metacognitive regulation

Figure 1 showed that the model is saturated (i.e., there are no unused degrees of freedom). Consequently, the fit of the model (Hu & Bentler, 1999) is necessarily perfect ($\chi 2$= 808.89,df=225, p=.00, RMSEA=.08, NFI=.91, NNFI=.93,CFI=.93,IFI=.93, RFI=.90, SRMR=.06). It can be seen that reflective scepticism and critical openness have significant effects on metacognition

DISCUSSION

The present study examined the relationship between critical thinking and metacognition. Correlation analysis and SEM confirm the hypothesis. Indeed there is a positive relationship between metacognition and dimensions of critical thinking. Moreover, according to the goodness of fit indexes the model was acceptable and the model explained correlations among measures (Hu & Bentler, 1999). Findings show that there is a significant relationship between factors of critical thinking and metacognition. These results are in line with the findings of the previous models that indicated the association between critical thinking and metacognition (Akama 2006; Arslan, 2014; Antonietti et al. 2000;Başbay, 2013; Berardi-Coletta et al. 1995; Black, 2005; Choy and Cheah, 2009; Coutinho et al. 2005;Kogut, 2005; Kuhn and Dean, 2004; Magno, 2010; Orion and Kali, 2005; Schroyens, 2005). The important relationship between metacognition and critical thinking has been investigated in the literature, such as Kuhn's (1999) and Willingham's (2008) studies examined the relationship between metacognition and critical thinking. Moreover, according to Lipman (1991) one's metacognition must be "self-correcting' in order to qualify it as critical thinking. Even though it is necessary for a person to think about his or her thinking, if he or she is not critical in his/her thinking process, his or her thinking is not considered as critical thinking. Thus, for a successful critical thinking, previous experiences and prior cognitive development are essential. There are important studies indicating the relationship between critical thinking and metacognition. Kogut (1996) claimed that specific strategies, promoting critical thinking, are metacognitive in nature. Furthermore,

Orion and Kali (2005) examined the impact of science learning program on students' scientific thinking skills and found a relationship between critical thinking and metacognition. Besides, according to Choy and Cheah (2009) critical thinking necessitates higher level of metacognition. Magno (2010) stated that to make students think critically, it is necessary to teach them how to be aware of the underlying ways of thinking. As Ku and Ho (2010) indicated that good critical thinkers engaged in more metacognitive activities, especially higher order planning and higher order evaluating strategies. For an effective metacognitive regulation, metacognitive knowledge is important as a supporting factor. The association between critical thinking and metacognition was firstly introduced by Schoen (1983) that " a successful pedagogy that can serve as a basis for the enhancement of thinking will have to incorporate ideas about the way these representations change and resist change when new information is encountered" (p. 87). According to his explanation, the enhancement of knowledge referred to critical thinking and the process of organizing knowledge was a significant factor of metacognition (Magno, 2010). Particularly, critical thinking provides students with developing their metacognitive skills. Specifically, the use of metacognitive strategies has been asserted as a significant factor during thinking process (e.g., Facione 1990; Halpern 1998; Luckey 2003; Swartz 2003). For example, Halpern (1998) pointed out that; "When engaging in critical thinking, students need to monitor their thinking process, checking whether progress is being made toward an appropriate goal (and) ensuring accuracy…. Metacognitive monitoring skills need to be made explicit and public so that they can be examined " (p. 454). Swartz (2003) claimed in his reflection on teaching methods, which simplify metacognition that "thinking about their thinking has dramatic effects on students' learning and is usually not a difficult or complicated task for even primary-level children" (p.237). According to the findings of Başbay's (2013) study, students' critical thinking tendencies affect their epistemological beliefs and metacognition plays a partially mediating role. As Lee (2009) found that performing two metacognitive tasks strengthened the critical thinking tendencies of experimental group. According to Ku and Ho (2010) investigating individual's on-line thinking processes was useful in order to understand factors behind thinking performance better. In a study which examined thinking process of two groups of participants that were matched in terms of their cognitive ability, thinking disposition, and academic achievement, the importance of metacognitive strategies in critical thinking was revealed. Chisholm (1999) stated that there was a significant relationship between metacognitive and critical thinking skills in terms of comparing students' grades. One limitations of the current study is its sample size. In other words, future studies should investigate the same research question with a larger sample size. A larger sample size may clarify some correlations and thus increase the validity of the findings. Moreover, conducting this study in various rural areas of Turkey may represent whether these results could be generalized to a wider population. University environments put more emphasis on team work and interaction. There are many aspects of metacognition, especially social metacognition that affect student achievement. It may be useful to explore this association in terms of how these students interact with others and approach critical thinking situations. Another limitation of the current study is that the sample was composed of university students, which restricted the generalizability of the findings. Hence, it could be important to investigate the relationship of these variables in other sample groups. Other limitation is about statistical method used in analysis. In other words, correlational statistics used in the present study does not represent any causality about the findings. Further studies should consider this issue to obtain effective knowledge about the direction of causality. Another limitation is due to data collection method. In fact, data about critical thinking and metacognition was collected through self-report instruments. Future studies may use other tools to decrease subjectivity of the findings. All in all, current study states that critical thinking affects metacognition so that there is a relationship between critical thinking and metacognition. Therefore, according to the present study critical thinking may be an important predictor of the metacognition dimensions. Thus, the current findings increase our understanding in terms of the relationship between critical thinking and metacognition.

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