

THE INTERPLAY BETWEEN METACOGNITIVE AWARENESS AND SCIENTIFIC EPISTEMOLOGICAL BELIEFS

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ABSTRACT

Considering the importance of epistemological beliefs in students' learning process and how students reach knowledge; this study explored contributions of metacognitive awareness level to students' scientific epistemological beliefs. Discipline Focused Epistemological Beliefs Questionnaire and Metacognitive Awareness Inventory were administered to 250 eighth graders. Correlation analysis indicated that both knowledge of cognition and regulation of cognition dimensions of Metacognition related with certainty/simplicity of knowledge, source of knowledge, attainability of truth dimensions of epistemological beliefs. Multiple Regression Correlation analysis, however, revealed that the model that includes regulation of cognition reached statistical significance and explained 11% of the variation in certainty/simplicity of knowledge; ($F= 14.772$, $p < .05$) and 7% of variation in attainability of truth ($F= 8.396$, $p < .05$). The positive beta values indicated that students controlling all aspect of their learning tended to see scientific knowledge as more certain, simple as well as more attainable.

Keywords: Epistemological beliefs, metacognitive awareness.

INTRODUCTION

The role and influence of an individual's epistemological views on learning and other cognitive processes have been investigated in educational and psychological literature recently. (Buehl & Alexander, 2001). Researchers in education claimed that epistemological views of individuals may influence their learning strategies and reasoning modes. Although previous studies indicated that epistemological beliefs and metacognition may have influence on students' achievement toward science (Kuhn 1991, Schommer- Aikins 2004; Scraw 2006), relatively few studies were investigated the possible link between students' metacognitive awareness level and their scientific epistemological beliefs among elementary students. After a review of extant theories on personal epistemology, Buehl and Alexander (2001) implied that to get to the "roots" of epistemology, it is crucial to explore "how epistemological beliefs change as a result of maturation and educational experience" (Akerson & Donnelly, 2008, p. 416). For instance; Bendixen and Rule (2004) implied an "important link between

personal epistemology and conceptual change” and stated that “as the promotion of epistemological change happens with students, this, in turn, facilitates conceptual change” (p. 77). In Turkish Elementary Science Education Curriculum it is stated that one of the main goal of education is to improve the students’ learning and thinking abilities; therefore to access this goal it is important to measure students’ epistemological beliefs and variables (e.g. metacognition, critical thinking ability) that have relationship and influence on this beliefs. Therefore; considering the importance of epistemological beliefs in students’ learning process and how students reach knowledge, in this study we claimed that students’ metacognitive awareness level might predict their scientific epistemological beliefs and the we explored the predictive influence of Turkish eight grade elementary students’ metacognitive awareness level on their scientific epistemological beliefs.

THEORETICAL FRAMEWORK

Epistemological beliefs refer to beliefs of students related with knowledge (Hofer & Pintrich, 1997). William G. Perry (1970) is the first person who investigated students’ beliefs experimentally. Based on relativistic and dualistic approaches of students toward beliefs; Perry divided students into two groups. This means that students who are in the dualistic approach side consider that knowledge is certain (right or wrong) and derived from authority however; students in the relativistic approach side; they are questioning the certainness of the knowledge. After his studies; Belenky, Tarule and Goldberger (1986) worked on gender issue through epistemological beliefs and later, Magolda (1994) developed Women’s Ways of Knowing model and examined the development processes of women’s epistemological beliefs. She interviewed 135 women by asking them vulnerable questions to evaluate different aspects of their epistemological beliefs. In addition, Schommer (1993) has developed new model for conceptualizing beliefs and developed new instrument to measure general epistemological beliefs of students. In contrast to Perry; she suggested that epistemological beliefs are multidimensional. In her hypothesis; Schommer stated that students’ beliefs toward knowledge are related with five basic dimensions which are knowledge is simple or complex, knowledge is certain or tentative, ability to learn is fixed or acquired, knowledge is occurred quickly or step by step and knowledge is handed down by the authority or not. Besides, Hofer (2000) developed a quantitative instrument that is called Disciplined Focused Epistemological Beliefs Questionnaire (DFEBQ) to measure students’ epistemological beliefs. For the purpose of the present study we used DFEBQ to measure students’ scientific epistemological beliefs to examine young students’ epistemological beliefs.

Metacognition defined as the ability to reflect upon, understand, and control one’s learning (Schraw & Dennison, 1994) and the term metacognitive awareness refers to students learning to both be aware of and to control thinking processes (Wyre, 2007). Previous research indicated that metacognition has two major components (Brown, 1987; Flavell, 1987; Jacobs & Paris, 1987) that are knowledge of cognition and regulation of cognition. Knowledge of cognition includes what individuals know about their own self strategies about their cognition and being aware of how, when and why they use these strategies (Schraw & Dennison, 1994). Regulation of knowing includes number of sub processes that enhance the control aspects of learning (Schraw & Dennison, 1994). Research studies have revealed that if students are more metacognitively aware; they become more strategic and perform better than students who are less aware (Garner & Alexander, 1989; Pressley & Ghatala, 1990).

There has been growing research about whether there exist any relationship between epistemological beliefs and metacognition. Some have claimed that a connection between metacognition and personal epistemology must be considered (Bendixen & Hartley, 2003; Dean & Kuhn, 2003; Hammouri, 2003; Hofer, 2004b; Kuhn et al., 1995). The contention is that when one facilitates a student’s thinking about his or her thinking process, that student will indicate improved skills associated with more mature epistemologies. For instance; Kuhn (2001) stated “To fully understand processes of knowing and knowledge acquisition, it is necessary to examine people’s understanding of their own knowledge”. In recent years; there have been an increasing effort to develop a new “integrated” construct (Bendixen & Rule, 2004) or model in which personal epistemology and

other factors such as metacognition are combined (Hofer, 2004b; Schommer-Aikins, 2004). Bendixen (2002) and Bendixen and Rule (2004) presented an integrated model in which epistemological belief and metacognition are indicated to be part of a larger process. In addition to these researchers; Hofer thought metacognition as critical to any development. The model of metacognition, Hofer (2004b) used, includes three components. One is metacognitive knowledge, that refers to “the most static and includes one’s knowledge about cognition and strategies, as well as knowledge of self as a learner or thinker” (Hofer, p. 48). In this component, Hofer embedded the epistemological dimensions of certainty of knowledge and simplicity of knowledge. Another component of the metacognition model is metacognitive judgments and monitoring, which includes thinking that is “more process-oriented and involve such aspects as judging task difficulty, monitoring one’s comprehension and learning, and assessing confidence” (Hofer, p. 48). This component embedded the epistemic dimensions of the source of knowledge and justification for knowing. The last component is self-regulation and control of cognition and learning. This component is interested in “planning, strategy selection, allocation of resources, and volitional control” (Hofer, p. 48).

Considering the lack of studies and the nature of the relationship between metacognitive enrichment and the maturing of a student’s personal epistemology (Buelh, 2003), examining the interplay between metacognitive awareness and scientific epistemological beliefs will contribute to the studies conducted in the field of science education.

METHOD

The Discipline Focused Epistemological Beliefs Questionnaire and Metacognitive Awareness Inventory were administrated to 250 eight grade students in five elementary public schools located in Ankara, Turkey and schools were randomly selected.

Discipline Focused Epistemological Beliefs Questionnaire (DFEBQ)

Discipline Focused Epistemological Beliefs Questionnaire (DFEBQ) developed by Hofer (2000) was used to measure students’ epistemological beliefs in four factors (certainty/ simplicity of knowledge, justification for knowing, source of the knowledge and attainability of truth). Exploratory factor analysis and reliability analysis was conducted to ensure reliability and validity of the translation form of the instrument. Exploratory factor analysis produced three factor structures namely, certainty/ simplicity of knowledge, source of the knowledge and attainability of truth. Cronbach alpha values for these dimensions were ranging from .53 to .63.

Metacognitive Awareness Inventory (MAI)

A 52 item Metacognitive Awareness Inventory (Schraw & Dennison, 1994) was translated and adapted into Turkish by Sungur and Şenler (2009). MAI includes items belonging to knowledge of cognition and regulation of cognition components of metacognition. Reliability analysis indicated that the Cronbach alpha values of these dimensions were ranging from .75 and .89.

Data analysis

To see the relationship that might exist among students’ scientific epistemological beliefs dimensions and metacognitive awareness level; Pearson correlation analysis was computed. In the second part of data analysis, Multiple Regression Correlation (MRC) Analysis was used to explore contributions of students’ metacognitive awareness level to their scientific epistemological beliefs.

RESULTS

Descriptive statistics for the data obtained showed that participants of this study have a higher mean score on epistemological beliefs indicates agreement with less sophisticated epistemological beliefs. Pearson correlation indicated that both knowledge of cognition and regulation of cognition dimensions of metacognition related

with certainty/simplicity of knowledge, source of knowledge, attainability of truth dimensions of epistemological beliefs. Analysis revealed that knowledge of condition dimension is significantly related with certainty/simplicity of knowledge, $r = .270$, $p < .05$, source of the knowledge, $r = .247$, $p < .05$ and attainability of truth, $r = .214$, $p < .05$. Moreover; regulation of cognition dimension is also significantly correlated with certainty/simplicity of knowledge, $r = .325$, $p < .05$, source of the knowledge, $r = .263$, $p < .05$ and attainability of truth, $r = .249$, $p < .05$.

Multiple Regression Correlation (MRC) Analysis was used to explore contributions of students' metacognitive awareness level to their scientific epistemological beliefs. The analysis indicated that with $R = .327$, with $R^2 = .107$, regulation of cognition significantly accounted for 11% of the variation in students' beliefs toward certainty/simplicity of knowledge ($F = 14.772$, $p < .05$). This means that regulation of cognition made a statistically significant contribution to the variation in students' understanding beliefs toward certainty/simplicity of knowledge. Moreover; another MRC analysis revealed that with $R = .252$, with $R^2 = .064$ regulation of cognition significantly accounted for 7% of the variation in students' beliefs toward attainability of truth ($F = 8.396$, $p < .05$). Regulation of cognition made a statistically significant contribution to the variation in students' understanding beliefs toward attainability of truth. Results with $.203$ beta value indicated that regulation of cognition level of students might predict their beliefs toward attainability of truth.

In conclusion; the positive beta values indicated that students controlling all aspect of their learning tended to see scientific knowledge as more certain, simple as well as more attainable.

DISCUSSION

This study investigated the contributions of metacognitive awareness level to students' scientific epistemological beliefs. Regarding Pearson Correlation analysis, this study revealed that knowledge of cognition and regulation of cognition dimensions of metacognitive awareness level positively associated with certainty/simplicity of knowledge, source of knowledge and attainability of truth dimensions of epistemological beliefs. Highest correlation was observed between regulation of cognition and certainty/simplicity of knowledge domains. This means that students, who can control their learning process, easily believe that scientific knowledge is more certain and more simple, in other words they hold less sophisticated epistemological beliefs concerning simplicity/certainty of knowledge domain. This result can be explained by considering characteristics of learning environment, critical thinking ability and background knowledge of students that have great influence on students' metacognition and their epistemological beliefs (Schommer & Aikins, 2004). For instance, students might consider that if scientific knowledge was more complex and uncertain; it would be difficult to learn and control learning of knowledge. Therefore, students might think that if they can control their learning process in science subject easily, this might be resulted from certainty and simplicity features of scientific knowledge. Multiple Regression Analysis indicated that eight grade elementary students who indicate more tendencies to control all aspect of their learning, have less sophisticated epistemological beliefs concerning certainty/simplicity of knowledge and attainability of truth dimensions. This result is somewhat surprising because studies claim that when one have higher awareness of him/her learning strategies and controlling strategies for him/her learning, s/he will demonstrate improved skills associated with more mature epistemologies (Bendixen & Hartley, 2003; Dean & Kuhn, 2003). However there is not much consensus about this issue, for instance a study conducted in India suggested that preservice teachers who are aware of their own strengths, weaknesses and their strategies for learning, they do not recognize that scientific knowledge is subjective and they consider scientific knowledge as more certain (Akerson & Donnelly, 2008). In another study, it is found that although students have higher metacognitive awareness level; they might not have sophisticated epistemological beliefs (Yılmaz & Topçu, 2010). In fact, some studies claimed that relationships among epistemological beliefs, metacognition and learning variables would be highly context-sensitive (Pintrich & Hofer, 1997). This means that it would be difficult to generalize how epistemological beliefs promote or restrict metacognition and learning, therefore generalizations between these variables might not be true across different context or domains, for this reason variation among results of different

studies is quietly possible. This research might generate different findings and different relationships for the future and there needs to develop new models in order to explain why and how personal epistemological beliefs related to metacognition and learning in academic context. Moreover; there exist many other variables that might influence students' epistemological beliefs level. One of these variables is teacher' beliefs and attitudes toward nature of scientific knowledge that further affect students' epistemological beliefs systems toward science. For example; if teachers generally emphasize that scientific knowledge consists of facts and truths, then students would try to learn scientific knowledge based on facts and truths, they would believe that scientific knowledge is certain and they will try to study for memorizing the facts, truths and learn certain knowledge to get higher grade from exam. Therefore although students develop better metacognitive strategy for learning and controlling their learning in science; they might have less sophisticated epistemological beliefs toward science.

There are a number of limitations of the present study. First, the study was limited by its reliance on self-reported data. Subsequent research is needed to verify the consistency and accuracy of the present findings through use of multiple methods and measures. Secondly, the study conducted by a relatively small sample. Future research will use larger data set to obtain broader and more comprehensive picture of students' epistemological beliefs and their metacognitive awareness level. Current study is limited to 8th graders and science domain. Thus, this research can be replicated by using different grade level and different domains, such as mathematics, literacy, history.

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