Mathematical Modeling of Preschool Children's Epistemological Views

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Abstract

Epistemology is a branch of philosophy that focuses on the source, nature, limitations, system and accuracy of human knowledge. Children's epistemological views start to develop in the very early years as they gradually develop the ability to understand others' beliefs, actions, and desires, with primary attention to the onset of this cognitive achievement occurs between the ages of 3 and 5 (Burr and Hofer, 2002). The purpose of the current study was to analyze and model epistemological views of five-year-old children. The mathematical model developed for this study attempts to predict to what direction the missing domains in young children's epistemological thoughts will be evolved. Significant and profound changes in children's concept of the mind occurs between the ages of 3 and 5, allowing a five-year-old perform better in some tasks in the cognitive field (Gopnik and Astington, 1988). This study was carried out with a total of 183 five-year-old children (79 boys and 84 girls), from five state preschools. The Epistemological Beliefs Scale for Children (EBSC) was used for the data collection. EBSC is based on Elder's (2002) Scientific Epistemological Beliefs Scale (SEBS) and was adapted for children by the researchers of the current study. EBSC consists of 25 practical items in the following five sub-dimensions: authority/accuracy, knowledge production process, sources of knowledge, hypothesizing, and change of knowledge. EBSC was prepared as a three-point Likert-type scale with the Cronbach alpha value of .87. According to the results of the descriptive statistics obtained from EBSC, dogmatic thoughts shaped children's epistemological views (54%). In particular, authority/accuracy, the source of knowledge and hypothesizing sub-dimensions of epistemological views were the areas in which dogmatic thinking was most apparent. Despite not being in the majority, a considerable percentage of children (38%) had skeptical thoughts, which is a promising result. The remaining 8% of the children had not yet constructed conceptual knowledge.

Keywords: *early childhood education; philosophy; children's epistemological views; mathematical model for epistemology*

Introduction

Driven by the strongest, intrinsic curiosity, humankind has been trying to discover itself, life, and the world since the beginning of time. Being one of the natural results of this process, philosophy, as the oldest scientific discipline, offers many different answers to the same questions since the ancient Greek times. Defined as a love of wisdom, philosophy not only focuses on many fields such as ontology, education, science, ethics and art but also directs the development of these fields.

Epistemology, as a branch of philosophy concerned with the theory of knowledge, poses questions about the source, nature, limitations, system and accuracy of human knowledge (Brownlee, Purdie and Boulton-Lewis, 2001; Hofer and Pintrich, 2002; Ravindran, Greene and DeBacker, 2005). According to Mascaro and Morin (2015), there is no theory "that would unify the range of epistemic intuitions elicited by falsity and truth, by facts and by the way propositions adhere to them (or fail to do so) (p. 1)". Even so, epistemology focuses on the structure, sources, boundaries and justification of knowledge while personal epistemology in psychological literature relates to individuals' perceptions on what knowledge is and how to know (Hofer and Bendixen, 2012; Ryan, 1984).

Personal epistemology is interested in what individuals believe about the source, certainty, and organization of knowledge, as well as the control and the speed of learning. Epistemological beliefs have been found to relate to reading comprehension, learning in complex and ill-structured domains, as well as learners' active participation and persistence in learning (Schommer, 1994). In other words, personal epistemology focuses on explaining the epistemological views of individuals by asking questions such as:

- Is knowledge constructed by a person or learned using innate talents?
- Are individuals connaturally intelligent or do they learn by their own efforts?
- Is learning ability inherent or acquired over time? (Dinç, İnel and Üztemur, 2016)

Personal epistemological development and epistemological views are growing areas of interest for psychologists and educators focusing on topics like how individuals come to know, the theories and beliefs they hold about knowing, and the manner in which such epistemological premises a part are of and an influence on the cognitive processes of thinking and reasoning (Hofer and Pintrich, 1997). Various authors see epistemological views as a developmental path from simple to complex, from undeveloped / immature/ naive beliefs to mature/ sophisticated beliefs. Developmental approaches, such as Perry's Scheme of Intellectual and Ethical Development (Perry, 1970), Women's ways of knowing (Belenky, Clinchy, Goldberg and Tarule, 1986), Epistemological Reflection Model (Baxter Magolda, 1992), and the Reflective Judgment Model (King and Kitchener, 1994), all assume that epistemological views of children follow a predictable path.

Schommer was the first author who questioned the validity of developmental approaches that divide the progress of epistemological views into stages, claiming, *"*A more plausible conception is that personal epistemology is a belief system that is composed of several more or less independent dimensions. Beliefs about the nature of knowledge are far too complex to be captured in a single dimension (p. 498) (Murray, 2013)*"*. On the other hand, some researchers discuss the nature of knowledge and the nature of knowing (Hofer and Pintrich, 2002; King and Kitchener, 1994; Perry, 1999). Dogmatic thoughts on knowledge are based on the external development and definition of knowledge without questioning it while skeptical thoughts on knowledge accept authority-free development of knowledge based on questioning (Hofer and Pintrich, 1997). Moving

from the former towards the latter indicates a shift from absolute/unchanging knowledge to non-absolute/changing knowledge in epistemological views (Perry, 1981). Dogmatic attitude, whether in general or toward a range of propositions, but in what it is to hold a belief dogmatically? The general attitude is that, in some way a matter of dogmatically holding beliefs, and the personality trait of dogmatism is in some way a matter of having dogmatic attitudes. Dogmatism in relation to a belief is not equivalent to stubbornness in holding it; for even if a dogmatically held belief cannot be easily given up, one could be stubborn in holding a belief simply from attachment to it, and without the required disposition to defend it or regard it as better grounded than alternatives (Audi, 1988, De Villiers and Pyers, 2002).

Dogma means taking accepted ideas without asking for evidence (Schofield, Burnyeat and Barnes, 2002) and dogmatism is a form of opinion or belief that consists of strong stereotypes and unquestioned information (Ambrose, Sternberg, and Sriraman, 2013). Dogmatism based mainly on a merely academic understanding does not allow knowledge to change; in addition, dogmatists can be committed to some doctrines, which are considered as indisputable in terms of truth and facts (Aydın, 2004). The dogmatist assumes that only form of knowledge or idea is correct and there is no need to present proof about them (Çüçen, 2001). The more dogmatic the individual's thinking style, caused by factors such as the family, moral values and personality features of the person, the more dogmatism views he will possess (Brown, 2012). Dogmatism inhibits individuals from thinking creatively by narrowing and shortening their viewpoint (Ambrose and Sternberg, 2012).

Skepticism, on the other hand, is a philosophical standpoint advocating that we do not have as much knowledge as we think we do, to make judgments (O'Brien, 2006; Popkin, 2003; Pritchard, 2013). The extreme version of skepticism advocates that we even do not have the ability to possess beliefs, which are known to be true; in other words, absolute knowledge is impossible (Hazlett, 2014; Morton, 1997). Skepticism as a method, however, is about more than doubt about knowledge; it is using doubt as a way to gain knowledge (Çüçen, 2001). Thus, the distinction between a dogmatic person and a sceptic is in their reactions to understand of what it means to search for while the dogmatic person claims that they reached what they are looking for without doubting, the sceptic continues searching (Hankinson, 1995; Popkin and Neto, 2007). Schools need to teach children to be skeptical by questioning the authority of the words, which they read as analytical thinkers (DeVoogd, 2006). It is widely claimed that it is very important to teach students to think skeptically in order to improve their critical thinking skills, such as judging, evaluating, and problem solving (Lai, 2011).

According to the results of various studies, children's epistemological views begin developing in the very early years (Collins and Pinch, 1993; Schommer, 1990; Yang and Tsai, 2010). These beliefs may influence comprehension and cognition in academic tasks; in any case, the research was most concerned with classroom learning. In addition, children's epistemological views are affected by their emotions and experiences (Yang and Tsai, 2010). For learners to select appropriate high-quality content from which to learn, and to be able to deal with multiple conflicting viewpoints, it is critical that they develop appropriate learning skills, are able to regulate the emotions they experience during learning and develop the ability to evaluate the epistemic aspects of new information (Muis, Chevrier and Singh, 2018). Generally, children's epistemological beliefs have an egocentric edge in early years, with limits to knowledge acquisition and sources of knowledge based on authority figures. This early period is marked by the egocentrism, and contrasts with the subjectivity of multiplism, in which an individual recognizes multiple opinions of others and acknowledges them as equally valid, unable to yet evaluate competing claims (Piaget,

1955). This initial stage (egocentric subjectivity) progresses to a certain, absolute, objective view of knowledge (dualism) in which the views of others are recognized but may be challenged, to an uncertain subjectivism (multiplism), to the coordination of objectivity and subjectivity and a reconciliation of knower and known (constructivism or evaluativism) (Inhelder and Piaget, 1958). The preschoolers in their study were generally absolutists, claiming that only one character could be correct. These children often consulted authority figures and used personal experience as their justification for knowing (Burr and Hofer, 2002). Through the maturing and development of the brain, epistemological views may change and move towards a skeptical structure (Weinstock, Neuman and Glassner, 2006). Wellman (1990) claims those children's beliefs about knowing and knowledge are part of their theory of mind. From this perspective, personal changes in worldview over a 3- to 4-year-period indicate that the period of early adolescence ties in with the onset of epistemological reasoning. Montgomery (1992) suggests that investigation of these beliefs in children fit within developmental studies of folk epistemology, which deals with the nature of knowledge and its acquisition. He examined children's definition of knowing and their approach to attributing conflicting truth propositions and acknowledging sources of knowledge.

Significance of the Study

Skeptical thinking and critical thinking skills play central roles in cognitive processes, such as problem solving, analytical approaches, and decision-making. For this reason, understanding how children gain knowledge via different approaches and determining the elements of these approaches are crucial steps in supporting children's cognitive development and their education. Understanding the children's approach to knowledge is important to help them improve their epistemological views and to the design an effective learning environment, which will encourage them to construct their own knowledge rather than memorizing knowledge presented by adults. Therefore, modeling the children's epistemological views in a mathematical axiom may help to evaluate children's thinking system more efficiently. Development of such model with a mathematical algorithm based on standard calculations will provide a concrete and analytical tool for studying the development epistemological beliefs in early childhood age children. Distinct from the other models developed in this area, the mathematical model developed in this study not only provides concrete data regarding the epistemological thoughts of young children, but also indicates a potential on to which direction children's epistemological thoughts might evolve by analyzing the "missing domains," or the epistemological questions that children answer as "I don't know."

Methodology

Study Group

The participants were 183 five-year-old children (79 boys and 84 girls) attending five public preschools located in Ankara, Turkey in the 2015-2016 academic year. The children came from families with low to mid-high socio-economic status, and the schools were conveniently selected for the study. A total of 15 classes (three from each school) took part in the study. All the students, whose parents provided written permission, were included in the data collection procedures.

Human subject approval was obtained from the University Review Board, and the necessary permissions for data collection from public schools were granted by the Turkish Ministry of National Education. Parental consent was obtained via signed parental consent forms (pre-approved by both the University Review Board and the Ministry of National Education).

The Instrument

The Epistemological Beliefs Scale for Children (EBSC, See Appendix I) was used as a data collection instrument. EBSC was developed by Güneş (2014), based on Elder's (2002) Scientific Epistemological Beliefs Scale was adapted for children by the researchers of the current study. EBSC has 25 practical items in the following five sub-dimensions: authority/accuracy, knowledge production process, sources of knowledge, hypothesizing, and change of knowledge. EBSC was prepared as a three-point Likert-type scale and the EBSC Cronbach alpha value was found to be .87 in this research. The time needed to implement EBSC was on average between 15-20 minutes.

Sample items from EBSC are given in Table 1. The responses were evaluated using the postulations of Hofer and Pintrich (1997) about epistemology questions concerning dogmatic and skeptical thoughts.

Table 1. *Items and Evaluation of EBSC*

Items of EBSC		**Skeptical (3 points)**	**Dogmatic (2 points)**	**No answer (1 point)**
Item 1	Which one sinks and which one floats (stone and wood)? And why?	Finding by doing and hypothesizing	Giving a direct response and dogmatic arguments (I heard it from my teacher or parents, I saw it in a cartoon)	I do not know
Item 5	Do you think the teacher knows everything or are there things s/he does not know about?	She/he may not know everything	She/he knows everything	I do not know
Item 16	Do you think all children should believe everything their parents/teachers say or are there times that they do not have to believe what they say?	We should not believe everything	We should believe everything	I do not know

Data Analysis

The results obtained from EBSC were presented using a scale interval formula (series width/number of groups [2/3≈0.66]). Accordingly, the interval values in EBSC were: 1.00-1.66 interval for "no knowledge – conceptual knowledge not yet constructed", 1.67-2.33 for "dogmatic philosophical thought", and 2.34-3.00 for "skeptical philosophical thought."

Mathematical Modeling

The epistemological model has been developed as a mathematical model in which the aim is that the structural characteristics and working principles of an object or situation in real life beyond its physical characteristics (Lehrer and Schauble, 2007; Lesh and Doerr, 2003) are described with patterns, symbols, and formulae (Verschaffel, Greer and De Corte, 2002) using a mathematical language (Haines and Crouch, 2001).

The dogmatic thought points are placed as x=-1 and skeptical thought point values are placed as x=+1 on the geometry plane. Therefore, the +x direction on the axis on the plane represents the skeptical philosophical thinking domain while the -x direction on the axis on the plane represents the dogmatic philosophical thinking domain. The y axis represents "no knowledge-conceptual knowledge not yet constructed". Each axis length is considered as 1.00 unit.

In the mathematical modeling, the philosophical thought points are determined on the axis of x=-1 and x=+1 line (epistemological sub-dimensions axis) by calculating the frequency values of the responses given by all the children in the study to the questions in the sub-dimensions. For instance, a total of 815 (163*5) answers were obtained for questions 6, 10, 13, 14 and 25 in the *Source of Knowledge* sub-dimension, and the rate of the responses for each philosophical thought were calculated to determine the sub-dimension point value. After determining the sub-dimension point value, the sub-dimensions curved lines were obtained from these values. The curved lines indicate the area of philosophical thought belonging to the related EBSC sub-dimensions. All domains under the sub-dimensions curved lines determine the total of the epistemological views of the children.

Findings

The descriptive statistical results of EBSC are given in Table 2.

Table 2. *EBSC Descriptive Statistics and Scale Interval Results*

Sub-dimension	Min.	Max.	SD	S	$\bar{X}$	Scale interval
Authority/ accuracy	7.00	21.00	2.34	5.17	11.83	1.69= Dogmatic Thought
Knowledge production process	7.00	21.00	3.07	9.43	16.44	2.35= Skeptical Thought
Source of knowledge	5.00	15.00	2.17	4.71	8.75	1.75= Dogmatic Thought
Hypothesizing	3.00	9.00	1.45	2.09	6.64	2.21= Dogmatic Thought
Change in knowledge	3.00	9.00	1.47	2.10	7.10	2.37= Skeptical Thought
Total EBSC	28.00	75.00	8.51	72.42	50.76	2.03= Dogmatic Thought

As shown in Table 2, the children's epistemological views were generally between the borders of dogmatic philosophical thought. The cut-off point between dogmatic and skeptical

philosophical thought was determined as 2.33 in this research. Therefore, preschool children with the scale values of 2.35 and 2.37 may slightly exceed the limit of skeptical philosophical thinking. In the sub-dimensions of knowledge production and change in knowledge, the children moved away from statements implying dogmatic philosophical thought while they seemed to prefer loyalty to authority/accuracy and external sources, tools or solutions for the source of knowledge and hypostasizing process.

The point values of EBSC are given in Table 3.

Table 3. *Point Values of Sub-Dimensions in EBSC*

	Items			
Authority/Accuracy				
	1	12	109	42
	5	11	112	40
	12	14	114	35
	15	16	116	31
	16	13	116	34
	20	13	100	50
	23	12	99	52
		91	766	284
	Point value	**.08**	**.67**	**.25**
Knowledge production process				
	3	13	73	77
	4	12	67	84
	7	14	69	80
	8	12	71	80
	11	16	75	72
	18	17	70	76
	24	14	65	84
		98	490	553
	Point value	**.08**	**.43**	**.49**
Source of knowledge				
	6	12	105	46
	10	10	110	43
	13	11	108	44
	14	14	111	38
	25	13	106	44
		60	540	215
	Point value	**.07**	**.63**	**.30**
Hypothesizing				
	2	12	101	50
	21	10	102	51
	22	9	87	67

		31	290	168
	Point value	**.07**	**.60**	**.33**
Change in knowledge				
	9	10	64	89
	17	13	63	87
	19	11	60	92
		34	187	268
	Point value	**.07**	**.39**	**.54**

The sub-dimensions curved lines can be determined from the point values from EBSC (Figure 1, next page). In this figure, x=-1 and x=+1 axes indicate dogmatic and skeptical thoughts, respectively, and the y axis represents no knowledge. For the *authority/accuracy* sub-dimension, the curved lines pass from y_2=.67 points on x=-1, y=.08 points on y axis and y_1=.25 points on x=+1 axis. The curved lines *of the knowledge production process* sub-dimension pass from y_2=.43 points on the x=-1 axis, y=.08 points on the y axis, and y_1=.49 points on the x=+1 axis. For the *source of knowledge* sub-dimension, the curved lines pass from y_2=.63 points on the x=-1, .07 points on the y axis, and y_1=.30 points on the x=+1 axis. The curved lines of the *hypothesizing* sub-dimension pass from y_2=.60 points on the x=-1 axis, .07 points on the y axis, and y_1=.33 points on the x=+1 axis. For the *change in knowledge* sub-dimension the curved lines pass from y_2=.39 points on the x=-1 axis, .07 points on the y axis, and y_1=.54 points on the x=+1 axis.

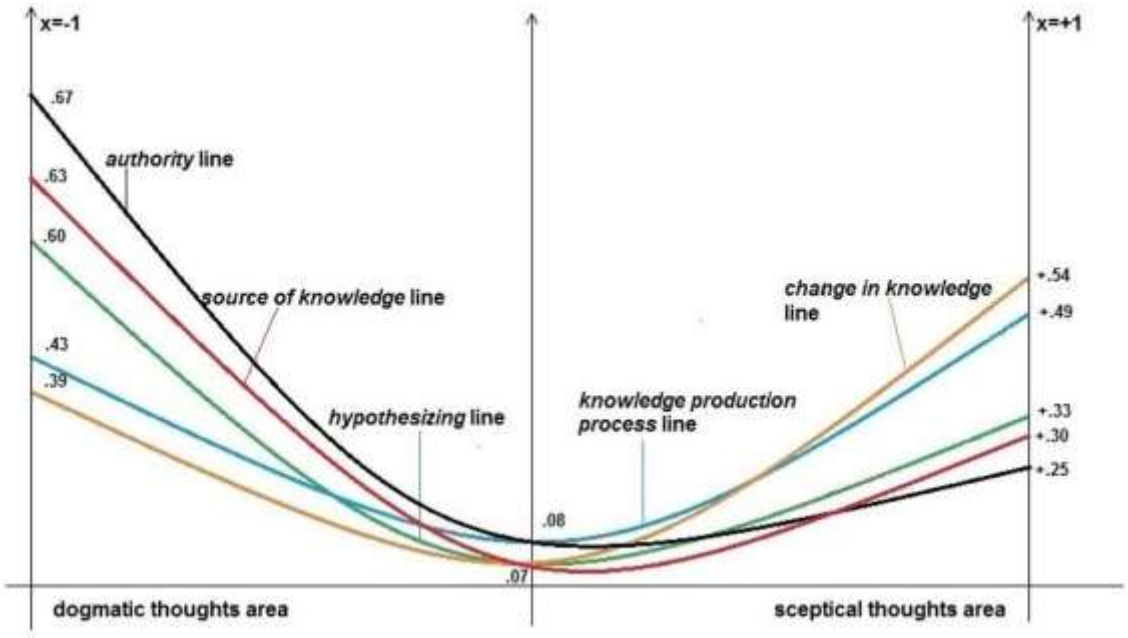

Figure 1. The curved lines showing the children's epistemological views

These curved lines can be used to calculate the areas of children's epistemological views. From under the curved line, the area of relevant sub-dimensions of epistemological views can be determined. The calculation can be achieved with the application of an integral First, a line

equation for each sub-dimension of epistemological views has to be found. The line equations of the sub-dimensions for dogmatic and skeptical thoughts are shown in Table 4.

Table 4. *The Line Equations of Sub-Dimensions for Dogmatic and Skeptical Thoughts*

Sub-dimensions	**Dogmatic Thought Equations**
Authority/Accuracy	$d \Rightarrow \frac{y_2-y_1}{x_2-x_1}=\frac{y-y_2}{x-x_2} \Rightarrow \frac{.67-.08}{-1.00-(0)}=\frac{y-(.67)}{x-(-1)}; d \rightarrow f(x)=-.59x+.08$
Knowledge Production Process	$d \Rightarrow \frac{y_2-y_1}{x_2-x_1}=\frac{y-y_2}{x-x_2} \Rightarrow \frac{.43-.08}{-1.00-(0)}=\frac{y-(.43)}{x-(-1)}; d \rightarrow f(x)=-.35x+.08$
Source of Knowledge	$d \Rightarrow \frac{y_2-y_1}{x_2-x_1}=\frac{y-y_2}{x-x_2} \Rightarrow \frac{.63-.07}{-1.00-(0)}=\frac{y-(.63)}{x-(-1)}; d \rightarrow f(x)=-.56x+.07$
Hypothesizing	$d \Rightarrow \frac{y_2-y_1}{x_2-x_1}=\frac{y-y_2}{x-x_2} \Rightarrow \frac{.60-.07}{-1.00-(0)}=\frac{y-(.60)}{x-(-1)}; d \rightarrow f(x)=-.53x+.07$
Change in Knowledge	$d \Rightarrow \frac{y_2-y_1}{x_2-x_1}=\frac{y-y_2}{x-x_2} \Rightarrow \frac{.39-.07}{-1.00-(0)}=\frac{y-(.39)}{x-(-1)}; d \rightarrow f(x)=-.32x+.07$
Sub dimensions	**Skeptical Thought Equations**
Authority/Accuracy	$d \Rightarrow \frac{y_2-y_1}{x_2-x_1}=\frac{y-y_2}{x-x_2} \Rightarrow \frac{.25-.08}{1.00-(0)}=\frac{y-(.25)}{x-1}; d \rightarrow f(x)=.17x+.08$
Knowledge Production Process	$d \Rightarrow \frac{y_2-y_1}{x_2-x_1}=\frac{y-y_2}{x-x_2} \Rightarrow \frac{.49-.08}{1.00-(0)}=\frac{y-(.49)}{x-1}; d \rightarrow f(x)=.41x+.08$
Source of Knowledge	$d \Rightarrow \frac{y_2-y_1}{x_2-x_1}=\frac{y-y_2}{x-x_2} = \frac{.30-.07}{1.00-(0)}=\frac{y-(.30)}{x-1}; d \rightarrow f(x)=.23x+.07$
Hypothesizing	$d \Rightarrow \frac{y_2-y_1}{x_2-x_1}=\frac{y-y_2}{x-x_2} \Rightarrow \frac{.33-.07}{1.00-(0)}=\frac{y-(.33)}{x-1}; d \rightarrow f(x)=.26x+.07$
Change in Knowledge	$d \Rightarrow \frac{y_2-y_1}{x_2-x_1}=\frac{y-y_2}{x-x_2} \Rightarrow \frac{.54-.07}{1.00-(0)}=\frac{y-(.54)}{x-1}; d \rightarrow f(x)=.47x+.07$

The areas of epistemological views are shown in Table 5 according to the sub-dimensions.

Table 5. *The Areas of Epistemological Views and the Ratios of These Areas by Sub-Dimension*

Sub dimensions	**Kind**	**Thought areas**	**%**
Authority/ Accuracy	Dogmatic	$S=\int_{-1.00}^{0} f(x)dx=\int_{-1.00}^{0} -.59x+.08=-.295x^2+\frac{4}{5}x\Big\vert_{-1.00}^{0}=-.375S$	.375/.54= 69%
	Skeptical	$S=\int_{1.00}^{0} f(x)dx=\int_{1.00}^{0} .17x+.08=.085x^2+\frac{4}{5}x\Big\vert_{1.00}^{0}=.165S$	.165/.54= 31%

Knowledge Production Process	Dogmatic	$S=\int_{-1.00}^{0} f(x)dx=\int_{-1.00}^{0} -.35x+.08=-.175x^2+\frac{4}{5}x\Big\vert_{-1.00}^{0}=-.255S$	.255/.54= 47%
	Skeptical	$S=\int_{1.00}^{0} f(x)dx=\int_{1.00}^{0} .41x+.08=.205x^2+\frac{4}{5}x\Big\vert_{1.00}^{0}=.285S$	.285/.54= 53%
Source of Knowledge	Dogmatic	$S=\int_{-1.00}^{0} f(x)dx=\int_{-1.00}^{0} -.56x+.07=-.28x^2+\frac{7}{10}x\Big\vert_{-1.00}^{0}=-.350S$	.350/.54= 65%
	Skeptical	$S=\int_{1.00}^{0} f(x)dx=\int_{1.00}^{0} .23x+.07=-.115x^2+\frac{7}{10}x\Big\vert_{1.00}^{0}=-.185S$	.185/.54= 35%
Hypothesizing	Dogmatic	$S=\int_{-1.00}^{0} f(x)dx=\int_{-1.00}^{0} -.53x+.07=-.265x^2+\frac{7}{10}x\Big\vert_{-1.00}^{0}=-.335S$	.335/.54= 62%
	Skeptical	$S=\int_{1.00}^{0} f(x)dx=\int_{1.00}^{0} .26x+.07=.13x^2+\frac{7}{10}x\Big\vert_{1.00}^{0}=.200S$	.200/.54= 38%
Change in Knowledge	Dogmatic	$S=\int_{-1.00}^{0} f(x)dx=\int_{-1.00}^{0} -.32x+.07=-.16x^2+\frac{7}{10}x\Big\vert_{-1.00}^{0}=-.230S$	.230/.54= 43%
	Skeptical	$S=\int_{1.00}^{0} f(x)dx=\int_{1.00}^{0} .47x+.07=.235x^2+\frac{7}{10}x\Big\vert_{1.00}^{0}=.305S$	.305/.54= 57%

Table 5 shows that the participant children had a 57.2% dogmatic thought ratio in all sub-dimensions [69%+47%+65%+62%+43%]/500%) and 32.8% skeptical thought ratio in all sub-dimensions [31%+53%+35%+38%+57%]/500%). Interestingly, the areas of the sub-dimensions in epistemological views had different values from the relevant frequencies of the sub-dimensions in epistemological views. This result shows that it is not sufficient to evaluate the children's epistemological views only according to the frequencies or scores of the scales. The developed model provides a tool to overcome this difficulty by examining the domains under the sub-dimensions curved line. It is understood that the "no knowledge-conceptual knowledge not yet constructed" responses affects the ratio of epistemological views domains. This dramatic change is clearly shown in the authority/ accuracy sub-dimensions, in which the children had an 8% ratio regarding "no knowledge-conceptual knowledge not yet constructed." This can be accepted as a "missing domain" and changes the ratio of dogmatic and skeptical thought domains. For instance, the frequency of the authority/ accuracy sub-dimension was .67 *dogmatic thoughts*, .25 *skeptical thoughts* and .08 *no knowledge*; however, the domain ratios were 69% dogmatic thought and 31% skeptical thoughts. Thus, the missing domain (8%) in the authority/accuracy sub-dimension affects 75% (31%-25%=6%; 6%/8%=.75) of the skeptical thoughts and 25% (69%-67%=2%, 2%/8%=.25) of the dogmatic thoughts. The missing domain (8%) in the knowledge production process has an equal effect on the dogmatic thoughts (47%-43%=4%; 4%/8%=.50=50%) and skeptical thoughts (53%-49%=4%, 4%/8%=. 50=50%). The missing domain (7%) in the source of knowledge affects 29% (65%-63%=2%; 2%/7%=.29) of the dogmatic thoughts and 71% (35%-30%=5%, 5%/7%=.71) of the skeptical thoughts. The missing domain (%7) in hypothesizing affects 29% (62%-60%=2%; 2%/7%=.29) of the dogmatic thoughts and 71% (35%-30%=5%, 5%/7%=.71) of the skeptical thoughts. The missing domain (%7) in change in knowledge affects 57% (43%-39%=4%; 4%/7%=.57) of the dogmatic thoughts and 43% (53%-54%=3%, 3%/7%=.43) of the skeptical thoughts. The mathematical model developed in this study provides a projection of children's epistemological beliefs. Moreover, the model predicts the potential disposition of childrens' epistemological views by calculating the epistemological sub-dimension scores, their relation to each other, and the deviations from the standard scores.

Discussion

The findings provided by the model developed for this study are in line with the models developed by Perry (1981), Baxter Magolda (1992) and King and Kitchener (1994), who adopted different approaches to knowledge. These studies that examine the elements of knowledge and the development of epistemological views/beliefs, generally reported that children shift towards more flexible, changeable and questioning epistemological views. In the model adopted in the present study, the sources, change and hypothesizing processes of knowledge were used to examine the philosophical postulations developed to solve problems, and an effort was made to identify the thought domains formed by these hypotheses. According to the model, children's authority, source of knowledge and hypothesizing lines are so close with higher values than the other sub-dimension of epistemological views, which shows that the source of knowledge is dependent to the authority/accuracy for children. As defined in Baxter Magolda's epistemology model, this finding coincides with the absolute knower according to whom, knowledge is certain and authorities have all the answers (Baxter Magolda, 1992). Authority, source of knowledge and hypothesizing epistemological lines place in dogmatic areas can be interpreted from the point of view of King and Kitchener (1994) that knowledge is simple, concrete, and absolute and needs no justification for young children. The model shows that particularly the missing domains in authority/accuracy and source of knowledge sub-dimensions have significant effects on skeptical thoughts. Thus, these missing domains have a great potential to evolve to the skeptical domain in the future with cognitive development, maturing, increase in knowledge level and improving thinking skills. It is evident that there is a positive relation between both age and education and epistemological development (Burr and Hofer, 2002; Commons, Richards, and Armon, 1984; Commons, Sinnott, Richards, and Armon, 1989; Hofer and Pintrich, 1997; Inhelder and Piaget, 1958; King, 1977).

In the current study, although the majority of the participating children thought dogmatically, the percentage of children who held a skeptical point of view cannot be underestimated. The percentage of children who developed a skeptical perspective on knowledge in terms of sub-dimensions were: 31% in authority/accuracy, 35% in source of knowledge, 38% in hypothesizing whereas a large body of their personal epistemology tended to be more skeptical with 53% in knowledge production process and 57% in change in knowledge. This can be a crucial sign of dynamic thinking-freedom and flexibility in mental states allowing the viewpoints of individuals to vary with different contexts and content. This is contrary to the estimation that children have static thinking that refers to certain, unchangeable thoughts and automatism of actions (Pelczer, Singer and Voica, 2014). The results show that more than half of the young children in the current study welcomed changes in knowledge and producing knowledge. Thus, environments that allowed them to discover, ask questions and seek answers to their curiosity can change their personal epistemology from naive to more sophisticated. Moreover, social play, which requires listening and respecting different ideas, challenging tasks that promotes motivation and aims to reach new levels, and activities that requires problem solving and thinking alternatives can contribute to children's perceptions on how to know.

The children with a dogmatic thinking style have some similarities with individuals who are in the first positions or categories of some epistemological belief models. According to the Scheme of Intellectual and Ethical Development outlined by Perry (1968), *dualism* that is the first position referring to accepting knowledge based on authority without questioning since as a source of knowledge the authority knows right answers and absolute truths. Women's Ways of Knowing is a model that reflects women's epistemological views and development. In the *silence* position,

women are passive in the process of access to knowledge and they accept what authority figures say as true (Belenky, Clinchy, Goldberg and Tarule, 1986). Moreover, the Reflective Judgment Model focuses on development of reasoning from adolescence to adulthood. For individuals at *Stages 1 and 2 in the pre-reflective* level, knowledge is simple and based on concrete data. There are definite truths known by authority figures such as teachers, scientists and religious leaders (King and Kitchener, 1994). Baxter Magolda (2004) asserts that an *absolute* knower thinks that the accuracy of the knowledge given by authority figures, such as a teacher is certain.

Likewise, in Kuhn's model of Argumentative Reasoning, *absolutists* believe that experts have certain and absolute knowledge (Deryakulu, 2014). In a similar manner, generally, in the current study, children adopted dogmatic philosophical thinking regarding the accuracy and certainty of knowledge. Children can take everything that teachers say and all knowledge imparted by them as unconditionally accurate. Similar features can be recognized in children who have a dogmatic thinking style and those individuals in the first positions or levels of models of epistemological development. They believe that teachers do not teach the wrong information. This may reveal the influence of teachers' epistemological belief systems on those children (Anderson, 1984; Clark, 1988). Regarding this influence, Hofer (2001) and Schraw (2001) emphasize the potential role that teachers have in appropriately shaping and changing children's epistemological beliefs.

Moreover, Grüne-Yanoff (2014) comments that most students are only taught conventional methodology, meaning a fixed set of methods. These methods may influence children's thinking systems; however, a wider range of methods enable children to find various solutions for different problems and can also affect positively academic success (Schraw and Sinatra, 2004). Also, Schommer (1990) suggests that teachers should inform children in grade school that knowledge is integrated, that prior knowledge should be accessed, and that generally there is more than one right answer.

Many children in the current study seem to think that scientists and parents teach absolute and unchanging truths. Change of knowledge is only possible for some children (nearly 40%) through tools or the person they see as authority figures. Triandis (1989) stated that existing epistemological models posit a movement toward increased individualism of thought and a freedom from the dictates of authority. It is possible that in a more collectivist culture in which the view of self has inter individual implications, personal theories of knowledge and knowing could evolve toward an acceptance of consensus, not a reliance on independent thinking (Triandis, Bontempo, Villareal, Asai and Lucca, 1988). Students would believe that the certainty of knowledge is high and that the simplicity dimension is also high given the common belief that there is only one way to solve a problem. The data also suggests that in terms of the nature of knowing, the source is the teacher, an adult or something external to the learner, and justification of knowledge comes from the teacher or the field (Stodolsky, Salk and Glaessner, 1991). These should be evaluated in relation to the conclusion made by Anderson (1984) that teachers are children's second most effective experience guides and authority figures after their families, and Schommer's (1993) view that teachers may at times inadvertently affect children's epistemological views negatively. To overcome this problem and to achieve a specific set of results, it is necessary to give the positive epistemic role to learners, teachers and scientists (Biddle and Leuschner, 2015). Salmon and Lucas (2011) claim that teachers can improve children's thinking ability, and they can support children in thinking on thinking by applying a different approach.

In knowledge production processes, the empirical approaches of the children lead them to the postulations of skeptical philosophical thoughts. Experimental approaches by the children suggest that children make an effort to acquire knowledge, which develops their epistemological

views (Başbay 2013). Meanwhile, by learning, children start to seek external solutions to the problems in the loyalty to authority and hypothesizing sub-dimensions. The egocentric tendency seen in the epistemological views of the children in the present study is in line with Burr and Hofer's (2002) conclusion that early epistemological views start to develop subjectively during the children's egocentric era. The effects of children's emotions on epistemological views and their development may explain the reasons for certain responses being shaped by personal and momentary feelings (Louca, Elby, Hammer and Kagey, 2004). In addition, children's responses to epistemological activities are shaped by their daily routines and acquisitions from their social environment. The closest social learning circle (families-school-friends-teachers) determines the development of the epistemological views, which may also be the reason for negative/insufficient knowledge views, beliefs or values. According to Schommer (1990), the family structure and educational background affects the epistemological views of students. Individuals who are supported in constructing their ideas have more matured epistemological beliefs. This idea is promoted by Johnston, Woodside-Jiron and Day (2001) who argued that children acquire behavior routines, beliefs, values, roles and identities from their environment, which in the long run may turn into problems.

According to Vygotsky's sociocultural theory, children's learning is affected by the social and cultural environment in which they live (Marginson and Dang, 2017). Children who have a skeptical thinking style should be supported by their families or teachers by the means of fostering their critical thinking skills. Acharya (2016) claims that critical thinkers ask questions, find creative answers, question authorities and traditional beliefs, and most importantly challenge received dogmas. Young children can think and reason critically, and home and school environment can provide opportunities to foster their analytic and critical thinking skills through dialogue, play and reading interactions (Murphy, Rowe, Ramani and Silverman, 2014). In the same way, children's skeptical thinking can be fostered and promoted.

Conclusion and Implications

This study aimed to examine and model preschool children's epistemological views. The findings provided by the mathematical model of epistemological views are parallel with the models developed by Perry (1981), Baxter Magolda (1992) and King and Kitchener (1994), even though those models adopted different approaches to knowledge. These studies examine the elements of knowledge and the development of epistemological views/beliefs, generally reported that children shift towards more flexible, changeable and questioning epistemological views. In the model adopted in the present study, the sources, change and hypothesizing processes of knowledge were used to examine the philosophical postulations developed to solve problems, and an effort was made to identify the thought domains formed by these hypotheses. Although the current study was limited by the number of the sample group and the fixed age group, the results can be a source of inspiration for more similar studies to be carried out on the personal epistemology of young children. According to the results of the descriptive statistics obtained from EBSC, dogmatic views shaped children's epistemological views. This was particularly apparent in the authority/accuracy, source of knowledge and hypothesizing sub-dimensions of epistemological views. Approximately 54% of children's epistemological views were in the dogmatic thought domain, 38% in the skeptical philosophical thought domain, and nearly 8% in the missing domain. The distribution rates of sub-dimension areas were not balanced. The five dogmatic philosophical thought domains were: 67% for authority/ accuracy domain, 63% for source of knowledge, 60% for hypothesizing, 43% for knowledge production process, and lastly 39% for change in knowledge. On the other hand,

the results for the skeptical thought domains were: 25% for authority/ accuracy domain, 30% for source of knowledge domain, 33% for hypothesizing, 49% for knowledge production process, and 54% for change in knowledge. These results indicate that the children in the current study had skeptical thoughts in the sub-dimensions of knowledge production process and change in knowledge, and nearly 8% had not constructed conceptual knowledge yet.

In future, it may be useful to engage in longitudinal studies on the epistemological views of preschool children. With these studies, the variables influencing the formation and development of epistemological views and the levels of influence may be identified. More general epistemological models and their change over time can be undertaken with longitudinal studies containing very large sample sizes. The factors influencing the formation of the "*missing domain*" defined in epistemological models should also be studied. Practical studies should be conducted to narrow the missing domain in epistemological models. In addition, the mathematical models that will be developed can be used in other studies.

Moreover, a qualitative research study can allow researchers to gain a deeper understanding of the epistemological beliefs of children, particularly with the use of data triangulation. This method brings two or more methods together, such as case studies, interviews and surveys. Although each method has weaknesses, in triangulation, one method can help to eliminate the deficiencies of the others to improve validity (Gray, 2014). For example, based on the dimensions and questions of this study, a practitioner researcher or insider observer could observe children's behaviors when they want to know something: Who do they ask when they want to learn about something or what processes do they engage in (source of knowledge / knowledge production)? Do they change their belief about the knowledge or do they maintain the same belief for every element of knowledge as they did in the past (change in knowledge)? In addition, open-ended interview questions can provide information about children's perspective on knowledge: These days, is there anything you wonder about? How can you learn about it? (They may say "I can ask my mother/ father/teacher or I can observe or create an experiment." Their responses can give clues to the source of knowledge or authority/ accuracy). Then, the question can be posed as to why they chose that method.

References

Acharya, K. P. (2016). Fostering critical thinking practices at primary science classrooms in Nepal. *Istraživanja u Pedagogiji*, *6*(2), 1-7.

Ambrose, D., & Sternberg, R. J. (2012). *How dogmatic beliefs harm creativity and higher-level thinking*. New York: Routledge.

Ambrose, D., Sternberg, R., & Sriraman, B. (2013). *Confronting dogmatism in gifted education*. New York: Routledge.

Anderson, R. (1984). Some reflections on the acquisition of knowledge. *Educational Researcher*, 5-10.

Audi, R. (1988). Foundationalism, coherentism, and epistemological dogmatism. *Philosophical Perspectives, 2,* 407-442.

Aydın, M. (2004). *Bilgi sosyolojisi* [*sociology of knowledge*]. İstanbul: Açılım Kitap

Başbay, M. (2013). Analyzing the relationship of critical thinking and metacognition with epistemological beliefs through structural equation modeling. *Education & Science*, *38*(169), 249-262.

Baxter Magolda, M. B. (2004). Evolution of a constructivist conceptualization of epistemological reflection. *Educational Psychologist*, *39*(1), 31-42.

Baxter Magolda, M. B. (1992). *Knowing and reasoning in college: Gender-related patterns in students' intellectual development*. San Francisco: Jossey-Bass.

Belenky, M., Clinchy, B., Goldberg, N., & Tarule, J. (1986). *Women's ways of knowing: The development of self, voice and mind.* New York: Basic Books.

Biddle, J. B., & Leuschner, A. (2015). Climate scepticism and the manufacture of doubt: Can dissent in science be epistemically detrimental? *European Journal for Philosophy of Science*, *5*(3), 261-278.

Brown, A. (2012). Dogmatism. In N. M. Seel (Eds.), *Encyclopedia of the sciences of learning* (pp. 1031-1032). Springer Science + Business Media, LLC.

Brownlee, J., Purdie, N., & Boulton-Lewis, G. (2001). Changing epistemological beliefs in preservice teacher education students. *Teaching in Higher Education, 6*(2), 247-268.

Burr, J. E., & Hofer, B. K. (2002). Personal epistemology and theory of mind: Deciphering young children's beliefs about knowledge and knowing. *New Ideas in Psychology*, *20* (2-3), 199-224.

Clark, C. (1988). Asking the rights questions about teacher preparation: Contributions of research on teacher thinking. *Educational Researcher*, *17*, 5-12.

Collins, H., & Pinch, T. (1993). *The golem: What everyone should know about science*? Cambridge: Cambridge University Press.

Commons, M. L., Richards, F. A., & Armon, C. (1984). *Beyond formal operations: Late adolescent and adult cognitive development.* New York: Praeger.

Commons, M. L., Sinnott, J. D., Richards, F. A., & Armon, C. (1989). *Adult development: Vol. 1. Comparisons and applications of developmental models.* New York: Praeger.

Çüçen, A.K. (2001). *Bilgi felsefesi* [*epistemology*]. Bursa: ASA

De Villiers, J. G., & Pyers, J. E. (2002). Complements to cognition: A longitudinal study of the relationship between complex syntax and false-belief-understanding. *Cognitive Development, 17,* 1037–1060.

Deryakulu, D. (2014). Epistemolojik inançlar. In Y. Kuzgun & D. Deryakulu (Eds.), *Eğitimde bireysel farklılıklar* (pp. 261-291) [Epistemological beliefs, In Y. Kuzgun & D. Deryakulu (Eds.), *Individual differences in education*]. Ankara: Nobel

DeVoogd, G. (2006). Question authority. *School Library Journal*, *52*(4), 48-52.

Dinç, E., İnel, Y., & Üztemur, S. (2016). Epistemik inanç ölçeği: Türkçeye uyarlama, geçerlik ve güvenirlik çalışması [Epistemic Belief Inventory: Its Adaptation Into Turkish and The Testing of its Validity and Reliability]. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi, 17*(3), 767-783.

Elder, A. D. (2002). Characterizing fifth grade students' epistemological beliefs in science. In P. R. Pintrich (Eds). *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 347–364). Mahwah, NJ, USA: Lawrence Erlbaum Associates.

Gopnik, A., & Astington, J. W. (1988). Children's understanding of representational change and its relation to the understanding of false belief and the appearance-reality distinction. *Child Development, 59*(1), 26-37.

Gray, D. E. (2014). *Doing research in the real world* (3rd ed.). London: Sage.

Grüne-Yanoff, T. (2014). Teaching philosophy of science to scientists: Why, what and how. *European Journal for Philosophy of Science, 4*(1), 115-134.

Güneş, G. (2014). *Çocukların epistemolojik görüşlerinin ve öğrenme stillerinin Öklidyen geometrisinde modellenmesi* [Developing a mathematical modelling of children's epistemological beliefs and learning styles by using Euclidian geometry]. Unpublished doctoral dissertation, Hacettepe University, Ankara, Turkey.

Haines, C., & Crouch, R. (2001). Recognizing constructs within mathematical modeling. *Teaching Mathematics and its Applications, 20*(3), 129-138.

Hankinson, R.J. (1995). *The sceptics*. New York: Routledge

Hazlett, A. (2014). *A critical introduction to scepticism*. London: Bloomsbury.

Hofer, B. (2001). Personal epistemology research: Implications for learning and teaching. *Journal of Educational Psychology Review*, *13*, 353-383.

Hofer, B. K., & Bendixen, L. D. (2012). Personal epistemology: Theory, research, and future directions. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, & J. Sweller (Eds.), *APA educational psychology handbook, Vol 1: Theories, constructs, and critical issues* (pp. 227–256). Washington, DC: American Psychological

Hofer, B. K., & Pintrich, P. (2002). *Personal epistemology: The psychology of beliefs about knowledge and knowing*. Mahwah, NJ: Lawrence Erlbaum.

Hofer, B. K., & Pintrich, P. R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research, 67*, 88-140.

Inhelder, B., & Piaget, J. (1958). *The growth of logical thinking from childhood to adolescence.* New York: Basic.

Johnston, P, Woodside-Jiron, H., & Day, J. (2001). Teaching and learning literate epistemologies. *Journal of Educational Psychology*, *93*, 223-233.

King, P. (1977). The development of reflective judgment and formal operational thinking in adolescents and young adults. *Dissertation Abstracts International, 38,* 7233A.

King, P., & Kitchener, K. (1994). *Developing reflective judgment: Understanding and promoting intellectual growth and critical thinking in adolescents and adults*. San Francisco: Jossey-Bass.

Lai, E. R. (2011). Critical thinking: A literature review. *Pearson's Research Reports*, *6*, 40-41.

Lehrer, R., & Schauble, L. (2007). A developmental approach for supporting the epistemology of modeling. In W. Blum, P. L. Galbraith, H-W. Henn, & M. Niss (Eds.). *Modeling and application in mathematics educations* (pp.153-160). NY: Springer.

Lesh, R., & Doerr, H. M. (2003). Foundations of a models and modeling perspective on mathematics teaching, learning, and problem solving. In R. Lesh, & H. M. Doerr (Eds.). *Beyond constructivism: models and modeling perspectives on mathematics problem solving, learning, and teaching* (pp. 3-33). Mahwah, NJ: Lawrence Erlbaum.

Louca, L., Elby, A., Hammer, D., & Kagey, T. (2004). Epistemological resources: Applying anew epistemological framework to science instruction. *Educational Psychologist, 39,* 57–68.

Marginson, S., & Dang, T. K. A. (2017). Vygotsky's sociocultural theory in the context of globalization. *Asia Pacific Journal of Education,* 37(1), 116-129.

Mascaro, O., & Morin, O. (2015) Epistemology for beginners: Two- to five- year-old children's representation of falsity. *PLoS ONE, 10*(10), 1-20.

Montgomery, D. E. (1992). Young children's theory of knowing: The development of a folk epistemology. *Developmental Review, 12,* 410-430.

Morton, A. (1997). *A guide through the theory of knowledge*. London: Blackwell.

Muis, K. R., Chevrier, M., & Singh, C. (2018). The role of epistemic emotions in personal epistemology and self-regulated learning. *Educational Psychologist.* doi:10.1080/ 00461520.2017.1421465.

Murphy, P. K., Rowe, M. L., Ramani, G., & Silverman, R. (2014). Promoting critical-analytic thinking in children and adolescents at home and in school. *Educational Psychology Review, 26*(4), 561-578.

Murray, A. M. (2013). *Personal epistemology and approaches to learning in medicine: A case study of second-year medical students.* Unpublished doctoral dissertation, The University of Adelaide, Adelaide.

O'Brien, D. (2006). *An introduction to the theory of knowledge*. Cambridge: Polity Press.

Pelczer, I., Singer, F. M., & Voica, C. (2014). Dynamic thinking and static thinking in problem solving: do they explain different patterns of students' answers? *Procedia-Social and Behavioral Sciences, 128*, 217-222.

Perry, W. G. (1999). *Forms of intellectual and ethical development in the college years: A scheme*. San Francisco: Josey-Bass.

Perry, W. G. (1981). Cognitive and ethical growth: The making of meaning. In A. W. Chickering & Assoc. (Eds). *The modern American college* (pp. 76–116). San Francisco: Jossey-Bass.

Perry, W. G. (1970). *Forms of intellectual and ethical development.* New York: Holt, Rinehart and Winston, Inc.

Perry, W. G. (1968). *Patterns of development in thought and values of students in a liberal arts college: A validation of a scheme* (ERIC Document Reproduction Service No. ED 024315). Cambridge, MA: Bureau of Study Counsel, Harvard University.

Piaget, J. (1955). *The language and thought of the child*. Cleveland, Ohio: World Publishing Co.

Popkin, R. H. (2003). *The history of scepticism: From Savonarola to Bayle*. Oxford: Oxford University Press.

Popkin, R. H., & Neto, J. R. M. (2007). *Scepticism: An anthology*. Amherst, NY: Prometheus Books.

Pritchard, D. (2013). *What is this thing called knowledge?* (3rd ed.). London: Routledge.

Ravindran, B., Greene, B. A., & DeBacker, T. K. (2005). The role of achievement goals and epistemological beliefs in the prediction of pre-service teacher's cognitive engagement and application learning. *Journal of Educational Research, 98*(4), 222-233.

Ryan, M. P. (1984). Conceptions of prose coherence: Individual differences in epistemological standards. *Journal of Educational Psychology, 76*(6), 1226-1238.

Salmon, A. K., & Lucas, T. (2011). Exploring young children's conceptions about thinking. *Journal of Research in Childhood Education, 25*(4), 364-375.

Schofield, M., Burnyeat, M., & Barnes, J. (2002). *Doubt and dogmatism: studies in Hellenistic epistemology* (2nd ed.). Oxford: Clarendon Press.

Schommer, M. (1994). Synthesizing epistemological belief research: Tentative understandings and provocative confusions. *Educational Psychology Review, 6*(4), 293- 319.

Schommer, M. (1993). Epistemological development and academic performance among secondary students. *Journal of Educational Psychology, 85*(3), 406-411.

Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology, 82*, 498–504.

Schraw, G. (2001). Current themes and future directions in epistemological research: A commentary. *Educational Psychology Review, 13*(4), 451-464.

Schraw, G., & Sinatra, G. M. (2004). Epistemological development and its impact on cognition in academic domains. *Contemporary Educational Psychology, 29*, 95-102.

Stodolsky, S. S., Salk, S., & Glaessner, B. (1991). Student views about learning math and social studies. *American Educational Research Journal, 28,* 89-116.

Triandis, H. C. (1989). The self and social behavior in differing cultural contexts. *Psychological Review, 96*(3), 506-520.

Triandis, H. C, Bontempo, R., Villareal, M. J., Asai, M., & Lucca, N. (1988). Individualism and collectivism: Cross-cultural perspectives on self-in group relationships. *Journal of Personality and Social Psychology, 54*(2), 323-338.

Verschaffel, L., Greer, B., & De Corte, E. (2002). Everyday knowledge and mathematical modeling of school word problems. In K. P. Gravemeijer, R. Lehrer, H. J. van Oers, & L. Verschaffel (Eds.). *Symbolizing, modeling and tool use in mathematics education* (pp. 171-195). Dordrecht, the Netherlands: Kluwer Academic Publishers.

Weinstock, M. P., Neuman, Y., & Glasser, A. (2006). Identification of informal reasoning fallacies as a function of epistemological level, grade level, and cognitive ability. *Journal of Educational Psychology*, *98*(2), 327-341.

Wellman, H. (1990). *The child's theory of mind.* Cambridge, MA: Bradford/MIT press.

Yang, F. Y., & Tsai, C. C. (2010). Reasoning about science-related uncertain issues and epistemological perspectives among children. *Instructional Science, 38*(4), 325-354.

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Appendix A: Epistemological Beliefs Scale for Children

	Epistemological Beliefs Scale for Children	1	2	3
1	Which one sinks and which one floats (stone and wood)? And why? *(I do not know=1 one response=2, more than one response=3)*			
2	Shall we discover the answer of this or ask the teacher? *(I do not know=1 ask=2, curiosity=3)*			
3	We do not know the reason why the balloon sinks or floats. Which one is more important do you think? To conduct an experiment and see if the paper clip floats or not, or find the reason why it does or doesn't float. *(I do not know=1, result=2, conduct=3)*			
4	Look, there are other items (coins, leaves, and paper) here. Should we conduct an experiment to see which floats or should we ask the teacher? *(I do not know=1, outsource=2, experiment=3)*			
5	Do you think the teacher knows about everything or there are things he/she does not know? *(I do not know=1, S/he must know =2, S/he cannot know every-thing=3)*			
6	Is the information given by the teacher always correct? *(I do not know=1, yes=2, no=3)*			
7	Can your teacher find the answers to questions that even he does not know by studying hard? *(I do not know=1, yes=2, no=3)*			
8	Which one of these items (coin and wood) would this magnet pull? Can we be sure about the results or should we try again to be certain? *(I do not know=1, no need to try again=2, we should try again=3)*			
9	Do you think the rules set by the teacher can change or do they re-main all the same? *(I do not know=1, no, they do not=2, yes, they can=3)*			
10	Look, this is a book about the animals written by teachers. Do you think we have to believe everything this book says? *(I do not know=1, yes, we do=2, no, we do not=3)*			
11	Do you think this magnet can pull the paperclip, stone, coin and wood from the water? Can we find out by doing an experiment or should we ask the teacher? *(I do not know=1=1, outsource=2, experiment=3)*			
12	Is everything that the teacher says correct? *(I do not know=1, yes=2, no=3)*			
13	Let us open a page in this book (one of TÜBİTAK books). Is everything it says true? *(I do not know=1, yes=2, no=3)*			
14	Should we believe the rules set by the teacher even though we do			

	not understand them? *(I do not know=1,we should believe=2, we should not believe=3)*			
15	We saw that the paperclips did not sink in the water when we drop them slowly. Will the same thing occur in the following experiments or is there any possibility that they will sink during an experiment? *(I do not know=1, single outcome=2, there may be other outcomes=3)*			
16	Do you think all children must believe everything their parents/teachers say or are there times that they do not have to believe them? *(I do not know=1, yes=2, no=3)*			
17	Do you think we can live in space someday, if the technology develops or is it impossible that we can live in space no matter what? *(I do not know=1, yes=2, no=3)*			
18	The wood we dropped into the water floated. Do you think we can claim that wood always floats after this experiment or should we repeat this experiment couple of times to be sure? (I do not know=1, it is sufficient=2, it is not sufficient=3)			
19	Does the teacher change the rules they set or are the rules always the same? (I do not know=1, they do not change=2, they may change=3)			
20	Do you think there are scientists and teachers who know everything that is definitely true? (I do not know=1, yes=2, no=3)			
21	Would you rather know some things in advance about a museum or a zoo before you visit or find everything out about them during the visit? (I do not know=1, No prior information=2, prior information=3)			
22	It is sometimes rainy, snowy or windy. Have you ever wondered about the reason why and wanted to find out? (I do not know=1, curious=2, not curious=3)			
23	Do you think all scientists know the same things? (I do not know=1, same things=2, different things=3)			
24	Does your teacher have an answer for every question you asked? Are they always correct? (I do not know=1, yes, he/she does=2, , he/she does not=3)			
25	Do you think that only inventors and scientists know about facts of nature, inventions and discoveries? Can only they think of them or can other people also think of them? (I do not know=1, yes=2, no=3)			