Factors Influencing Pre-Service Early Childhood Teachers' Outcome Expectancy Beliefs Regarding Science Teaching

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Abstract

This study investigated the contribution of scientific epistemological beliefs, personal self-efficacy beliefs, and attitudes towards science teaching on pre-service early childhood teachers' outcome expectancy beliefs. Data were collected from 362 pre-service early childhood teachers through administration of the Epistemological Beliefs Questionnaire, the Science Teaching Efficacy Belief Instrument and the Science Teaching Attitude Scale and were analyzed by using Multiple Regression analysis. The results revealed that justification of scientific knowledge and personal self-efficacy beliefs found to be important factors predicting pre-service early childhood teachers' outcome expectancy beliefs regarding science teaching. On the other hand, belief about source/certainty of scientific knowledge, development of scientific knowledge, and attitudes towards science teaching did not contribute the participants' outcome expectancy beliefs.

Keywords: science teaching, scientific epistemological beliefs, self-efficacy beliefs, outcome expectancy, attitudes, pre-service early childhood teachers

Introduction

Young children have intrinsic motivation towards science and science learning (French, 2004). Thus, early childhood science education not only supports children's better understanding of science concepts, acquisition of scientific thinking skills, and improvement in various developmental domains (Eshach & Fried, 2005; Olgan, 2008) but also contributes to children's whole development through the help of both indoor and outdoor learning environments (e.g., nature related activities) (Sackes, Trundle, & Flevares, 2009). At this point, early childhood teachers play a key role in offering first formal learning environments to children where they could gain science experiences. Besides, teachers' self-efficacy beliefs (Cantrell, Young, & Moore, 2003; Enochs & Riggs, 1990; Riggs, 1991), attitudes towards science teaching (Cho, Kim, & Choi, 2003; Palmer, 2001; Riggs, 1991) and their scientific epistemological beliefs (Buehl & Alexander, 2001; Hashweh, 1996) are identified as important and influential determinants of science teaching process and its quality.

As far as self-efficacy beliefs are considered, Bandura (1977), in the social cognitive theory, explains teacher self-efficacy in two cognitive perspectives namely personal self-efficacy and outcome expectancy. According to Bandura, personal self-efficacy is "the evaluations about being well-organized and taking essential precautions to deal with uncertain, unforeseen and possible situations mostly including stressful elements which could possibly occur in the future" (Bandura, 1977, p. 201). Outcome expectancy, however, is related to an individual's perceptions about the external factors on learning ability and defined as "a person's estimate that a given behavior will lead to certain outcomes and one can successfully execute the behavior required to produce the outcomes" (Bandura, 1977, p.193). When Bandura's self-efficacy theory is evaluated in terms of science teaching, it could be assumed that teachers

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who acknowledge their influential role of science teaching on science learning (outcome expectancy) and also believe their self-efficacy about effective science teaching (personal self-efficacy) could teach science in more systematic and effective manner (Riggs, 1991). Furthermore, according to Czerniack and Haney (1998), highly efficacious teachers tend to believe in necessity and significance of their own efforts in enhancing children's science learning and achievements. It was also indicated that these teachers are more prone to use inquiry-based and student-centered teaching strategies, have less anxiety towards teaching science and feel themselves more efficacious during science instruction. Besides, teachers with low sense of self-efficacy beliefs could have tendency to follow science textbooks or use teacher centered strategies like lecturing rather than using practice based instruction and even could spend less time to teach science. Similar findings were also highlighted by other studies (e.g. Enochs & Riggs, 1990; Riggs, 1991). Clearly, students generally learn more from teachers with high sense of self-efficacy compared to those with low self-efficacy (Ashton & Webb, 1986). Teachers' beliefs in their instructional efficacy, thus, are very strong predictor of academic attainment in young children (Saklofske, Michayluk, & Randhawa, 1988).

In most of the studies, self-efficacy beliefs found to be highly correlated with attitudes towards science teaching (Denizoğlu, 2008; Tekkaya, Çakıroğlu , & Özkan, 2002; Sarıkaya, 2008; Sünger, 2007; Watters & Ginss, 1995). Teachers' beliefs and attitudes related to their instructional practices also influence their teaching behaviors in educational environments and the quality of their science instruction (Koballa & Crawley, 1985; Li, 1999; Osborne, Simon, & Collins, 2003). For example, a teacher could think that he or she does not have an influence on children's science achievement (outcome expectancy) and he or she could not like spending too much time during science instruction (attitudes towards science teaching) and accordingly, he or she could avoid spending necessary time in applying various teaching strategies during science teaching (behavior). To be short, pre-service early childhood teachers' attitudes towards science teaching not only affect their classroom practices but also children's attitudes towards science. Therefore, it is important for pre-service teachers to equip with necessary skills to teach science in an effective way before they graduate.

Teachers' adopted scientific epistemological beliefs are stable traits that strongly influence the quality of their science teaching (Chan, 2004; Hashweh, 1996; Luft & Roehrig, 2007). According to Hofer and Pintrich (1997), epistemological beliefs are the theories about the structure of knowledge and about the nature of knowledge acquisition. Research in educational psychology focusing on the interaction between the epistemological beliefs and the students' learning outcomes highlighted that epistemological beliefs held by students not only shape their academic performances (Cano, 2005; Chen & Pajares, 2010; Conley, Pintrich, Vekiri, & Harrison, 2004; Hofer, 2000; Paulsen & Wells, 1998) but also strategies and learning approaches they use (Chan, 2003; Kardash & Howell, 2000; Tsai, 1998), their usage of self- regulated learning strategies (Paulsen & Feldman, 2005), and their construction of knowledge and conceptual change (Qian & Alverman, 1995; Tsai, 2000). Given the fact that epistemological beliefs have differential relationships with different learning outcomes, it is important for science educators to discover the potential contributors of those beliefs. A better understanding of the students' epistemological beliefs may be helpful in developing and implementing instruction that can enhance the epistemological beliefs of the students, which in turn may lead to better learning outcomes.

Teachers with sophisticated scientific epistemological beliefs are tended to support students' acquisition of scientific concepts and adopt student centered teaching strategies while teaching science (Hashweh, 1996; Luft & Roehrig, 2007). In fact, a statistically significant correlation among pre-service teachers' epistemological beliefs and their conception of teaching and learning was also demonstrated by Chan (2004). Similar findings were also reported by other researchers (Kang & Wallace, 2005; Mansour, 2013; Tsai, 2002).

Investigating the correlation among pre-service science teachers' epistemological beliefs, epistemological world views and self-efficacy beliefs, Yılmaz-Tüzün and Topçu (2008), showed that pre-service teachers with high self-efficacy and outcome expectancy beliefs are tended to believe students'

learning abilities are not inborn and believe the effectiveness of student centered teaching strategies. That is to say, students' learning abilities could be improved through the help of teacher's effective science instruction. The results also indicated that the certainty of knowledge is significantly but negatively correlated with outcome expectancy beliefs, implying that pre-service teachers with high outcome expectancy beliefs held less sophisticated beliefs in the aspects of certainty of knowledge. In another study, the relationship among pre-service elementary and secondary science teachers' self-efficacy beliefs, epistemological beliefs and their attitudes towards science teaching were examined (Sünger, 2007). While no correlation was found among pre-service science teachers' self-efficacy beliefs, attitudes towards science teaching and epistemological beliefs, epistemological beliefs significantly correlated attitudes towards science teaching. Besides, pre-service secondary science teachers' epistemological beliefs correlated neither with their self-efficacy beliefs nor attitudes towards science teaching. However, self-efficacy beliefs were associated with their attitudes towards science teaching.

Given the importance of the teachers' self-efficacy beliefs, attitudes towards science teaching, and epistemological beliefs on their classroom practices (e.g., Li, 1999; Schunk, Meece & Pintrich, 2014), this study seeks for the possible contribution of pre-service early childhood teachers' personal self-efficacy beliefs, attitudes towards science teaching, and scientific epistemological beliefs on their outcome expectancy beliefs. Particularly in the current study, in line with the idea that "how one behaves largely determines the actual outcome and, in the same way, beliefs about outcome expectations are dependent on self-efficacy judgments" (Schunk at al., 2014, p. 147), outcome expectancy was determined as dependent variable, and scientific epistemological beliefs, personal self-efficacy beliefs and attitudes towards science teaching were identified as dependent variables. Accordingly, the guiding research questions for this study were:

1. What are the levels of pre-service early childhood teachers' scientific epistemological beliefs, self-efficacy beliefs, and attitudes towards science teaching?
2. Is there any correlation among pre-service early childhood teachers' scientific epistemological beliefs, self-efficacy beliefs and attitudes towards science teaching?
3. Is there any contribution of pre-service early childhood teachers' scientific epistemological beliefs, attitudes towards science teaching and personal self-efficacy beliefs to their outcome expectancy beliefs regarding science teaching?

We hypothesized that, that those pre-service early childhood teachers who demonstrate higher outcome expectancy beliefs have a stronger sense of self-efficacy beliefs, develop more favorable attitudes towards science teaching and endorsed more sophisticated scientific epistemological beliefs.

Methodology

Sample

Convenience sampling method was used to determine the participants of the current study (Fraenkel & Wallen, 2006). The data were collected from 362 pre-service early childhood teachers (330 female, 32 male) who were enrolled in childhood education programs at three different public universities located in the Central Anatolia, Aegean, and Black Sea regions of Turkey. The age of the participants ranged from 18 to 21 and among them, 103 of them were freshmen (28.5%), 84 of them were sophomore (23.2%), 91 of them were junior (25.1%), and 84 of them were senior (23.2%).

Data Collection Tools and Data Analysis

We relied on three sources of data: (a) Epistemological Beliefs Scale; (b) The Science Teaching Efficacy Belief Instrument (Form B) and (c) Science Teaching Attitude Scale.

Epistemological Beliefs Scale: A 26 item Epistemological Beliefs Scale, originally developed by Conley et al. (2004), was utilized to examine pre-service early childhood teachers' scientific epistemological beliefs along four dimensions: Source, certainty, development and justification. Source dimension consists of five items concerning beliefs about knowledge residing in external authorities while Certainty dimension with six items referred to a belief in a right answer. Development dimension

has six items and assessed beliefs about science as an evolving and changing subject. Justification dimension included nine items and measured the role of experiments and how individuals justify knowledge (see Conley et al., 2004). The items were rated on a 5-point Likert scale (1= strongly disagree; 5= strongly agree) and prepared in respect to four dimensions to determine beliefs about the nature of knowledge and the nature of knowing (Hofer & Pintrich, 1997). The Scale was translated and adapted into Turkish by Ozkan (2008). In the current study, Conley et al.'s (2004) four-factor model was not replicated with the Turkish pre-service early childhood teachers. Exploratory factor analysis (EFA) of the 26-item questionnaire extracted three factors; source and certainty dimensions were emerged as one factor and therefore named as Source/Certainty (11 items, α=.81). Other factors, similar to original scale, were labelled as Development (6 items, α= .69), and Justification (9 items, α=.80). Thus, multidimensional theory, as proposed by Schommer (1990), is decided to be more appropriate than the unidimensional theory in explaining the Turkish pre-service early childhood teachers' epistemological beliefs. The scores obtained from the scale ranged from 26 to 130.

The Science Teaching Efficacy Belief Instrument, Form B-: The Science Teaching Efficacy Belief Instrument (STEBI-B, Enochs & Riggs 1990) was used to assess pre-service early childhood teachers' efficacy beliefs regarding science teaching. The STEBI-B is comprised of two subscales; personal science teaching efficacy beliefs (PSTE; 13 items) and science teaching outcome expectancy (STOE; 10 items). The items are scored on a 5-point Likert type scale ranging from strongly agree to strongly disagree. High scores on the PSTE scale indicate a strong personal belief in one's own efficacy, and on the STOE scale high expectations with respect to the outcomes of science teaching. The original STEBI-B scale was adapted and translated in to Turkish by Tekkaya et al. (2002). Since originally developed for elementary teachers, STEBI-B was used after being adapted for pre-service early childhood teachers (Tekkaya, Olgan & Güner 2010). The internal consistency of the PSTE and STOE components were found to be 0.87 and 0.72 respectively using Cronbach alpha. The scores obtained from the scale ranged from 23 to 115.

Science Teaching Attitude Scale: The Science Teaching Attitude Scale was a 22-item, 5-point Likert scale, measuring pre-service elementary teachers' attitudes towards science teaching (Thompson & Shringley, 1986). The original science teaching attitude scale was adapted and translated in to Turkish by Tekkaya et al. (2002) and used for current study after being adapted for pre-service early childhood teachers (Tekkaya, Olgan and Güner 2010). Measured by the Cronbach Alpha estimates of internal consistency, the total reliability of the 22-item science teaching attitude scale was calculated as 0.87. The scores obtained from the scale ranged from 22 to 110.

The data were analyzed by using descriptive and inferential statistical methods. Pre-service early childhood teachers' epistemological beliefs, self-efficacy beliefs and attitudes towards science teaching were examined by using descriptive statistics and correlations among them were investigated by utilizing Pearson correlation analysis. Besides, in order to examine above mentioned variables' possible contributions on pre-service teachers' outcome expectancy beliefs regarding science teaching, Multiple Regression analysis was conducted. Before data analysis, a number of data screening procedures were conducted to test for various statistical assumptions (sample size N≥ 50+8m; normality, multi-collinearity (r=≤.80), missing data etc.,) (Tabachnick & Fidell, 2007). Inspection of the analysis indicated no violation of the required assumptions.

Results

Descriptive statistics

The descriptive statistics (Mean, standard deviation, minimum and maximum values) concerning the participants' responses to the scientific epistemological beliefs scale, the dimensions of self-efficacy beliefs, and attitudes towards science teaching are presented in Table 1.

As reported in the Table 1, pre-service early childhood teachers' held fairly sophisticated epistemological beliefs. The Justification dimension had the highest mean value (M=4.06, SD=.49), followed by the Development (M=3.90, SD=.53), and source/certainty (M=3.40, SD=.61). The lowest mean

score appeared for the source/certainty dimension (M=3.40, SD=.61). These results imply that the participants of this study generally agreed with the idea that the experiments and using data are necessary to construct knowledge, that science is an evolving and changing subject, that knowledge is not certain and there may be more than one right answer, and is not constructed only by the teachers and the other experts.

Table 1.
Mean and Standard Deviation Values of Scientific Epistemological Beliefs, Self-efficacy Beliefs and Attitudes of Science Teaching Scales

Variable	Dimension	min.	max	*M*	SD
Scientific Epistemological Belief	Source/Certainty	1.27	5	3.40	.61
	Development	1.50	5	3.90	.53
	Justification	1.56	5	4.06	.49
Self-efficacy Beliefs towards Science Teaching	Personal Self-efficacy Beliefs	1.92	5	3.65	.61
	Outcome Expectancy Beliefs	1.70	5	3.62	.49
Attitudes towards Science Teaching		2.14	5	3.72	.49

Compared to other items in the epistemological beliefs scale, the highest percentage of agreement obtained with statements that "Good answers are based on evidence from many different experiments"(88.4%) followed by "Some ideas in science today are different than what scientists used to think"(72.8%). On the other hand, the great majority of participants strongly disagrees or disagrees with the statements emphasizing that "Only scientists know for sure what is true in science" (50.9%). Frequency analyses also revealed that the participants remained uncommitted to the some of the items found in the Scale, including "If you read something in a science book, you can be sure it's true" (41.3%), "Only scientists know for sure what is true in science" (29.4%) and "All questions in science have one right answer" (26.6%).

When pre-service early childhood teachers' self-efficacy beliefs regarding science teaching scores were examined, it was seen that their personal self-efficacy and outcome expectancy beliefs mean scores were slightly above the midpoint of the 5-point Likert scale, indicating that pre-service early childhood teachers had moderate sense of self-efficacy and outcome expectancy regarding science teaching. Generally, the participants believed that they could teach science effectively (73.1%), and would typically be able to answer students' science questions (61.6%). Concerning the attitudes towards science teaching, it was observed that the mean score of the pre-service early childhood teachers' attitudes towards science teaching was also higher than the midpoint of the scale. Most of the participants stated that "teaching science in the early years is important" (86.7%) and they won't feel uncomfortable when teaching science (73.9%) (Table 2).

Besides, for some items, the participants expressed a significant amount of uncertainty, among them are "When a student does better than usual in science, it is often because the teacher exerted a little extra effort" (self-efficacy) and "I will find it difficult to explain to children's questions about the science activities" (self-efficacy), and "I am not eager for teaching science in my classroom" (Attitude).

Table 2.
Frequency Distributions of Sample items Selected from Scientific Epistemological Beliefs, Self-efficacy Beliefs towards Science Teaching and Attitudes towards Science Teaching Scales

Sample Item	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
Scientific Epistemological Belief					
Some ideas in science are different than what scientists used to think	8.0	6.9	19.4	51.7	21.1
Good answers are based on evidence from many different experiments	1.4	1.9	8.3	47.0	41.4
All questions in science have one right answer	7.2	29.6	26.6	28.5	8.0
Only scientists know for sure what is true in science	15.6	35.3	29.4	15.0	4.7
If you read something in a science book, you can be sure it's true	7.8	23.7	41.3	22.9	4.2
Self-efficacy beliefs towards science teaching					
I will generally teach science ineffectively	26.6	46.5	14.1	11.1	1.7
When a student does better than usual in science, it is often because the teacher exerted a little extra effort	2.8	15.2	27.9	43.6	10.5
I will find it difficult to explain to children's questions about the science activities	18.5	43.1	25.1	8.8	4.4
Attitudes towards Science Teaching					
I am not eager for teaching science in my classroom	13.4	34.5	30.4	15.6	6.1
Teaching science in early years is important	1.7	3.3	8.3	43.1	43.6
I will feel uncomfortable when teaching science	16.3	57.6	12.2	10.0	3.9

To examine the associations among dimensions of the each instrument (i.e. epistemological beliefs, self-efficacy beliefs and attitude towards science teaching), Pearson correlation analysis was computed. When the associations are evaluated based on Cohen's (1992) conventions to interpret effect size, Table 3 indicates that while the participants' outcome expectancy beliefs were highly correlated with their beliefs on justification of knowledge (r=.502, p<.01), their outcome expectancy beliefs were moderately correlated with development (r=.381, p<.01), personal self-efficacy beliefs (r=.403, p<0.01), and attitudes towards science teaching (r=.394, p<.01). These findings showed that pre-service early childhood teachers who think that science learning can be influenced by effective science teaching (outcome expectancy) tended to believe in their own ability to teach science effectively, had positive attitudes toward science teaching and held sophisticated epistemological beliefs about justification and development of knowledge. No statistically significant relationship, on the other hand, was demonstrated between participants' outcome expectancy beliefs and belief regarding source/certainty knowledge (r=-.045, p>.01). Besides, as presented in Table 3, source/certainty scores correlated significantly with development (r=.247, p<0.01), justification (r=.154, p<0.01), personal self-efficacy beliefs (r=.206 p<0.01) and attitudes towards science teaching (r=.184, p<0.01), though correlations were generally small. Justification of knowledge beliefs, however, were moderately correlated with both personal self-efficacy beliefs (r=.380, p<0.01) and attitudes towards science teaching (r =.407, p<0.01).

What is more, while there was a positive but low correlation between personal self-efficacy (r=.270, p<0.01) and attitudes towards science teaching (r =.272, p<0.01), the correlation between personal self-efficacy beliefs and attitudes towards science teaching was relatively high (r =.730, p<0.01) (Table 3).

Table 3.
The Relationship among Epistemological Belief, Self-efficacy Beliefs towards Science Teaching and Attitude

	OE	C	D	J	PSEB	A
OE	-	-.045	.381**	.502**	.403**	.394**
C		-	.247**	.154**	.206**	.184**
D			-	.628**	.270**	.272**
J				-	.380**	.407**
PSEB					-	.730**

**p<.01

Multiple Regression Correlation (MRC) analysis was computed to examine contributions of pre-service early childhood teachers' scientific epistemological beliefs (development and justification of knowledge), personal self-efficacy beliefs, and attitudes towards science teaching to their outcome expectancy beliefs regarding science teaching. It was found that the model significantly accounted for 32% of the variation in the pre-service early childhood teachers' outcome expectancy beliefs (F=38.166, p<0.01) (Table 4).

According to Table 4, only justification and personal self-efficacy beliefs made statistically significant contribution on the variation in pre-service early childhood teachers' outcome expectancy beliefs regarding science teaching.

Table 4.
Multiple Regression Analysis regarding Prediction of Outcome Expectancy Beliefs

Variables	B	ß	t	p	partial	part
Development	.148	.096	1.643	.101	.090	.075
Justification	.369	. 333	5.395	.000	.284	.245
Personal Self-efficacy Beliefs	.107	.174	2.596	.010	.141	.118
Attitudes towards Science Teaching	. 048	.105	1.544	.124	.085	.070
Constant	10.306		4.681	.000		

R=.562 R^2=.316 $F_{(4-331)}$=38.166, p<.001

Discussion and Conclusion

This research attempted to investigate the epistemological beliefs, self-efficacy beliefs, and attitudes towards science teaching held by the pre-service early childhood teachers'. Specifically, this study sought for the possible contribution of pre-service early childhood teachers' personal self-efficacy beliefs, attitudes towards science teaching, and scientific epistemological beliefs on their outcome expectancy beliefs. The results of this study showed that the most important factors influencing pre-service early childhood teachers' outcome expectancy beliefs were their personal self-efficacy beliefs (β=.174) and their beliefs on justification of knowledge (β=.333). Therefore, our results highlighted the importance of enhancing pre-service early childhood teachers' self-efficacy beliefs and their scientific epistemological beliefs before they graduate. Since practicum courses play an important role in improving self-efficacy beliefs regarding science teaching (Bandura, 1981), it is suggested that teacher candidates should be provided with opportunities to spend more time with young children in real learning environments (Sarıkaya, 2004). Of course, more research, however, is needed to shed more light on this finding.

On the other hand, Yılmaz-Tüzün and Topçu (2008) addressed the difficulties in changing pre-service teachers' beliefs during pre-service training programs due to the fact that teachers' epistemological beliefs are not shaped in a short period of time. However, Tolhurst (2007) highlighted that when the courses are structured to create a learning environment in which teachers candidates can

engage in active and independent learning, they can have potential in contributing students' perceptions of knowledge and its nature. Therefore, it is still possible to improve pre-service teachers' beliefs by adopting a systematic approach and offering courses including nature of science, and philosophy and history of science. In addition to the above mentioned courses, in the light of the present study findings, we suggest inclusion of courses explicitly designed to improve teacher candidates' beliefs about justification of scientific knowledge. This can be achieved through proving them with argument-driven inquiry learning environments.

Contrary to expectations, in the current study neither attitude towards science teaching nor sophisticated epistemological beliefs in the source/certainty dimension contributed to the participants' outcome expectancy beliefs. Yılmaz-Tüzün and Topçu's (2008) study, a significant but negative relationship between certainty of knowledge and outcome expectancy beliefs, though small in magnitude (β=.129), was demonstrated. That is, pre-service teachers with high outcome expectancy beliefs have less sophisticated beliefs in the certainty dimension. Similarly, another study conducted with high school teachers found that teachers who believe in certainty of knowledge segregate students from science and focus on transmission of knowledge during their instruction. On the other hand, teachers who believe the development of scientific knowledge have tendency to support students' learning science by doing, arguing and inquiring as if they are scientists (Kang & Wallace, 2005). More recently, in a study exploring the relationship between science teachers' epistemological beliefs and their beliefs about science learning and teaching and how these beliefs reflect into teaching practices in classroom environment, Mansour (2013) also reported that teachers' epistemological beliefs are closely connected to their pedagogical approaches and therefore to their teaching practices.

Limitations and Directions for Future Research

The current study has some limitations to consider. First, this study was limited to the self-reported data. Further research is needed to verify the consistency and the accuracy of the findings through use of multiple methods and measures. Second, the study was conducted with the 362 pre-service early childhood teachers attending to the three different public universities located in the Central Anatolia, Aegean, and Black Sea regions of Turkey. Data from private universities or from other geographical regions, therefore, might provide different results. Hence, the results may not be fully generalized to the population as a whole therefore we recommend conducting similar nationwide study. The current study was also limited to three variables which are predicted to contribute to outcome expectancy beliefs. Therefore, the generalization of the results from this study should be viewed with caution. Further studies could be conducted considering other important variables (e.g., views on learning and teaching, epistemological world views, the number of theory and practice-based science courses etc.) which are thought to contribute pre-service teachers' outcome expectancy beliefs. Moreover, in the context of this study the relationship among the variables was investigated and cause-effect relationship was not examined. A future study should be longitudinal in nature such that data are collected several years in order to see the effects of education on their both attitudes and beliefs. In addition, it was thought that a similar study should be conducted with early childhood teachers working in the field.

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