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Developing Turkish preservice preschool teachers' attitudes and understanding about teaching science through play

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This research studied the development of preservice teachers' understandings and attitudes about teaching science through playful experiences. Subjects were 94 senior preservice teachers in two sections of a science methods class on teaching preschool children. Data sources were semi-structured interviews and open-ended questionnaire at the beginning and end of the semester, students' reflections on their field placement implementation, and a Playful Science Survey. At the beginning of the course, preservice teachers perceived teaching science through play primarily as drama and puppetry and saw it as an instrument for teaching, demonstrating, having fun, making competition, and making learning easier. At the end of the semester, the following themes emerged from the interviews: children play with materials and ideas as they actively participate, teachers' dialogue and questioning promotes exploration and variation in activity, children who are actively exploring can find answers by themselves and construct cause and effect relationships. At the end of the course, high mean ratings (4.5 out of 5) on the Playful Science Survey showed positive attitudes towards learning and teaching science and also recognizing the importance of play experiences in learning science and the importance of fun and active involvement in the science class and in the field assignments.

Keywords: preschool science education; teaching through play; play-based learning; understanding; attitudes

Introduction

Teaching through play-based activities with active participation of children is emphasized as a central strategy to achieve all objectives in the 2006 Turkish Preschool Education Curriculum (*Milli Eğitim Bakanlığı Okul* Öncesi Eğitimi Genel Müdürlüğü, 2006). Under Turkish guidelines, science should be taught to young children through play-based activities actively involving the children. How successfully Turkish preschool teachers are following these guidelines still needs to be determined. However, preschool studies in the United States and Hong Kong (Cheng & Stimpson, 2004; Cheng, 2001; Miller & Almon, 2009; Tu, 2006) identify challenges in teaching through play experiences. Focusing specifically on science with young children, Tu (2006) found that half of the preschools had a science area but that preschool teachers did not provide adequate science activities and also missed teachable moments. Cheng (2001) identified a gap between two preschool teachers' espoused theories and practice of *teaching through play* and Cheng and Stimpson (2004) found that all participants in their study acknowledged play as the best teaching and learning approach, but most of them were unable to implement teaching through play in their

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classroom. Miller and Almon (2009) note that most teachers say that play in preschool is important although few teachers or administrators are able to articulate the relationship between play and learning. The field of science education would therefore benefit from research that studies course designs intended to promote play-based learning and the value of play in science method courses.

The present research is designed to assess the effectiveness of a course designed to prepare Turkish preschool teachers to meet the 2006 curriculum objectives on teaching through play-based activities. The specific purposes of this paper are to examine Turkish preservice teachers' understanding of the integration of play and science in teaching preschoolers and to examine the effect on attitudes of a course designed to teach science through playful experiences. Research on the following informed this study: the role of play in science, methods of teaching science through playful experiences, drawing on the common dimensions in play and learning, effective teacher preparation strategies, and attitudes toward science in teaching and teacher preparation.

Role of Play in Science

According to Klugman and Fasoli (1995, p.101) play usually includes the following aspects: intrinsic, self-selected, enjoyable, active, mind involving, and empowering. It is intriguing and captivating, frequently involves choice on the part of the player, and can be self-perpetuating. Wolfe, Cummins, and Meyers (2006) described playful learning activities as "internally motivated, self-directed, spirited, and characterized by some degree of divergent "as if" thinking (p.201). According to Stone (2004), there is only a thin line between playing and experimenting, which offers possibilities for learning and teaching science through play.

A number of researchers indicate that play, playfulness, and fun are a part of scientific investigations of practicing scientists. Ganschow and Ganschow (1998) described the role of playfulness in research conducted by biologists, Kean (1998) identified fun and playfulness among chemists, and Jarrett and Burnley (2007; 2010) described the role of playfulness in geological research. Biographical information on scientists and engineers (Laszlo, 2004; Petroski, 1999) as well as research studies suggest that experimentation and play with scientific phenomena during childhood promotes interest in science and engineering as adults (Jarrett & Burnley, 2010). Laszlo (2004) states that one definition of science is play with ideas, a process of innovation and discovery, rather than a textbook exercise of learning definitions. He notes further that chemists play games with chemicals in a similar way as a child who mixes various colors in a paint box to see what comes out. In the same way, chemists ask themselves the question "what would happen if I change…?" This playful attitude can be extremely fruitful and can motivate scientists. However, childhood interest in scientific phenomena is often developed through home and extracurricular experiences but not in school. According to Rowsey (1997), 41% of research scientists said they had developed an interest in science by sixth grade but none credited their elementary school teachers with developing that interest.

Out-of-school contexts can make important contributions to science education. For instance, in Media Lab at (MIT) Resnick (2004) provides a playful learning environment in which play and learning are integrated for pupils. They work on creative projects together such as creating animation in the computer by using digital images, building "marble machines"- a series of ramps and raceways bouncing off bells and bumpers by using craft materials, pegboard, wooden slats, bells, string, marbles and crickets. In this environment children come up with "mini-hypotheses," making designs, which they test out and reproduce based on the results. All these abilities or skills seem to emerge in playful engagement with an activity or a task. Resnick

(2004) states that integration of play and learning creates self-motivation, responsibility, and great concentration. According to Resnick children are likely to learn the most and enjoy the most when they are engaged as active participants, not passive recipients. Resnick's Lab illustrates how a playful learning environment can be serious, creative, and imaginative as well as being fun and playful. Despite the fact that this lab is an example of informal learning, it illustrates what could be done in formal education context.

Methods of Teaching Science through Playful Experiences

Research on teaching young children science concepts through play experiences has been carried out in Göteborg University in Sweden (Fazey & Marton, 2002; Lindahl-Samuelsson & Pramling-Samuelsson, 2002; Marton & Ming-Fai, 1999; Pramling & Pramling-Samuelsson, 2001; Pramling-Samuelsson & Johansson, 2006; Pramling-Samuelsson, 2006; Pramling-Samuelsson & Asplund-Carlsson, 2008). Pramling-Samuelsson and Johansson (2006) states that play and learning are often separated both in research and in preschool practice because of the view that play is associated with free, leisure or recess time and that learning occurs through certain activities organized and led by the teacher. Pramling-Samuelson et al., (2002, 2006, 2008) illustrate that play and learning share many features for preschool education such as joy, creativity, creation of meaning, and children's possibilities to control and form goals. In preschool children can experience and create meaning of the surrounding world through playful learning. The characteristics or type of learning in preschool was described as "seeing, perceiving, experiencing, distinguishing or understanding something in a new way and qualitatively different way, and by relating to the surrounding world in the light of this experiencing (Pramling-Samuelsson & Johansson, 2006, p. 53)." In this type of learning, children's active participation is very crucial. Play is an important source for children's active participation, motivation and learning.

According to Eshach and Fried (2005), there are six reasons for including science as a part of the preschool curriculum: (a) enjoyment from observing and learning about nature, (b) development of positive attitudes toward science, (c) promotion of better understanding of science later in their school life, (d) use of scientific language at an early age to explain science concepts, (e) development of science concepts and scientific reasoning, (f) development of scientific thinking. Research studies demonstrate that even in preschool, children are capable of learning science concepts, e.g., energy concept (Van Hook & Huziak-Clark, 2008), explanatory language skills on color (French, 2004; May-Peterson & French, 2008), problem solving (Severeide & Pizzini, 1984), integrating inquiry and literacy for motivation in science learning (Patrick, Mantzicopoulos & Samarapungavan, 2009). However, Pramling-Samuelsson and Johansson (2006) call for paradigmatic shift within the research and preschool practice from seeing play and learning as two separate entities toward a more instrumental perspective, usually expressed in research as learning-centered play, playful learning, pedagogical play, play-based learning. Drawing upon the common dimensions of play and learning for preschool practice, play and learning are integrated in a goal-oriented preschool setting where there is a room for children's creativity, choices, initiatives and reflections. Pramling-Samuelsson (2006, p.117) refers to the "playing-learning child" and "playing-learning pedagogy."

Drawing on the Common Dimensions in Play and Learning

Pramling-Samuelsson et al., (2006, 2008), drawing on the similarities between play and learning, recommend the following instructional pedagogy for teachers: 1) teachers should use children's

experiences as a starting point; 2) teachers should use variation, discernment, and simultaneity as a source of play and learning and 3) teachers should be aware of the importance of meta-cognition, meta-cognitive dialogues, and meta-communication in play and learning.

Children's Experiences as a Starting Point

Experience emerges from interaction between the subject and the object. According to Lindahl-Samuelsson and Pramling-Samuelsson (2002), experience is about how something appears to a child, how s/he sees, discerns/notices, or understands the phenomena in focus. Whatever children are learning or playing, they need to experience through all their senses because without having experiences they cannot create meaning or make sense of their experiences. Lindahl-Samuelsson and Pramling-Samuelsson (2002, p.26) defined learning as "creating meaning in one's experiences by relating oneself to seeing, discerning, and making sense of or experiencing something different than before." In both learning and playing situation, there should be room for children to express themselves verbally, drawings, or bodily. Therefore, it is important for teachers to pay attention to what the children are doing or saying because they are reflecting on their own perspectives (Pramling-Samuelsson & Asplund-Carlsson, 2008). Both in play and learning situations, the teacher's role is to direct children's attention towards the learning objects s/he wants children to develop an understanding about (Pramling-Samulsson & Asplund-Carlsson, 2008). Therefore, the teacher must listen, observe children, and be willing to see and interpret what child sees.

Variation, Discernment and Simultaneity is the Source of Play and Learning

Flexibility, possibility, similarity and variation are important for both learning and play. Marton and Ming-Fai (1999, p.3) define variation as "different ways of seeing, experiencing, and understanding the same phenomena." According to Pramling-Samuelsson and Asplund-Carlsson (2008, p.11), "variation creates a basis for differentiation, which is as important in play as in learning." She says children use both repetition (the familiar/similar) and variation (abundance/the novel) in service of their learning goals and their engagement in activities that hold meaning for them. Discernment (noticing things) springs from the experiences of variation, especially as events occur simultaneously. According to Marton, Runesson & Tsui, 2004 (cited in Pramling-Samuelsson, 2006) a child cannot discern what does not vary. Pramling-Samuelsson (2006) illustrated the importance of variation and repetition using a study conducted by John Fazey. This study compared the scores of two groups of children throwing a ball into a basket. One group threw the same ball to the basket from the same distance; the other group threw different sizes and weights of ball from, different distances, and different angles. The group with greater variation had much better skill development in throwing balls than the group with less variation.

Pramling-Samuellson et al., (2001, 2006, 2008) states that children use repetition as a learning tool, especially when they are trying to master a physical skill or when they are simply fascinated by a phenomenon. Pramling-Samuelsson showed how toddlers naturally use repetition and variation for learning and playing as they go down a slide, master spinning rings (Lindahl-Samuelsson & Pramling-Samuelsson, 2002), and learn problem solving from experiences with apples (Doverborg & Pramling-Samuelsson, 1999). In a review of research studies, Fazey & Marton (2002) finds that students who experience variation in their practice conditions are generally more accurate and consistent in both tests of retention and transfer test trials to a new target. Pramling-Samuelsson and Asplund-Carlsson (2008) states variation is a teaching strategy that makes particular knowledge, skills, ideas, and phenomena visible to a child. As child thinks in

various ways about a topic or phenomenon, s/he becomes able to recognize variations within the topic or phenomenon, and different meanings that may be derived from it.

Meta-cognition, Meta-Cognitive Dialogues, and Meta-Communication in Play and Learning

In the playful learning environment, the teacher creates a situation and opportunities for students to think and reflect. The teacher needs to be aware of the child children's thinking so their different ways of thinking about phenomena become content for further explorations. When exploring and investigating, children are spontaneously open for alternatives and contrast different possibilities (Pramling & Pramling-Samuelsson, 2001). In this way, children create opportunities to pay attention to particular features of that which is investigated. The communication between teacher and students should not be just questions-and-answers. In the experimental situation, the teacher sets the scene. The teachers' intention is to get the child to think, reflect (think about their thinking), and verbalize.

Effective Teacher Preparation Strategies

The U.S. National Science Education Standards recommends modeling how science should be taught (National Research Council, 1996) as an important aspect of professional development. Kalande's (2006, p. 69) study of new teachers in Malawi found the need for modeling at the Teacher Training College level. Almost all participants said "science teacher educators should teach using the same kinds of instructional methods that they would like their students to use in the primary schools." Research studies with high school students (Court,1993; Palmer, 1999) and undergraduate students (Bulunuz, in press 2012, 2012; Jarrett & Burnley, 2010; Palmer, 2002) indicates that engagement with interesting hands-on science activities in a playful environment not only promotes students' learning science, but also helps them to recognize the value of making science exploratory, fun, interesting and motivational.

For preschool teachers to facilitate learning science through play, understanding of both science and play are important. According to Perkins (1993), theory needs to be applies in practice. Also "Learning for understanding requires not just taking what you hear, it requires thinking in a number of ways with what you heard—practicing and debugging your thinking until you can make the right connections flexibly" (Perkins, 1993, p. 32). Perkins and Unger (1994) recommend that the instructor provide powerful representations that facilitate the learner's construction of understanding and that students be given time for thinking and reflecting. In the preparation of teachers, according to Aikenhead (2006), student teaching (internship) is one of the influential experiences to develop understanding.

Attitudes toward Science in Teaching and Teacher Preparation

An attitude is another important aspect of science education. Osborne (2003) describes attitudes toward science as "feelings, beliefs, and values held about an object that may be enterprise of science, school science, the impact of science on society or scientist themselves" (p.1053). This study mainly focuses on the following components of attitudes such as enjoyment of science learning experiences, perception of the teacher, motivation towards science, the nature of the classroom environment, development of interest in science and science related activities. According to Ajzen and Fishbein, (1980 cited in Osborne, 2003) attitudes are enduring and they predict people's behavior. Therefore, attitudes toward science and attitudes towards doing school science predict teachers' behavior about doing science in the classroom. It is important for

teacher to have positive attitudes toward science and teaching science because the teacher variable is the most significant factor in determining students' attitude toward science (Osborne, 2003). Rich, positive and supportive classroom environment is another important determinant of students' attitude toward science. Myers and Fouts (1992) found that positive attitudes toward science related to students participation, supportive social environment, positive relationship with classmates, and the use of a variety of teaching strategies and interesting science activities. Woolnough (1991, cited in Osborne, 2003) found that quality of teaching exhibited in classroom activities was a strong influence on student's positive attitudes toward science.

Osborne (2003) listed the characteristics of good science teaching as being interested and enthusiastic about science, relating lesson in everyday context, and preparing well-ordered and stimulating science lesson. According to Hidi (2000) situational interest/extrinsic interest is highly effective in classroom to motivate students who are academically unmotivated. There are numerous research studies showed that science method courses can be very influential in developing positive attitudes toward science and motivation to teach science (Bulunuz, 2008, 2012a, 2012b; Eshach, 2003; Palmer, 2004). Research studies indicate that teachers with negative attitudes toward science spend less time teaching it and also use didactic approach rather than approaches that based on students active participation and explorations (Fulp, 2002; Goodrum, Hackling, and Rennie, 2001; Harlen & Holroyd 1997; Varelas, Plotnick, Wink, Fan, & Harris, 2008; Weiss, 1997). Teacher attitudes about play and science are also important. In a research study Wedoe (2001, p.6) concluded: "To create a valuable play-inspired learning environment the teacher must find this kind of activity enjoyable and meaningful. Only those teachers who are capable of experiencing a certain amount of 'flow' have positive attitudes towards play as an effective teaching method." The field of science education would therefore benefit from research that studies course designs intended to promote ideas about the value of play in science method courses.

Purpose of Study

The present study is designed to investigate preservice preschool teachers' attitudes and understanding about teaching science through play at the beginning and at the end of a science methods course. Also, the study examines the success of the preservice preschool teachers in integrating science and play in their field placement assignment and the success of the course in developing a relaxed, playful, and collaborative environment. More specifically this research tries to answer the following questions about preservice teachers' attitudes, understanding and their practice about teaching science through play:

1. What attitudes do preservice preschool teachers have about the teaching of science in kindergarten?
2. Does the preschool science method course affect preservice preschool teachers' understanding about teaching science through play in the kindergarten?
3. Are the preservice teachers able to integrate science and play in their field placement teaching practice?
4. Is the preschool science methods course successful in creating a playful and positive classroom environment and developing positive attitudes toward science education?

Method

Participants

The research was conducted spring semester 2008 in two sections of a science methods course in a preschool teacher preparation program at a university in the Northwest of Turkey. There were 94 students, 4 males and 90 females with an average age of 22. Most students had very little background in science, having graduated from a Turkish literacy and social science branch of high school where they took only one science course at grade 9. At the university, preservice preschool teachers take psychology and child development courses during their first four semesters, a play theory course called *Development of Play in the Child* in their third semester, and the science methods course during their eighth semester. In this paper, the participants are referred to as preservice teachers or students. The students that the preservice teachers work with in their field assignments are referred to as children (5-6 years old).

Design of the Science Method Course

The preschool science methods course was taught by the author in two sections, with 43 students in one and 51 in the other. There were approximately 52 hours of instruction (four hours a week for 13 weeks). The main emphases of the course were to teach preservice teachers how to integrate play and science and also how to integrate science with other subjects. The course was taught to develop understanding, based on Piaget's philosophy: "Understanding always means inventing or reinventing, and every time the teacher gives a lesson instead of making the child act, he prevents the child from reinventing the answer" (Piaget, 1973, p. 36). With the assumption that Piaget's statement applies to preservice teachers as well as the children they will teach, the course was focused on hands-on activities especially exploratory hands-on activities that are fun and playful for children and also for preservice teachers. The majority of class time was spent doing hands-on activities designed to model integrating play and science teaching to clarify important concepts and scientific processes, and spark the interest of the preservice teachers. The methods course emphasized science process skills that involved making predictions, setting up an experimental design in which hypotheses are tested, gathering data, making observations, examining and evaluating results. The instructional methods of the course were based on the three stage model Play-Debrief-Replay developed by Wassermann (1998) for primary school children. In the first one, after providing the necessary environment with equipment and materials, the instructor gives some time for free hands-on play/exploration time for students to get familiar with science materials. In the second stage, the instructor and students reflect on their experiences, and discuss what they observed, what they tried and what they wonder about, and what was surprising or new for them. The instructor helps students to draw conclusion from their experiences with connections to scientific concepts and principles. The third stage students extend their exploration and replicate earlier discoveries. Therefore, this is not the final stage on scientific inquiry; the students may have another question and may get into another play stage in this inquiry cycle. Throughout all stages the instructor's role is very crucial as a guide (Dewey, 1916) and to provide scaffolding (Vygotsky, 1978). Using the Play-Debrief-Replay model in the science methods class helped to build the preservice teachers' own understanding while modeling teaching methods appropriate for preschool classrooms.

In order to model the integration of play and science, the course applied the principles of "playing-learning pedagogy" (Pramling-Samuelsson, 2006, p.117) into practice by using repetition (the familiar/similar) and variation (the novel/abundance). This was achieved in three ways. First, many science activities were provided in the method course throughout the semester. Second, for each concept several science activities were included. In each activity, preservice

teachers were encouraged to explore different aspects of the concept by asking question and making predictions. In addition, the instructor modeled reading science concept books with children and presented examples of how to integrate drawing, singing and drama from his practice with preschool children. Preservice teachers kept journals and wrote and drew pictures of the activities they did in class.

A textbook was not used. Class activities were drawn from Jarrett (in press, 2012), Üçok (2003) or were developed locally with a focus on local materials and resources. A series of life science lessons was implemented. The preservice teachers went on a nature walk to make observations and activities in the forest and meadows and identified living things in their natural habitat. They collected different types of flowers and examined them with magnifying glasses. They circled a small area with string and counted the different types of plants and animals and searched for evidence of plants and animals that live in the forest (e.g., bones, shells, seeds etc.). They collected pine cones, rotten wood, snails, and moss from the forest to built a semi aquatic-terrarium. The instructor provided a toad for the terrarium. Students held snails and conducted simple activities to learn more about snails (e.g., what do snails eat? Can snails see colors? Can snails walk on toothpicks?). Students fed the toad with crickets and other kinds on insects and worms. In the class, they also had a silk worm as a pet, feeding it mulberry leaves and observing its life cycle. Class experiences also included physical science experiments with magnifying glasses, air, paper helicopters, static electricity, science with toys, dissolving, magnetism, chemical reactions, red cabbage juice as an acid/base indicator, floating and sinking, Cartesian divers, designing aluminum foil boats, and growing plants from seeds and cuttings. Also, the class did experiments with the senses, color mixing, heat, light and shadows, water drops, and bubbles. The instructor provided materials for activities and guided students while they were experimenting, investigating, and exploring. The instructor facilitated preservice teachers' exploration by encouraging the following questions: a) what will happen if…, b) When I do this…. the following….will happen. c) What did you find out about…? d) Can you show me what happened when…?

To teach preservice teachers how to adapt/manipulate an activity to make it more fun and playful for children, the class did an analysis of an activity from the recommended science activity book **(**Üçok, 2003). The author selected an activity from the book that the class had already done differently in the course and copied it on the board. The students were asked to reflect on the activity on the board, comparing how it was described in the book with how it was presented in class. This critical perspective helps preservice teachers to see opportunities for adding more materials to create variation in an activity and opportunities for removing treats to young children, such as use of a knife or chemicals. We also discussed how to come up with some testable questions with the available material (what will happen if…). Preservice teachers also took a midterm in which they were given a different activity from a science book and asked to analyze it qualitatively to make it playful for children.

When taking this course, the students were in field placements and worked with children to implement their assignments. Instructional goals for integrating science and play activities described in this study were designed to support preservice teachers understanding about integrating science and play by putting them into practice in their field placements (Perkins, 1993). Before preservice teachers did their assignment, the instructor showed a PowerPoint Presentation of his experiences teaching science through play with children in a preschool classroom. The presentation included many pictures of children while they were doing indoor and outdoor activities and also integration of science with other subjects like drama, art, music, and literacy. These activities were similar to activities the preservice teachers did in the methods course. Since they were familiar with the activities they could easily focus on children' faces to

see their response to the activities. In addition, the instructor's reflection on what children in the pictures did, how they reacted to activities, and how the activities went in the preschool classroom connected theory and practice (Perkins, 1993). All students had two assignments to implement in their field placement. One was to integrate science with play with a small group (4 to 6 children). The second assignment was to work with all children in the class, teaching science through play and also integrating the science topic into other areas such as reading, art, dramatic play, music and mathematics.

Data Sources

Preservice preschool teachers' attitudes and their understanding of teaching science through play were investigated through questionnaires and semi-structured interviews at the beginning and end of the course. In addition, the students were also asked to rate playfulness and interestingness of the science activities provided in the science methods course, their enjoyment of assignments in the field placement, opportunities of playful social interactions with peers, and relaxedness of the classroom environment.

Open-ended questionnaire. At the beginning and at the end of the course, participants were asked to fill out a questionnaire about their attitudes and understanding of teaching science in kindergarten. Eighty-one out of 94 participants' pre and post questionnaires could be matched. They were asked to write answers to the following questions: (1) What do you think about teaching science in the kindergarten classroom? (2) Do you think science can be taught through play? Explain. (3) What do you think about the role of play in teaching science in kindergarten?

Semi-structured interview. Twelve students were interviewed at the beginning of the course. At the end, only nine of them could be matched. The interviews lasted approximately 20 minutes and were audio-taped and transcribed. The first question was do preservice preschool teachers think that science can be taught through play? If the answer was yes, they were asked to explain how they would teach it. The questions elicited the following: (a) descriptions about feeling about teaching science in kindergarten (e.g., "What is your feeling about teaching science in kindergarten?"), (b) integration of science and play in kindergarten (e.g., "Do you think science and play can be integrated in kindergarten classroom?"), (c) understanding about teaching science through play (e.g., "What do you understand about the statement "teaching science through play"?), and (d) understanding about learning science through play (e.g., How can you make the transition from play to more organized learning? Or how can you combine/reshape play to be a more organized and systematic way of discovering?").

Playful Science Survey. In order to assess participants' attitudes and the role of playfulness and class atmosphere in learning and teaching science, an eight statement survey was developed from Jarrett and Burnley (2010). A science educator who has researched the role of play and playfulness in the development of interest in science (Jarrett & Burnely, 2007; Jarrett & Burnley, 2010) reviewed the survey for content validity.

In order to calculate the internal consistency coefficient, Alpha, the unidimensionality of the scale was checked by using explanatory factor analysis. All eight items in the survey loaded on one factor, indicating the unidimensionality of the survey. The following first factor loadings were found for 8 items: 0.76, 0.73, 0.70, 0.69, 0.68, 0.65, 0.59 and 0.57. As it is seen from the factor loadings, each items factor loadings is greater than the minimum criteria (0.40) (Stevens, 2002). The first factor accounted for 45.28% of the total variance, and the reliability coefficient of the scale was 0. 85. This coefficient indicates that the internal consistency of the scale is high.

Preservice teachers' practice on their teaching of science through play. To integrate science and play, the preservice teachers were required to choose a science topic and implement it in a kindergarten with children. In this assignment, they were asked to write a lesson plan, do-

cument their teaching by including pictures from their practice, and write a reflection about what they planned, how it went and how they plan to teach differently in the future. In addition to preservice teachers' reflections and reports, author supervised one of the students to see how preservice teachers teach science through play in their placement by integrating with other subjects such as art, reading, and drama. The author took notes, videos and pictures during this observation.

Data Analysis

To answer the first two questions, the pre and post questionnaires and interview transcripts were analyzed qualitatively for categories of answers (themes). To check reliability of the categories, the author and a colleague separately coded the participants' answers to the questions at the beginning and at the end of the course. The inter-rater agreements on the exact categories of responses on the pre and post questionnaire were 79 % and 85% respectively. The inter-rater agreement on whether the students mentioned integration of science and play as exploration and experimentation in the pre and post interview were 88 % and 100 % respectively. The validity of the study was verified by using triangulation of multiple data sources: participants' written explanations on the open-ended questionnaire, verbally reported explanations in the interviews, the author's field observations of their teaching, and their field placement reports on teaching science through play. After categorizing the responses that emerged from the pre and post course questionnaire and interviews, percentages were calculated from the number of students whose answers fit in each category.

To analyze teaching science through play practice in the field placement, 12 of the 81 assignments were randomly selected to compute a percentage of successful implementation in kindergarten classrooms. The Playful Science Survey data were analyzed using descriptive statistics, means and standard deviations.

Results

What attitudes do preservice preschool teachers have about the teaching of science in kindergarten?

The purpose of this question is to examine preservice teachers' attitudes and feelings at the about teaching science in kindergarten. For this purpose, in the questionnaire participants were asked what they think/feel about teaching science in kindergarten. At the pre and post-questionnaire approximately 80% of the students were positive about teaching science in kindergarten. They stated that science is useful, necessary, and important for children's development and learning about nature and their environment. Following are typical examples from the questionnaires:

> ST37Pre "I think teaching science in kindergarten necessary and useful because children learn by doing. In other words, they use one of the effective ways of learning. While learning, children have fun at the same time."

> ST2Post: I think teaching science is important and necessary in kindergarten. Since children perceive science as play, they are asking curiously, and communicate with their friends. Children were very happy while they were doing experiments and also they were participating in all activities.

As in the questionnaire analysis, all of the students in the interview were also positive about teaching science in kindergarten. An example from an interview shows growth in attitudes and understanding about the importance of play when teaching science.

> ST12Pre: I have a very positive feeling to teach science through play. I think it will be very good when science is integrated with play. Children think that science is difficult but when it is integrated with play it will be easy for them and they will like it very much.
>
> ST12Post I think science is a good thing and it will be even better when integrated with play. Play is very good to keep students' attention on task. I am positive because children like to explore, learn something, and play with science.

However, more than 1/5 of participants (22%) stated in the both pre and post questionnaire that science was taught very little and poorly or not taught at all in their field placements. They mentioned the following themes: 1) little emphasis or no science teaching at all in kindergarten, 2) absence of science corner or materials in the classroom, and 3) teachers not qualified to teach science. Participants stated that little time was spent on science and some classrooms do not have science centers and materials. The following are examples of participants' concerns about teaching science in kindergarten:

> ST78: There has been little emphasis on science in my field placement schools. A few science activities are done and no science corner is present. Mostly science is included in other activities, instead of doing science activity by itself.

Other participants stated that teacher qualifications are not sufficient to teach science in kindergarten and there is a need for better qualified teachers for teaching science in kindergarten. For example:

> ST54: Science should be taught but we have difficulty to reduce science to a simpler state for children. Teachers need a practical knowledge to teach science.

Does the preschool science method course affect preservice preschool teachers' understanding about teaching science through play in the kindergarten?

This question was designed to detect changes in understanding from the beginning to the end of the semester. A coding scheme was developed based-on the participants' answer to the questions in the open-ended questionnaire and interviews. Students' responses were grouped into five types of categories. In the first one, teaching science in kindergarten was found difficult. In the second, third and fourth, science-play integration was mixed with general descriptions of benefits of play, integrating science with drama, and creating competition in science activities. The fifth one is about children's active participation in an activity to experiment with materials and ideas. Specifically, the five categories of responses were: (1) Difficult, (2) Descriptions of benefits of play, (3) Integrating with drama, (4) Creating competition, and (5) Experimentation.

1. *Difficult:* This includes explanation such as "I don't know" or "no explanation", 'difficult to integrate science with play", "I have never seen this kind of example".

2. *Descriptions of benefits of play:* This includes descriptions of benefits of play such as "integrating play with science makes lesson fun, and interesting", "makes learning and teaching science easy", "makes learning becomes long lasting", "liking science", Effective teaching and learning", "useful to reduce science simpler level", "relive boredom", and "makes transfer of knowledge easy". Also, perceiving experiment and play separately.
3. *Integrating with drama*: These comments include integration of science with drama, but not integration of play and science. (e.g., "…children will be asked to animate experiment", "we can compose a song related to air phenomena and then set up a choreography with children", "animation or role play of animals, plants and natural phenomena such as day and night formation", "melting", "thunder", "imitation of rain formation").
4. *Creating competition*: These are making competitions of science activities such as completing the activity in a short time or collecting the maximum number of something. Examples are, "…collecting maximum leaves competition", "who will find the most strange leaves", "I asked children to leave their finger print in a competition", and "who will finish activity first."
5. *Experimenting***:** This is about providing opportunities for children to actively participate in experiments in which they predicting, experimenting and exploring. Examples are, "hands-on experience with hot and cold concepts," "science and play integration can be achieved by guiding children to explore," and "science can be taught through play with trial-error, and finding answer."

Using the coding categories developed above, the frequency of each category was compared from the beginning to the end of the course. Table 1 shows the frequency and percentages of the five different categories.

Table 1. Frequencies and Percentages of Coding Categories

Categories		Pre-questionnaire		Post-questionnaire	
	N	f	%	f	%
Difficult	81	5	6.2	0	0
Descriptions of benefits of play	81	41	50.6	34	42
Integrating with drama	81	26	32.1	1	1.2
Creating competition	81	5	6.2	3	3.7
Experimenting	81	4	4.9	45	55.6

To examine preservice preschool teachers' understanding about teaching science through play from beginning to the end of the course, percentages of answers in the five categories were calculated for pre and post data.

Difficult. On the pre-questionnaire, five responses out of 81 (6.2%) fit this category. Their comments most commonly said that teaching science through play in kindergarten is difficult, and they have never experienced or practiced this type of teaching practice before. The followings are example of explanations from pre-questionnaire:

> ST52Pre: I don't know. I have never seen an example this type of practice before. If science is taught with play, I am sure it could be fun and educational.

> ST44Pre: It is hard to make it playful. It needs to be done seriously and carefully. So far, I have not encountered a science lesson made into play. Teachers are doing, and students are watching.

However, at the post-questionnaire, none of the participants commented that integration of science and play is difficult. All of the preservice teachers made positive comments about teaching science through play. They stated they will enjoy teaching science through play, children will like it if science and play are integrated, children enjoy learning science, they learn science better, they like science, and play makes science fun, simple and easy for children. The following are examples of explanations from the post-questionnaire:

> ST63 Post: From my assignments experiences, science can be taught through play. Children learn science easily. Also, play relives boredom.

> ST76 Post: Definitely! Play is the biggest joy of children and they learn easily this way. Science has abstract concepts, with play these concepts are concretized and given to children.

Descriptions of benefits of play. This category includes participants' comments on general descriptions on benefits of play in the questionnaire. These explanations were examined from beginning to the end of the course. The proportions of participants who have an instrumental perspective on teaching science through play was rather similar from the beginning to the end of the semester. Specifically, 41 of the 81 participants (50.6%) at the beginning, and 34 of the 81 participants (42%) at the end of the course, described benefits of play for teaching science but did not explain how to teach science through play. They most commonly mentioned that science makes learning easy, fun, interesting, and permanent. In the instrumental perspective, play and science were thought of separately (i.e., play either comes before or after experimenting). In this category some students' description of play and science were kept separately, meanings that they did experiments first then let the children play or vice versa. Play was perceived as a tool that makes science easy, fun, interesting, good for permanent learning, and effective in getting children to attend to the lesson. The following are examples of comments from pre and post-questionnaires.

> ST4 Pre: Science is necessary but every child does not have the same qualification so they don't understand easily. Play is an important tool to make learning science easy, fun, and permanent.

> ST65 Pre: I think it is possible to integrate science and play. Because teaching through play is an easy and fun way of teaching for children. I think play is an activity that can support science lessons.

> ST53 Post: Science can be taught better with play. In order to do this, first of all the experiments are done, then it made into play. This way it will be effective for children.
> The coding scheme was also applied to the interviewees' verbatim-recorded responses.

At the beginning of the semester, three of the nine (22%) interviewees' answers fit this category, reduced to one out of nine (11%) at the end. The students answering in this category perceive play as the sugar coating on a pill that helps children to swallow scientific knowledge.

They think that science is difficult for kindergarten children and it will be easy with play. However they do not have clear understanding of how to make science playful. They think that children like science with play or play makes learning science easy. Also they talked about going on field trips and playing outdoors. The followings are examples from the benefits of play category:

> ST80 Pre: I understand reducing science level to the children. It is very difficult for children to adapt experiments directly. First, we need to prepare them with play. For example, if we teach the air exist; we can do this first with play such as blow something or each other etc… Later we can do an experiment. We cannot do experiment play at the same time.

> ST60 Pre: Children like play the most. Therefore we should use play to teach science. We can use play in many ways that takes children attention. For example in paper helicopter activity, when children throw the helicopter, they can jump three times. This can be play. Also we can go field trip and play outdoors.

Integrating with drama. Participants' comments on drama on the pre and post-questionnaire were compared. A lower percentages of participants explained teaching science through play with drama at the end of the course. Twenty-six of the 81 (32.1%) of the participants mentioned drama at the beginning of the semester to explain teaching science through play. However, of the 81 participants, only one (1.2%) equated play with drama at the end of the course. The followings are examples from pre and post-questionnaires.

> ST75 Pre: "Yes, science and play can be integrated. For instance, after lecturing about rain formation, we can assign children roles (e.g. Sun, cloud, rain etc...) they can present rain formation by playing their role in a drama. By this way, they can have fun and learn at the same time."

> ST40 Post: Yes, play is very important for teaching science in kindergarten. For example, we can teach children phases of water. For example, to teach phase changes from solid to liquid, they play a "snow man melts" game.

To examine interviewees' understanding about teaching science through play, the coding scheme was applied to the verbatim-recorded responses. Three of the nine (33%) participants talked about drama at the beginning of the course to explain integration of science with play. The followings are example of integration with drama narratives:

> ST75 Pre: I understand that to make science understandable for children, it must be made visual and hands-on. For example, we can integrate play and science to teach rain formation. I can assign one child as rain and the other as a cloud. Two clouds rub each other, and then lightning and thunder happens. Then rain drops from the sky. First of all we explain the rain formation, and then we can ask children to dramatize it"

> ST37 Pre: Yes, I can fuse science and play. There are things in science that will be taught with experiments. We can merge these things into play. Within play, we can include these things in play.

Instructor: How can you include them in play?

ST37Pre: For example a drama. As you know drama is a play.

Creating Competition. Participants' comments on competition were compared from the beginning to the end of the course. The percentages of the participants who view teaching through play as competition decreased from pre to post questionnaire. Specifically, five of the 81 participants (6.2%) the beginning described including science competition as science and play integration. At the end of the course 3 of the 81 (3.7%) preservice teachers described including science competition. Participants stated that competition makes an activity fun and interesting. They mentioned competing for speed, amount accomplished, and finding the most different objects. However, creating competition is highly inappropriate in early childhood education but this view even kept at the posttest by a few preservice teachers. Typical examples from pre and post-questionnaire are below:

> ST79 Pre: All lessons can be integrated with play. For example, in an activity related to fall, children can be asked to collect leaves from outside. Then they can make a competition of collecting the most leaves.

> ST1 Post: Yes science can be taught with play. I have an example that I did in my field placement. I had children do an experiment with sugar cubes. They made a tower with 5 cubes of sugar. Then, they poured juice under the cube tower and saw whose tower would collapse first. They acquired this concept with excitement, curiosity, and play.

None of the interviewees mentioned competition at the beginning or at the end of the semester.

Experimenting. Participants' comments on experimenting with science were compared. Greater number of the participants mentioned play as experimenting with ideas and materials at the end of the course, compared to the beginning. On the pre-questionnaire, only four of the 81 participants (4.9%) mentioned children's active participation in hands-on activities in explaining how to teach science through play. However, on the post questionnaire, 45 of the 81 participants, (55.6%) explained integrating science and play as active participation of children in activity. Participants' explanations also differed qualitatively compared to the beginning. At the end of the semester, participants described teaching science through play as student-teacher dialogue and questioning to promote exploration and as using repetition with variation in activities. The followings are examples from pre and post-questionnaire.

> ST32 Pre: Children are naturally curious and active. They eagerly explore their environment and interact with people which helps them to: 1) create a friendly atmosphere in which children can take risk and enjoy their learning; 2) provide feedback for learning; 3) provide opportunities for children to experiment with science; 4) construct their understanding of the world they live in.

> ST32 Post: I think it's really good to give science through play because, children love to play and they can learn from it. Children are naturally interested in learning things in the nature and teachers have to use it to teach children about it. But it's important to be a

guide and let them ask questions, you can lead it in the right direction, but children already know a lot.

ST2 Post: Yes, science can be taught through play. Because children do not separate science and play, they perceive science as play. When they are experimenting they are having fun; they are asking questions with curiosity to their friends; and they are sharing new things that they learned with their friends and teachers; while they are experimenting they are predicting like if I do this the following will happen…

ST18 Post: Yes, science can be taught through play. Creating repetition and variation in a science activity allows children see the things different ways. In this way, children can make generalization or comprehend differences. For example, when they use different materials in an experiment, they can come up with better conclusions. Using various materials in an experiment provides children a way to look at the phenomena from different perspectives.

ST77 Post: Playful experiences with science are an important factor that makes learning science easy, interesting and motivational. Also, in playful learning experiences, children easily can construct cause and effect relationships.

To examine interviewee understanding about teaching science through play, the coding scheme was applied to the verbatim-recorded responses. Three of the 9 (33%) participants mentioned science experimentation as play at the beginning of the course. However, at the end of the course, eight of nine (88%) interviewees described teaching science through play as active participation and exploration of children. The following are example of pre and post narratives of integrating science experimentation with play.

ST75 Post: "At the beginning of the course, I could not think anything in my mind about play. I was thinking to integrate with drama. For example, for rain I talked about lightning and thunder storm. Now I am thinking differently. I am thinking about repeating the same experiment with various things to explore in the activity…"

ST32Post: I understand from the statement, "teaching science through play" that you can teach science to kindergarten children. For example through making a topic easier for the children (searching for the right level) also you can combine science with playing. Let them discover and don't tell them exactly what they have to do, because if we told them what to do then it won't be interesting anymore. Children can do a lot more then what we are thinking. We can have a table with various materials where children can explore and research. Also, you can go with children outside and let them search for plants or creatures. You can look for things like the shadow and sun, there are many ways you can play and integrate science.

ST 37 Post: By doing various experiments with children and by including children' ideas in the experiment, and creating variation in an experiment.

Instructor: What you mean by creating variation in experiment?

> ST37 Post: By asking questions to children or by letting children to explore their question with our guidance. For example, while doing experiment related to water by asking questions what will happen if I add red food color.

Are the preservice teachers able to integrate science and play in their field placement teaching practice?

To answer this question, the 12 assignments randomly selected from the 81 were used to compute a percentage of successful implementation of teaching science through play in the kindergarten classroom. Also, author evaluated his field observation while preservice teachers teach science through play integrating with other subjects. The criteria for successful implementation are children's active participation that is ensured by creating variation and repetition in activity and practice of the Wassermann's (1998) three stage model Play-Debrief-Replay. Eleven of the 12 assignments (92%) were successful in integrating science and play in their field placements. The one assignment that was not counted as successful was a demonstration about hygiene using liquid soap in a washbowl to show how soap interacts with microbes (represented by black pepper). From the picture and student's reflection, it was obvious during the experiment that the teacher was active and the students were mostly watching. Two successful illustrative examples from the preservice preschool teachers' reflections on teaching science through play were selected. These reflections are written evaluations of preservice teachers' teaching experiences in their field placements. The first one is a detailed reflection of a preservice teacher on teaching science through play in the field placement. The student used snails and different types of materials (e.g., magnifying glass, beakers, water, toothpicks, salt, flour, chips, leaves etc.) to experiment with what snails like.

> From my field placement experience, I learned that it is important to give children the opportunity to ask questions, make observations, by giving guidelines to help them think and think different way; letting them test the thing they learned; when I do *this* then *that* is happening…' Teaching something that is new for them. I would like to ask questions about the things that children have seen before but they did not explore or realize. In my assignment I took a snail to the kindergarten classroom. When I asked about the snails, they told me that they have seen one before, but they have not looked carefully. They enjoyed experimenting: What do snails eat? Do they like water? Can snails swim? What are two short antennas for under the long ones?
>
> It was fun. Children and I were very happy. Because we never thought before that snails have many eggs. It was interesting that snails were trying to get out of water. I know they usually like moist environment, but they were insisting to get out of water. This was cool! You can follow where they went by looking at the wet tracks they leave on the surface. When children tried to touch their antenna, the snails were pulling their antennas back. It was interesting to know that snails have similar reflexes as humans have. To protect themselves, they were instinctively going inside of their shell. It was interesting to see that they were eating grass, chips, and papers. Children said wow wow! I liked it when children were cheering and screaming with joy and said "they are eating!" They were not just observing but also trying, and reaching their goals. What will happen if we try these things differently? We can vary our questions. We can provide variations in the activity with different materials for children.

> The most important and also what I liked the most was that children were exploring with magnifying glasses. Learning with children by sharing the same learning process was very beautiful. I enjoyed the feedback that I got from children. Children told me that the activity was very interesting, and they enjoyed it very much. They said we hope you come back, and we can do experiments again; but next time when you are coming bring another animal.
>
> Play and science is a combined thing. We cannot separate! Especially for children! Because when children explore something, they are telling their friends. They are saying wow this happened. They are doing things and being happy. They are thinking "does it happen if we do this…" they are asking interesting questions. I mean they are being happy. Seeing a smile on their face is the most beautiful thing.

As we can the reflection above, preservice teacher was successful providing various materials for children active participation to exploration about snails. The author supervised this preservice teacher while she was teaching practice in the field placement. The author's observation, notes and pictures also showed that after experimenting with snails, preservice teacher integrated the lesson very well with other subjects by guiding children for drawing pictures, reading books, singing song and creating drama.

The second example is one in which questions were used to initiate integration of science with teacher-directed play. A preservice teacher selected rain formation activity in which she boiled water in a kettle and put a cold plate on top to observe rain drops. The challenge for her was how to make it playful, and explore more from this activity instead of just demonstrating rain drops on the cold plate. The following are the questions that the preservice teacher generated to extend the rain formation activity by creating repetition and variation in the activity.

1. What is rising up in the boiling water?
2. What will happen if you place a cold plate on water vapor?
3. If you add red food color to boiling water, what will be the color of water drops from cold plate?
4. If you add salt to the boiling water, would the water drops taste salty?

Preservice teachers reflected that children' predicted for the 3rd questions was that the water drops from the cold plate also will be colorful. To test their prediction, they added red food color to boiling water to see what will happen and found that the drops from the plate were colorless. The fourth question was tested the same way, and they found out that the drops from the plate were not salty.

Is the preschool science methods course successful in creating a playful and positive classroom environment and developing positive attitudes toward science education?

To examine the effect of the course on preservice teachers' attitudes about the class atmosphere and playfulness, descriptive statistics were calculated on the seven survey statements answered at end of the course. Each was scored on a 1-5 scale with 5 being the most positive. Table 2 shows the means and standard deviations of student ratings at the end of the course.

Table 2. Means and Standard Deviations of Rating of Playfulness and Positive Classroom Environment in the Methods Course

Topic	N	Mean	SD
Role of Play in Learning Science			
1. In science class, playful activities made learning easier	81	4.90	.40
2. Playful/fun activities increased my interest on learning science concepts.	80	4.88	.35
3. Playful activities helped me to develop positive attitude toward science learning and teaching.	81	4.81	.47
4. Playful activities relieved boredom	81	4.790	.54
Class atmosphere and content of class group work			
5. Interesting science phenomena and concepts provided in science class.	81	4.37	.81
6. Field placement assignments were enjoyable.	81	4.72	.61
7. The science activities we did as partner or group was fun	80	4.68	.56
8. Classroom atmosphere was positive, friendly, supportive, and relax learning environment which we were able to engage actively with scientific phenomena and interact and discuss their understanding with their friends and instructor.	80	4.62	.75

The mean ratings for the descriptors of the methods course about the role of play in learning science, class atmosphere, and content of the class work were very high, indicating that by the end of the course, the preservice teachers understood the importance of play in teaching science and enjoyed the playfulness of the methods course.

Discussion and Conclusion

The science methods course focused on creating a positive classroom environment in which preservice teachers experienced various playful and interesting science activities to develop positive attitudes and understanding on how to teach science through play. This study provides valuable information on the development of preservice teachers' attitudes and understanding about teaching science through play. Also, the study reports preservice teachers' practice and reflections on teaching science through play in kindergarten classrooms.

It is an encouraging finding that most of the preservice teachers were positive and valued teaching science through play in kindergarten. However, only a few of them had a clear understanding about how to integrate play and science in kindergarten. This finding was similar to research studies (Cheng, 2001; Cheng & Stimpson, 2004) that identified a gap between preschool teachers' espoused theories and practice of teaching through play. This finding was also verified by preservice teachers in this study. Even though they were not asked to evaluate science education in their field placements, they stated that there was no science corner or materials in kindergarten classrooms. Also, they mentioned that in-service kindergarten teachers were not qualified to integrate science with play. These findings were parallel with studies (Miller & Almon, 2009;

Tu, 2006) that reported kindergarten teachers did not teach enough science. These findings imply the need for more work on evaluating and improving science education in kindergarten classrooms.

As mentioned above, being positive about integrating science play in kindergarten does not necessarily mean preservice teachers have true theoretical and practical knowledge about teaching science through play. As this study indicated, the majority of the preservice teachers initially had naïve and simplistic understandings about how to teach science in kindergarten. At the beginning of the semester, a few of them thought that teaching science through play was difficult. Most of the participants mixed teaching science through play with integrating science with drama and making/creating competition in activities. However, from these creating competition is inappropriate and it goes against best practice early childhood education. The rest of them described the benefits of play but did not explain how to teach science through play. These results are similar to other conclusions (Cheng, 2001; Cheng & Stimpson, 2004; Miller & Almon, 2009) noting that kindergarten teachers had difficulty understanding and implementing "teaching through play". This finding indicates that preservice teachers not only misunderstand about integration of play and science; they are not generally aware that curriculum can be integrated. The finding that the majority of the participants had naïve understandings about teaching science through play and integrated curriculum at the beginning of the course means that their child development courses and theoretical play courses did not build understanding of how to integrate science and play. Courses are needed that focus on teaching both theoretical and practical knowledge on science through play.

At the end of the course, increases were found on preservice teachers understanding about teaching science through play. Student explanations were more related to experimenting with science ideas and materials rather than making drama or creating competition in science activities. This finding indicated that preservice preschool teachers' understanding can be developed when they are engaged with fun and playful activities in a methods course as suggested by several research studies (Court, 1993; Jarrett & Burnley, 2010; Palmer 2002). In addition to playful engagement with science in the methods course, this study indicated that the instructor's representations and reflections on his own practice with pictures in the preschool classroom was very effective in developing understanding about teaching science through play. Research (Perkins, 1993; Perkins & Unger, 1994) shows that teaching for understanding requires powerful representations that clearly link theory and practice. The methods course helped students to develop better and more coherent understanding of teaching science through play. At the end of the course, most of the participants were able to translate their understanding into practice in their field placement.

The purpose of the third question was to assess whether preservice teachers were successful in implementing their learning about teaching science through play in their field placement. Preservice teachers' assignments were on various science topics. The analysis of their assignment report and reflection indicated that they were successful in integrating science and play but also that they were able to integrate their science lesson with other subject areas such as reading, drawing pictures, singing, and creating drama. In their reflections, preservice teachers mentioned their excitement about starting a lesson with teaching science through play with active participation of children, then extending the same topic throughout the day by integrating literacy, art, music, and drama. Their comments expressed obvious enjoyment in what they were teaching and rated teaching science through play as a superior method. The findings indicated that teaching theory to put into practice in the preschool classroom were crucial for preservice teachers' developing understanding of teaching science through play as argued by Perkins (1993) and Aikenhead (2006). At the end of the course, their ratings of the field placement assignments

were very positive, suggesting that field placement experiences were enjoyable. The written reflections indicated that the children found their experiences joyful and fulfilling. Children's drawings and quotations from children showed that a lot of learning had taken place.

The final question was about the evaluation of the science methods course in terms of providing interesting and playful science activities, and also creating a playful and positive course environment. The result indicated the methods course experience was playful, interesting, and enjoyable for students. The course included various materials and hands-on activities in which preservice preschool teachers were encouraged to investigate different aspects of phenomena through experimentations and exploration. Finding a positive attitude toward the course at the end of the course suggests that active engagement with fun, interesting inquiries should be incorporated into science methods courses. The finding was similar to research (Bulunuz, 2008, 2012a, 2012b; Eshach, 2003; Myers & Fouts, 1992; Palmer, 2004) showing that positive and supportive social environments with various interesting activities has an important influence on developing positive attitudes and motivation for teaching science.

The science methods course was especially designed to address the need of preservice preschool teachers to understand and implement and value teaching science through play. Previous research studies indicated the need for science education in preschool classrooms (Eshach & Fried, 2005), but none of them examined preschool teachers' understanding and practice. This study is a good start in focusing on the role of methods courses in helping preservice teachers to teach science through play. I personally think this effort is necessary and worthwhile because it is almost universally accepted that play is most important for learning and development of children, but in practice it is often not practiced. An extensive literature review indicates there has not been enough research on science teaching in preschool classrooms. This study provides some of the evidence that it is possible to achieve understanding of teaching science through play for preservice preschool teachers who hopefully will put their understanding into practice in their future classrooms. Courses in child development, child psychology, development of creativity, and child development and play are important courses for understanding development and child psychology and supposedly to develop understanding of teaching through play. However, it is not realistic to expect these courses will explicitly help preservice teachers teach science through play because these courses have their own content and do you focus explicitly on play and subject matter content. One possible solution might be a collaborative effort with other professors to develop research-based integrated courses that specifically address the needs of preservice preschool teachers to teach through play.

This study provided some important findings about developing preservice teachers' understanding, attitudes and practice about integrating science and play in early childhood education. However, it also had several limitations. First, the research was conducted in Bursa-Turkey so it is difficult to generalize the results to other geographic areas. Further research in different parts of the Turkey or other parts of the world is needed. Second, study lacked control group and the sample was a convenience sampling. Therefore, further research would have control group with random sampling. Third, the study relied on preservice teachers' survey, interviews for attitudes, and field assignments for practice. Therefore, further research should investigate whether they actually integrate science and play when they become teachers and determine whether positive attitudes shown in the method course has long term effect on teaching.

References

Aikenhead, G.S. (2006). *Science education for everyday life: Evidence-based practice***.** New York: Teachers College Press.

Bulunuz, M, & Jarrett, O (2008). Development of positive interest and attitudes toward science and interest in teaching elementary science: influence of inquiry methods course experiences. Paper was presented at the Teacher Education Policy in Europe (TEPE 2008), Univesity of Ljubljana, Slovenia.

Bulunuz, M. (2012a). Motivational qualities of hands-on science activities for Turkish preservice kindergarten teachers. *Eurasia Journal of Mathematics, Science and Technology Education, 8*(2), 73-82.

Bulunuz, M., Jarrett, S. O., & Martin-Hansen, L. (in press, 2012b). Level of inquiry as motivator in an inquiry methods course for preservice elementary teachers. *School Science and Mathematics*.

Cheng, P. W. D. (2001). Difficulties of Hong Kong teachers' understanding and implementation of 'play' in the curriculum. *Teaching and Teacher Education, 17* (7), 857-869.

Cheng, P. W. D. & Stimpson, P. (2004). Articulating contrasts in preschool teachers' implicit knowledge on play-based learning. *International Journal of Educational Research, 41*(4-5), 339-352.

Court, D. (1993). A playful environment in a cooperative physics classroom. *Clearing House, 66*(5), 295-299.

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. NY: The Free Press.

Doverborg, E. & Pramling-Samuelsson, I. (1999). Apple cutting and creativity as a mathematical beginning. *Preschool Education: Theory, Research and Practice, 4* (2), 87-103.

Eshach H. (2003). Inquiry-events as a tool for changing science teaching efficacy belief of preschool and elementary school teachers. *Journal of Science Education and Technology, 12*, 495-501.

Eshach, H., & Freid, M. (2005). Should science be taught in early childhood? *Journal of Science Education and Technology, 14,* 315-336.

Fulp, S. (2002). The status of elementary science teaching: National survey of science and mathematics education. Chapel Hill, NC: Horizon Research, Inc. Retrieved December 20, 2005 from, http://2000survey.horizon-research.com/reports/elem_science.php.

Fazey, J.A. & Marton, F. (2002). Understanding the space of experimental variation. Active Learning in Higher Education, 3 *(3), 234-250.*

French, L. (2004). Science as a center of a coherent, integrated early childhood curriculum. *Early Childhood Research Quarterly, 19,* 138-149.

Ganschow, R. & Ganschow, L. (1998). Playfulness in biological science. In D.P. Fromberg & D. Bergen (Eds.), *Play from birth to twelve and beyond: Context, perspectives, and meanings* (pp. 455-460). New York: Garland Publishing.

Goodrum, D., Hackling, M. & Rennie, L. (2001). *The status and quality of science teaching and learning of science in Australian schools. A research report* (Canberra: Department of Education, Training and Youth Affairs).

Harlen, W. & Holroyd, C. (1997). Primary teachers' understanding of concepts of science: Impact on confidence and teaching. *International Journal of Science Education, 19*, 93–105.

Hidi, S. (2000). Motivating the academically unmotivated. *Review of Educational Research*, *7*, 151-179.

Jarrett, O. S. & Burnley, P. (2007). The role of fun, playfulness, and creativity in science: Lessons from geoscientists. In D. Sluss and O. Jarrett (Eds). *Investigating play in the 21st century: Play and culture studies, Vol. 7*. Lanham, MD: University Press.

Jarrett, O. S. & Burnley, P. (2010). Lessons on the role of fun/playfulness from a geology undergraduate summer program. *Journal of Geoscience Education, 58* (2), 213-220.

Jarrett, O. S. (in press, 2012). *Çocuğun dünyasından bilim: Anlamlı öğrenme için etkinlikler* (Drawing on the child`s world: Made science relevant). Ankara: TÜBİTAK.

Kean, E. (1998). Chemist and play. In D.P. Fromberg & D. Bergen (Eds.), *Play from birth to twelve and beyond: Context, perspectives, and meanings*. (pp. 468-472). New York: Garland Publishing.

Kalande, W. M. (2006). The influence of science teacher preparation programs on instructional practices of beginning primary school teachers in Malawi. Doctoral dissertation at Virginia Polytechnic Institute and State University.

Klugman, E., & Fasoli, L. (1995). Taking the high road toward a definition of play. In E. Klugman (Ed.), *Play, policy and practice*. St. Paul, MN: Redleaf Press.

Lindahl-Samuelsson, M. & Pramling-Samuelsson, I. (2002). Imitation and variation: reflections on toddlers' strategies for learning. *Scandinavian Journal of Educational Research, 46* (1), 25-45.

Laszlo, P. (2004, September-October) Science as play. *American Scientist*. Retrieved February 13, 2010 from http://www.pierrelaszlo.com/activities/lectures/110-science-as-play

Marton, F., & Ming-Fai, P. (1999). Two faces of variation. Paper presented at 8th European Conference for Learning and Instruction, Göteborg, Sweeden.

May-Peterson, S., & French, L. (2008). Supporting young children's explanations through inquiry science in preschool. *Early Childhood Research Quarterly, 23*, 395-408.

Miller, E. & Almon, J. (2009). *Crisis in preschool: Why children need to play in school*. College Park, MD: Alliance for Childhood.

Milli Eğitim Bakanlığı Okulöncesi Eğitimi Genel Müdürlüğü (2006). *Okulöncesi Eğitim Programı: 36-72 Aylık Çocuklar İçin* (Preschool Education Curriculum: for 36-72 Month Children). Ankara: Devlet Kitapları Genel Müdürlüğü.

Myers, R. E. & Fouts, J. T. (1992). A cluster analysis of high school science classroom environments and attitude toward science. *Journal of Research in Science Teaching*, 29, 929–937.

National Research Council (1996). *National science education standards.* Washington, DC: National Academy Press.

Osborne, J. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079.

Palmer, D. (1999). Students' perceptions of high quality science teaching. *Australian Science Teachers Journal, 45*(3), 41-45.

Palmer, D. (2002). Preservice elementary teachers' perceptions after visiting an interactive science center. *An Online Journal for Teacher Research, 5*(3), 1-6.

Palmer, D. (2004). Situational interest and the attitudes towards science of primary teacher education students. *International Journal of Science Education, 26*(7), 895-908.

Patrick, H., Mantzicopoulos, P. & Samarapungavan, A. (2009). Motivation for learning science in preschool: Is there a gender gap and does integrated inquiry and literacy instruction make a difference. *Journal of Research in Science Teaching, 46*(2), 166-191.

Perkins, D. (1993). Teaching for understanding. *The Professional Journal of the American Federation of Teachers, 17* (3), 28-35.

Perkins, D.P. & Unger, C. (1994). A new look in representations for mathematics and science learning. *Instructional Science, 22* (1). 1-37.

Petroski, H. (1999). Work and play. *American Scientist, 87*(3), 208-212.

Piaget, J. (1973). How a child's mind grows. In M. Miller, *The neglected years: Early Childhood* (pp. 24-36). New York: United Nations Children's Fund.

Pramling-Samuelsson, I. & Asplund-Carlsson, M. (2008). The playing learning child: Towards pedagogy of early childhood. *Scandinavian Journal of Educational Research, 52* (6), 623-641.

Pramling, N. & Pramling-Samuelsson, I. (2001). "It is floating 'cause there is a hole: A young child's experience of natural science. *Early Years, 21* (2), 139-149.

Pramling-Samuelsson, I. (2006). Teaching and learning in preschool and the first years of elementary school in Sweden. In J. Einarsdottir & T. J. Wagner (Eds.), *Nordic early childhood education: International Perspectives on Educational Policy, Research and Practice*. Greenwich, Connecticut: Information Age Publishing.

Pramling-Samuelsson, I. & Johansson, E. (2006). Play and learning—inseparable dimensions in preschool practice. *Early Child Development and Care, 176* (1), 47-65.

Resnick, M. (2004). Edutainment? No thanks. I prefer playful learning. Retrieved 30 December, 2009) from http://www.roboludens.net/Edut_Articoli/Playful_Learning.pdf

Rowsey, R. E. (1997). The effects of teachers and schooling on the vocational choice of university research scientists. *School Science & Mathematics, 97*(1), 20-26.

Stone, B. (2004), 'Playing with science. Elementary school science: Learning through play', Paper presented at the 23rd ICCP World Play Conference, 'Play and Education', Cracow, 15-17 September 2004.

Severeide, C.R., & Pizzini, L.E. (1984). The role of play in science. *Science and Children, 21*(8), 58-61.

Stevens, J.P. (2002). *Applied multivariate statistics for the social sciences*, Mahwah, New Jersey: Lawrence Erlbaum Associates.

Tu, T. (2006). Preschool science environment: What is available in a preschool classroom? *Early Childhood Education Journal, 33* (4), 245-251.

Üçok, K. (2003). *Deneyler Anasınıfı 1, 2, 3*. (Experiments for Kindergarten 1, 2, 3). Ankara: TUBİTAK Yayınları.

Varelas, M., Plotnick, R., Wink, D., Fan, Q., & Harris, Y. (2008). Inquiry and connections in integrated science content courses for elementary education majors. *Journal of College Science Teaching*, *37*(5), 40-45.

Van Hook, S., & Huziak-Clark, T.L. (2008). Lift, squeeze, stretch, and twist: research-based inquiry physics experiences (RIPE) of energy for preschoolers. *Journal of Elementary Science Education, 20* (3), 1-16.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge: Harvard University Press.

Wassermann, S. (1998). Teaching strategies. Play-debrief-replay: An instructional model for science. *Childhood Education, 64* (4), 232-34.

Wedoe, L. (2001). Science and play - oil and water? Paper presented at the International Council for Children's Play, Erfurt.

Weiss, R. I. (1997). *The status of science and mathematics teaching in the US: Comparing teacher views and classroom practices to national standards.* National Institute for Science Education (NISE Brief), 1 (3).

Wolfe, C., Cummins, R. & Meyers, C. (2006). Scientific inquiry and exploratory representational play. In D.Fromberg, D.P.& Bergen,D. (Eds.), *Play from birth to twelve: Contexts, perspectives, and meanings*, (pp:199-206). New York: Taylor & Francis Group.

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Okulöncesi Öğretmen Adaylarının Oyun-Yoluyla Fen Öğretimi Hakkında Bilgi ve Tutumlarının Geliştirilmesi

Bu çalışmada, öğretmen adaylarının oyun-yoluyla fen öğretimi hakkında bilgi ve tutumlarındaki gelişmeler incelenmiştir. Çalışma okul öncesi fen eğitimi dersini iki ayrı şubede alan toplam 94 öğretmen adaylarından oluşmuştur. Yarı-yapılandırılmış görüşme kayıtları, dönem başı ve sonunda uygulanan açık uçlu sorular, öğrencilerin stajda yapmış oldukları uygulamalarla ilgili değerlendirme raporları ve Oyunla Fen Öğretimi Anketi veri kaynaklarını oluşturmuştur. Dönem başında öğretmen adaylarının çocuklara kukla oynatmayı, drama, gösteri deneyi, yarışma ve eğlenceli oyun etkinlikleri yaptırmayı oyun ile fen öğretimini olarak algıladıkları ve de oyun ile öğretimi sadece öğrenmeyi kolaylaştırıcı bir araç olarak gördükleri anlaşılmıştır. Dönem sonunda ise oyun-yoluyla fen öğretimi hakkında aşağıdaki temalar ortaya çıkmıştır: 1) çocukların, çeşitli malzemelerle oynayarak aktif katılımının sağlanması ve fikir yürütmeleri, 2) öğretmen, çocuklara diyalog yoluyla sorular sorarak etkinliklerde çeşitliliği artırmalı ve onları araştırmaya teşvik etmeli ve sonuç olarak çocukların etkin katılımının sağlanması durumunda merak ettikleri sorulara kendilerinin de cevap bulabileceği ve neden-sonuç ilişkisi kurabileceği ortaya çıkmıştır. Oyunla Fen Öğretimi Anketi'nden çıkan yüksek ortalama (4.5/5), öğretmen adaylarının okul öncesi fen eğitimine yönelik olumlu tutum geliştirdiklerini göstermiştir. Bunun yanı sıra öğretmen adaylarının hem üniversitedeki fen derslerine etkin ve eğlenceli katılımları hem de öğretmenlik stajındaki oyun-temelli fen öğretimi uygulamaları, onların, fen öğrenmede oyunun önemini kavramalarını sağlamıştır.

Anahtar Sözcükler: okulöncesi fen eğitimi; oyun-yoluyla fen öğretimi; oyun-temelli öğrenme; tutum