Examining Pre-School Education Teacher Candidates' Content Knowledge and Pedagogical Content Knowledge

*Hatice Zeynep İNAN**

Abstract

One of the requirements of the twenty-first century is raising a child who is an explorer and who can solve problems rather than being able to memorize facts. One of the indispensible foundations of exploring and problem-solving is having scientific process skills and being able to use them effectively. In order to raise little scientists with a researcher soul and research skills, teachers should be qualified as well. They should know "how" to give their students "what" about scientific process skills. It is aimed in this study first to check content knowledge of teacher candidates on scientific process skills and then to analyze their pedagogical content knowledge on the subject. 31 female and 2 male, total 33 teacher candidates in Dumlupınar University Pre-School Teaching Department participated in the study. In the study, in which qualitative research methods are used, 4th grade teacher candidates participated in. Research findings and suggestions for further research are discussed at the end.

Key Words

Pre-school, Teacher Candidates, Science Process Skills, Pedagogical Content Knowledge, Content Knowledge.

* *Correspondence*: Assist. Prof. Hatice Zeynep INAN, Dumlupinar University, Faculty of Education, Department of Elementary Education, Merkez Kampus, Tavsanli Yolu 10.km, Kutahya/Turkey.
E-mail: haticezeynep@hotmail.com

Kuram ve Uygulamada Eğitim Bilimleri / Educational Sciences: Theory & Practice
10 (4) • Autumn 2010 • 2309-2323

One of the requirements of the twenty-first century is raising a child who is an explorer and can solve problems rather than being able to memorize facts. One of the indispensible foundations of exploring and problem solving is having Scientific Process Skills and being able to use them effectively. Today the aims of equipping children with Scientific Process Skills at an early age are stated clearly in early childhood education programs (e.g., Aylık Çocuklar için Okul Öncesi Eğitim Programı, Milli Eğitim Bakanlığı [MEB], 2006, p. 36-72). In order to raise little scientists with a researcher soul and research skills, teachers should be qualified as well. They should know "how" to give their students "what" about Scientific Process Skills. Meetings and research on the quality and adequacy of pre-school education teacher candidates emphasize the need for raising qualified teachers in Turkey and stress that relevant research should be carried out (Haktanır, 2008; Özbey & Alisinanoğlu, 2009, 2010).

Two concepts have often stood out in studies on teachers' adequacy and how to make education process productive: Content Knowledge and Pedagogical Content Knowledge. These two concepts rather new in early childhood education point out two facts: teachers should have an adequate level of Content Knowledge in their domain and they should have a strong Pedagogical Content Knowledge to transfer the subject to their students effectively (Al-Hooli, 2001; Maxedon, 2003; McCray, 2008; Rojas, 2008; Smith, 2000). In order for pre-school teachers to raise children who can analyze, solve problems and use Scientific Process Skills to reach for knowledge, they should know not only Scientific Process Skills well but also the ways to donate their students at early childhood with these powers well. However, it was determined in a study carried out on pre-school teachers that teachers were using Scientific Process Skills but the examples they had given did not support their claim (Inan, 2011).

It is aimed in this study first to check Content Knowledge of teacher candidates on Scientific Process Skills and then to analyze their Pedagogical Content Knowledge on the subject. Thus, it will be determined whether the problem determined in pre-school teachers exists in teacher candidates, and if it does, it will be determined whether inadequate Content Knowledge accompanies similar problems. In this article, research on Early Childhood Education Pedagogical Content Knowledge will be analyzed before presenting the research on early childhood period Scientific Process Skills.

Pedagogical Content Knowledge in Early Childhood Education

The concept of Pedagogical Content Knowledge is defined as the teacher's knowing his/her students well, his/her being able to use the necessary pedagogical techniques and his/her being mastering Content Knowledge in teaching-learning process (Shulman, 1986, 1987). Many factors are mentioned in the success of early childhood education such as teacher, environment, materials, teaching methods and techniques, right timing and suitability of the subject to the development level of the child. Pedagogical Content Knowledge has merged all these factors in one concept. Pedagogical Content Knowledge requires that the teacher not only possess mastery of his/her domain, but also have sufficient pedagogical knowledge in transferring his/her knowledge to the child; besides, studies have pointed out a close relation between Content Knowledge and Pedagogical Content Knowledge (Ozden, 2008; Usak, 2009).

Studies on Pedagogical Content Knowledge of teachers and teacher candidates of 0–7 ages have been carried out on a general frame or in terms of different disciplines. These studies are mostly on early childhood mathematics education (e.g. Maxedon, 2003; McCray, 2008; Smith, 2000). Researchers argue that in order for teachers of early childhood period to achieve effective teaching, they should check both their Content Knowledge and their educational philosophy and pedagogical applications (Fleer, 2009). In order to strengthen their Pedagogical Content Knowledge, researchers suggest that these teachers participate in professional development studies in child development and education (Smith, 2000) and in such content areas in which they feel insufficient (e.g. Geometry; Maxedon, 2003). On the other hand, Al-Hooli (2001) stated in one of his studies that pre-school teachers have strong Content and Pedagogical Content Knowledge, that the choosing appropriate children books is the right teaching method in science and that productive results are obtained thanks to children books.

Studies on Pedagogical Content Knowledge in early childhood period are rather limited. McCray (2008) divided Pedagogical Content Knowledge into two: Elaborative and evaluative. Elaborative Pedagogical Content Knowledge calls for such a guidance that allows the student to use his/her free will, while Evaluative Pedagogical Content Knowledge requires the teacher to understand the point where the student stands. Rojas (2008) explained Pedagogical Content Knowledge in

three different dimensions: what is taught (curricular content); to whom (students); and how (pedagogy). As understood from these definitions, Pedagogical Content Knowledge is teacher-focused not isolated from the student but embracing the student.

Scientific Process Skills

Scientific Process Skills is an inherent part of research and knowledge producing process. When still young, little children should be instilled with research spirit through various activities. Many researchers and educators have done studies on equipping children with Scientific Process Skills at early age (Akman, Üstün, & Güler, 2003; Alisinanoğlu, Özbey, & Kahveci, 2007; Arı & Öncü, 2008; Hachey & Butler, 2009; Inan, 2011; Nikolaeva, 2008; Ömeroğlu & Dere, 2001; Quigley, Beeman-Cadwallader, Riggs, Rodriguez, & Buck, 2009; Sullivan, 2008). Scientific Process Skills are basic such Scientific Process Skills as observation, prediction, interpretation, measuring, grouping, communication; such Integrated Scientific Process Skills as controlling variables, building hypothesis, interpreting data, doing experiment and formulating a model (Keil, Haney, & Zoffel, 2009). On the other hand, Scientific Process Skills often appearing in studies on pre-school period are observation, prediction, measuring/calculating, comparison, categorizing/grouping, data collection/ recording and communication (Inan, 2007).

Through curiosity-focused activities, children have the chance to use their Scientific Process Skills naturally and meaningfully to satisfy their curiosity in their environment (Akman et al., 2003; Aktaş-Arnas, 2002; Dzerviniks, 2009; Hachey & Butler, 2009; Kesicioğlu & Alisinanoğlu, 2009; Monhardt & Monhardt, 2006; Nell, 2009; Sullivan, 2008; Şahin & Ökçün, 2000). Quigley et al. (2009) stated that problem-based learning is effective in children and it facilitates active participation of the children and streamlines meaningful learning. Nikolaeva (2008) also stated that using Scientific Process Skills arouses interest of children in nature and science, enables children to solve reason-result relations, helps them to know their environment and life and facilitates consciousness of responsibility. Thus, while children strive for satisfying their natural curiosity by using Scientific Process Skills, they can also structure their knowledge about science and nature.

Torres and Vitti (2007) suggest that as little scientists, children should use their sense organs and that they should predict, analyze, calculate,

compare, group, communicate, test their predictions, use tools and pay attention to details. According to Torres and Vitti, children work together with other scientists by asking questions, by repeating experiments again and again until the answer is found and by enjoying themselves in the meantime.

In a study on pre-school teachers, Inan (2011) stated that teachers had activities to equip children with Scientific Process Skills, but their examples and explanations revealed that the children were passive while the teacher was active in those activities. Scientific Process Skills, as can be understood from its name, require using the relevant skills. Therefore, children should be using Scientific Process Skills actively while they are searching the subjects they are curious about and while they are answering the questions in their minds. The aim of this study is to reveal whether the 4th grade (senior) teacher candidates experience similar problems and, if they do, to check whether Content Knowledge accompanies with the problem. After all, previous studies point out that there is a close relation between Content Knowledge and Pedagogical Content Knowledge (Ozden, 2008; Usak, 2009).

Method

The study made use of a qualitative research method: A Case Study (Case Study; Yin, 1993; Yin, 2003). Through this comprehensive method in terms of data collection and data analysis (Yin, 1993; Yin, 2003) and by analyzing a sample case in depth (Stake, 1995), Content Knowledge and Pedagogical Content Knowledge of senior students of Dumlupınar University Pre-School Teaching Program about Scientific Process Skills were analyzed. Picturing, which is utilized in this study, is usually used in science education studies to find out misconceptions and the level of conceptual understanding of participants on some topics (Ozden, 2008; Ozden, 2009). Thanks to Qualitative Case Study, instead of making a generalization, an existing little section was analyzed in depth and an integrated definition was made (Merriam, 1998).

Sampling

31 female and 2 male, total 33 teacher candidates in Dumlupınar University Pre-School Teaching Department participated in the study. Analyzing the self-sufficiency beliefs of teacher candidates of 1st year

(freshman) and 3rd year (junior) pre-school teaching program in terms of science course, Ekinci-Vural and Hamurcu (2008) determined that the junior teacher candidates considered themselves sufficient and there was a statistically significant difference between freshman and junior students. Therefore, the sampling group of our study was totally composed of 4th grade (senior) students to study on a sampling with sufficient experience through sufficient applications and science courses.

Data Collection Tools

"Data Collection Tools" are composed of two: A classroom order picturing activity (activities, corners, games, etc) aimed at grasping, gaining and using Scientific Process Skills in terms of Content Knowledge and a questionnaire with open-ended questions about Pedagogical Content Knowledge. Picturing the subject is one of the methods in collecting data about the knowledge and misconceptions of students in science subjects (Ozden, 2009; Usak, 2009). The questions in the questionnaire about Pedagogical Content Knowledge were determined after reviewing the relevant study on the matter (e.g. Keil et al., 2009; Hachey & Butler, 2009; Monhardt & Monhardt, 2006; Inan, Trundle, & Kantor, 2010).

Data Collection Process

The teacher candidates participated in the study altogether on individual chairs in a classroom designed as U. First, they were asked to complete the first study on Content Knowledge. After completing the study in one and a half hours, questions of teacher candidates on Scientific Process Skills were answered.

Data Analysis

It is common to utilize qualitative research methods in studies related to Pedagogical Content Knowledge (ex., Abd-El-Khalick, 2006; Ozden, 2008; Usak, 2005, 2009). In such studies, researchers usually look for patterns and categories in terms of Content Knowledge and Pedagogical Content Knowledge by reexamining the data again and again and give examples which represent similarities, differences and relationships among categories (Abd-El-Khalick, 2006; Ozden, 2008; Usak, 2005, 2009).

So as to reveal the Content Knowledge of teacher candidates, classroom environment picturing activities aimed at grasping, gaining and using Scientific Process Skills were evaluated qualitatively. Answers of teacher candidates to the questions asked to reveal their Pedagogical Content Knowledge were coded and the resulting categories were merged under common domains. Later, explanations for each domain and data examples were presented.

Findings

Content Knowledge

The teacher candidates in the study know such Scientific Process Skills frequently used in pre-school teaching as observation, prediction, measuring/computing, comparison, categorizing/grouping, data gathering/recording and communicating and included them in their classroom plans at the rate of 40% (93 ticks of 231 choices) . The teacher candidates in the study showed 40% overall success in picturing activities of Scientific Process Skills. The Scientific Process Skills can be listed from the most used to the least by the most number of teacher candidates as follows: observation skill 90%, measuring/computing skill 52%, communicating skill 45%, comparison skill 42%, prediction skill 24%, categorizing/grouping skill 21% and data gathering/recording skill 9%.

Pedagogical Content Knowledge

In order to reveal Pedagogical Content Knowledge of teacher candidates, the question "What do you do to improve your students' Scientific Process Skills?" was asked separately for each scientific process skill. Accordingly, all of the teacher candidates (100%) said that they were doing activities to equip their students with observation, prediction, measuring/computing, comparison and communicating skills. While 93% said that they were doing data gathering/recording, 90% said that they were doing categorizing/grouping.

Discussion and Suggestions

In the literature, the frequently used Scientific Process Skills by little children are observation, prediction, measuring/computing, comparison, categorizing/grouping, data gathering/recording and communicat-

ing (Akman et al., 2003; Aktaş-Arnas, 2002; Hachey & Butler, 2009; Inan, 2007; Kilmer & Hofman, 1995; Nikolaeva, 2008; Quigley et al., 2009; Sullivan, 2008). In the first stage of the study, pre-school teacher candidates were asked to picture their Content Knowledge about Scientific Process Skills and the above mentioned Scientific Process Skills were checked one by one. In this study, teacher candidates showed overall success at the rate of 40%. When considered separately, 90% of the teacher candidates used observation skill and 52% used measuring/computing skill whereas 45% used communication skill, 42% used comparison skill, 24% used prediction skill, 21% used categorizing/grouping skill and 9% used data gathering/recording skill.

As seen above, those who used observation, measuring/computing, comparison and communicating skills were above 40%. On the other hand, those who used prediction, categorizing/grouping and data gathering/recording were below 40%. The most frequently used skill was observation skill. Nikolaeva (2008) stated that observation skill is very useful in developing attitudes towards nature in children. She said that children make use of observation skill in cognitive interest, appreciating nature and being sensitive to nature and pointed out that children can solve many cause-result relations thanks to observation. In this respect, it is very pleasing that teachers focus on observation skill. Other findings besides the above mentioned Scientific Process Skills are as follows: experiment, excursion, trial and error, researching, learning by doing/experiencing, book research, computer research, analysis, brain storming and problem solving.

Teacher candidates could picture such a classroom environment where children can observe, where they can measure and compute to collect information, where they can use their comparison skill, and where they can use their communication skill by using various ways to share this information with others. The teacher candidates could also prepare relevant activities and corners for these purposes. On the other hand, they could merge data sources with data acquisition process by saying research from books and computer.

In the second stage of the study, whether the teacher candidates have Pedagogical Content Knowledge in giving students Scientific Process Skills, in other words, as Shulman (1986, 1987) puts it, whether they use the required pedagogical techniques suitable for the age group they work with during teaching-learning process was researched. Through

questions asked to reveal Pedagogical Content Knowledge, it was found that all of the teacher candidates (100%) said that they made use of activities to give students observation, prediction, measuring/computing, comparison and communicating skills. The Scientific Process Skills used by more than 40% of teacher candidates in the first part of the study are the same with those answered with 100% success in the second part. Such a similarity between Content Knowledge and Pedagogical Content Knowledge of teacher candidates about Scientific Process Skills is also supported by literature. After all, in the definition of Pedagogical Content Knowledge, it was demanded that teacher should both master his/her domain field and have sufficient pedagogical knowledge in teaching this subject to children; previous studies point out a close relation between Content Knowledge and Pedagogical Content Knowledge (Ozden, 2008; Usak, 2009).

The results are coherent in this respect; however, the only exception is seen in prediction skill. Only 24% of the teacher candidates pictured prediction skill, but in the second part of the study, with examples all of them supported the fact that they do activities for prediction skill. Analyzing the answers, it was thought that this exception might have arisen from the fact that teachers used prediction skill not only in studies on science- nature but in other different studies as well. In future studies, this matter can be researched in details. On the other hand, almost all of the teacher candidates could give examples for activities about other Scientific Process Skills. In a study by Inan (2011) on pre-school teachers, similar results were obtained; that is, teacher could give successful examples for activities they did to give their students Scientific Process Skills and to make them use these skills.

After analyzing Scientific Process Skills, teacher candidates were asked indirect questions about the matter. Analyzing the answers given to the first of these questions "You explained how you did an experiment and its process in pre-school period", it was determined that teacher candidates encouraged their students to learning by doing/experiencing rather than learning passively; in other words, they tried to involve the students actively into the experiment process. As seen in other previous studies which are not parallel to this conclusion, it appeared in the examples they gave for the opinion that the teachers made their students do the experiment for the sake of furnishing them with Scientific Process Skills that it was the teachers themselves who in fact did the experiment and the students were only "observers" (Inan, 2011).

New studies can be carried out to find out the reason for the discrepancy above and it can be researched whether trying to furnish teacher candidates with a constructivist view would yield a different result than the teachers already working in the field. At any rate, in their study, Ertem and Alkan (2002) also came to the conclusion that teachers already working in the field do not try to give their students Scientific Process Skills. In their study on giving students data collection and analysis course to primary school children including kindergarten, Ertem and Alkan determined that students weren't given data collection and analysis course. A similar result was obtained in the methods used. In that study, teacher candidates stated that they used different techniques and methods (drama, games and stories) in giving their students Scientific Process Skills and in evaluating these skills. However, Ayvacı, Devecioğlu, and Yiğit (2002) found that pre-school teachers aren't aware of and do not use teaching methods effective in science-nature activities and that they do not develop original materials. Ozbey and Alisinanoglu (2008) emphasized in their study that for various reasons like crowded classes, insufficient space in class and teacher's feeling insufficient, pre-school teachers couldn't give science education sufficiently.

The answers to another question "Is it important for you whether students ask questions or not? If yes, why? What do you do to encourage them to ask questions?" showed that teacher candidates give great importance to students' asking questions. In relevant studies it was emphasized that students, especially those who are shy, not aware of the fact that they are allowed to ask questions or do not have sufficient experience in asking questions should be encouraged to ask questions (Science & Children, 2006). Teacher candidates stated in this study that asking questions supports development and learning of children in several ways and increases the teachers' awareness of children and what they are curious about. In terms of the importance of asking questions, the following points stand out about children's development and learning: Asking questions develop curiosity of children, enables them to focus on something, urges them to learn, supports their creativity and critical thinking, and boosts assimilation and arrangement in the learning process. Teacher candidates also pointed out the following to encourage asking questions: redesigning the classroom environment, enriching the environment with materials, asking provoking questions, preparing

activities and games to make students think and showing positive attitudes. In the literature it was emphasized that evaluating students under Peer Culture and integrating them with School Culture support the meaningfulness of education and efficient learning (Corsaro, 1997; Inan et al., 2010; Inan, in press). In fact, evaluation of children's questions, curiosity, interests and fear within Peer Culture is one of the natural and meaningful ways that reach to their heart and mind.

To the question how students' questions should be answered, teacher candidates gave rich array of examples in which teachers and students can both be active and passive reciprocally. Reactions of teacher candidates to students' questions are as follows: When students ask a question, checking whether the activities are suitable for their level, giving concrete and clear answers, seeking expert opinion if needed, asking other students and trying to get possible answers from them, giving hints to make students look for the answer themselves, directing students by asking questions to students' questions, guiding and encouraging the student to find the answer him/herself, preparing an environment for the student to find the answer him/herself, and designing activities and games for the student to find the answer. It draws attention that most of the teacher candidates suggested suitable environment and encouragement for enabling students to find the answer themselves.

10 categories came out of the answers given to the question "In which subjects/concepts in science do your students have difficulty in learning?": time; living things and life; weight; living and non-living things; the Earth and space; geometry; concepts of left and right; death, angel, jinni, devil; some scientific process skills; and human body. As seen above, teacher candidates put Scientific Process Skills in "hard subjects" category. These are experiment, measuring/computing, comparison and categorizing/grouping. Further studies are needed to understand why teacher candidates think they have difficulty in certain areas and to support them.

Finally, the question "What do you do to assess whether children have gained Scientific Process Skills?" was answered with 7 evaluation methods and techniques. Analyzing the categories, it is seen that both process and result evaluation was done and there is a wide array in which different methods and techniques were used. the categories are as follows: Comparison of their prior and post nature; Discussion and debate: starting a discussion by giving an imaginary discussion topic; Ques-

tion-answer: Asking why they do what; Documentation: Recording the process (taking photos, note taking); Different methods and techniques: Drama, game, story; During the process: Participating in the activity with spontaneous feedback and help; Post-process: Asking consolidation questions and designing consolidation activities right after observation or follow up or following weeks (to determine the subjects they have difficulty in and to observe their strengths and weaknesses).

In the future studies, as distinct from the data depending on the views of pre-school teachers, using such data collection methods and techniques as in-class observation or documentation, Content Knowledge and Pedagogical Content Knowledge of teacher candidates about Scientific Process Skills can be analyzed. After all, Yin (1993; 2003) stated that a more integrated picture can be drawn in studies by using different data sources like questionnaire, interview, observation, etc in Case Study Method. Whether teachers and teacher candidates act upon their statements can be checked through such methods as in-class observation. Another study conducted on big masses by using "Scale to Determine Efficiency of Pre-School Teachers in Science Activities", which was developed and whose reliability and validity studies were conducted by Özbey and Alisinanoğlu (2010), might be useful in determining the shortcomings in science-nature activities of pre-school teachers and thus having necessary precautions.

References/Kaynakça

Abd-el-Khalick, F. (2006). Preservice and experienced biology teachers' global and specific subject matter structures: Implications for conceptions of pedagogical content knowledge. *Eurasia Journal of Mathematics, Science and Technology Education, 2* (1), 1-29.

Akman, B., Üstün, E., ve Güler, T. (2003). 6 yaş çocuklarının bilim süreçlerini kullanma yetenekleri. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 24,* 11-14.

Al-Hooli, A. A. (2001). *Science and children's literature: Kindergarten teachers' attitudes and pedagogical content knowledge.* Unpublished doctoral dissertation, University of Virginia.

Alisinanoğlu, F., Özbey, S. ve Kahveci, G. (2007). *Okul öncesinde fen eğitimi.* Ankara: Nobel.

Aktaş-Arnas, Y. (2002). Okulöncesi dönemde fen eğitiminin amaçları. *Çocuk Gelişimi ve Eğitimi Dergisi, 6/7,* 1-6. http://egitim.cukurova.edu.tr/myfiles/open.aspx?file=213.pdf adresinden 1 Mart 2010 tarihinde edinilmiştir.

Arı, M. ve Öncü, E. Ç. (2008). *Okul öncesi dönemde fen-doğa ve matematik uygulamaları.* Ankara: Kök Yayıncılık.

Ayvacı, H. Ş., Devecioğlu, Y. ve Yiğit, N. (2002, Eylül). Okul öncesi öğretmenlerinin fen ve doğa etkinliklerindeki yeterliliklerinin belirlenmesi. *V. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi kitapçığı* içinde (s. 277-279). Ankara: ODTÜ. http://www.fedu.metu.edu.tr/ufbmek-5/b_kitabi/PDF/OgretmenYetistirme/Bildiri/t277d.pdf adresinden 1 Nisan 2010 tarihinde edinilmiştir.

Corsaro, W. A. (1997). *The sociology of childhood.* CA: Pine Forge Press.

Dzerviniks, J. (2009). Evaluation of changes in pedagogic opinions within the process of teaching of natural sciences in basic school. Problems of Education in the 21st Century, *17*, 49-57.

Ekinci-Vural, D. ve Hamurcu, H. (2008). Okul öncesi öğretmen adaylarının fen öğretimi dersine yönelik öz yeterlik inançları ve görüşleri. İlköğretim Online, *7* (2), 456-467.

Ertem, S. ve Alkan, H. (2002, Eylül). *İlköğretim ilk kademesinde veri toplama ve analizi konularının işlenişi. V. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi kitapçığı* içinde (s. 230-235). Ankara: ODTÜ. http://www.Fedu.Metu.Edu.Tr/Ufbmek-5/B_Kitabi/Pdf/Matematik/Bildiri/T230d.Pdf adresinden 1 Mart 2010 tarihinde edinilmiştir.

Fleer, M. (2009). Supporting scientific conceptual consciousness or learning in 'a round about way' in play-based contexts. *International Journal of Science Education, 31*, 1069-1089.

Hachey, A. C., & Butler, D. L. (2009). Science education through gardening and nature-based play. Young Child, *64,* 42-48.

Haktanır, G. (2008). Okul öncesi öğretmeninin niteliği. *Eğitime Bakış-Eğitim-Öğretim ve Bilim Araştırma Dergisi, 4* (12), 22-35.

Inan, H. Z. (2007). *An interpretivist approach to understanding how natural sciences are represented in a Reggio Emilia-inspired preschool classroom.* Unpublished doctoral dissertation, The Ohio State University, Columbus/OH, U.S.A.

Inan, H. Z. (2011). Teaching science process skills in kindergarten. *Social and Educational Studies (Energy Education Science and Technology Part B), 3* (1), 47-64.

Inan, H. Z. (in press). Peer culture processes embedded in natural sciences projects of preschoolers. In Rebecca Kantor, David Fernie, & Samara Madrid (Eds.), *Discourse and Social Processes.* NJ: Hampton Press.

Inan, H. Z., Trundle, K. C., & Kantor, R. (2010). Understanding natural sciences education in a Reggio Emilia-inspired preschool. *Journal of Research in Science Teaching.* DOI 10.1002/tea.20375.

Keil, C., Haney, J., & Zoffel, J. (2009). Improvements in student achievement and science process skills using environmental health science problem-based learning curricula. *Electronic Journal of Science Education, 13* (1), 1-18.

Kesicioğlu, O. S. ve Alisinanoğlu, F. (2009). Ebeveynlerin okul öncesi dönemdeki çocuklarına (60-72 ay) yaşattıkları doğal çevre deneyimlerinin incelenmesi. *Elektronik Sosyal Bilimler Dergisi, 8* (29), 1-14.

Kilmer, S.J., & Hofman, H. (1995). Transforming science curriculum. In S. Bredecamp & T. Rosegrant (Eds.), *Reaching potentials: Transforming early childhood curriculum and assessment* (V.2). Washington, DC: NAEYC.

Maxedon, S. J. (2003). *Early childhood teachers' content and pedagogical knowledge of geometry.* Unpublished doctoral dissertation, The University of Arizona.

McCray, J. S. (2008). *Pedagogical content knowledge for preschool mathematics: Relationships to teaching practices and child outcomes.* Unpublished doctoral dissertation, University Of Loyola University Chicago Erikson Institute.

Milli Eğitim Bakanlığı [MEB]. (2006). *Okul öncesi eğitimi programı.* http://www.meb.gov.tr adresinden 1 Nisan 2009 tarihinde edinilmiştir.

Merriam, S. B. (1998). *Qualitative research and case study applications in education* (2nd ed.). San Francisco: Jossey-Bass Publishers.

Monhardt L., & Monhardt R. (2006). Creating a context for the learning of science process skills through picture books. Early Childhood Education Journal, *34,* 67-71.

Nell, M. (2009). Using the integrative research project approach to facilitate early childhood teacher planning. Journal of Early Childhood Teacher Education, *30,* 79-88.

Nikolaeva, S. N. (2008). The ecological education of preschool children. Russian Education, *50* (3), 64-72.

Ozbey, S., & Alisinanoglu, F. (2008). Identifying the general ideas attitudes and expectations pertaining to science activities of the teachers employed in preschool education. *Journal of Turkish Science Education, 5* (2), 82-95.

Ozden, M. (2008). The effect of content knowledge on pedagogical content knowledge: The case of teaching phases of matters. *Educational Sciences: Theory & Practice, 8* (2), 633-645.

Ozden, M. (2009). Primary student teachers' ideas of atoms and molecules: Using drawings as a research method. *Education, 129* (4), 635-642

Ömeroğlu, E. ve Dere, H. (2001). *Okulöncesi dönemde fen doğa matematik çalışmaları.* Ankara: Anı Yayıncılık.

Özbey, S. ve Alisinanoğlu, F. (2009). Okul öncesi eğitim kurumlarında görev yapan öğretmenlerin fen etkinliklerine ilişkin yeterliliklerinin bazı değişkenlere göre incelenmesi. *Gazi Eğitim Fakültesi Dergisi, 29* (1), 1-18.

Özbey, S. ve Alisinanoğlu, F. (2010). Okul öncesi öğretmenlerinin fen etkinliklerine ilişkin yeterliliklerini belirleme ölçeğinin geçerlilik ve güvenirlik çalışması. *Milli Eğitim, 39* (185), 266-276.

Quigley, C.F., Beeman-Cadwallader, N., Riggs, M., Rodriguez, A., & Buck, G. (2009). Deer tracks in the city? Science & Children, *47* (2), 34-37.

Rojas, R. L. M. (2008). *Pedagogical content knowledge in early childhood: A study of teachers' knowledge.* Unpublished doctoral dissertation, Loyola University Chicago. Chicago, IL.

Science & Children. (2006) Young questioners (The early years: Resources and conversations on preK to 2 science). Science and Children, *44,* 20-22.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15* (2), 4–14.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57* (1), 1-22.

Smith, K. H. (2000). *Early childhood teachers' pedagogical content knowledge in mathematics: A Quantitative study.* Unpublished doxtoral dissertation, Georgia State University, Georgia, Atlanta.

Stake, R. E. (1995). *The art of case study research.* Thousand Oaks: Sage.

Sullivan, F. R. (2008). Robotics and science literacy: Thinking skills, science process skills and systems understanding. Journal of Research in Science Teaching, *45,* 373-394.

Şahin, F. ve Ökçün, F. (2000). Okulöncesinde aktivitelerle fen kavramlarının geliştirilmesi üzerine bir araştırma. *Marmara Üniversitesi Sosyal Bilimler Enstitüsü Dergisi (Öneri), 3* (13), 23-30.

Torres, A., & Vitti, D. (2007). A kinder science fair. Science and Children, *45,* 21-25.

Usak, M. (2005). *Prospective elementary science teachers' pedagogical content knowledge about flowering plants*. Unpublished doctoral dissertation, Gazi University, Insitute of Educational Science Ankara.

Usak, M. (2009). Fen ve teknoloji öğretmen adaylarının hücre konusundaki pedagojik alan bilgileri. *Kuram ve Uygulamada Eğitim Bilimleri, 9*, 2013-2046.

Yin, R. K. (1993). *Applications of case study research.* Newbury Park, Calif.: Sage.

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, Calif.: Sage.