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Investigating Prospective Primary Teachers' Pedagogical Content Knowledge of "Effect of Human on Environment" Subject in the Process of Teaching Practice*

Muammer ÇALIK[a]
Karadeniz Technical University

Ayşe AYTAR[b]
Recep Tayyip Erdoğan University

Abstract

The principal aim of this study is to determine what the extent of the prospective primary teachers' (PPT) pedagogical content knowledge (PCK) is on "effect of human on environment" subject in grade 5 science and technology curriculum before and after "Teaching Practice" course. Within case study research methodology, the study sample consisted of 6 senior PPTs selected from 49 trainees who attended "Teaching Practice-II" course in spring semester of 2009-2010 schooling year in the programme of primary teacher education in Rize University. To collect data, lesson plans, observations, and semi-structured interviews were used. While the data obtained from lesson plans and observations were analyzed by means of rubrics developed, those from semi-structured interviews were analyzed using content analysis. It was found that the PPTs did not have sufficient idea of subcomponents of the PCK, especially curriculum knowledge, and knowledge of students' learning difficulties. Nevertheless, it was determined that the PPTs had adequate idea of pedagogical knowledge in context of the PCK. However, it was drawn out that although they had sufficient theoretical knowledge about instructional methods, techniques, strategies, measurement and assessment, they encountered some problems in transferring the theoretical knowledge into practicum. In the light of the results, it is suggested that the PPTs should be given more opportunities for practicing complementary measurement-assessment techniques. Furthermore, it is recommended that the PPTs with their own lesson plans ought to be given more opportunities to transfer their PCK into related subject matter one.

Key Words

Pedagogical Content Knowledge, Prospective Primary Teachers, Teaching Practice, and Effect of Human on Environment.

In the age of information, today's society needs to well-qualified individuals with good education background (Özoğlu, 2010). Because quality of education depends on quality of teacher, all countries in the world have constantly been searching alternative ways on how to train the teachers (Özer, 2008). In fact, such an effort may be more reasonable with idea *"the teachers, who principally deploy the teaching and learning process, are even educated"* (Gelen & Özer, 2008).

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a **Muammer ÇALIK. Ph.D.**, is currently an associate professor of chemistry education. He has published more than sixty papers of chemistry and science education in national and international journals and proceedings and actively acts as a reviewer for approximately 15 journals. *Correspondence:* Assoc. Prof. Muammer ÇALIK, Karadeniz Technical University, Fatih Faculty of Education, Department of Primary Education, Trabzon, Turkey. Email: muammer38@hotmail.com Phone: +90 462 377 7251.

b Ayşe AYTAR is a research assistant and has been studying on science education. Contact: Recep Tayyip Erdoğan University, Faculty of Education, Department of Primary Education, Rize, Turkey. Email: aytar.ayse@gmail.com.

In training qualified teacher, pre-service education affords prospective teachers to capture general and special domain qualifications/competencies that the teachers should possess (Milli Eğitim Bakanlığı [MEB], 2008). In other words, the teachers' qualifications and competencies substantially depend on the pre-service education they attended (Semerci, 2004). In Turkey, given characteristics of the teacher education programs, certain ratios of "subject matter knowledge (SMK), pedagogical content knowledge (PCK) and general culture (GC)" domains were re-arranged in 2006. However, these domain ratios seem to still be one of much-debated issues (Yazıcı, 2009; Yüksek Öğretim Kurumu [YÖK], 2007).

Teaching practice gives an opportunity for the prospective teachers to apply and experience their gained knowledge/skills in real school environments. However, related literature reports that the prospective teachers have some deficiencies and problems in integrating theoretical knowledge into practicum (Aydın, Boz, & Boz, 2010; Bartholomew, Anderson, & Moeed, 2012; Güzel, Cerit Berber, & Oral, 2010; Sadler, 2006; Sılay & Gök, 2004). This situation is a discussed issue in National Education Council and Scientific Meetings on Teacher Education (Bulut & Doğar, 2006). To put it differently, the prospective teachers have pitfalls linking their theoretical knowledge with practical one or balancing *what is known* with actions (practices) during applied courses (Ekiz, 2006; Uşak, 2009). Furthermore, a few studies point that the prospective teachers who are familiar with demands and traits of 2005 Science and Technology Curriculum generally prefer following the teacher-centered approach (Uşak, 2005; Uşak, Özden, Ülker, & Šorgo, 2013) and using traditional measurement-assessment techniques (Uşak, 2009). Also, the other studies report that the prospective teachers lack of considering such pedagogical issues as the students' learning difficulties (Frederik, Van der Valk, Leite, & Thorén, 1999; Halim & Meerah, 2002; Henze, Van Driel, & Verloop, 2008; Özden, 2008; Uşak et al., 2013), curriculum knowledge (Bozkurt & Kaya, 2008; Özden, 2008), subject matter knowledge (SMK) (Bozkurt & Kaya, 2008; Ekinci, 2010; Kaya, 2009; Özden, 2008), pedagogical knowledge (PK), and pedagogical content knowledge (PCK) (De Jong, Van Driel, & Verloop, 2005; Ekinci, 2010; Henze et al., 2008; Käpyläa, Heikkinenb, & Asuntaa, 2009; Kaya, 2009). The foregoing literature calls for a study examining how "Teaching Practice" course, which gives an opportunity for the prospective teachers to transfer their theoretical knowledge into practicum, makes a contribution to their professional development (Aydın et al., 2010; Dursun & Kuzu, 2008; Kaya, 2009; Sadler, 2006).

In recent years, a few studies of environmental education in teacher education have been conducted. Of these studies, the following perspectives as *environmental awareness, environmental attitude, views of environmental problems, and environmental sensitiveness* have been investigated (Çalık, 2009; Çalık & Eames, 2012). However, only one study, Uşak et al. (2013), purpose to determine the prospective primary teachers' PCK of "human and environment" subject. It is recommended that future studies should have been undertaken on how the PCK changed or improved during "Teaching Practice" course. This reveals a need for study concerning the prospective primary teachers (PPTs)' PCK development in duration of the 'Teaching Practice' course. It is needless to say that a review study by Aydın and Boz (2012) also address that few studies are carried out about whole components of the PCK. Hence, this review study calls for a need for future study to investigate whole components of the PCK.

Purpose

The purpose of this study was to examine what the extent of the PPTs' PCK is on "effect of human on environment" subject in grade 5 science and technology curriculum before and after the "Teaching Practice" course.

Method

Research Design

In this study, case study research methodology allowing the researchers to study a specific phenomenon or case in depth was employed. Furthermore, the case study research design was also selected because it gives an opportunity for the researcher to carry his/her study out with a small sample size (Ekiz, 2003).

The Study Group

The study sample consisted of 6 senior PPTs selected from 49 trainees who attended "Teaching Practice-II" course in spring semester of 2009-2010 schooling year in the programme of primary teacher education in Rize University. In selecting the sample, the PPTs were initially asked to draw a concept map of "effect of human on environment" subject in grade 5 science and technology course. Then, the researchers scored their concept maps using a rubric developed by them. Later on, taking the PPTs' scores into account, six PPTs (two from each

level--TA_1 and TA_2—above average, TA_3 and TA_4—average, TA_5 and TA_6—under average) were drawn from the sample. By the way, TA means the PPT in the sample and each footnote number shows the PPT's identity number in the present study.

Data Collection Instrument

Lesson Plan: In this study, lesson plan suggested by related literature of the PCK (Aydın et al., 2010; Faikhamta, Coll, & Roadrangka, 2009; Käpylä et al., 2009; Özden, 2008; Uşak, 2009; Uşak et al., 2013), measured the PPTs' knowledge of instructional strategies and assessment before and after the teaching practice. In the current study, the PPTs were asked to prepare a lesson plan on "effect of human on environment" subject in grade 5 science and technology course within an hour.

Interview: In this study, given the related literature of the PCK (De Jong, Ahtee, Goodwin, Hatzinikita, & Koulaidis, 1999; Halim & Meerah, 2002; Kaya, 2009; Uşak, 2005), interviews were used to investigate the PPTs' knowledge of curriculum, students' learning difficulties, instructional strategies and assessment before and after the teaching practice. The second researcher, Aytar conducted each interview session by means of a 12-question interview protocol. Each interview session took about 20-50 minutes.

Observation: To portray consistency between lesson plans developed by the PPTs and their performances in "Teaching Practice" course, the researcher, Aytar conducted observations based on some related studies of the PCK (Aydın et al., 2010; Faikhamta et al., 2009). In this process, the second researcher rated the lesson observation form (YÖK, 1998) and took some field notes when necessary.

Data Analysis

Lesson Plan: Within the study, a 17-item rubric, called *lesson plan assessment rubric* was developed by using lesson planning strategies (Ayas et al., 2007; Topsakal, 2006). Then, the researchers scored the PPTs' lesson plans using a three point scale (from one to three points).

Interview: Each interview session was initially imported into the computer and then transcribed. Later on, these transcribed documents were analyzed conducting content analysis in regard to their similarities and differences. Related codes and themes emerged from the content analysis of the documents.

Observation: A 30-item rubric, named *observation assessment rubric*, was employed to assess the sample's PCK performance in the "Teaching Practice" course. A three point scale (from one point to three points) was used to score their performances.

Results

The results of the observations indicated that TA_4 got the highest scores in terms of *"teaching process and classroom management"*. TA_4 showed an effective performance in the teaching practice on scheduled time. TA_{1-2} (from above average), TA_3 (from average) and TA_{5-6} (from under average) had some problems concerning time management during the teaching practice. When TA_3 accelerated his activities in rush, TA_{5-6} did not possess enough time for assessment. Also, TA_6 (from under average) paid more attention to constitute a democratic learning environment with the following behaviors: equal contribution to the instruction, helping the students share their responsibility in group work, and feedbacks "very nice, well done, thank you" during the teaching practice. TA_3 (from average) had some pitfalls in affording continuity of the lesson interest whilst TA_2 (from above average) had deficiencies taking precautions against course interruption or classroom management.

In the pre- and post-interview results of curriculum, TA_1 (from above average) mentioned that the curriculum was based on contemporary philosophy-approaches, i.e. first hand experience, student-centered learning whereas TA_2 stated that the curriculum aimed to enable the students to gain higher-order skills, i.e. problem solving, and critical thinking. Also, for the pre- and post-interviews, TA_3 (from average) addressed significance of inquiring knowledge rather than transmission of knowledge and knowledge that the students construct in mind. Furthermore, in the pre-interview, TA_3 mentioned concise knowledge in the curriculum whereas in the post-interview he also referred to learning objectives in the curriculum. Similarly, in the pre- and post-interviews, TA_4 depicted bases of contemporary philosophy/approaches and content visuality in the curriculum. Also, TA_4 stated that the students constructed new knowledge on their pre-existing knowledge in the pre-interview while he referred such topics as learning fields and themes in the post-interview. For the pre- and post-interviews, TA_5 (from under average) stressed knowledge that the students constructed in mind. In the pre-interview, TA_5 addressed that the curriculum was attributed as contemporary education,

whilst he implied intra- and inter relations in the course for the post-interview. TA_6 dealt with the learning fields, themes, intra- and inter-relations in the curriculum in the pre-interview, whereas he implied significance of inquiring knowledge rather than its transmission in the post-interview. For the teacher role in the curriculum, all PPTs depicted the teacher role as a mediator/guide in the post-interview. Furthermore, TA_3 (from average) and TA_5 (from under average) viewed the teacher role as an organizer of the learning environment. For the parent role in learning/teaching procedure, all PPTs stated that the parents had responsibility of learning. Also, TA_2 and TA_3 considered the parents as a guide in the pre- and post- interviews. Moreover, in the post- interview, TA_3 thought the parents as an environment organizer for student learning.

For the PPTs' views on students' learning difficulties of environmental pollution, TA_1 (from above average) stated "light pollution" in the pre- and post-interviews. Besides, TA_1 referred to the student learning difficulties of "soil, sound pollution and radiation" concepts in the post-interview. TA_2 (from above average) addressed that the students might find "effects of environmental pollution" difficult in the post-interview. TA_3 (from average) depicted "sound pollution" in the pre- and post-interview and dealt with "extinction of animals" in the post-interview. TA_4 (from average) implied that the students might find "soil pollution" tough. TA_5 (from under average) addressed cleaning materials and radiation in the pre-interview and pointed out temporary/permanent pollution in the post-interview. TA_6 (from under average) mentioned factory wastes in the pre-interview.

For the PPTs' views of instructional strategies in teaching environmental problems, TA_1 (from above average) depicted project based learning and field trip observation in the pre- and post-interviews. TA_1 implied explanatory and inquiry teaching strategies, question-answer technique and brain storming in the pre-interview whilst he addressed drama, homework, picture drawing, poem/essay writing, poster/brochure/notice board techniques and visual teaching tools (picture/power point/video) in the post-interview. TA_2 (from above average) dealt with the project based learning, discussion method, 5E model and visual educational tools (picture/power point/video) in the pre-interview while TA_2 stated investigation-examination strategies in the port-interview. Also, TA_2 emphasized cooperative learning, brain storming, six thinking hats and homework in both pre- and post-interviews. TA_3 (from average) addressed the question-answer technique and homework method in the pre-interview whereas referring to the explanatory method in the post-interview. Additionally, TA_3 (from average) implied cased-based learning and field trip methods in the pre- and post-interviews. TA_4 (from average) stressed cooperative learning during the pre-interview and cited interviews during the pre-and post-interviews. In addition, TA_5 (from under average) depicted the explanatory method in the pre-interview whilst stating concept mapping technique and guide book in the post-interview. TA_5 referred to demonstration technique in the pre- and post-interviews. TA_6 (from under average) mentioned the project based learning, drama, and homework in the pre-interview whilst TA_6 implied cooperative learning, the explanatory method, the brain storming, and the six thinking hats in the post-interview.

Discussion

In light of the results, it could be deduced that the PPTs at different levels possessed some pitfalls in classroom management and in taking precautions against course interruptions, i.e. talking without permission, interrupting friends and the PPTs (Menteş, Sever, Yıldız, & Yıldız, 2010). Moreover, for the PPTs' views of the curriculum knowledge, they were aware of the complementary measurement-assessment techniques depicting that the learning process was as important as the learning product. This might be seen as an indicator of the pre-service courses (e.g. "measurement and assessment", "science and technology education" and "mathematics education" courses) in which the complementary measurement-assessment techniques were followed (Kazu, Eroğlu, & Şenol, 2010).

For the curriculum knowledge, the PPTs regarded the teachers as the guide/mediator or the organizer of learning environment. This may stem from effect of their experiences with 2005 Science and Technology Curriculum through the pre-service education. Also, the 2005 Science and Technology Curriculum released by MEB (2005) required the teacher to create a constructivist learning environment. The PPTs' views of the teacher role in the curriculum were in a harmony with this demand. The PPTs also considered the parents as the guide. Likewise, in view of the PPTs, the parents had responsibility of learning and prepared a learning environment for student. This supports the idea *"learning involves cooperation amongst the teacher, the student and the parents"* (Shymansky, 1992; Umdu-Topsakal, Çalık, & Çavuş, 2012). Also, this situation advocates the idea *"con-*

structivist learning, constructing philosophy of the 2005 science and technology curriculum, takes places indoor and outdoor of the school" (Akpınar, 2010). Thus, further cooperation with the parents should be undertaken (Ersoy, Gürdoğan Bayır, & Güvey, 2010; Güven, 2008). Furthermore, the PPTs' views of the student learning difficulties is consistent with Seçgin, Yalvaç, and Çetin's (2010) study in which the primary students did not complete learning or misconceptions concerning "air pollution, water pollution, soil pollution, extinction of animals" concepts. This may result from a lack of the PCK course of misconceptions (Kolomuç & Çalık, 2012).

Given the PPTs' views of the instructional strategies, it could be concluded that they realized knowledge of contemporary teaching principles, methods and techniques. This is quite promising when Akçadağ's (2010) study is taken into account. That is to say, Akçadağ determines that majority of primary teachers need an in-service education on "project, drama, demonstration and concept mapping" methods/techniques. Moreover, in view of the PPTs' views, lecturers tended to use the traditional methods/techniques during the pre-service education. This may result from several reasons, i.e. lacks of interest, motivation, reluctance, capability and infrastructure or crowded classroom, technological incompetency or a PCK need (Evran Acar, Kılıç, Ay, & Kuyumcu Vardar, 2010). Nevertheless, the fact that the PPTs frame their teaching practices on the contemporary methods/approaches fosters the idea *"they teach as they were taught"* (Aydın et al., 2010; Calik, 2011; Çalık, 2013; Özyurt & Akdeniz, 2010). Because half of the PPTs stated that mentor teachers were apt to employ the traditional techniques/methods, it could be inferred that the teachers had difficulty understanding messages from the 2005 Science and Technology Curriculum and tended to be resistant to its demands/requirements (Akyol İnç, 2009).

The results of the PPTs' lesson plans indicated some pitfalls on teaching and learning activities. For example, inappropriate lesson plan for the 5E model pointed out lacks of knowledge for the 5E model stages, of subject matter knowledge, or of linking theoretical knowledge with novel issues (Bozdoğan & Altunçekiç, 2007; Metin & Özmen, 2009). All things considered, it could be deduced that the PPTs had an idea on the complementary measurement-assessment techniques (Duban & Küçükyılmaz, 2008). In fact, this knowledge claim is inconsistent with Birgin and Gürbüz's (2008) one reporting that the PPTs were more familiar with traditional measurement-assessment techniques than the complementary ones. However, the PPTs had deficiencies in transferring these techniques into practicum. Based on the foregoing issues, it is suggested that the PPTs should be directed to more practical experiences with the complementary measurement-assessment techniques during their pre-service education. Furthermore, the PPTs with their designed lesson plans ought to be given more opportunities to transfer their PCK into related subject matter.

References/Kaynakça

Akçadağ, T. (2010). Öğretmenlerin ilköğretim programındaki yöntem teknik ölçme ve değerlendirme konularına ilişkin eğitim ihtiyaçları. *Türk Dünyası Sosyal Bilimler Dergisi*, *53*, 29-50.

Akpınar, B. (2010). Yapılandırmacı yaklaşımda öğretmenin, öğrencinin ve velinin rolü. *Eğitime Bakış*, *16*, 16-20.

Akyol İnç, N. (2009). *Fen ve teknoloji dersi veren öğretmenlerin kılavuz kitaptaki yöntem ve tekniklerle ilgili yeterliliklerinin belirlenmesi*. Yayımlanmamış yüksek lisans tezi, Karadeniz Teknik Üniversitesi, Fen Bilimleri Enstitüsü, Trabzon.

Ayas, A., Çepni, S., Akdeniz, A. R., Yiğit, N., Özmen, H. ve Ayvacı, H. Ş. (2007). *Kuramdan uygulamaya fen ve teknoloji öğretimi.* Ankara: Pegema Yayıncılık.

Aydın, S. ve Boz, Y. (2012). Fen öğretmen eğitiminde pedagojik alan bilgisi araştırmalarının derlenmesi: Türkiye örneği. *Kuram ve Uygulamada Eğitim Bilimleri*, *12*, 479-505.

Aydın, S., Boz, N., & Boz, Y. (2010). Factors that are influential in pre-service chemistry teachers' choices of instructional strategies in the context of methods of separation of mixtures: A case study. *The Asia-Pacific Education Researcher*, *19* (2), 251-270.

Bartholomew, R., Anderson, D., & Moeed, A. (2012). Resilience of science teaching philosophies and practice in early career primary teaching graduates. *Eurasia Journal of Mathematics, Science & Technology Education*, *8* (2), 103-112.

Birgin, O. ve Gürbüz, R. (2008). Sınıf öğretmeni adaylarının ölçme ve değerlendirme konusundaki bilgi düzeylerinin incelenmesi. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *20*, 163-179.

Bozdoğan, A. E. ve Altunçekiç, A. (2007). Fen bilgisi öğretmen adaylarının 5E öğretim modelinin kullanılabilirliği hakkındaki görüşleri. *Kastamonu Eğitim Fakültesi Dergisi, 15* (2), 579-590.

Bozkurt, O., & Kaya, O. N. (2008). Teaching about ozone layer depletion in Turkey: Pedagogical content knowledge of science teachers. *Public Understanding of Science*, *17* (2), 261-276.

Bulut, H. ve Doğar, Ç. (2006). Öğretmen adaylarının öğretmenlik mesleğine karşı tutumlarının incelenmesi. *Erzincan Eğitim Fakültesi Dergisi*, *8* (1), 13-27.

Calik, M. (2011). How did creating constructivist learning environment influence graduate students' views? *Energy, Education, Science and Technology Part B Social and Educational Studies*, *3* (1), 1-13.

Çalık, M. (2009). An integrated model for environmental education in Turkey. In N. Taylor, R. K. Coll, M. Littledyke & C. Eames (Eds.), *Environmental education in context: An international perspective of the development and implementation of environmental education and its impact on student knowledge, attitudes and behaviour* (pp. 109-122). Rotterdam, The Netherlands: Sense Publishers.

Çalık, M. (2013). Effect of technology-embedded scientific inquiry on senior science student teachers' self-efficacy. *Eurasia Journal of Mathematics, Science and Technology Education, 9*(3), 223-234. doi: 10.12973/eurasia.2013.931a

Çalık, M., & Eames, C. (2012). The significance of national context: A comparison of environmental education in Turkey and New Zealand. *Asia Pacific Education Researcher*, *21* (3), 423-433.

De Jong, O., Ahtee, M., Goodwin, A., Hatzinikita, V., & Koulaidis, V. (1999). An international study of prospective teachers' initial teaching conceptions and concerns: The case of teaching "combustion". *European Journal of Teacher Education*, *22* (1), 45-59.

De Jong, O., Van Driel, J., & Verloop, N. (2005). Preservice teachers' pedagogical content knowledge of using particle models when teaching chemistry. *Journal of Research in Science Teaching*, *42* (8), 947-964.

Duban, N. ve Küçükyılmaz, E. A. (2008). Sınıf öğretmeni adaylarının alternatif ölçme-değerlendirme yöntem ve tekniklerinin uygulama okullarında kullanımına ilişkin görüşleri. *İlköğretim Online*, *7* (3), 769-784.

Dursun, Ö. Ö. ve Kuzu, A. (2008). Öğretmenlik uygulaması dersinde yaşanan sorunlara yönelik öğretmen adayı ve öğretim elemanı görüşleri. *Selçuk Üniversitesi Ahmet Keleşoğlu Eğitim Fakültesi Dergisi*, *25*, 159-178.

Ekinci, A. (2010). İlköğretime öğretmen yetiştirmede sorunlar, nitelik arayışı ve bir model önerisi. *20. Ulusal Özel Eğitim Kongresi "Öğretmen Yetiştirme" bildirileri kitabı* içinde (s. 50-51). Gaziantep: Kök yayıncılık.

Ekiz, D. (2003). *Nitel, nicel ve eleştirel kuram metodolojileri*. Ankara: Anı Yayıncılık.

Ekiz, D. (2006). Kendini ve başkalarını izleme: Sınıf öğretmeni adaylarının yansıtıcı günlükleri. *İlköğretim Online*, *5* (1), 45-57.

Ersoy, A., Gürdoğan Bayır, Ö. ve Güvey, E. (2010). İlköğretimde proje çalışmaları: Sınıf öğretmenlerinin velilerden beklentileri. *Anadolu Üniversitesi Sosyal Bilimler Dergisi*, *10* (3), 157-170.

Evran Acar, F., Kılıç, A., Ay, Ş. ve Kuyumcu Vardar, A. (2010). Öğretim elemanlarının pedagojik formasyon ihtiyacı. In *International conference on New Trends in Education and Their Implications (ICONTE)* (pp. 1028-1040). Antalya.

Faikhamta, C., Coll, R. K., & Roadrangka, V. (2009). The development of Thai pre-service chemistry teachers' pedagogical content knowledge: From a methods course to field experience. *Journal and Science and Mathematics Education in Southeast Asia*, *32* (1), 18-35.

Frederik, I., Van der Valk, T., Leite, L., & Thorén, I. (1999). Pre-service physics teachers and conceptual difficulties on temperature and heat. *European Journal of Teacher Education*, *22* (1), 61-74.

Gelen, İ. ve Özer, B. (2008). Öğretmenlik mesleği genel yeterliklerine sahip olma düzeyleri hakkında öğretmen adayları ve öğretmenlerin görüşlerinin değerlendirilmesi. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *5* (9), 39-55.

Güven, S. (2008). Sınıf öğretmenlerinin yeni ilköğretim ders programlarının uygulanmasına ilişkin görüşleri [Çevrimiçi sürüm]. *Milli Eğitim Dergisi*, *177*, 224-236.

Güzel, H., Cerit Berber, N. ve Oral, İ. (2010). Eğitim fakültesi uygulama okulları işbirliği programında görevli öğretmenlerin ve öğretim elemanlarının öğretmenlik uygulamasına yönelik görüşleri. *Kastamonu Eğitim Dergisi, 18* (1), 19-36.

Halim, L., & Meerah, S. M. (2002). Science trainee teachers' pedagogical content knowledge and its influence on physics teaching. *Research in Science and Technological Education*, *20* (2), 215-225.

Henze, I., Van Driel, J. H., & Verloop, N. (2008). Development of experienced science teachers' pedagogical content knowledge of models of the solar system and the universe. *International Journal of Science Education*, *30* (10), 1321-1342.

Käpyläa, M., Heikkinenb, J., & Asuntaa, T. (2009). Influence of content knowledge on pedagogical content knowledge: The case of teaching photosynthesis and plant growth. *International Journal of Science Education*, *31* (10), 1395-1415.

Kaya, O. N. (2009). The nature of relationships among the components of pedagogical content knowledge of preservice science teachers: "Ozone layer depletion" as an example. *International Journal of Science Education*, *31* (7), 961-988.

Kazu, İ. Y., Eroğlu, M. ve Şenol, C. (2010). İlköğretim öğretmen adaylarının değerlendirme tercihlerinin incelenmesi (Fırat üniversitesi örneği). *9. Ulusal Sınıf Öğretmenliği Eğitimi Sempozyumu* içinde (s. 460-464). Elazığ.

Kolomuç, A., & Çalık, M. (2012). A comparison of chemistry teachers' and grade 11 students' alternative conceptions of 'Rate of Reaction'. *Journal of Baltic Science Education, 11* (4), 333-346.

Menteş, C., Sever, Ö., Yıldız, S. ve Yıldız, K. (2010, Mayıs). Aday öğretmenlerin uygulama okullarında karşılaştıkları istenmeyen öğrenci davranışları ve bu davranışları önlemede kullandıkları stratejiler. *9. Ulusal Sınıf Öğretmenliği Eğitimi Sempozyumu*'nda sunulan bildiri, Elazığ.

Metin, M. ve Özmen, H. (2009). Sınıf öğretmeni adaylarının yapılandırmacı kuramın 5E modeline uygun etkinlikler tasarlarken ve uygularken karşılaştıkları sorunlar. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi (EFMED)*, *3* (2), 94-123.

Milli Eğitim Bakanlığı (MEB). (2005). *İlköğretim fen ve teknoloji dersi öğretim programı ve kılavuzu 6-7-8. sınıflar*. Ankara: Yazar.

Milli Eğitim Bakanlığı (MEB). (2008). *Öğretmen yeterlikleri, öğretmenlik mesleği genel yeterlikleri.* Ankara: Yazar.

Özden, M. (2008). The effect of content knowledge on pedagogical content knowledge: The case of teaching phases of matters. *Kuram ve Uygulamada Eğitim Bilimleri*, *8*, 633-645.

Özer, B. (2008). Öğretmenlerin mesleki gelişimi. A. Hakan (Ed.), *Öğretmenlik meslek bilgisi alanındaki gelişmeler* (s. 195–216). Eskişehir: Anadolu Üniversitesi Açıköğretim Fakültesi.

Özoğlu, M. (2010). Türkiye'de öğretmen yetiştirme sisteminin sorunları. *Seta Analiz*, *17*, 3-35.

Özyurt, A. ve Akdeniz, A. R. (2010). Eğitim fakültelerindeki öğretim üyelerinin yapılandırmacı öğrenme kuramını kendi derslerinde uygulamalarına yönelik bir araştırma: KTÜ Fatih Eğitim Fakültesi örneği. *10. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi Bildiri Kitabı* içinde (s. 55). İzmir: Güler Mat.

Sadler, T. D. (2006). "I won't last three weeks": Preservice science teachers reflect on their students-teaching experiences. *Journal of Science Teacher Education*, *17*, 217-241.

Seçgin, F., Yalvaç, G. ve Çetin, T. (2010). İlköğretim 8. sınıf öğrencilerinin karikatürler aracılığıyla çevre sorunlarına ilişkin algıları. In *International conference on New Trends in Education and Their Implications (ICONTE)* (pp. 391-398). Antalya.

Semerci, N. (2004, Temmuz). *Öğrenci görüşlerine göre sınıf öğretmenliği derslerinin işleyişi*. 13. Ulusal Eğitim Bilimleri Kurultayı'nda sunulan bildiri, Malatya.

Shymansky, J. A. (1992). Using constructivist ideas to teach science teachers about constructivist ideas, or teachers are students too! *Journal of Science Teacher Education*, *3* (2), 53-57.

Sılay, İ. ve Gök, T. (2004). Öğretmen adaylarının uygulama okullarında karşılaştıkları sorunlar ve bu sorunları gidermek amacıyla hazırlanan öneriler üzerine bir çalışma. *13. Ulusal Eğitim Bilimleri Kurultayı* içinde (s. 1-8). Malatya.

Topsakal, S. (2006). *İlköğretim 6., 7. ve 8. sınıflar fen ve teknoloji öğretimi*. Ankara: Nobel Yayın Dağıtım.

Umdu-Topsakal, U., Çalık, M., & Çavuş, R. (2012). What trends do Turkish biology education studies indicate? *International Journal of Environmental and Science Education, 7* (4), 639-649.

Uşak, M. (2005). *Fen bilgisi öğretmen adaylarının çiçekli bitkiler konusundaki ilişkin pedagojik alan bilgileri*. Yayımlanmamış doktora tezi, Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Uşak, M. (2009). Preservice science and technology teachers' pedagogical content knowledge on cell topics. *Kuram ve Uygulamada Eğitim Bilimleri*, *9*, 2033-2046.

Uşak, M., Özden, M., Ülker, R., & Šorgo, A. (2013). Prospective primary teachers' pedagogical content knowledge about the subject of human and environment. *Journal of Environment Protection and Ecology (in press).*

Yazıcı, H. (2009). Öğretmenlik mesleği, motivasyon kaynakları ve temel tutumlar: Kurumsal bir bakış. *Kastamonu Eğitim Dergisi, 17* (1), 33-46.

Yükseköğretim Kurulu (YÖK). (1998). *Fakülte-okul işbirliği.* https://www.yok.gov.tr/content/view/506/ adresinden 30 Mart 2010 tarihinde edinilmiştir.

Yükseköğretim Kurulu (YÖK). (2007). *Öğretmen yetiştirme ve eğitim fakülteleri (1982-2007)*. http://www.yok.gov.tr/content/view/16/52/ adresinden 21 Ekim 2010 tarihinde edinilmiştir.