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# Examining Development of Curriculum Knowledge of Prospective Mathematics Teachers

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**Abstract**
Explanatory-confirmatory research design, one of the mixed methods research designs, was used in this study to investigate Curriculum Knowledge developments of prospective teachers regarding algebra. Cross-sectional study method, as a type of descriptive research and one of the non-experimental research designs, was used to collect quantitative data in the study. In the qualitative part of the study, case study was used. The participants of the study were composed of 176 prospective teachers studying in the elementary mathematics education department of a university in Turkey, who were first, second, third, and fourth year students with equal numbers. Interview, observation (observation notes, lesson video recordings, in-class observation form), knowledge test were used as the instruments for the purpose of examining prospective teachers' curriculum knowledge development. Kruskal-Wallis test, which is a non-parametric test, was used to compare the means of prospective teachers' Algebra Curriculum Knowledge Test (ACKT) scores since these scores are not normally distributed. According to the results of the study, it was observed that knowledge levels of the prospective teachers in terms of curriculum knowledge developed as directly proportional depending on the class level. In addition, it was also observed that the knowledge of prospective teachers in terms of curriculum knowledge was not at the desired level. Also, considering the general centrality of prospective teachers' answers on the partially true A and partially true B categories, it can be already concluded that prospective teachers' curriculum knowledge is inadequate.
**Keywords:** Curriculum Knowledge, Pedagogical Content Knowledge, Prospective Mathematics Teachers

## 1. Introduction

In the process of education, teachers try to find answers to some questions in order to improve the quality of education. The questions such as "How can I better explain basic concepts to my students?, Which materials can I use?, How can I assess them the best?, What kind of difficulties will my students encounter in the learning process?" can be given as examples of these questions (Magnusson, Krajcik ve Borko, 1999). The chaos emerging in the education system and growing over time as a result of teachers' not being able to produce any solutions to these problems caused many studies to be carried out on the education system in America at the beginning of the 1980s (Carlsen,1999). The studies carried out revealed that the most important duty and responsibility in rendering the education system more qualified belong to teachers. Furthermore, as a result of these studies carried out, a lot of models on the professional knowledge development of teachers emerged (Ball, Thames ve Phelps, 2008; Cochran, De Ruiter ve Kin, 1993; Grossmann,1990; Marks,1990; Shulman, 1987; Tamir,1988). In the models developed on the vocational development of teachers, the researchers benefited from the concept of the "Pedagogical Content Knowledge" developed by Shulman (1986) (Ball, Thames ve Phelps, 2008; Cochran, De Ruiter ve Kin, 1993; Grossmann,1990; Marks,1990; Shulman, 1987; Tamir,1988). Shulman (1986), in the model he developed, stated that content knowledge and pedagogical knowledge are not completely independent of one another, on the contrary, a relation between content knowledge and pedagogical knowledge should be established (Cochran, De Ruiter ve Kin, 1993). Because a domain expert and a teacher differentiate with regard not only to the knowledge they possess but also to presenting and organizing information (Gudmundsdottir, 1987).

In the teacher knowledge model developed by Shulman (1986), content knowledge, pedagogical content knowledge, knowledge of learners, curriculum knowledge, knowledge of educational context, knowledge of educational ends and general pedagogical knowledge take place, respectively (Shulman, 1986, 1987). Moreover, how the PCK subcomponents were included in the PCK models was summarized in Table 1 in order to compare different PCK models developed with one another and with Shulman's (1986) model.

**Table 1. Components of Pedagogical Content Knowledge from Different Conceptualizations (Park and Oliver, 2008, p. 265).**

| *Scholars* | Purposes for teaching a subject matter | Student understanding | Curriculum | Instructional strategies and representations | Media | Assessment | Subject matter | Context | Pedagogy |
|---|---|---|---|---|---|---|---|---|---|
| Shulman (1987) | **D** | **O** | **D** | **O** | | | **D** | **D** | **D** |
| Tamir(1988) | | **O** | **O** | **O** | | **O** | **D** | | **D** |
| Grossman (1990) | **O** | **O** | **O** | **O** | | | **D** | | |
| Marks (1990) | | **O** | | **O** | **O** | | **O** | | |
| Smith and Neale (1989) | **O** | **O** | | **O** | | | **D** | | |
| Cochran et al. (1993) | | **O** | | **N** | | | **O** | **O** | **O** |
| Geddis (1993) | | **O** | **O** | **O** | | | | | |
| Fernandez-Balboa ve Stiehl (1995) | **O** | **O** | | **O** | | | **O** | **O** | |
| Magnusson et al.(1999) | **O** | **O** | | **O** | | **O** | | | |
| Hasweh (2005) | **O** | **O** | **O** | **O** | | **O** | **O** | **O** | **O** |
| Loughran et al. (2006) | **O** | **O** | | **O** | | | **O** | **O** | **O** |

***D:*** Author placed this subcategory outside of PCK as a distinct knowledge base for teaching;
***O:*** Author did not discuss this subcategory explicitly.
***N:*** Author included this subcategory as a component of PCK.

As seen in Table 1, the curriculum knowledge, which is one of the subcomponents of the pedagogical content knowledge, was included in some teacher knowledge models (Geddis, 1993; Grossman, 1990; Hasweh, 2005; Tamir,1988) while it was not included in other models (Cochran et al.,1993; Loughran vd., 2006; Magnusson vd.,1999; Smith and Neale, 1989). The curriculum knowledge, which was considered to be a separate category from pedagogical content knowledge in the teacher knowledge model Shulman (1987) developed, was addressed as a subcomponent of the pedagogical content knowledge in the models subsequently developed (Geddis, 1993; Grossman, 1990; Hasweh, 2005; Tamir,1988). Shulman (1987) defined the curriculum knowledge as knowledge aimed at teacher's reaching teaching materials and curriculums and using these resources most effectively. Furthermore, curriculum knowledge is addressed under two subcategories, knowledge aimed at students' purposes and targets which are required to be reached and knowledge aimed at concepts and materials included in the curriculum, peculiar to the subjects to be taught (Baştürk and Dönmez, 2011). In other words, it can be stated that curriculum knowledge is an important kind of knowledge with respect to the teaching profession. However, when sample studies on the PCK developments of preservice teachers in the related literature (Aksu and Konyalıoğlu, 2015; Jenkins, 2010; Gökkurt et al., 2015; Koçak and Soylu, 2016; O'Hanlon, 2010; Şahin et al., 2014; Şahin, Gökkurt& Soylu, 2015; Şahin, 2016; Şimşek and Boz, 2015) are examined, it is seen that the researchers focus more on content knowledge, knowledge of understanding students and knowledge of educational strategies. Nevertheless, it is seen that sufficient studies were not carried out on curriculum knowledge (Baştürk and Dönmez, 2011; Lannin et al., 2013). In this context, the purpose of the study is to investigate curriculum knowledge developments of prospective mathematics teachers regarding algebra. In this study, the curriculum knowledge of preservice teachers was examined within the scope of basic concepts related to algebra, acquisitions, learning approach, basic skills, teacher and student roles, changes occurring in the curriculum.

## 2. Method

In this study, the *explanatory-confirmatory* (Quantitative → Qualitative) *research design*, one of *mixed research* designs, has been used to investigate curriculum knowledge developments of prospective mathematics teachers regarding algebra. *The cross-sectional comparative study* method has been used in the process of obtaining quantitative data and the case study method has been used in the qualitative section in this study.

### *2.1. Participants*

The participants of the study were composed of 176 prospective teachers studying in the elementary mathematics education department of a university in Turkey, who were first, second, third, and fourth year students with equal numbers. Since the cross-sectional study method is employed in the study, it gains importance for preservice teachers studying at the same university to be selected with regard to rendering the groups be close to each other.

The participants were determined by a convenience sampling method from non-random sampling methods. Within the frame of the study ethics, the real names of the preservice teachers who participated in the study have not been used. The first class who participated in the study were assigned with the codes from *1S1* to *1S44*, the second class from *2S1* to *2S44*, the third from *3S1* to *3S44,* the fourth from *4S1* to *4S44.*

*2.2. Data Collection Tools*

In this study, for the purpose of examining the curriculum knowledge developments of preservice teachers, interview, observation and Algebra Curriculum Knowledge Test (ACKT) have been used as data collection tools.

*2.2.1. Algebra Curriculum Knowledge Test (ACKT)*

In this study, ACKT which consists of a total of eleven questions has been used in order to determine the PCK component curriculum knowledge levels of preservice teachers (APP-1). While preparing ACKT, initially a question pool of 14 questions was created by the researcher. The questions which do not serve the purpose of the study and measure the similar skills were eliminated from the test in accordance with the expert opinions and the number of questions was reduced to eleven. For instance, "*Which sub learning domains does algebra learning domain consist of?"* was excluded from the test since it is similar to the ACKT first question. Besides, the expression at which grade level the acquisitions take place, in the first question of ACKT, was removed from the test at the request of the experts. Thereafter, ACKT, which consists of eleven questions, was applied to 65 preservice teachers within the frame of the pilot practice. Following the pilot practice, the experts stated that ACKT, which consists of eleven questions, can be used to measure curriculum knowledge for algebra of preservice teachers. Furthermore, the *Secondary School Mathematics Curriculum (SSMC)* was benefited from in the process of creating ACKT.

*2.2.2. Interviews*

In this study, interviews were mostly carried out with the preservice teachers who gave an answer in the categories of partially true B and wrong. In other words, the interview focused more on the questions in which the preservice teachers had difficulty in reaching the correct answer. After all, an answer to why the preservice teachers had difficulty in these questions was searched as a result of the interviews. In the process of data collection, semi-structured interviews with the duration of 2-6 minutes were carried out with approximately 20 preservice teachers. However, some of these interviews were not included in the study since they yielded the same results as the interviews in the findings.

*2.2.3. Observations*

In this study, observations were performed with the help of a structured observation form for the purpose of seeing the reflections of written and oral answers given to the knowledge test by the preservice teachers on the course applications. It was paid attention that they did not have a failed course and that their knowledge test scores represented the class mean in the selection of the preservice teachers who would participate in the course applications. In other words, it was aimed that the preservice teachers who would be observed constitute groups parallel to each other with respect to the grade level. It was deemed suitable that observations were video-recorded since it was considered to be difficult to observe and record many components at the same time in mathematics teaching environments. Furthermore, while observations were being made, notes were taken on observation forms (APP2). The developed observation forms were examined by two academicians, expert in their fields. The items having similar meanings or not serving the purpose of the study were removed from the observation form in accordance with the expert opinions.

*2.3. Data Analysis*

The scoring categories (Kwong et al., 2007; Şahin et al., 2014) regarding the answers of the students to the curriculum knowledge test take place in Table 2 below.

**Table 2. The Scoring Categories of ACKT**

| Categories | Completely true | Partially True (a) | Partially True (b) | Wrong Answer | No Answer |
|---|---|---|---|---|---|
| **Score** | 4 | 3 | 2 | 1 | 0 |

- **Completely true:** This category is the case when the preservice teachers answer a question precisely and completely.
- **Partially True (a):** This category is the case when the preservice teachers cannot give a precise, in other words, complete answer but the answer to the question is very close to the correct and contains minor mistakes.
- **Partially True (b):** This category is the case when the preservice teachers do not give a completely wrong answer, and their answers contain correct expressions though little when compared to the wrong.
- **Wrong Answer:** This category is the case when the answers of the preservice teachers are completely wrong.
- **No Answer:** This category is the case when the preservice teachers cannot give any answer to the

question.

In this study, the *intraclass correlation coefficient*, which examines the correlation among the scorings different raters make, was benefited from in order to ensure the reliability of the curriculum knowledge test. Initially, a new data set was created randomly in a way that it would represent at least 10% (Cleophas and Zwinderman, 2015) of the total data for each test with the help of SPSS program. The data in this data set were graded by two researchers with the help of the answer key which was previously prepared and organized in accordance with the expert opinions. Afterwards, the correlation coefficient between these two scorings was calculated by SPSS program. The intraclass reliability coefficient of the curriculum knowledge test was included in Table 3 below.

**Table 3 The Intraclass Correlation Coefficient of ACKT**

| Number of Researchers | İntraclass Correlation Coefficient | df1 | df2 | sig |
|---|---|---|---|---|
| 2 | .991 | 19 | 19 | .000 |

As seen in Table 3 above, the intraclass correlation coefficient of the curriculum knowledge test is quite high and significant. In other words, it can be stated that the data obtained in this study are highly reliable.

**Since the sample size in this study was 176>50, the Kolmogorov-Smirnov test was used. Furthermore, the fact that the p-value is smaller than α=0.05 indicates that the distribution is not normal. The Kolmogorov-Smirnov test results regarding the curriculum knowledge test take place in the table below.**

**Table 4 The Results of Kolmogorov-Simirnov Test**

| | Kolmogorov-Simirnov Test | | |
|---|---|---|---|
| | Statistics | df | P(sig) |
| ACKT | 0.097 | 176 | 0.000 |

As seen in Table 4, since $p < .05$, it can be stated that the scores of the curriculum knowledge test of the preservice teachers are not distributed normally. Thus, Kruskal-Wallis test, which is a non-parametric test, was used to compare the means of prospective teachers' Algebra Curriculum Knowledge Test (ACKT) scores since these scores are not normally distributed. The Kruskal-Wallis test included in SPSS program does not yield the results that indicate between which groups there are significant differences (Büyüköztürk, 2011). Therefore, in order to determine between which groups there were significant differences, paired comparisons of the groups were carried out with the help of the Mann-Whitney U test. In accordance with the results of the Mann-Whitney U test, between which groups there was a statistically significant difference was revealed. In this study, in the assessment of the quantitative findings obtained, SPSS program was used. Furthermore, the interviews with the preservice teachers were reported in the form of direct quotations. The data on the classroom observations of the preservice teachers were presented in the form of direct quotations in the study in accordance with the observation forms.

## 3. Findings

**The descriptive statistics of the Algebra Curriculum Knowledge Test are presented in Table 5 below.**

**Table 5 The Descriptive Statistics of ACKT**

| ACKT | N | $\overline{X}$ | Std. Deviation | Std. Error | Min. | Max. |
|---|---|---|---|---|---|---|
| First Grade | 44 | 9,55 | 3,393 | ,511 | 4 | 16 |
| Second Grade | 44 | 17,14 | 3,495 | ,527 | 9 | 25 |
| Third Grade | 44 | 23,36 | 3,491 | ,526 | 14 | 29 |
| Fourth Grade | 44 | 27,52 | 3,288 | ,496 | 22 | 36 |
| Total | 176 | 19,39 | 7,598 | ,573 | 4 | 36 |

When the means of the total scores in Table 5 which elementary school mathematics preservice teachers obtained from ACKT are examined, the curriculum knowledge levels of the preservice teachers are observed to increase depending on the grade level. In other words, whereas the highest curriculum knowledge test mean belongs to the preservice teachers studying in the fourth grade, the lowest mean belongs to the preservice teachers studying in the first grade. As seen in the graphic below and in Table 5, the algebra curriculum knowledge mean which is 9,55 in the $1^{st}$ grade has reached 27,52 in the $4^{th}$ grade.

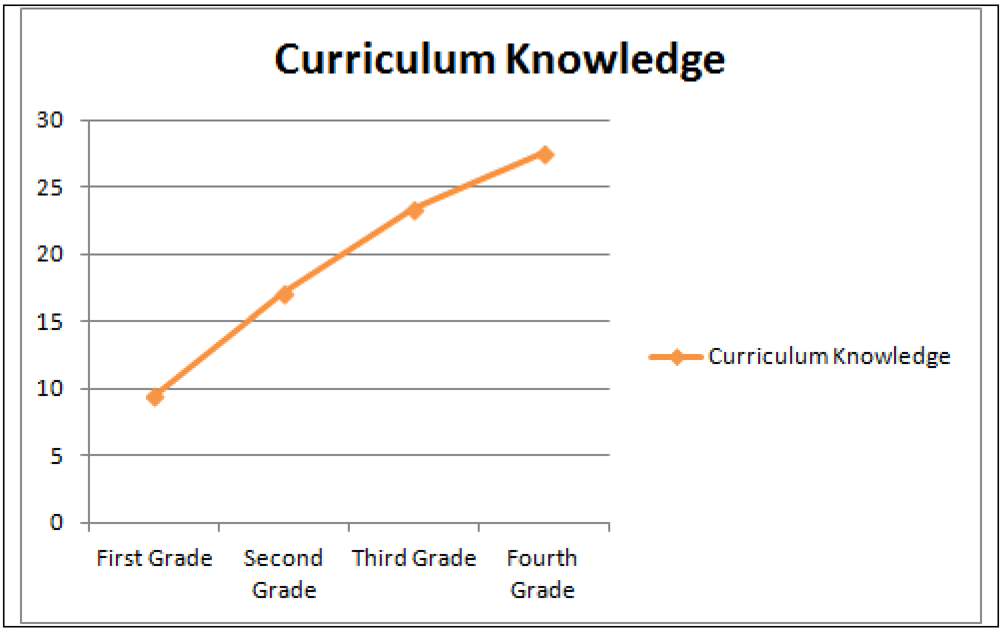


**Figure 1. The Development of Curriculum Knowledge**

Making use of the data in Table 5 and Figure 1, it is seen that improvement occurs in the curriculum knowledge levels of elementary school mathematics preservice teachers regarding algebra at each grade level throughout their undergraduate education. Moreover, the curriculum knowledge improvements of preservice teachers display a significant increase in the second grade when they take teaching vocational courses. Although the curriculum knowledge improvement continues in the third and fourth grades, the improvement rate decelerates. However, these data are not sufficient to understand whether there is a statistically significant difference among the groups. The Kruskal-Wallis test among non-parametric tests was used in order to understand whether there is a significant difference among the grade levels.

**Table 6 Kruskal-Wallis Results of ACKT**

| Sınıf | n | Mean Rank | df | $\chi^2$ | p |
|---|---|---|---|---|---|
| First Grade | 44 | 25,47 | 3 | 140,451 | .000 |
| Second Grade | 44 | 68,93 | | | |
| Third Grade | 44 | 113,95 | | | |
| Fourth Grade | 44 | 145,65 | | | |

As seen from the results in Table 6, it is observed that there is a statistically significant difference among the curriculum knowledge levels of preservice elementary school mathematics teachers regarding algebra depending on the grade level ($\chi^2(3)=140{,}451$; $p=0{,}000$; $p<0{,}05$). After all, when the mean ranks of ACKT are considered, success is seen to increase in accordance with the grade level. However, the Kruskal-Wallis test results do not indicate among which groups there are significant differences. Thus, in order to determine among which groups there are significant differences, in other words, to make paired comparisons, the results of the Mann-Whitney U test are presented in Table 7 below.

**Table 7 Mann-Whitney U Results of ACKT**

| Group | U | p | Significant Mean Difference |
|---|---|---|---|
| 1-2 | 117,500 | ,000 | 1-2,1-3,1-4,2-3,2-4,3-4 |
| 1-3 | 13,000 | ,000 | |
| 1-4 | ,000 | ,000 | |
| 2-3 | 206,000 | ,000 | |
| 2-4 | 18,500 | ,000 | |
| 3-4 | 371,000 | ,000 | |

When the findings in Table 7 are examined, the curriculum knowledge test scores of preservice teachers are seen to differentiate in accordance with the grade level. In other words, as the grade level increases, the curriculum knowledge scores increase as well. Despite this, the fact that the means of the fourth-grade preservice teachers are 27,52 in the Algebra Curriculum Knowledge Test in which maximum 44 scores can be obtained can indicate that the curriculum knowledge of preservice teachers of algebra does not reach a satisfactory level at the end of the undergraduate education. In other words, it can be stated that the curriculum knowledge of preservice teachers of the algebra learning domain improves statistically significantly but this improvement is not sufficient.

The findings regarding the first question of ACKT indicate that preservice teachers have trouble in determining to which sub learning domain the acquisitions regarding the algebra learning domain belong to. It can be stated that they have difficulty in determining sub learning domains since preservice teachers do not examine *Secondary School Mathematics Curriculum* (SSMC) or review it sufficiently. For instance, in the interview held with 4S9 preservice teacher, upon asking the preservice teacher "*Have you ever examined the curriculum?*", the preservice teacher replied, "*In special teaching methods course in the third grade*." 1S28 preservice teacher stated that he had no knowledge of SSMC. In other words, it can be said that preservice teachers come across the secondary school mathematics curriculum very late.

The findings regarding the third question of ACKT indicate that first and second-grade preservice teachers have misinformation about the learning approach on which SSMC is based. The answers given by 1S1 preservice teacher "*It is based on the simple lecture technique. The teacher narrates, the student listens"* and by 2S12 preservice teacher "*It is based on the lecture method. The teacher narrates, the student gives meaning."* are the indicator of the misinformation of first and second-grade preservice teachers about the curriculum since the renewed secondary school mathematics curriculum pays regard to the learning principles such as the active participation of the student in the process, the need for the establishment of the relation between the old and new knowledge and meaningful learning [MEB, 2013].

When first and second-grade preservice teachers are asked to choose methods-techniques suitable for the secondary school mathematics curriculum, it is seen from the findings regarding the fifth question of ACKT that they make explanations suitable for teacher-centered traditional teaching approaches. The explanation of 1S37 preservice teacher "*I would choose demonstration because I think that the student cannot discover mathematics by himself."* supports this result.

In the findings regarding the sixth question of ACKT, it is seen that first and second-grade preservice teachers interpret teacher and student roles in the classroom environment usually in accordance with the teacher-centered traditional teaching approaches. However, in the renewed mathematics curriculum, students are expected to be active in the process and to take the responsibility for their own learning and teachers are expected to be a guide leading students in the process of learning [MEB, 2013]. The answer 1S6 preservice teacher gave "*The teacher is a narrator, the student is a listener."* supports this result. Most of the third and fourth-grade preservice teachers are seen to explain teacher and student roles suitable for the philosophy of SSMC.

The findings regarding the eighth question of ACKT indicate that third and fourth-grade preservice teachers are aware of the fact that they can reach SSMC from the internet site of the MNE Board of Education and Discipline. Second-grade preservice teachers gave universal responses in the form that they could reach it from the Internet. For instance, the expression 2S37 preservice teacher used "*The* c*urriculum can be searched on the Internet class by class"* indicates that he does not know what primary source he should monitor for the changes occurring regarding SSMC. First-grade preservice teachers usually preferred not answering this question or stating that they had no knowledge about this question.

## 4. Conclusions and Discussion

In SSMC, the mean of first-grade preservice teachers is 9.55, the mean of second-grade preservice teachers is 17.14, the mean of third-grade preservice teachers is 23.36, and the mean of fourth-grade preservice teachers is 27,52. Furthermore, in the Algebra Curriculum Knowledge Test from which maximum 44 scores can be obtained, the means of fourth-grade preservice teachers are 27,52. When the fact that partially A and partially B answers are dominant in the answers which fourth-grade preservice teachers give to SSMC is considered, it can be said that the curriculum knowledge of fourth-grade preservice teachers of algebra does not reach a very good level at the end of the undergraduate education because it was seen that fourth-grade preservice teachers had trouble in reaching the correct answers to many questions. After all, in many studies in the literature, it was seen that the knowledge level of teachers and preservice teachers regarding the curriculum was not at the desired level (Baştürk and Dönmez, 2011; Canbazoğlu, 2008; Gökkurt, 2014). In other words, it was observed that teachers and preservice teachers had limited curriculum knowledge, had difficulty in applying the strategies determined in the curriculum, made superficial explanations regarding the basic skills stipulated in the curriculum and did not have sufficient information about the changes made in the curriculum (Gökkurt, 2014; Yeşildere-İmre and Akkoç,2010). The fact that preservice teachers come across the curriculum very late and that they do not examine the curriculum thoroughly can be indicated as the reason for the curriculum knowledge of preservice teachers not being at the desired level. Because when it is considered that first and second-grade preservice teachers have never examined the curriculum and that third-grade preservice teachers have first examined the curriculum owing to the courses such as Special Teaching Methods as understood from the oral answers of preservice teachers, including such courses as of the first grade should contribute positively to the curriculum knowledge improvements of preservice teachers. Accordingly, Baştürk and Dönmez (2011) stated in their study that preservice teachers do not pay sufficient attention to the curriculum. In the course applications of preservice teachers, it was observed that first and second-grade preservice teachers had trouble in creating a classroom environment suitable for the basic philosophy of the curriculum and planning the lesson. Furthermore, it can be said that educational activities which first and second-grade preservice teachers carried out were not suitable for the SSMC basic philosophy because first and second-grade preservice teachers carried out their activities completely in accordance with the traditional teaching approaches. Third and fourth-grade preservice teachers can be said to have attempted to carry out education suitable for learning approaches which SSMC has adopted in their teaching activities.

When the ACKT means of preservice teachers are examined, the curriculum knowledge test scores of preservice teachers are observed to differentiate in accordance with the grade level [$\chi^2(3)=140,451$; $p=0,000$; $p<0,05$]. In other words, as the grade level increases, the curriculum knowledge scores increase as well. As seen from the means of preservice teachers, the biggest improvement occurred in the transition from the first grade to the second grade. In the following years, the improvement of the curriculum knowledge continued. Canbazoğlu (2008) stated that teaching experience plays an important role in the improvement of the curriculum knowledge. In other words, it can be said that the courses which provide professional experience such as "*Special Teaching Methods I, Special Teaching Methods II, School Experience and Teaching Application*" have a positive effect on the curriculum knowledge improvement. After all, it is seen from the written and oral explanations of fourth-grade preservice teachers and their classroom observations what a significant role the internship course performed at schools plays in the improvements of the curriculum knowledge of preservice teachers.

**References**

Aksu, Z. ve Konyalıoğlu, A. C. (2015). Sınıf öğretmen adaylarının kesirler konusundaki pedagojik alan bilgileri. *Kastamonu Eğitim Dergisi*, *23*(2), 723-738.

Ball, D.L., Thames, M.H. & Phelps, G.(2008). Content knowledge for teaching: what makes it special? *Journal of Teacher Education , 59*(5), 389 –407.

Baştürk, S. &Dönmez, G. (2011). Examining pre-service teachers' pedagogical content knowledge with regard to curriculum knowledge. *International Online Journal of Educational Sciences,3*(2), 743-775.

Büyüköztürk, Ş., Kılıç -Çakmak, E., Akgün, Ö.E., Karadeniz, Ş. Ve Demirel, F. (2011). *Bilimsel araştırma yöntemleri.* (8.baskı). Ankara: Pegem Yayınları.

Canbazoğlu, S. (2008). *Fen bilgisi öğretmen adaylarının maddenin tanecikli yapısı ünitesine ilişkin pedagojik alan bilgilerinin değerlendirilmesi.* Yayınlanmamış Yüksek Lisans Tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü.

Carlsen, W.S.(1999). Domains of teacher knowledge', Geess-Newsome, J. and Lederman, N.G., (Ed.), " *Examining pedagogical content knowledge*", London: Kluwer Academics Publishers.

Cleophas, T. J., & Zwinderman, A. H. (2015). SPSS for Starters and 2nd Levelers. Second Edition.

Cochran, K. F., DeRuiter, J. A & King, R. A. (1993). Pedagogical content knowing: an integrative model for teacher preparation. *Journal of Teacher Education*, *44* (4), 263–272.

Geddis, A. N. (1993). Transforming subject matter knowledge: the role of pedagogical content knowledge in learning to reflect on teaching. *International Journal of Science Education, 15*, 673–683.

Gökkurt, B. (2014). *Ortaokul matematik öğretmenlerinin geometrik cisimler konusuna ilişkin pedagojik alan bilgilerinin incelenmesi.* Yayımlanmamış doktora tezi, Atatürk Üniversitesi Eğitim Bilimleri Enstitüsü, Erzurum.

Gökkurt, B., Şahin,Ö., Erdem, E., Başıbüyük,K. & Soylu,Y. (2015). Investigation of pedagogical content knowledge of middle school prospective mathematics teachers on the cone topic in terms of some components*. Journal of Cognitive and Education Research, 1* (1), 18-40.

Grossman, P. L. (1990). *The making of a teacher: Teacher knowledge and teacher education*. Teachers College Press, Teachers College, Columbia University.

Gudmundsdottir, S. (1987). *Pedagogical content knowledge: teachers' ways of knowing* . East Lansing, MI: National Center for Research on Teacher Learning. (ERIC Document Reproduction Service No. ED290701).

Hashweh, M. Z. (2005). Teacher pedagogical constructions: a reconfiguration of pedagogical content knowledge. Teachers and Teaching: Theory and Practice, 11(3), 273–292.

Jenkins, O. F.(2010). Developing teachers' knowledge of students as learners of mathematics through structured interviews. *J Math Teacher Educ, 13,*141–154.

Koçak, M.& Soylu, Y. (2016). A study on elementary mathematics prospective teachers' interpretation of algebra formulas. *Journal of Cognitive and Education Research, 2* (1), 1-23.

Kwong, C. W. , Joseph, Y. K. K., Eric, C. C. M. & Khoh, L.T. S. (2007). Development of mathematics pedagogical content knowledge in student teachers. *The Mathematics Educator, 10* (2), 27-54.

Lannin, J. K., Webb, M., Chval, K., Arbaugh, F., Hicks, S., Taylor, C., & Bruton, R. (2013). The development of beginning mathematics teacher pedagogical content knowledge. *Journal of Mathematics Teacher Education*, *16*(6), 403-426.

Loughran, J., Berry, A., & Mulhall, P. (2006). Understanding and developing science teachers' pedagogical content knowledge. Rotterdam, The Netherlands: Sense Publishers.

Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources, and development of PCK for science teaching (pp. 95-120). In J. Gess-Newsome & N.G. Lederman (eds.) *Examining PCK: The construct and its implications for science educatio*n. Boston: Kluwer Academic Press.

Marks, R. (1990). Pedagogical content knowledge: from a mathematical case to a modified conception. *Journal of Teacher Education, 41*, 3-11.

MEB, (2013).Milli Eğitim Bakanlığı Talim ve Terbiye Kurulu Başkanlığı Ortaokul Matematik Dersi (5. 6. 7. ve 8. Sınıflar) Öğretim Programı, http://ttkb.meb.gov.tr/www/guncellenen-ogretim-programlari/icerik/151 adresinden 8 Mart 2014 tarihinde indirilmiştir.

O'Hanlon, W. A. (2010). *Characterizing the pedagogical content knowledge of pre-service secondary mathematics teachers*. Doctoral Disertation, Illinois State University, USA.

Park, S., & Oliver, J. S. (2008). Revisiting the conceptualisation of pedagogical content knowledge (PCK): PCK as a conceptual tool to understand teachers as professionals. *Research in Science Education*, *38* (3), 261-284.

Shulman L. (1986). Paradigms and research programs in the study of teaching: a contemporary perspective. In M, Wittrock (Ed.), *Handbook of Research on Teaching.* NY: Macmillian Publishing Company.

Shulman, L.S. (1987). Knowledge and teaching: foundation of the new reform. *Harvard Educational Review, 57*(1), 1-21.

Smith, D. C, & Neale, D. C. (1989). The construction of subject matter knowledge inprimary science teaching. *Teaching and Teacher Education,5,* 1-20.

Şahin, Ö. (2016). *An examination of development of pedagogical content konowledge of middle school prospective mathematics teachers on algebra.* Doctoral Dissertation (PhD), Atatürk University, Erzurum.

Şahin, Ö. Erdem, E., Başıbüyük, K., Gökkurt, B., & Soylu, Y. (2014). Examining the development of secondary mathematics teachers' pedagogical content knowledge on numbers. *Turkish Journal of Computer and Mathematics Education, 5*(3), 207-230.

Şahin,Ö., Gökkurt, B.& Soylu, Y. (2015). Examining prospective mathematics teachers' pedagogical content knowledge on fractions in terms of students' mistakes, *International Journal of Mathematical Education in Science and Technology*, 1-21, DOI:10.1080/0020739X.2015.1092178.

Şimşek, N. ve Boz,N. (2015). Sınıf öğretmeni adaylarının uzunluk ölçme konusunda pedagojik alan bilgilerinin öğrenci kavrayışları bağlamında incelenmesi. *Cumhuriyet International Journal of Education*, *4*(3),10-30.

Tamir, P. (1988). Subject matter and releated pedagogical knowledge in teacher education. *Teaching and Teacher Education,* 4(2), 99-110.

Yeşildere-İmre, S. & Akkoç, H. (2012). Investigating the development of prospective mathematics teachers' pedagogical content knowledge of generalising number patterns through school practicum. *J Math Teacher Educ,15*,207–226.

**APP. 1 CURRICULUM KNOWLEDGE TEST**

**Q.1.** The acquisitions regarding the subject of algebra included in the mathematics curriculum are presented in the Table below. Write down which sub learning domain of the algebra learning domain these acquisitions belong to.

| No | Acquisitions | Sub Learning Domain |
|---|---|---|
| 1 | They express the rule for an arithmetic sequence in letter; find the requested term of the sequence of which rule has been expressed in letter. | |
| 2 | They multiply the algebraic expressions. | |
| 3 | They recognize the coordinate system with its characteristics and show ordered pairs. | |
| 4 | They divide the algebraic expressions into multipliers. | |
| 5 | They establish equations with one unknown of the first order suitable for real life situations. | |
| 6 | They draw a graph of linear equations. | |
| 7 | They understand the principle of conservation of parity in equations. | |
| 8 | They solve inequalities with one unknown of the first order. | |
| 9 | They write a suitable algebraic expression for a situation given orally and write a suitable oral situation for an algebraic expression given. | |
| 10 | They solve the problems which require establishing an equation with one unknown of the first order. | |

**Q.2.** Which **basic concepts** regarding Algebra take place in the Mathematics Curriculum?

**Q.3.** On which learning approach is the Mathematics Curriculum based? What are the basic principles of this approach?

**Q.4.** The improvement of which **basic skills** in the Mathematics Curriculum does Algebra ensure? Explain.

**Q.5.** Which strategies, methods, and techniques do you prefer in order to render teaching Algebra more comprehensible for secondary school students within the basic philosophy of the Mathematics Curriculum? (Lecture method, expository teaching, exploratory teaching, question and answer method, discussion, brainstorming, case method, problem solving, demonstration, computer-assisted teaching, etc.) Explain your reasons?

**Q.6.** What are **the teacher and student** roles in a classroom environment according to the Mathematics Curriculum?

**Q.7.** How much do you know about **the changes made in the last 10 years** in the Mathematics Curriculum in our country? Explain.

**Q.8.** How can you reach the Mathematics Curriculum? Where and how often can you follow the changes regarding the curriculum?

**Q.9.** In your opinion, what are the prior knowledge and concepts students need to know before learning the Algebra concepts given below?

| Concepts | Prior Knowledge |
|---|---|
| Operations in Algebraic Expressions | |
| Patterns | |
| Equations | |
| identical | |
| Inequalities | |

**Q.10.** What are the characteristics of **an acquisition statement** regarding the Secondary School Algebra subjects?

**Q.11.** What are the characteristics and basic components of **a lesson plan**? How are the lesson plans procured in the current system?

***APP. 2. CURRICULUM CONTENT KNOWLEDGE OBSERVATION FORM***

| **No** | **Behaviour** | **Not Observed** | **Insufficent** | **Partially Sufficent** | **Sufficent** |
|---|---|---|---|---|---|
| 1 | They used activities suitable for the basic skills the gaining of which the Secondary School Mathematics Curriculum aimed. | | | | |
| | They used activities suitable for the basic skills the gaining of which the Secondary School Mathematics Curriculum aimed. | | | | |
| 2 | They carried out assessment and evaluation activities suitable for the philosophical approach on which the Secondary School Mathematics Curriculum is based. | | | | |
| 3 | They used time effectively. | | | | |
| 4 | They carried out the teaching activities that they targeted in the lesson plan effectively. | | | | |
| 5 | They did not go beyond the limits of the acquisitions which the Secondary School Mathematics Curriculum aimed. | | | | |
| 6 | They used a content suitable for the acquisitions which the Secondary School Mathematics Curriculum targeted. | | | | |
| 7 | They performed education suitable for the level of the students. | | | | |
| 8 | They created a classroom environment suitable for the philosophical approach on which the Secondary School Mathematics Curriculum is based and ensured realizing teacher and student roles. | | | | |
| 9 | Being aware of the place in the curriculum and situation of the subject taught. | | | | |

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## APP.3 FREQUENCY-PERCENTAGE DISTRIBUTION OF EACH QUESTION

| First Question | Scoring Categories | Completely true | | Partially True (a) | | Partially True (b) | | Wrong Answer | | No Answer | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grade Level | f | % | f | % | f | % | f | % | f | % |
| | 1.Grade | - | - | - | - | 6 | 13.6 | 8 | 18.2 | 30 | 68.2 |
| | 2.Grade | - | - | - | - | 26 | 59.1 | 10 | 22.7 | 8 | 18.2 |
| | 3.Grade | - | - | 2 | 4.5 | 38 | 86.4 | 4 | 9.1 | - | - |
| | 4.Grade | - | - | 8 | 18.2 | 34 | 77.3 | 2 | 4.5 | - | - |

| Second Question | Scoring Categories | Completely true | | Partially True (a) | | Partially True (b) | | Wrong Answer | | No Answer | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grade Level | f | % | f | % | f | % | f | % | f | % |
| | 1.Grade | - | - | 2 | 4.5 | 16 | 36.4 | 5 | 11.4 | 21 | 47.7 |
| | 2.Grade | - | - | 5 | 11.4 | 27 | 61.4 | 6 | 13.6 | 6 | 13.6 |
| | 3.Grade | 1 | 2.3 | 19 | 43.2 | 21 | 47.7 | 3 | 6.8 | - | - |
| | 4.Grade | 4 | 9.1 | 22 | 50 | 16 | 36.4 | 2 | 4.5 | - | - |

| Third Question | Scoring Categories | Completely true | | Partially True (a) | | Partially True (b) | | Wrong Answer | | No Answer | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grade Level | f | % | f | % | f | % | f | % | f | % |
| | 1.Grade | - | - | - | - | - | - | 17 | 38.6 | 27 | 61.4 |
| | 2.Grade | - | - | - | - | 1 | 2.3 | 31 | 70.5 | 12 | 27.3 |
| | 3.Grade | - | - | 23 | 52.3 | 9 | 20.5 | 12 | 27.3 | - | - |
| | 4.Grade | 1 | 2.3 | 28 | 63.6 | 9 | 20.5 | 6 | 13.6 | - | - |

| Fourth Question | Scoring Categories | Completely true | | Partially True (a) | | Partially True (b) | | Wrong Answer | | No Answer | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grade Level | f | % | f | % | f | % | f | % | f | % |
| | 1.Grade | - | - | - | - | 11 | 25 | 24 | 54.5 | 9 | 20.5 |
| | 2.Grade | - | - | - | - | 12 | 27.3 | 28 | 63.6 | 4 | 9.1 |
| | 3.Grade | - | - | - | - | 14 | 31.8 | 28 | 63.6 | 2 | 4.5 |
| | 4.Grade | - | - | 7 | 15.9 | 34 | 77.3 | 3 | 6.8 | - | - |

| Fifth Question | Scoring Categories | Completely true | | Partially True (a) | | Partially True (b) | | Wrong Answer | | No Answer | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grade Level | f | % | f | % | f | % | f | % | f | % |
| | 1.Grade | 2 | 4.5 | 4 | 9.1 | 11 | 25 | 14 | 31.8 | 13 | 29.5 |
| | 2.Grade | 1 | 2.3 | 8 | 18.2 | 18 | 40.9 | 16 | 36.4 | 1 | 2.3 |
| | 3.Grade | 6 | 13.6 | 26 | 59.1 | 6 | 13.6 | 6 | 13.6 | - | - |
| | 4.Grade | 10 | 22.7 | 21 | 47.7 | 6 | 13.6 | 7 | 15.9 | - | - |

| Sixth Question | Scoring Categories | Completely true | | Partially True (a) | | Partially True (b) | | Wrong Answer | | No Answer | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grade Level | f | % | f | % | f | % | f | % | f | % |
| | 1.Grade | 1 | 2.3 | 4 | 9.1 | 12 | 27.3 | 24 | 54.5 | 3 | 6.8 |
| | 2.Grade | 1 | 2.3 | 10 | 22.7 | 13 | 29.5 | 20 | 45.5 | - | - |
| | 3.Grade | 8 | 18.2 | 20 | 45.5 | 8 | 18.2 | 8 | 18.2 | - | - |
| | 4.Grade | 12 | 27.3 | 21 | 47.7 | 9 | 20.5 | 2 | 4.5 | - | - |

| Seventh Question | Scoring Categories | Completely true | | Partially True (a) | | Partially True (b) | | Wrong Answer | | No Answer | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grade Level | f | % | f | % | f | % | f | % | f | % |
| | 1.Grade | - | - | - | - | 2 | 4.5 | 19 | 43.2 | 23 | 52.3 |
| | 2.Grade | - | - | - | - | 10 | 22.7 | 18 | 40.9 | 16 | 36.4 |
| | 3.Grade | 1 | 2.3 | - | - | 17 | 38.6 | 19 | 43.2 | 7 | 15.9 |
| | 4.Grade | 1 | 2.3 | 3 | 6.8 | 22 | 50 | 18 | 40.9 | - | - |

| Eighth Question | Scoring Categories | Completely true | | Partially True (a) | | Partially True (b) | | Wrong Answer | | No Answer | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grade Level | f | % | f | % | f | % | f | % | f | % |
| | 1.Grade | - | - | 7 | 15.9 | 10 | 22.7 | 2 | 4.5 | 25 | 56.8 |
| | 2.Grade | 13 | 29.5 | 15 | 34.1 | 11 | 25 | 3 | 6.8 | 2 | 4.5 |
| | 3.Grade | 18 | 40.9 | 17 | 38.6 | 5 | 11.4 | 4 | 9.1 | - | - |
| | 4.Grade | 14 | 31.8 | 22 | 50 | 8 | 18.2 | - | - | - | - |

| Ninth Question | Scoring Categories | Completely true | | Partially True (a) | | Partially True (b) | | Wrong Answer | | No Answer | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grade Level | f | % | f | % | f | % | f | % | f | % |
| | 1.Grade | - | - | 1 | 2.3 | 27 | 61.4 | 4 | 9.1 | 12 | 27.3 |
| | 2.Grade | - | - | 11 | 25 | 28 | 63.6 | 2 | 4.5 | 3 | 6.8 |
| | 3.Grade | - | - | 9 | 20.5 | 34 | 77.3 | 1 | 2.3 | - | - |
| | 4.Grade | 5 | 11.4 | 15 | 34.1 | 22 | 50 | 2 | 4.5 | - | - |

| Tenth Question | Scoring Categories | Completely true | | Partially True (a) | | Partially True (b) | | Wrong Answer | | No Answer | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grade Level | f | % | f | % | f | % | f | % | f | % |
| | 1.Grade | - | - | - | - | 2 | 4.5 | 13 | 29.5 | 29 | 65.9 |
| | 2.Grade | - | - | 3 | 6.8 | 9 | 20.5 | 19 | 43.2 | 13 | 29.5 |
| | 3.Grade | - | - | 7 | 15.9 | 18 | 40.9 | 16 | 36.4 | 3 | 6.8 |
| | 4.Grade | 4 | 9.1 | 21 | 47.7 | 8 | 18.2 | 11 | 25 | - | - |

| Eleventh Question | Scoring Categories | Completely true | | Partially True (a) | | Partially True (b) | | Wrong Answer | | No Answer | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grade Level | f | % | f | % | f | % | f | % | f | % |
| | 1.Grade | - | - | - | - | 4 | 9.1 | 22 | 50 | 18 | 40.9 |
| | 2.Grade | 1 | 2.3 | 5 | 11.4 | 23 | 52.3 | 10 | 22.7 | 5 | 11.4 |
| | 3.Grade | - | - | 6 | 13.6 | 26 | 59.1 | 12 | 27.3 | - | - |
| | 4.Grade | 2 | 4.5 | 22 | 50 | 20 | 45.5 | - | - | - | - |