juhaina awawdeh shahbari

**Investigation of mathematical-pedagogical knowledge among students in the Early Childhood Program at the College of Arabic Speakers**

Introduction

Up until a few years ago, teachers for first and second grades were trained through the Department of Early Childhood Education. This training process is similar to the training process in various countries around the world and allows teachers to teach language, science, and mathematics (Hesson & Karp, 2000). The lack of specialized training in mathematics was highlighted in a comprehensive study conducted in the United States. All first and second grade mathematics teachers studied lacked a major specialization in mathematics or mathematics education (Malzan, 2002). Ginsburg, Lee and Boyd (2008) emphasized that the number of courses related to mathematics or mathematics education in early childhood training tracks in colleges and universities is very small or even nonexistent. The present study was conducted to examine whether training for prospective teachers in the first and second grades of the Early Childhood Education Program at the College of Arabic Speakers provides learners with the various knowledge components of mathematics education.

**Mathematical content knowledge and pedagogical content knowledge**

Mathematical content knowledge includes knowledge about the structure of knowledge, facts, theories and principles related to the field (Shulman, 1986). Mathematical content knowledge is considered by Ball, Thame and Phelps (2008) as knowledge of common mathematical content and unique mathematical knowledge. Knowledge of common mathematical content refers to content knowledge shared by mathematics educators who are not necessarily teachers, including basic algorithmic and procedural knowledge for problem solving and the ability to define and write mathematical concepts correctly (Delaney, Ball, Hill, Schilling & Hill, 2004). Knowledge of unique mathematical content for teachers includes the knowledge and skills required for teaching mathematics to students (Delaney et al., 2008). The component of content knowledge is expressed in knowledge and insight into the historical development of key mathematical concepts, which are considered an inseparable part of existing mathematics. It is also expressed in the interrelationship between ideas, analogies, and images related to different principles (Davis & Simmt, 2006).

Pedagogical content knowledge combines content knowledge with pedagogic knowledge, and it deals with adapting specific content and organizing it for students while understanding the reasons that make learning easy or difficult. In addition, pedagogic knowledge deals with the different ways of presenting the subject, building on the students' previous knowledge, and common mistakes related to the content or concept learned and the difficulties involved in learning it (Shulman, 1986). Pedagogical content knowledge is considered to be the core of the understanding of content and pedagogy (Ball, Lubinski & Mewborn, 2001). Ball and her colleagues (Ball et al., 2008) refer to two categories of pedagogical content knowledge: the first is knowledge of content and students that includes awareness of how students think and understand; the second category, knowledge of content and teaching, combines knowledge of mathematics and knowledge of instruction (Hill, Ball & Schilling, 2008). An extensive breakdown of pedagogic knowledge components has been proposed in the research literature, such as elements relating to the teachers' understanding of the structures and mathematical links, the teachers' knowledge of a variety of alternative representations of concepts for explanation, the ability of teachers to analyze cognitive demands of mathematical tasks, the ability of teachers to understand students' learning difficulties and abilities to take appropriate action to address them (Cheang et al., 2007). Additional components include knowledge related to the curriculum including teaching goals, knowledge of the design and teaching of mathematics, including the design of mathematics classes and the choice of different activities, the choice of evaluation patterns, the prediction of typical responses of students, including misconceptions, etc. Teachers must also have knowledge of the learning and teaching of mathematics within an action, including evaluation of student solutions and the discourse created and analyzed, analysis of the content of students' questions, diagnosis of student answers, explanation of mathematical concepts or procedures, and more (Tatto et al., 2008).

**Knowledge of mathematical content and pedagogical knowledge among students of mathematics teaching**

Mathematical content knowledge and pedagogical knowledge have been extensively studied and research findings (Livy & Vale, 2011; Venkat & Spaull, 2015) indicate limited and insufficient knowledge among students in mathematics teaching. The limitations of knowledge among students in mathematics teaching have been exposed regarding knowledge of one mathematical concept or subject (Tutak, 2009) in rational numbers (Depaepe, Torbeyns, Vermeersch, Janssens, Janssen, Kelchtermans, & Van Dooren, 2015), in ratio (Livy & Vale, 2011); in average (De Haro & Moll, 2014) and in number of components belonging to different topics (Cheang et al., 2007; Shirvani, 2015).

Despite the extensive review of mathematical content knowledge and pedagogical knowledge among students of mathematics teaching, there is little reference to knowledge related to first and second grades and to prospective teachers who are supposed to teach in these classes (Mewborn, 2001). Mewborn (2001) suggests that the lack of reference to the lower grades stems from the assumption that teachers understand topics such as addition and subtraction, integers, and other basic subjects.

**Methods of testing material mathematic knowledge and practical information in education**

The best way to test teachers' knowledge is not by the number of courses they have taken but by testing their knowledge in content of specific subjects (Ball et al., 2001). Indeed, research literature is rich in studies that examine content knowledge among students through the use of various tasks. Some of the studies used ready-made tests of students' knowledge, such as the TIMSS (Trends in International Mathematics and Science Study) for grades 4 and 8 (Tatto et al., 2008). Another approach to testing teachers' content knowledge proposes that the test should include the specific knowledge that teachers are supposed to teach in classrooms and at least two levels of knowledge above. Accordingly, it was proposed to examine elementary school teachers’ content knowledge through basic concepts including the four arithmetic operations, comparison and arithmetic operations in simple fractions, decimal numbers, percentages, measurements, and word problems (Southwell, White, Way & Perry, 2006). In another study, Hill, Rowan and Ball (2005) examined teachers' mathematical knowledge with items relating to numbers and arithmetic operations up to grade 8, as well as items related to functions and amplification to that level. The scales were selected by Goulding (2003) who chose questions in algebra, proofs, measurements, probability and statistics, to examine the knowledge of prospective primary school teachers.

Each study used a different index for testing pedagogical knowledge. Several studies used items representing different topics to test general content knowledge, for example, Chin et al. (2007), which examined pedagogical knowledge by means of items relating to four main topics: numbers, geometry, algebra, and data processing. Other research focused on testing pedagogical knowledge on specific mathematical subjects, for example Hill et al. (2005), which examined special mathematics knowledge of first and third graders by analyzing strategies for students' solutions to exercises in four arithmetic operations.

**Research questions**

1. To what extent are prospective teachers in the Early Childhood Education track limited in mathematical and pedagogical knowledge related to first and second grades in four areas (numbers, arithmetic operations, geometry, and word problems)?

2. To what extent is the level of mathematical content knowledge and pedagogic knowledge in these four areas among prospective teachers in the early childhood education track at the beginning of the training process different from prospective teachers at the end of the training process?

**Sample**

The sample included 150 students in the Early Childhood Track at the College for Teaching Training, 75 first-year students and 75 third- and fourth-year students. 97% of the participants indicated that they wanted to teach in first and second grades, and only 3% indicated that they intended to teach in kindergarten. 71% of the participants had completed a 3-unit mathematics secondary school matriculation program, 26% of them completed 4 units, and only 3% of the subjects studied at a level of 5 units.

**Research tools**

The data were collected in a three-part questionnaire. Part A of the questionnaire included items relating to the background variables of the participants, such as the number of mathematics units they studied in the high school and information about participants’ training at the college, including the mathematics courses taken. Part B of the questionnaire included items that examined mathematical content knowledge and part C included items that examined pedagogical knowledge. The items in Part B and C that examine mathematical and pedagogical content knowledge related to subjects and concepts studied in first and second grades. The study topics can be divided into four main categories, which reflect the first and second grade curriculum:

A. Numbers: decimal structure, place value, zero features, numbers divisibility by 2, 5, and 10, even and odd.

B. Arithmetic operations: addition, subtraction, multiplication and division.

C. Geometry and measurements: Length measurements, time measurements, area measurements, polygons and polyhedrons.

D. Word problems: solving word problems, writing word problems and sorting word problems.

Part B, the section examining mathematical content knowledge, was constructed according to view that supports the examination of mathematical content knowledge on subjects and concepts that participants learned or are supposed to teach (Ball et al., 2001). This part included 25 items. The reliability measures examining internal consistency (Cronbach's α) indicate high scores; the reliability coefficient in the mathematical content knowledge test was 0.89 = α. The items were collected from various sources: from Ministry of Education professional tests; from items used in similar studies and published in the research literature (e.g. Ball & Hill, 2004); and from the researcher. Following are two examples of items included in the questionnaire. The following item was suggested by the researcher and examines mathematical knowledge in polygons.

Divide a square into two parts using a section. What is the polygon with highest number of sides that you can obtain?

Prospective teachers with mathematical content knowledge can recognize that the polygon with the highest number of sides can be obtained by creating another side as in the example below:

Another item that was taken from the Professionalization Test 2008/09 examines mathematical content knowledge regarding reflection.

Samar drew a rectangle with a short side equal to half of its long side. Samar reflected this rectangle through one of its sides. The shape obtained from the rectangle and its reflection was a square. Was the reflection on the long side of the rectangle or on its short side? Explain your answer.

Prospective teacher with efficient knowledge, will answer that the mirror should be on the long side.

Part C included items that examine pedagogical knowledge presented as important in the research literature (Cheang et al., 2007): understanding mathematical structures and mathematical relationships; understanding difficulties; misconceptions and strategies of student solution and response; knowledge of alternative teaching methods and various concepts for explanation. Part C included 25 items. The reliability measures that examined internal consistency (α of Cronbach) indicate high scores, the reliability coefficient in the pedagogical knowledge test is 0.90 = α. The test items were collected from various sources: from the Ministry of Education's proficiency tests and from items used in similar studies (e.g., Ball & Bass, 2000; Lim, Teo, Chua, Cheang & Yeo, 2007). The following is an example of an item that examines pedagogical knowledge related to the number place value. The task was taken from Losq's (2005).



The teacher presented her students with ten patterns of numbers from zero to 10 (shown above) and requested from students to represent the number 27 using these patterns. Rami chose two patterns and arranged them as the following form:



Explain Rami's choice in both patterns to represent the number 27

Prospective teachers with efficient pedagogical knowledge about number place value can indicate about the problematic nature of Rami's solution, which does not distinguish between the number of tens and their value and the amount represented.

Another example below of an item that examines pedagogical knowledge in a vertical subtraction is taken from the study by Hill, Bull and Schilling (2008).

The teacher wants to divide her students into groups according to their type of errors in the subtraction operations. Following are three incorrect student solutions:

I II III

15 8 9 6 15 4 12 4

5 0 0 7 5 0 0 5 3 2 0 5

7 - 6 - 6 -

\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ \_\_\_\_\_

8 8 9 6 9 0 0 4 3 6 0 4

Which ones have the same error? Circle the correct answer.

* 1. I and II
	2. I and III
	3. II and III
	4. I, II and III

The item refers to one of the common mistakes among students in subtraction exercises that include zero in the internal digits of the number. In the conversion from one unit to the other, students skip the number zero. The student in example II only made the conversion from the thousand digit to units, while ignoring the numbers in the hundreds and tens digits. The student in example III did the same thing. Prospective teachers with pedagogical knowledge in subtraction will indicate that option C includes the same error.

**Research process**: The questionnaires were distributed to the prospective teachers in their first year of study, at the beginning of the academic year. Prospective teachers in their third and fourth year of study were given the questionnaires at the end of same year.

**The training process in mathematics for prospective teachers in the Early Childhood Track**

Colleges for Arabic speakers and Israeli colleges in general offer an average of three courses in mathematics and geometry and their instruction in the early childhood tracks. The syllabi of the courses relate to various subjects in mathematics and geometry and their teaching. The courses in mathematics and its teaching relate to topics such as numbers, primary numbers, simple fractions, decimal numbers, four arithmetic operations and data processing. The courses in geometry relate to basic topics and concepts in geometry such as: the concepts of a point, a line, a ray, an angle, and a plane; definition and classification of figures and polygons; perimeters and areas of geometric figures; systems of measurement; overlapping triangles and similar triangles.

**Findings**

In order to conduct the statistical analyzes, each participant was given five scores for each questionnaire (overall score, numbers score, operations score, geometry and measurement score and word problems score) and a total of 10 scores. The score for each questionnaire was determined so that the correct answer was one point and the wrong answer was zero points. The mean scores for each questionnaire were calculated separately. In addition, the scores for each field (numbers, account operations, geometry and measurements, and word problems) were calculated separately among the two study groups. In addition, a comparison was made between the average scores in the different fields in each of the two questionnaires.

**Knowledge of mathematical content among preschool students**

The findings relating to mathematical content knowledge indicate an average of 46 among prospective teachers studying in the third and fourth years and a lower average of 36 among first-year prospective teachers. This hierarchy among the two research groups was observed in each of the areas examined in mathematical content knowledge (MCK): numbers, arithmetical operations, geometry and measurements, and word problems. In addition, the findings indicate that in both of the groups there was higher average knowledge related to numbers and that the lowest average was in geometry and measurements. The averages and standard deviations in the areas examined for mathematical content knowledge are presented in Table 1.

Table 1. Means and standard deviations for mathematical content knowledge and for each component

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *N* | *SD* | *M* |  |  |
| 75 | 14.84 | 35.96 | MCK | First year prospective teachers |
| 75 | 19.86 | 46.05 |  | Third/fourth-year prospective teachers |
| 150 | 18.19 | 41.00 |  | Total |
| 75 | 21.83 | 48.38 | Numbers | First year prospective teachers |
| 75 | 16.48 | 60.19 |  | Third/fourth-year prospective teachers |
| 150 | 19.93 | 54.29 |  | Total |
| 75 | 22.81 | 46.67 | Arithmetic operations | First year prospective teachers |
| 75 | 31.43 | 55.02 |  | Third/fourth-year prospective teachers |
| 150 | 27.69 | 50.48 |  | Total |
| 75 | 16.25 | 21.33 | Geometry | First year prospective teachers |
| 75 | 24.34 | 31.66 |  | Third/fourth-year prospective teachers |
| 150 | 21.27 | 26.50 |  | Total |
| 75 | 27.92 | 43.56 | Word problems | First year prospective teachers |
| 75 | 26.63 | 52.00 |  | Third/fourth-year prospective teachers |
| 150 | 29.00 | 47.78 |  | Total |

In order to compare the level of knowledge and mathematical content between the two research groups, a *t* test for independent samples was conducted in mathematical content knowledge as a whole and for each knowledge component (numbers, arithmetical operations, geometry and measurements, and word problems) separately. The findings indicate that the mean of third/fourth-year prospective teachers is higher than the mean of first year prospective teachers and the differences is significant in MCK *(t = 148) = -3.52, p <0.05* and in content knowledge in geometry *t (148) = -3.05, p <0.05.* Regarding content knowledge in arithmetic operations and in word problems, there was no significant difference between the two groups.

The mean of content knowledge in geometry and measurements, as seen in Table 1, is lower than the means in the other fields of mathematical content knowledge for both of the two research groups. In order to examine whether the difference between the means is significant in the various knowledge components, a paired-samples *t*-test was conducted. The findings indicate that among the first-year prospective teachers group, the mean of geometry and measurements was significantly lower than the mean of numbers *t(74) = -10.40, p <0.001*; the mean of arithmetic operations *t(74) = -9.25, p <0.001* and the mean of word problems *t(74)= -7.03, p <0.001*. Similarly among the third/fourth-year prospective teachers, the mean in geometry was lower and statistically significant than the mean in numbers *t(74) = -10.33, p <0.001*, the mean in arithmetic operations *t(74) = -7.00, p <0.001*, and the mean in word problems *t(74) = -7.28, p <0.001.*

In order to identify more specific difficulty points in mathematical content knowledge in geometry and measurements, each subject in the field of geometry and measurements was examined separately, which included measurements of length, time, area, weight, transformations, polygons, and polyhedrons. It was found that the participants in both groups have more difficulties in transformation and in polyhedrons. Figure 1 presents the mean of the content knowledge in the various subjects examined.

Figure 1: The mean of the two research groups in mathematical knowledge of selected subjects in geometry

Figure 1 shows that the difficulty in transformations and polyhedrons was found in both groups. Analysis of the questionnaires further indicates common mistakes among the subjects. The following are examples of the common mistakes among the participants.

In a task that requires the participants to divide a square into two parts using a section and to find the polygon with highest number of sides that can be obtained:

The participant drew a square and divided it into two rectangles as depicted below.

It is important to note that in all the answers which chose the rectangle as a solution to the task, it is expected that the most common division of the given square is by crossing it into two overlapping parts, either through a vertical or horizontal line. Another example that examines content knowledge is shown in the following polyhedrons.

The box is given below

1cm

1cm

1cm

1. What is the volume of the box drawn? \_\_\_\_\_\_\_\_\_\_\_\_ (cm2)
2. Write the dimensions of a box that is three times larger than the size of the drawn box.

Half of the students who answered item a correctly did not succeed in answering item b and set correct measurements for a box that was three times larger than the volume of the given box. The most common error was to increase the three dimensions of the drawn box by 3 times, by recording the dimensions as 3, 3 and 3.

Another example of the errors was in an item that examined the layout of polyhedrons: Using the layouts of surfaces (the facades without the bases) of three polyhedrons. What are the polyhedrons?

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |

Polyhedron 1\_\_\_\_\_\_\_\_\_\_\_\_\_ Polyhedron 2\_\_\_\_\_\_\_\_\_\_\_\_ Polyhedron 3\_\_\_\_\_\_\_\_\_\_\_\_\_

The task was considered difficult for the students, 80% of them failed to recognize the first polyhedron as a pyramid and the second polyhedron as a cylinder. In addition, 70% failed to identify polyhedron 3 as a prism.

**Pedagogical and content knowledge among early childhood prospective teachers**

The findings related to pedagogical knowledge in each of the areas examined: numbers, arithmetical operations, geometry and measurements, and word problems indicate means lower than those obtained in mathematical content knowledge between the two groups. However, similar to the findings regarding mathematical content knowledge, the findings indicate a mean of 21 among third/fourth-year prospective teachers and a lower mean of 16 among first-year prospective teachers. This hierarchy among the research groups was maintained in all fields of pedagogical knowledge. As with mathematical content knowledge, pedagogical knowledge of numbers was the highest among each group. In contrast to the findings obtained on mathematical knowledge, the lowest mean in pedagogical knowledge was in word problems. The means and standard deviations in all components of pedagogical knowledge examined are presented in Table 2.

Table 2. Means and standard deviations in content pedagogical knowledge

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *N* | *SD* | *M* |  |  |
| 75 | 16.34 | 16.81 | MPCK | First year prospective teachers |
| 72 | 21.72 | 21.57 |  | Third/fourth-year prospective teachers |
| 147 | 19.52 | 19.14 |  | Total |
| 75 | 27.97 | 23.33 | Numbers | First year prospective teachers |
| 72 | 49.21 | 40.28 |  | Third/fourth-year prospective teachers |
| 147 | 40.75 | 31.63 |  | Total |
| 75 | 19.39 | 20.38 | Arithmetic operations | First year prospective teachers |
| 72 | 22.81 | 23.02 |  | Third/fourth-year prospective teachers |
| 147 | 21.10 | 21.67 |  | Total |
| 75 | 20.91 | 15.33 | Geometry | First year prospective teachers |
| 72 | 27.96 | 21.64 |  | Third/fourth-year prospective teachers |
| 147 | 24.37 | 18.42 |  | Total |
| 75 | 17.06 | 10.38 | Word problems | First year prospective teachers |
| 72 | 16.49 | 9.13 |  | Third/fourth-year prospective teachers |
| 147 | 16.47 | 9.77 |  | Total |

To compare the level of pedagogical knowledge between the two research groups, an independent sample was conducted for pedagogical knowledge as a whole and for each of the fields of knowledge separately: numbers; arithmetical operations; geometry and measurements; and word problems. The findings indicate that there is no significant difference between the two groups in general pedagogical knowledge, in pedagogical knowledge in arithmetic operations, in pedagogical knowledge in geometry and measurement, and in pedagogical knowledge in word problems (p> 0.05). It was found that the mean of third/fourth-year prospective teachers was significantly higher than mean of first year prospective teachers *t(145) = -2.57, p <0.05.*

The mean of the pedagogical knowledge in word problems as observed in Table 2 was lower than the means in the other components of pedagogical knowledge in both of the research groups. To examine whether the differences between the means is significant, a paired simple *t*-test was conducted. The findings indicate that among the first year prospective teachers, word problems were significantly lower than the mean of numbers *t(74) = 4.04, p <0.05*, lower than the mean of arithmetic operations *t(74)= 4.48, p< 0.05*, and lower than the mean of geometry and measurements *t(74) = 2.13, p <0.001.* For the third/fourth-year prospective teachers, the mean of word problems was statistically significant and lower than the mean of numbers *t (71) = -80, p <0.05*, lower than the mean of arithmetic operations *t(71) = -4.91, p <0.05*, and lower than the mean of geometry and measurements *t(71) -4.41, p <0.001.*

To identify specific difficulty points in pedagogical knowledge of word problems, reference was made to each item that relates to word problems separately. It was found that most of the participants found it difficult to classify division problems into partitioning and division problems. In addition, they had trouble composing word problems that fit a specific exercise. The most common errors among the participants in both groups were in composing word problems in addition in which the initial group was not known, and in contrast, they were more successful in composing problems in which the final group was not known. Figure 2 shows the mean in composing word problems for addition and subtraction exercises among the two groups.

Figure 2: Average success in composing word problems appropriate for exercises

Figure 2 shows that the participants in both groups were more successful in constructing word problems in which the question relates to the sum and less successful in composing word problems in which the question relates to the initial group.

**Comparing the level of mathematical and pedagogical knowledge**

The mean of mathematical content knowledge was higher than the mean of pedagogical knowledge in the two research groups, as illustrated in Tables 1 and 2. In order to examine whether the differences iare significant, a paired sample t-test was conducted between the means of the two research groups. The findings indicate a higher mean in mathematical content knowledge than in the pedagogical knowledge and the differences were significant among third/fourth-year prospective teachers *t(71) = 9.411, p <.001* and among first year prospective teachers *t(74) = 11.37, p < .001.*

**Discussion**

The purpose of this study is to provide a snapshot of the mathematical content knowledge and pedagogical knowledge of early childhood education students at a teacher training college. Mathematical content knowledge and pedagogical knowledge is examined in the context of the topics that the research subjects are supposed to teach and according to the mathematics curriculum for first and second grades. The content was divided into four main areas: numbers, geometry and measurements, arithmetic operations, and word problems

There is insufficient knowledge among prospective teachers studying in the early childhood education track, both among those at the beginning of their studies and those at the end of the training process. The mean of third/fourth-year prospective teachers in mathematics content knowledge is 46 (on a scale of 0-100) and in the pedagogical knowledge of content is 21 (on a scale of 0-100). Lower scores were observed among first year prospective teachers. The differences between the third/fourth-year prospective teachers and the first year prospective teacherswere significant only in some of the components of mathematical content knowledge and in pedagogical knowledge. This can indicate that the process for training prospective teachers to teach math in first and second grades is deficient. This picture differs from the findings of Chein et al. (2007), which showed a significant improvement in the pedagogical knowledge of mathematics students in the first year and after completion of the mathematics training in Singapore. Hamlet (2007) attributed the knowledge disability in mathematical content among first-year students in the Early Childhood Education Track for the mathematics forgetfulness taught in schools.

The findings indicate that the level of knowledge of mathematical content in the field of geometry and measurements is lowest among both of the research groups. Limited knowledge of geometry and measurement has also been identified as the weakest field among students from different countries who participated in the Times test (Tatsuoka, Corter & Tatsuoka, 2004). Similar findings have been reported in studies among teachers (Jones, 2000; Baturo & Nason, 1997). In the area of pedagogical knowledge, the findings indicate that word problems were the most difficult for participants. The participants were able to solve word problems and but had less success in composing word problems to fit a given exercise, especially when the unknown was in the initial group. Other research also found that composing problems was a difficult task for prospective mathematics teachers when they were required to compose word problems corresponding to a given symbolic structure in fractions (Luo, 2009). Word problems are considered a difficult topic among students (Rogers, 2004). Limitations of pedagogical knowledge regarding word problems was also revealed in a study of first-grade teachers (Carpenter, Fennema, Peterson & Cary ,1988). Similarly, Ball (1988) reported that teachers were successful in performing an algorithm correctly, but they found it difficult to explain the underlying principle and the relationship to the place value of the number.

It is important to note that the findings indicate a difference between the levels of mathematical content knowledge and the level of pedagogical knowledge. The level of mathematical content knowledge was higher than the level of pedagogical knowledge in both research groups. This finding is consistent with reports in the research literature (Turnuklu & Yesildere, 2007). The gap between the components of content knowledge and the elements of pedagogical knowledge is reasonable, because pedagogical knowledge includes not only mathematical content knowledge, but also analysis of solution strategies, misconceptions, teaching methods, and other components. The difference between the levels of knowledge and the higher level of mathematics content knowledge can be attributed to two factors. One is the greater exposure of the two groups to content knowledge throughout their years of study, especially in high school and during academic training at the college. Another reason for the difference is exposure to mathematical content knowledge components and the use of this knowledge in daily life, in contrast to pedagogical knowledge, which is used only while teaching.

In conclusion, the main conclusion of the study is that teacher training for the first and second grades in the Early Childhood Education Track is deficient in imparting mathematical content and pedagogical knowledge for graduate students. It is important to note that there has been a change in the teachers' training process for the first and second grades, so that according to the new guidelines of the Ministry of Higher Education, the early childhood education track has been canceled. Training for elementary school teaching offers a major specialization in mathematics. However, it is still possible for prospective teachers in the kindergarten track to expand their training in math instruction for first and second grades, while completing only a limited number of courses in mathematics and mathematics education. This is similar to the training of the teachers in this study. In light of this situation, it is recommended to enrich the curriculum for prospective teachers in the kindergarten program who wish to teach mathematics in first and second grades by expanding the number and variety of courses in mathematics and mathematics education that emphasize the content for these grades in mathematical and pedagogical aspects. It should be noted special intervention programs should be included in mathematics and mathematics education courses to address specific fields of knowledge, geometry and measurement and word problems, which were found to be two weak areas among participants.

This study was conducted in accordance with the recommendation of the Inter-Academic Committee of the Mofet Institute and with the support of the Department of Teacher Education in the Ministry of Education.