Transformation of theoretical knowledge into instructional practice: A mathematics teacher's journey

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Our study aimed to examine the transformation of pre-service mathematics teachers' theoretical knowledge into in-service mathematics teachers' instructional practice. We carried out seven focus group interviews, three individual phone call interviews, and classroom observations in four semesters with three Turkish pre-service mathematics teachers. This longitudinal study provides a significant insight into the transformation of knowledge through three phases: (i) theoretical knowledge (pre-service teacher education); (ii) practices in internships (pre-service teacher education); and (iii) real classroom settings (in-service teaching experience). The participants realised the difficulties related to implementing student-centred approaches when they experienced real classroom settings during their internships. Despite the participants' rigorous knowledge of teaching and motivation, their realisation about practice was changed through the experiences they had during their internships. Upon becoming in-service mathematics teachers, the participants encountered a need to adapt student-centred activities according to their student and classroom circumstances.

Introduction

One of the fundamental challenges in teacher education programs is to give equal emphasis to theory and practice of teaching (Allen, 2009; Cochran-Smith, 2001; Korthagen, Loughran & Russell, 2006; Shulman, 1987). As emphasised by Caires, Almeida and Vieira (2012), the majority of the investment in teacher education is covered by the theoretical infrastructure of education. This may be the reason why teacher education programs are often not successful enough to prepare pre-service teachers for the realities of classrooms (Goodland, 1990; Korthagen, et al., 2006; Sandlin, Young, & Karge, 1992). Ball (2000) stated that the fundamental tension in teacher education is still present, however adding that it can be overcome through the "proper relationship of theory and practice" assertion by John Dewey (1904/1964). Korthagen et al. (2001) evaluated Clandinin's (1995) "the sacred theory practice story" as the transformation of theoretical knowledge into practice in teacher education, further emphasising its importance. Identifying how and in what ways theoretical knowledge is transformed into the instructional practice in teacher education is important (Yazgan-Sağ, Emre-Akdoğan & Argün, 2016).

However, a number of studies show that there is little transition from knowledge of theory into actual practices (Allen, 2009; Korthagen et al., 2001; Korthagen, et al., 2006). Studies have also shown that teachers encounter problems with their teaching experiences after they have finished their pre-service education (Cole & Knowles, 1993; Feiman-Nemsera & Parker, 1990; Zeichner & Tabachnick, 1981). Teachers may experience a large

gap between theory and practice in their profession; usually they try to adapt themselves to practices in their school during their first years of teaching, thus failing to focus on their education about teaching (Cochran-Smith, 2005; Korthagen et al., 2001). Teachers create and maintain an identity during their early years in the profession (Flores & Day, 2006), developing their identities and knowledge through (i) teacher education programs; (ii) teaching experiences in school; and (iii) their own previous K-12 learning experiences (Feiman-Nemser, 2001; Friedrichsen et al., 2009; Kleickmann et al., 2013; Lannin et al., 2013). Korthagen et al. (2006: p.1020) emphasised that "although various studies on restructuring teacher education have been published, no coherent body of knowledge exists about central principles underlying teacher education programs that are responsive to the expectations, needs and practices of student teachers".

Studies that focus on mathematics teachers' knowledge are generally based on teachers' theoretical knowledge without analysing teachers knowledge in the context of teaching practice (An, Kulm & Wu, 2004; Chick, Baker, Pham & Cheng, 2006) or mathematics teachers' knowledge of instructional practices (Kinach, 2002; Kleickmann et al., 2013; Lannin et al., 2013). Shulman's (1986, 1987) pedagogical content knowledge (PCK), which is well-accepted in the literature, contributes significantly to teaching and learning mathematics (Hill, Ball & Schilling, 2008). Shulman's theory of teacher knowledge has been extended by researchers in the field of mathematics education (Baumert et al., 2010; Fennema & Franke, 1992; Grossman, 1990; Hill et al., 2008). Pedagogical content knowledge comprises a comprehension of students' thinking and knowing how to teach mathematical content (An et al., 2004). Teaching experiences can be considered as one of the sources for the implementation process of PCK in teacher education (Kleickmann et al., 2013). Lannin et al. (2013) examined how the PCK of two prospective teachers changed after they initiated their careers. Kinach (2002) investigated the PCK of the prospective teachers in addition and subtraction operations, with a view to developing a model of effective practice. PCK development of teachers is fundamentally influenced by their teaching experience; in this respect, examining the PCK development process of prospective teachers in teaching practice is of importance (Yazgan-Sağ, et al., 2016).

It is important to recognise teachers' theoretical knowledge on teaching and how they transform their theoretical knowledge into their instructional practices in the context of a longitudinal study, instead of analysing only their current theoretical knowledge and instructional practices (Korthagen, et al., 2006). Having deeper insights into teachers' theoretical knowledge and the transformation of knowledge into their instructional practices enables a determination of whether their theoretical knowledge is robust and adequate, and also the applicability of this theoretical knowledge. Therefore, we formulate our research question as "How pre-service mathematics teachers' theoretical knowledge is transformed into in-service mathematics teachers' instructional practices?" This study provides insight into the complexity of the transformation of knowledge from pre-service teacher education into use in real classroom settings, based upon observations with three teachers, who had just commenced their careers after being graduating in the same initial teacher education cohort.

Method

Context of the study

In teacher education programs, pre-service teachers usually take the course Teaching Methods after completing mathematics content and pedagogy courses. In Turkey, pre-service secondary school mathematics teachers take mathematics content courses including algebra, geometry, calculus, and analysis, as well as pedagogy courses such as Developmental Psychology, Classroom Management, Approaches and Theories of Teaching and Learning, and Technologies and Material design. After completing these courses, for two semesters they take the course Teaching Methods in Mathematics Education, which consists of a combination of knowledge on mathematics content and pedagogy courses. In the Teaching Methods course, pre-service teachers obtain knowledge about mathematics curriculum and mathematical thinking processes, including abstracting, proving, and representing abstract notions. Pre-service teachers apply constructivist approaches and student-centred activities while designing and implementing a lesson plan, which is the core of this course. Pre-service teachers could form and improve their theoretical teaching knowledge via these courses.

The senior year of teacher education programs often includes experiencing real classroom settings within the scope of School Experience and Teaching Practice courses (practices in internships). Pre-service teachers observe school administration, students and teachers in the public schools according to the schedule of the School Experience course. They conduct a few classroom activities such as using group work and manipulatives. In contrast to the School Experience course, pre-service teachers are active agents in the classroom setting with the guidance of a mathematics teacher in the Teaching Practice course. This course aims to develop the knowledge of pre-service teachers with a holistic perspective. School Experience and Teaching Methods courses (practices in internships) serve as a context through which pre-service teachers can develop their teaching knowledge through practice. They improve their teaching skills and try to orchestrate the classroom while implementing their lesson plans. Pre-service teachers get the opportunity to improve their own knowledge on teaching and to make reflections regarding their own teaching experiences with the help of these courses (Kleickmann et al., 2015; Oliveira & Hannula, 2005).

Participants

We conducted this study with three secondary mathematics teachers, Burcu, Hande and Eda (pseudonyms). Participants (all aged 22 years) graduated from the same five-year teacher education program at the Secondary Mathematics Education department of a public university in Turkey. We began with observing them as pre-service mathematics teachers in the Teaching Methods course. After the course was completed, we selected them as volunteer participants to be part of the project; they were curious, questioning and willing about teaching, and on implementing the new teaching methods that they learnt during the teacher education program. Upon graduation they took a national examination in order to become an in-service teacher, and were assigned to public high

schools in different cities. We believed that they could reflect upon their experiences in the teacher education program, and their instructional practice as in-service mathematics teachers, for the sake of the research question of this study.

Data collection

We initially collected data from the Teaching Methods in mathematics education course, which is taken by pre-service secondary mathematics teachers in the 8th semester (spring semester in the academic year of 2013-2014), the School Experience course, which is taken in the 9th semester of the program (fall semester in the academic year of 2014-2015), and the Teaching Practice course, which is taken in the 10th semester of the program (spring semester in the academic year of 2014-2015). Then we proceeded with retrieving data at the end of their first year of working as an in-service secondary mathematics teacher (fall semester in the academic year of 2016-2017). The data for this longitudinal study was collected through focus group interviews and classroom observations, as well as phone call interviews, which were recorded. Participants taught in the classrooms with neatly aligned rows of desks that include approximately 35 students during their teaching experiences as a pre-service and an in-service secondary mathematics teacher. The whole data collection period took four semesters (Table 1).

Table 1: Data collection period

Teacher education program (pre-service)			Instructional practice (in-service)
Teaching Methods course (sem. 8)	School Experience course (sem. 9)	Teaching Practice course (sem. 10)	
2 focus group interviews 14 weeks of observations	3 focus group interviews 2 observations in the real classroom setting	2 focus group interviews 2 observations in the real classroom setting Documents of lesson plans	3 individual phone call interviews

Two focus group interviews were conducted at the end of the Teaching Methods course. The focus group interviews took approximately 35 minutes and were video recorded. Within the scope of this course, pre-service teachers were separated in two groups to prepare and present a lesson plan in accordance with a certain acquisition included in the mathematics curriculum (MoNE, 2013). In the focus group interviews, we asked the question displayed in Table 2, so as to reveal the experiences the pre-service teachers had during the process of designing a lesson plan. We observed the Teaching Methods course for 14 weeks in order to understand the context, through which pre-service teachers construct their theoretical knowledge and teaching philosophy.

During the School Experience course, the data were collected via three focus group interviews, which were video recorded and lasted for 45 minutes. For the first two focus group interviews, we asked questions to reveal their reflections about their observations.

In the last focus group interview, we asked the question displayed in Table 2. Two real classroom setting observations were conducted while participants in pairs were implementing the activities they had prepared within the scope of the School Experience course.

Table 2: Interview questions

Can you discuss the experiences you had during the process of preparing a lesson plan? (What did you primarily take into consideration as you started to design a lesson such as sources, previous lesson plans, acquisitions, etc. What was the final objective of the lesson you planned: enabling students to obtain acquisitions, using the lesson efficiently, etc.?)

Throughout the Teaching Practice course, data were collected through one focus group interview and two real classroom setting observations, which were video recorded, as well as documents of lesson plans the participants implemented in the classrooms for 12 weeks. In the focus group interview, lasting about 75 minutes, we asked the question displayed in Table 2. Two classroom observations were video recorded while participants were implementing the lesson plan they had prepared within the scope of Teaching Practice course.

Afterwards we conducted three individual phone call interviews, which were recorded, after they have obtained experience as a result of completing their first term as in-service teachers in public high schools. Each phone call interview took about 30 minutes, again asking the questions displayed in Table 2.

Data analysis

We analysed the data in two parts: firstly from focus group interviews and observations in the Teacher education program, in order to reveal participants' knowledge on teaching. We carried out a content analysis, through categorisation of participants' theoretical knowledge on teaching. Data were transcribed and analysed according to Auerbach and Silverstein's (2003) four coding steps, including (i) highlighting relevant text; (ii) gathering repeated ideas; (iii) constructing themes; and (iv) constructing categories. Firstly, data retrieved from the Teaching Methods course (semester 8) were coded. Taking this coding into account, data obtained from the School Experience course (semester 9) were next coded. Then, the data that we obtained from the Teaching Practice course (semester 10) were coded. In the second part, the data that we collected from the instructional practice in the real classroom setting were given. We analysed the data for examining participants' experiences about teaching while they were in-service teachers, in order to reveal their instructional knowledge. We made a descriptive analysis in order to explain participants' instructional knowledge.

Results and discussion

In this section, firstly, participants' knowledge on teaching during Teaching Methods, School Experience and Teaching Practice courses will be discussed. In accordance with teaching knowledge in theory, we will focus on the transformation of theory into practice by examining the experiences of the participants as in-service mathematics teachers.

Teaching knowledge of participants in teacher education program

We have categorised teaching knowledge of the participants in the teacher education program, obtained via Teaching Methods, School Experience and Teaching Practice courses (Table 3). We have coded the data separately for each course and in this section, we have listed the categories emerged from the entire course.

Table 3: Teaching knowledge of participants in teacher education program

(i) enabling students to discover/ to question reasons,
(ii) using group work
(iii) being aware of and using different forms of representation
(iv) having knowledge on the documents to be used in class
(v) being aware of students' prior knowledge
(vi) allowing students to think

Our observations in the Teaching Practice course reveal that the participants carried out the activities that were present in their lesson plans, which aimed at enabling students to discover. Eda prepared an activity in her lesson plan, which had the intention to enable students to discover, is indicated in Figure 1.

As it is seen from the activity, Eda targeted enabling the students to discover the "common ratio" concept in geometrics sequences. She presented this activity to the students and asked to individually work on it. The activity lasted for 10 minutes and she never revealed the answer to the students in the meantime. Instead, she asked questions to make the students think about the core concept, which was the common ratio.

In the interviews and observations conducted in the Teaching Methods course, the participants participated in group work and carried out their activities on a student-centred basis. Hande's explanation excerpted from the interview conducted at the end of the Teaching Methods course is as follows:

> I think the structure of the classroom is very important. If the classroom is suitable, we can use group work and computer-based activities, of course, as we did in the Teaching Methods course. But we don't know, maybe, we couldn't use what we had prepared for the lesson.

Hande declared that they could use the student-centred approaches and group work when they become teachers. She also highlighted her hesitation to implement group work due to the structure of the classroom.

Investigate the terms of given sequences. Find the ratio of successive terms in the table. In which of the sequences above have the ratio (r) between successive terms are constant?

$(a_n) = 2.\left(\frac{3}{5}\right)^n = (\frac{6}{5}, \frac{18}{25}, \frac{54}{125}, \frac{162}{625}, \dots, 2.\left(\frac{3}{5}\right)^n, \dots)$	$\frac{a_2}{a_1}$	$\frac{a_3}{a_2}$	$\frac{a_4}{a_3}$	...	$\frac{a_{n+1}}{a_n}$
$(b_n) = \left(\frac{1}{2}\right)^{n-1} = (1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \dots, \left(\frac{1}{2}\right)^{n-1}, \dots)$	$\frac{b_2}{b_1}$	$\frac{b_3}{b_2}$	$\frac{b_4}{b_3}$	...	$\frac{b_{n+1}}{b_n}$
$(c_n) = (n^2) = (1, 4, 9, 16, \dots, n^2, \dots)$	$\frac{c_2}{c_1}$	$\frac{c_3}{c_2}$	$\frac{c_4}{c_3}$	...	$\frac{c_{n+1}}{c_n}$

Figure 1: The activity prepared by Eda

In the School Experience course, we observed that the participants were aware of different types of representations of the mathematical concepts and tried to use them. Burcu's explanation about this situation, excerpted from the focus group interview, is as follows:

> I believe they have trouble with verbally expressing mathematical statements or mathematically writing what is verbally written, because a student told me during the lesson, "Although, I have verbal skills, I actually love mathematics." Afterwards, the student wrote that if the areas of these triangles are equal, then the area of ABC is equal to that of BCD. The student wrote a verbal sentence, in which he/she stated that the areas of triangles are equal. I told him/her "no, we indicated above that their areas are equal and I want you to write them in equations by using mathematical statements", he/she asked me how and told me "I am already [verbally] writing that they are equal".

Burcu mentioned that the student was unable to use algebraic mathematical symbols and terms. She realised that the student tried to express them verbally. It could be argued that she emphasised the necessity for teachers to correctly and consistently use mathematical symbols and terms.

In the observations conducted in the Teaching Practice course, the participants provided information regarding the documents they could use in class, such as material design, study papers, everyday life problems, modelling, and portfolio. For instance, Eda enabled students to question the relation between rabbits breeding and Fibonacci sequence by using the everyday-life examples she had provided in her lesson plan (Figure 2).

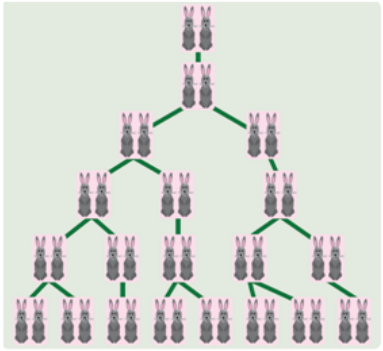	Step 1: The picture on the left shows rabbits breeding by months. Let two rabbits represent a pair of rabbits (a boy and a girl) and each line represents a month. Then find how many pairs of rabbits we have at the end of each month.	Step2: Find the relation between the pairs of rabbits in each month and the pairs of rabbits breeding in the previous month. According to this relation, find how many pairs of rabbits we have at the end of one year.

Figure 2: An example on everyday-life used in the lesson plan

The participants stated that being aware of students' prior content knowledge is a key point in preparing activities for the lesson plan. They especially emphasised this point in the focus group interview conducted at the end of the Teaching Practice course. For instance, Hande stated that "different classes could have different prior content knowledge and I mean for the same subject, we have to think different activities for different classrooms". It means that the participants were able to arrange the activities by taking students' cognitive levels into account.

The participants indicated that allowing students to think in classroom is also significant. For example, Burcu's explanation on why it is necessary and important to allow students to think, in the second focus group interview of the School Experience course is, as follows:

> If the students did not understand, I would grab their attention to the lesson. After asking the question, I would wait for their answers, of course. I would provide guide them by saying "remember what we have done in the previous problem, was it this way?" I would definitely ask questions until they have answered the question by understanding the situation.

Burcu stated that if students did not understand something in the lesson, she would try to grab the attention of the students. Thus, it could be said that Burcu stresses the significance of students' thinking and understandings in the classroom context.

Transformation of knowledge from pre-service to in-service teaching experience

The participants' reflections about knowledge of teaching are included in this section within the context of lesson plans during their experiences as pre-service and in-service mathematics teachers. We discuss the transformation of theory into the practice by examining the experiences of the participants throughout their process of becoming in-service mathematics teachers.

The participants had assumed the constructivist and student-centred approaches to teaching were applicable in classroom, before they applied them in School Experience and Teaching Practice courses. However, they stated that they came across issues, which they did not take into account beforehand, when they applied the activities in classroom as pre-service gteachers. These issues include (i) deficiencies in students' readiness; (ii) inconvenient time planning; and (iii) intensity of mathematical content. The focus group interviews conducted after Teaching Methods course indicated that the participants stressed the necessity to implement the lesson plans, which are prepared through constructivist perspectives, in the real classroom setting when they become in-service teachers. Although Eda, Hande and Burcu, who supported applying constructivist approaches on teaching during their undergraduate education, indicated that they could not implement student-centred activities during their first year of teaching. The reasons why they could not implement constructivist approaches to instruction in the classroom could be as follows: (i) crowded classrooms, making it specifically hard to apply group work; (ii) the intensity of mathematical content; and (iii) deficiencies in students' readiness. We found out about these reasons, which include "intensity of mathematical content" and "deficiencies in students' readiness", while the participants were having their experiences as pre-service teachers. Eda explained why she was unable to implement constructivist approaches in her classroom as an in-service teacher:

> There are students who could not even do addition operation, thus it is really tough to apply activities that we learned during our pre-service training [...] I tried to do student-centred activities in the classroom but students had not been instructed through a constructivist approach before. I tried to catch up with the curriculum while implementing student-centred activities at the same time. I realised that I could not do both of them, so I preferred to proceed with direct instruction in order to implement all the acquisitions in curriculum.

Eda declared that she could not apply constructivist approaches in the lessons due to the cognitive level of her students and the fact that they were not used to student-centred activities. She also emphasised shortage of time for acquisitions in the curriculum.

One of the reasons why they were unable to implement constructivist approaches may be the deficiencies in the readiness of students. The participants stated that it is important to design lesson plans according to students' readiness in the early years of their teaching. Burcu stated:

> While designing lesson plans, we should take students' readiness into account. Students' motivation in mathematics lessons is low because their success at mathematics is low. That's why I should remind students of what we did in the previous lesson. After doing so, motivation of students increases.

As an in-service teacher, Burcu discovered a connection between success level and students' motivation. Burcu also emphasised that since students did not aim at going to university, they did not display interest in mathematics lessons, thus she had to instruct the lessons by employing teacher-centred approaches. Her explanation was:

> The main goal of the students is passing the mathematics lesson; they are not interested in the lesson. I always warn them to be silent and not to talk to each other, but I could not make them participate in the class. Because of that, my lessons have been teacher-centred, even though I do not favour it at all. Besides, students do not aim to go to university.

Eda, Hande, and Burcu clearly indicated the differences between their thoughts after the Teaching Methods course and their practice in internships. The participants seemed to be quite eager to apply student-centred activities when they became teachers, in all of the interviews, except for the last interview conducted while they were still pre-service teachers. After the practice they experienced during their internships, the participants mentioned that such activities may not be convenient in every classroom. In this respect, participants stated that they could not apply group work in their classrooms as an in-service teacher. Eda explained her idea by making the following statement:

> Since it was too crowded, I could not implement student-centred activities in my classroom. I did not apply group work in my classes either, because groups would be too crowded, which would make it difficult to deal with all students, besides success level of students was very low.

Eda stated the importance of enabling students to discover and question reasons during the pre-service teacher education. Furthermore, she indicated that it is difficult to implement activities which make students question and discover, as an in-service mathematics teacher:

> I tried to enable the students to start questioning, but they were not willing to do so. For example, once I asked them why exponent of a number is zero. They all said that it was a rule. I wanted to discuss the reasons behind this rule but students did not want to. It did not grab the attention of the students.

Eda indicated that she were unable to design her lesson by using student-centred and constructivist activities as she did in her pre-service teacher training. But she explained that she was able to use some parts of what she learned during her pre-service teacher education, by saying:

> For example, I asked the students to pick a parabola in their environment, after taking a photograph; they tried to locate it on the coordinate system. Other teachers ask students to solve 300 or 500 problems to count for a project; at least I did not do that. I generally give them projects, which involve real life problems.

The participants' knowledge of teaching and views on its implementation after their in-service experience displayed significant changes from those they had during their pre-service teacher education. However, through the experiences they had in the School Experience and the Teaching Practice courses, the participants realised that the classroom setting they idealised after taking the Teaching Methods course did not correspond to the real classroom setting. Thus it is possible to say that although pre-service teachers are quite eager to apply student-centred activities and constructivist approaches, they still question the circumstances under which those activities could be applied in real-life

classroom settings. However, when they became in-service teachers, Eda, Burcu and Hande could not use constructivist approaches and student-centred activities, which they were initially willing to apply. Burcu specified that:

> Here it is really tough to implement student-centred activities [in a real classroom setting] which we learn during our pre-service teacher education. At least we could use them [the constructivist approaches] during our School Experience and Teaching Practice courses.

Eda, Burcu, and Hande identified the main reasons why they were unable to use constructivist approaches as (i) crowded classrooms; (ii) the deficiencies in readiness of students; (iii) low cognitive level of students; and (iv) the intensity of mathematical content in the curriculum.

Discussion and conclusion

In this study, we aimed to reveal the transformation of pre-service mathematics teachers' theoretical knowledge into in-service mathematics teachers' instructional practice. This study provides a significant insight into the transformation of knowledge through three phases: (i) theoretical knowledge (pre-service teacher education); (ii) practices in internships (pre-service teacher education); and (iii) real classroom settings (in-service experience). The participants were eager and self-motivated to apply constructivist approaches and student-centred activities which they had learned during their pre-service teacher education. They experienced real classroom settings through the internships they had during their undergraduate education. They have continued to use student-centred approaches, and their self-motivation has been still present.

However, despite their rigorous knowledge on teaching and motivation, their realisation on practice has changed due to the experiences they had through their internships. They recognised that they needed to adapt student-centred activities according to their students and classroom circumstances, when they became in-service teachers. The participants realised the difficulties of implementing student-centred approaches when they experienced real classroom settings during their internships. They listed the challenges they came across with as (i) crowded classrooms; (ii) deficiencies in the readiness of students; and (iii) inconvenient time planning while applying student-centred activities. The participants indicated the challenges about practising student-centred approaches after obtaining field experience as a mathematics teacher in a public high school. Even although they had a rigorous knowledge of teaching and motivation to convey their knowledge into real classroom setting, they still declared the inconvenience of applying such activities in their classroom. They summarised the challenges of conveying their knowledge into real classroom setting as (i) crowded classrooms; (ii) deficiencies in the readiness of students; (iii) low cognitive level of students; and (iv) the intensity of mathematical content in the curriculum.

These results show that mathematics teachers encounter certain challenges while transforming their theoretical knowledge into practice in real classroom settings. This illustrates a gap between theory and practice that is a continual issue in teacher education,

as discussed by Ball (2000) and Korthagen et al. (2001). Although teachers have a rigorous education in terms of new theories, teaching strategies, and tools related to mathematics education during their pre-service education, they still experience problems with applying strategies, which they have learned during their teacher education, to the real classroom setting during the first years of their profession. This result is consistent with the literature (Allen, 2009; Cole & Knowles, 1993; Feiman-Nemsera & Parker, 1990; Zeichner & Tabachnick, 1981). The reasons why these problems are observed during the first years of teaching may be due to (i) the lack of context-specific learning environments on teaching during pre-service teacher education; (ii) having an inadequate level of experience in terms of modifying teaching strategies according to their classroom; and (iii) adjusting practices in the schools, they could not focus on their knowledge of teaching (Korthagen et al., 2001). Besides, if teachers do not have support from other teachers in the school, they may have challenges while using their theoretical knowledge in their instructional practices (Allen, 2009).

The role and influence of the cultural pedagogy within the schools where the participants worked has importance. If a participant worked in a school that did not encourage student-centred learning then it would be very difficult for them to adopt approaches to teaching that may not be approved by their colleagues. Teachers tend to use direct instruction during their first years of working as an in-service teacher, similar to the education they received as students in their K-12 mathematics classrooms; (Lannin et al, 2013) emphasised that such knowledge must be obtained through teacher education programs, professional development, and teaching experiences in school instead of teachers' own K-12 experiences. In structuring teacher education programs, taking into consideration the problems faced by teachers during their first years of working as an in-service teacher is crucial (Ball & Bass, 2002).

We investigated problematic issues in teachers' transformation of knowledge from pre-service teacher education to real classroom settings. Utilising "mathematical practices as a component of mathematical knowledge" plays a fundamental role in teacher education programs (Ball & Bass, 2002). Thus, teacher education programs should consider teaching as a practice that is based on professions and provide a more contextual education (Korthagen, et al., 2006; Yazgan-Sağ, et al., 2016). This can be actualised by (i) introducing pre-service teachers to different learning situations by using scenarios and teaching situations in classroom (Yazgan-Sağ, et al., 2016); (ii) spending more time in schools in order to gain more experience during internships; and (iii) changing the structure of internships in schools during teacher preparation. Supporting teachers during their first years of teaching experience will help them to transform their knowledge into practice. More longitudinal studies could be conducted on teachers' experiences from their teacher preparation to in-service, to help attain more fruitful teacher education programs. For instance, observing teachers in real classroom settings after they have graduated from their teacher training programs could give significant insights into evaluating teacher education programs. Carrying out longitudinal research that analyses teachers' knowledge of teaching and its implementation in schools, three or four years after their graduation may develop a fundamental contribution to the literature.

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