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An exploration of the gap between theory and practice in online field experience in mathematics teaching

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ABSTRACT Past research has growingly shown importance of teacher candidates' ability to connect theory and practice for applying what they have acquired in coursework into practice. This study examined 23 mathematics teacher candidates' (TCs) ability to link coursework and online mathematics teaching field experiences in a mathematics teacher education program. Data included transcripts of 24 videotaped lesson plan meetings before the TCs' online teaching for one semester and transcripts of 9 videotaped whole group discussions after the TCs' online teaching in the Online Laboratory School. Data also included TCs' short reflections written immediately after online teaching based on interesting and significant moments in their teaching. The results indicated that TCs often struggled to make connections between theory and practice, suggesting the need for teacher educators to offer more coursework integration opportunities in their assignments of mathematics teaching field experiences. This study, utilizing multiple data sources such as instructors' goals, TCs' reflections, lesson plans, and whole-group meetings, provides valuable qualitative evidence that may help bridge the existing gap in this area of educational research.

Keywords: *Mathematics teaching, Online field experience, Teacher education, Theory and practice, University-school partnership*

Çevrim-içi matematik öğretimi alan deneyiminde teori ve pratik arasındaki mesafe üzerine bir inceleme

ÖZ Geçmiş çalışmalar, öğretmen adaylarının teori ve pratiği birleştirme becerisinin, derste öğrendiklerini pratiğe dökebilmek için artan öneminden bahsetmektedir. Bu çalışma, 23 matematik öğretmenliği adayının bir matematik öğretmen eğitimi programındaki ders ve çevrim-içi matematik öğretimi alan deneyimlerini birleştirme becerisini incelemiştir. Bu çalışmanın verisini, öğretmen adaylarının bir dönem boyu süren çevrim-içi ders verme deneyiminden önce gerçekleşen 24 video-kayıtlı ders planlama toplantısının transkripleri ve Çevrim-içi Laboratuar Okulu'ndaki çevrim-içi ders anlatımlarından sonra gerçekleşen 9 video-kayıtlı tüm sınıfın dahil olduğu tartışma toplantılarının transkripleri kapsamaktadır. Ayrıca, bu çalışmanın verisini öğretmen adaylarının çevrim-içi ders anlatımlarından sonra ders anlatımlarındaki ilginç ve önemli buldukları durumlar üzerine yazdıkları kısa notları da içermektedir. Sonuçlar, öğretmen adaylarının sıklıkla teori ve pratik arasındaki bağlantıları kurmakta zorlandıklarını göstermekte ve öğretmen eğitimcilerinin matematik öğretimi alan deneyimleri ödevlerinde daha fazla ders entegrasyon fırsatlarını kullanmasını önermektedir. Ders öğretim üyelerinin amaçları, öğretmen adaylarının düşünümleri, ders planları ve tüm sınıfın dahil olduğu tartışma toplantıları gibi birden fazla veri kaynaklarını kullanan bu çalışma, eğitim araştırması alanındaki var olan mesafenin kapanması için değerli bir nitel kanıt sunmaktadır.

Anahtar Sözcükler: *Çevrim-içi alan deneyimi, Matematik öğretimi, Öğretmen eğitimi, Teori ve pratik, Üniversite-okul iş birliği*

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INTRODUCTION

Theory in education is defined as a field of study that examines how people learn, how people apply what they have learned, and how to improve the efficiency and effectiveness of educational programs. Theories help educators to explain the learning process accompanied by pedagogical approaches, curricula, and assessments (Lockey et al., 2021; Resch & Schrittesser, 2023). Field experiences are a critical link between the theory of teaching and learning and the theory of practice. Field experiences in teacher education refer to the activities and experiences that take place in a K-12 school setting (practicum school), where teacher candidates are supervised by mentor teachers and university teacher educators. These experiences demand complex interactions among the learning environment, teachers, students, and curriculum features (Darling-Hammond, 2006a, 2006b; Guler & Celik, 2022). Theory plays a crucial role in teacher education programs worldwide. The mission of these programs is to graduate competent teacher candidates who possess knowledge of content and curriculum, teaching skills, positive attitudes towards teaching and students, and the ability to serve as role models for students (Helleve et al., 2021). In addition, a considerable amount of literature emphasizes the importance (Kvam et al., 2023) of teacher candidates being able to bridge the gap between theory and practice. This indicates that teacher candidates are expected to apply what they have learned in their coursework to their field experiences. In our study, theoretical knowledge refers to mathematics teacher candidates' (TCs) mathematics education coursework, while field experience pertains to their mathematics teaching experiences in an Online Laboratory School.

In accordance with the Council of Higher Education (CoHE, 2017), our mathematics teacher education program in Türkiye distributes freshman year courses as 20% theoretical knowledge and 0% field experience, sophomore year courses as 39% theoretical knowledge and 0% field experience, junior year courses as 73% theoretical knowledge and 18% field experience, and senior year courses as 12.5% theoretical knowledge and 25% field experience (Elementary Mathematics Education Curriculum, 2023). Although the percentages of theoretical knowledge per grade level in the curriculum are known, it is difficult to determine how theoretical knowledge in teacher education programs translates to field experience. An ongoing issue with enactment (Allsopp et al., 2006; Helleve et al., 2021) is that teacher candidates do not always apply what they have learned (Hirshberg et al., 2020).

To address the issue of enactment, university-school partnerships are crucial. These partnerships provide teacher candidates with the opportunity to apply reflective practice in practicum schools and learn how to organize their actions based on instructional theories and teaching methodologies acquired at the university (Allsopp et al., 2006; Helleve et al., 2021). Reflective practice is the process of critically examining one's own actions and adopting a critical point of view towards one's own and others' practices. This results in a constant process of adaptation and learning, as defined by Cavanagh and Prescott (2010).

University-School Partnerships in Teacher Education

University-school partnership models are considered as a requirement in teacher education (Grinshtain et al., 2024; Lavonen et al., 2019) because universities could support teacher candidates' practice in the practicum schools. During their practicum, teacher candidates have the chance to reflect on their experiences and connect them to the theoretical knowledge gained in their coursework. Despite the emphasis on connecting theory and practice in teacher education programs, teacher candidates could still face challenges in the school environment (Resch & Schrittesser, 2023). This is because universities tend to promote a theoretical approach to the teaching profession, while schools tend to value practical experience without opportunities for reflection (Grossman et al., 2009). For instance, there exists approximately 90 universities in Türkiye, which prioritize the delivery of theoretical knowledge (Özcan, 2013). Conversely, third space teacher education programs, like the one where this study was conducted, establish closer relationships between universities and schools, emphasizing equal partnership in teacher education (Trepper et al., 2023). Within the scope of these programs, teacher candidates are required to allocate a significant amount of time to internships at selected practicum schools.

This study investigates the connection between theory and practice in the context of University within School (UwS), a third space teacher education program implemented in Türkiye since 2014 (Özcan, 2013). The aim is to bridge the gap between theory and practice and improve the quality of teacher education programs. In the UwS, teacher education programs typically span four years. The first two years are primarily focused on theoretical knowledge through coursework, while the remaining two years are dedicated to K-12 field experiences (Daza et al., 2021).

Internship programs based on university-school partnerships have been implemented in various countries, including the USA (Ünver, 2014), North Europe (Jenset et al., 2018), and Australia (Sharma et al., 2021). The UwS program, which was one of the first attempts in Türkiye (Özcan, 2013), was executed online during the COVID-19 pandemic to provide internship experience (Taylan et al., 2022; Tunç-Pekkan & Taylan, 2022). Therefore, it is critical to conduct studies that demonstrate the extent to which teacher candidates can connect theory and practice, especially in programs that are based on this principle. To address this significant gap, we aim to explore the extent TCs were able to make connections between the theoretical knowledge related to the courses they have completed so far and its application evident in their reflections during online mathematics teaching field experiences. The research question of the present study is as follows:

How do TCs connect theory (coursework hereafter) and practice during online field experiences at an Online Laboratory School in the UwS context?

John Dewey's Reflections on Early Practice as a Way of Bridging the Gap

Teacher candidates in field experiences have struggled to make effective and confident transitions between coursework and field experiences (Zhang et al., 2023). Field experiences are based on the work of Dewey (1916), who stated that learning by doing is crucial to teacher candidates' teaching experience. By transforming theory into practice in education, Dewey (1904) conceptualized a gap between university and industry and emphasized how coursework learned in teacher education programs could be exemplified in field experiences in schools. Dewey (1938) believed that true learning in teaching experience occurs while teacher candidates are actively engaged in their own learning experiences. For example, teacher candidates can practice designing a lesson plan according to the teaching method, asking critical questions to K-12 students, preparing teaching materials, and using theoretical references in their lesson plans. They learn how to be socially responsible, watch, listen, observe their mentor teachers, and study and reflect on their field experiences (Lafferty, 2018). Although conventional wisdom considers university teacher educators as the only authority to teach how to be a professional teacher and provide teacher candidates with mainly theoretical perspectives, university-school partnerships consider mentor teachers (i.e., in-service teachers in K-12 school settings) as another authority to train teacher candidates in terms of theoretical knowledge and field experiences.

Previous studies have consistently emphasized the importance of Dewey's suggestions in teacher education within university-school partnership models. Most existing studies (e.g., Cross & Bayazit, 2014; Lafferty, 2018) have examined the extent to which university-school partnership models can connect teacher candidates' theoretical knowledge with their reflections in field experiences. One way to approach this connection is through teacher candidates' reflections on planning and teaching in the practicum schools. While existing studies have generally relied on surveys or single data sources, the present study relied on multiple data sources, including videotaped whole group meetings and lesson planning sessions. The current study differs from these studies in the sense that we examined TCs' ability to connect theoretical knowledge and field experience more deeply by looking at their reflections on lesson planning and reflection on teaching as a group, in addition to individual reflections on their own teaching. We analyzed the experiences of TCs while they were practicing in the Online Laboratory School (OLS), in their natural environment for an online internship.

In order to address the importance of teaching as a professional and complex work, the studies conducted by Grossman and her colleagues (2009) highlight the relationship between the teaching profession and

teacher education by decomposing the practice of teaching and providing a theoretical framework to measure novice teachers' teaching practices and sources of their knowledge such as training, subject matter, and teaching experience. Our conceptual framework in the present study was based on Grossman et al.'s (2009) designation of core practices by attributing our TCs as reflective practitioners. We look for evidence of theoretical knowledge in the core practices of teaching; in other words, how TCs learn and reflect on the core practices and reconstruct their own knowledge about teaching and learning as in their online mathematics teaching field experiences.

Importance of the Study

Investigating teacher candidates' ability to make the connections between coursework and practice in teacher education that relies on university-school partnerships is a global phenomenon (Allsopp et al., 2006; Jenset et al., 2018; White et al., 2022). Previous studies have used quantitative and qualitative methods and discussed the experiences before and after adopting a university-school partnership (e.g., Allsopp et al., 2006; Canlıer et al., 2020; Cross & Bayazit, 2014). Some systematic review studies on university-school partnerships (e.g., Green et al., 2019; Sarmiento-Marquez et al., 2023) also gathered common results on the efficiency of such partnerships according to teaching and learning practices, types of evaluation, methodological aspects, and particular or local contexts. For example, while the ideas of Green et al. (2019) were based on reviews mainly in the Australian context, the ideas of Lawson et al. (2015) reflected international contexts. These studies often focused on teacher candidates' perspectives on their efficacy, beliefs and experiences, and challenges during field experiences. They mostly used qualitative research design and analyzed interviews, reflective journals, and observations (Sarmiento-Marquez et al., 2023). The review studies showed that some outcomes discussed the development of teaching skills, the role of teacher educators, the quality of practicum, and technology support, but only one discussed the outcomes related to the connection between theoretical knowledge and field experience (Woo et al., 2023). This indicates a lack of understanding of the connections between teacher candidates' coursework and their practice during online field experiences and more studies are needed to examine such connections. Furthermore, to our knowledge, no studies have examined the connections between coursework and practice using multiple data sources, including instructors' goals in their courses, teacher candidates' reflections on the connections between coursework and practice, and lesson plans and reflections on their implementation of lessons. Given the recent proliferation of online classes and practicums due to advances in technology and the limitations of the COVID-19 pandemic (Carrillo & Flores, 2020; Luke et al., 2023; Page & Jones, 2018), the present study is promising to help fill this gap by providing in-depth qualitative evidence from TCs' written reflections as well as their lesson plans and whole-group meetings.

METHOD

We used qualitative research methods (Fraenkel et al., 2015), specifically content analysis, to uncover TCs' ability to make connections between theoretical knowledge related to their courses and mathematics teaching practice during their online field experiences. As a precursor to the research process, the supporting data consists of the Instructors' Course Objectives Survey (ICOS), which was designed for instructors (see Appendix 1). The main data consists of videotaped lesson planning meetings and whole group reflection meetings in which TCs and supervisors participated to share their online mathematics teaching experiences, as well as TCs' short written reflections after TCs had implemented their planned lessons.

Research Context

In 2020, due to the COVID-19 pandemic, face-to-face internships were not possible as K-12 schools were closed in Türkiye (CoHE, 2020). An OLS at a foundation university in Türkiye was founded in Spring 2020 for TCs so that they could continue their field experience without interruption (Taylan et

al., 2022; Tunç-Pekkan & Taylan, 2022). The OLS aimed to provide free mathematics courses for hundreds of low socio-economic status (SES) middle school students and online mathematics teaching field experience opportunities for TCs (Taylan et al., 2022; Tunç-Pekkan & Taylan, 2022). We aimed to move our system toward equity to support all learners (Ladson-Billings, 2021) including TCs and low SES students.

Instructors in our mathematics teacher education program offered theoretical and field-based courses. In this context "instructor" refers to teacher educators who teach education-related courses designed to develop TCs' theoretical knowledge in the 4-year teacher education program. We developed the ICOS (Appendix 1) and asked eleven instructors who taught education-related courses in the teacher education program to complete this survey. We evaluated a total of fifteen mathematics education and educational science courses that were part of the teacher education program: a) The instructor reviewed the course learning outcomes and then rated the extent to which they thought they were able to achieve the learning outcomes at the end of the semester (1: Low, 2: Medium, 3: High). Based on the descriptive statistics for the ICOS data, the instructors believed that they were able to achieve course learning outcomes at the end of the semester in "2: Medium" (58.62% of the rankings) and "3: High" (41.38% of the rankings). Thus, according to the instructors, they achieved course learning outcomes at least at a medium level (e.g., Ertmer & Newby, 2013; Herbel-Eisenmann & Breyfogle, 2005; Piaget, 1952). The ICOS data helped us gain insight into the extent to which the course objectives in our teacher education program were achieved, according to the instructors.

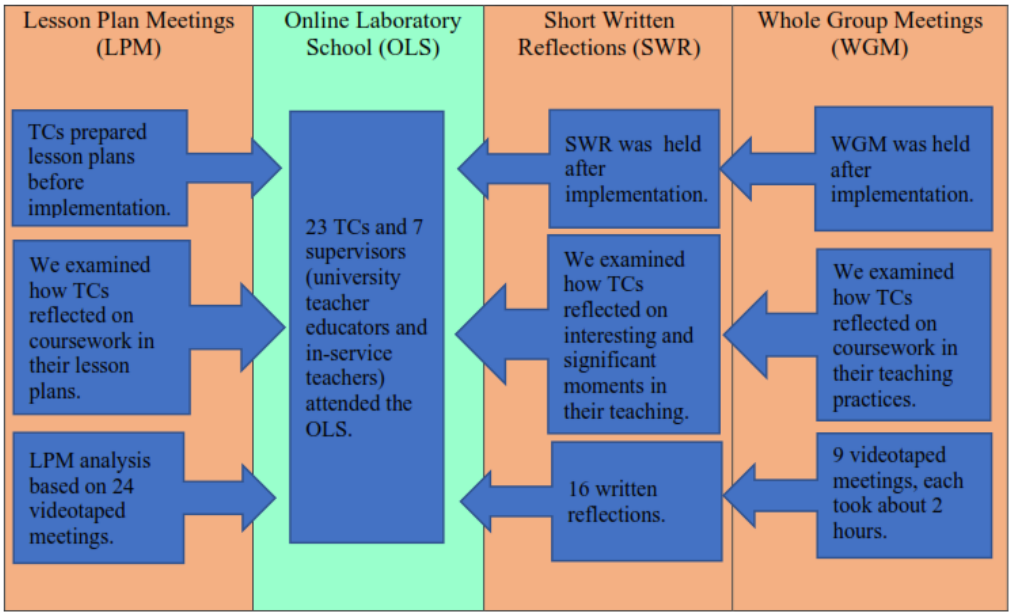
Ethics committee approval was received for this study from MEF University Ethics Committee [Ethics' Document Number: E-47749665-050.01.04-2771, 26.07.2022].

Participants and Setting for the Study

The participants in this study were 23 middle school TCs (22 females and 1 male) and seven supervisors including university teacher educators and in-service mathematics teachers in our mathematics teacher education program. During data collection in the Fall of 2020, the TCs completed online internships at their assigned practicum schools and spent one day at the OLS. Of the 23 TCs, 13 were juniors who completed internships two full days per week, and 10 were seniors who completed internships three full days per week at their practicum schools and the OLS together. The role of the supervisors at the OLS was to guide the TCs in preparing lesson plans, observing their teaching, and providing feedback. While juniors had already completed their first-year and second-year courses, they were taking field-based (i.e., methods) courses on teaching mathematics in Fall 2020. Seniors, on the other hand, had finished most of the coursework on both theoretical and field-based courses and were allocating more time to internships.

A total of 24 lesson plans have been cooperatively prepared by the TCs and the supervisors. Each senior TC prepared a total of 4 lesson plans together with juniors and taught a total of 8 lessons for middle school students, each lasting 40 minutes. The mathematics content included whole numbers, fractions, and geometry. Figure 1 describes the whole process from data collection to data analysis including data sources in the OLS such as lesson plan meetings, whole group meetings, and short written reflections. While lesson plan meetings took place before TCs' online teaching, whole group meetings and short written reflections took place after their online teaching.

Figure 1.
Research Design and Data Sources



Data Collection

To explore the extent that TCs were able to make connections between theoretical knowledge related to their coursework and online mathematics teaching field experience, data sources were as follows:

Lesson Plan Meetings (LPM)

Twenty-four LPMs were held to bring 23 TCs and supervisors together to study the weekly lesson plans before online teaching took place in the OLS. The purpose of LPM was to facilitate collaboration between TCs and supervisors as they studied the weekly lesson plans together and prepared them for TCs to teach in OLS. During the LPM, discussions focused on how to prepare the mathematics lesson plan, analyzing the learning outcomes determined in line with the national mathematics curriculum (Ministry of National Education [MoNE], 2018), sharing and/or suggesting relevant references, and providing feedback on instructional design and assessment. Each meeting lasted approximately two hours and was videotaped. We used the LPM data to examine whether the TCs could reflect the theoretical knowledge in the lesson plans and use their reflective practice by relating to the coursework learned in the teacher education program.

Short Written Reflections (SWR)

SWR were the brief documents that TCs wrote immediately after their online mathematics teaching in the OLS. There were 104 entries over eight weeks (see Table 1 as examples of SWR). In these reflections, TCs reflected on interesting and significant moments in their teaching in terms of students' mathematical thinking, mathematical content, instructional design, assessment, and classroom management. This assignment was not graded. What was written in each of the SWR became a guide for supervisors to lead the whole-group meetings. TCs also answered the following two guiding questions for each of the SWR: "How do you connect your teaching experience in the OLS to the courses you have completed so far in your program?" and "What course content/theories helped you during online teaching, and how?"

Whole-Group Meetings (WGM)

WGM were the meetings where TCs and supervisors came together to evaluate and reflect on the daily online mathematics teaching after the teaching took place. There was a total of 9 videotaped meetings, each lasting about 2 hours. All supervisors and TCs attended WGM to discuss TCs' teaching experience in different online classrooms and their reflections on the extent to which their teaching aligned well with their lesson plans in the OLS. Each supervisor took turns to lead the meetings each week and was responsible for welcoming TCs, informing them about the objectives of the particular meeting, and asking probing questions based on TCs' reflections regarding their online mathematics teaching. The weekly leader reviewed what was written in the SWR and asked TCs to draw attention to the points they felt were important during online teaching. During these meetings, we also explored to what extent TCs could make connections between theories that they had learned so far in their theoretical and field-based courses and their online mathematics teaching. Specifically, we asked each TC in these meetings to discuss their daily online mathematics teaching, students' mathematical thinking, questioning styles, and to reflect on their strengths and weaknesses regarding their teaching. We used the WGM data to examine the extent to which the TCs were able to apply the theoretical knowledge they learned in our mathematics teacher education program based on their reflections in a whole group setting.

Data Analysis

We used content analysis to analyze the written documents, including SWR and verbatim transcriptions of the videotaped sessions of LPM and WGM, "as a technique to study teacher candidates' noticing and reflection in an indirect way, through an analysis of their communications" (Fraenkel et al., 2015, p. 478). The unit of analysis was a comment indicating each of the TCs' connection between a course-related topic, an experience, and one or more instances in the field experience (Allsopp et al., 2006).

Coding categories of each data source including LPM, SWR, and WGM are presented as a table in Appendix 2 with specific examples of connections between the particular coursework and mathematics teaching field experience. Specifically, we analyzed these data sources to explore what TCs focused on and the extent to which they were able to make connections between coursework and their mathematics teaching practice. The theoretical references (e.g., foundations of theories, books, articles) that TCs mentioned in their lesson plans were also linked to courses offered by faculty in the teacher education program. As in Appendix 2, each connection that TCs made between coursework and practice based on the transcriptions of the videotapes was coded as a tally and linked to a course. For example, in one of WGM, when a junior said that "The first weeks in OLS were for meetings. Classroom norms were mentioned in those weeks," we linked the phrase "classroom rules" to the Classroom Management course in our teacher education program. The unit of analysis was not explicitly naming the course but making theoretical knowledge connection to the course content and assessing its frequency. Similarly, in one of LPM, when a junior said, "When TCs prepare a lesson plan for geometry, they may prepare it in accordance with student thinking and teacher instructions taught in the ELE 208 lesson [Foundations of Teaching Geometry, Probability and Statistics course]," we linked this explanation to the particular course because she seems aware of the connections between the course and her possible lesson plan. Similarly, when a senior wrote in his one of SWR that ".... The Geoboard activity was implemented at the last minute of the lesson. Only two students participated, and we did not know what other students understood," we linked this reflection to the particular course (i.e., Instructional Technology and Materials Design course) because TCs have learned practicing Geoboard in this course and using this tool was encouraged in field-based courses.

Regarding the extent to which we interpreted TCs' reflections during LPM, SWR, and WGM as connected to their coursework, we paid attention to the details and what they were referring to. For example, in one of SWR, a senior wrote that:

> *"Another point that caught my attention was a student's response 'We equate the denominators to the least common multiple' while adding the fractions 1/4 and 1/3, because I think it is a nice detail that he has this prior knowledge in 5th grade and realizes it".*

In this example, the TC appears to connect what she learned in the course (Foundations of Teaching Numbers, Operations, and Algebra course) based on what students are expected to learn in the curriculum with order and connected this theoretical knowledge to the specific mathematics teaching practice. Thus, we evaluated such examples as evidence of connections between coursework and practice. On the other hand, we interpreted reflections such as the following as lack of connections between coursework and practice due to missing details:

> *"Because of the learning outcomes, the intensity of the lesson plan changed the flow of the lesson a lot. I think it would have been a more productive lesson if we had made the plan with a lower number of learning outcomes".*

Initially, two authors (First author and third author) coded a small portion of each data source, and they reached 89.9% of consistency overall in terms of the coding categories. Discrepancies were resolved and all data were coded. An expert in mathematics teacher education reviewed the coding categories in Appendix 2 and confirmed that the coding categories adequately represented the connections between coursework and online mathematics teaching practice.

RESULTS

Results on LPM

Analysis of the LPM data and TCs' lesson plans showed that TCs mostly included theoretical references such as foundations of theories, book and article information in their lesson plans. However, some TCs mentioned that the discussions about preparing lesson plans were generally related to students' possible misconceptions and the flow of the lesson plans. Three TCs expressed that when they watched their own teaching videos as part of the course assignment in the field-based course named Methods of Teaching Mathematics and Classroom Management, they were able to link them to the articles assigned in the course (i.e., Herbel-Eisenmann & Breyfogle, 2005, mentioning questioning skills). On the other hand, none of the TCs demonstrated sufficient connections between the courses they had completed so far, such as Introduction to Education (see Appendix 2), and their lesson plans. For example, a junior seemed to be aware of her weakness in making connections between coursework and practice as follows:

> *"In preparing a lesson plan, there is no specific connection from the theories. However, in courses such as ELE 302 [Internship II] -ELE 304 [Methods of Teaching Mathematics II] -ELE 301 [Internship I] -ELE 303 [Methods of Teaching Mathematics I], we watch our own course recordings [video recordings] and link them to the articles we read in these courses. We determine the types of questions (e.g., funneling and focusing) that we use after watching the course recording according to the articles we read."*

Results on SWR

Analysis of SWR showed that only four TCs out of 23 TCs made connections between coursework and practice. The remaining 19 TCs did not explicitly refer to their coursework in their reflections despite asking them to respond how they could connect their teaching experience in the OLS to the courses they have completed so far in our program and what course content or theories they think helped them during online teaching. Their explanations were mostly related to their teaching practice for that day and how they responded to students' questions and managed the online classroom. This indicates that the majority of the TCs in the present study struggled to make connections between their coursework and their mathematics teaching practice.

On the other hand, those four TCs who could make the connections generally reflected on students' misconceptions, mathematical thinking, questioning styles, online tools, teaching methods, classroom, and time management. These connections appeared to be related to coursework based on particular courses such as Methods of Teaching Mathematics, Instructional Technology and Materials Design, and Classroom Management (see Appendix 2 for more details).

Table 1 presents examples of TCs' SWR that connected their coursework to their mathematics teaching practice. As one example, a senior expressed the connection between her coursework and online mathematics teaching field experience as follows:

> *"My student said that 'when multiplying a number by 25, I divide the number by 2 and multiply by 50.' The students were very active during the lesson, I gave them enough time to think about each question. After experiencing some classroom management problems in my previous class, I implemented a technique where each student was given a card that allowed them to speak during the lesson. This approach ensured that all my students had an equal opportunity to participate in class."*

This example clearly shows that the TC connected what she learned in the Classroom Management course to her mathematics teaching practice. In another example, a different senior expressed the connection between her coursework and online field experience as "… Edpuzzle we learned in the Instructional Technology and Materials Design course was helpful. Students were able to understand how to find the area of a parallelogram using the area of a rectangle."

Table 1.
SWR Examples Indicating Connections Between Coursework and Practice

Sample SWR examples
We finished the presentation but we couldn't move on to Nearpod **[Instructional Technology and Material Design course].** In the first three questions in the introduction, we discussed with the students for a long time, I listened to different solutions from them. …At the end of the lesson, we talked about the fact that if I suddenly made a mistake at the end of the lesson and asked the students where I made it, it could attract them to the lesson, we talked about the fact that it would be better in terms of classroom management **[Classroom Management course]** if I did not repeat the places I repeated. In the 4836/6 operation we did at the end, we talked about the fact that I should emphasize that I made an operation with place values, I forgot to emphasize the place values part because I was focusing on the "there is 0 times" situation.
My student said that 'when multiplying a number by 25, I divide the number by 2 and multiply by 50.' The students were very active during the lesson, I gave enough time for students to think about each question. After experiencing some classroom management issues in my previous class, I implemented a technique where each student was given a card that allowed them to speak **[Classroom Management course]** during the lesson. This approach ensured that all of my students had an equal opportunity to participate in class.
… Edpuzzle we learned in the ***Instructional Technology and Materials Design*** course was helpful. Students were able to grasp how the area of a parallelogram was found using the area of a rectangle.

Results on WGM

Of the nine WGM, only three WGM included discussions of connections between coursework and online mathematics teaching practice in small portions of the meetings. In these discussions, only five out of 23 TCs reflected on their field experiences by making connections to their coursework (e.g., Methods of Teaching Mathematics, Instructional Technology and Materials Design, and Classroom Management courses). This indicates that TCs seemed to be not aware of the connections between coursework and practice, such as reflecting on the extent to which they could apply what they learned in the courses to their teaching.

On the other hand, those five TCs who could make the connections came up with specific examples on how they could apply what they learned in the coursework to their teaching practice. For example, a junior said:

> *"What I noticed was that in the previous term, we tried to ask more of these types of questions in our lessons and in the lessons, we did this term, like the 'discourse' articles we read in the method lesson [Methods of Teaching Mathematics course], or how a teacher asks funneling and focusing questions and how he/she prepares them."*

In another example, a senior explained that she greatly benefited from the Methods of Teaching Mathematics course in her teaching because it allowed her to refresh her thinking at critical moments in the lesson, such as "what questions to ask next" and "how to organize the rest of the lesson materials based on the flow of the lesson". This indicates that a few TCs could apply what they learned in coursework into their teaching practice. However, the majority of TCs had difficulties in connecting their coursework to their teaching practice in the field, indicating a large gap between their theoretical knowledge and their field experience.

DISCUSSION

The application of theoretical knowledge based on the courses completed in teacher education programs to practice is a key challenge, and the design of field experiences is critical to making such connections between coursework and practice. As part of the university-school partnerships, the present study focused on exploring the extent to which TCs were able to make connections between the theoretical knowledge related to the courses they had completed so far and the application of this knowledge in their online mathematics teaching practice in the OLS. Using multiple data sources such as LPM, SWR, and WGM, we found that TCs struggled to make connections between theoretical knowledge and online mathematics teaching field experiences. Whereas the instructors' self-reports (ICOS survey data) indicated that the courses provided the necessary theoretical knowledge by achieving the learning outcomes at a moderate level, the extent to which the TCs applied the theoretical knowledge into their online mathematics teaching field experiences was not observed at the same level. Although TCs provided theoretical references in their lesson plans such as foundations of theories, book and article information, only a few TCs reflected the noticeable connections that existed between the theoretical knowledge in the courses such as Methods of Teaching Mathematics, Classroom Management, Instructional Technology and Materials Design and their online field experiences. Being aware of the theories learned in the courses and applying the coursework into the mathematics teaching field experiences may be a developmental process for the TCs, and they may not explicitly express or notice this connection as they gain field experience. However, the clearest connections between theoretical knowledge (i.e., coursework) and online mathematics teaching practice occurred during the WGM, when they were able to verbally express their ideas and had enough time to refer back to what they had read in the coursework.

In contrast to the findings of the present study, Cross and Bayazit (2014) found that the majority of TCs cited specific strategies and theoretical knowledge directly from the readings in their written analysis of classroom activities during the field experience. In addition, they found that many of their TCs directly used the course readings as conversation starters with their mentor teachers. In our study, TCs' connections to the readings assigned in the Methods of Teaching Mathematics course can be seen as a reference to theoretical knowledge. Therefore, providing specific instructions in written assignments related to field experiences may help TCs make such connections to the theoretical ideas they discuss and learn in the courses.

In our study, the importance of the Methods of Teaching Mathematics course for TCs' making connections between coursework and online mathematics teaching practice was found to be consistent with other studies (e.g., Canlıer et al., 2020; Cross & Bayazit, 2014; Ünver, 2014). For example, Canlıer et al. (2020) found that TCs were able to transfer theoretical knowledge about lesson plan design, material and activity design, time and classroom management issues, and learner characteristics. The majority of TCs in their study reported that they acquired the necessary theoretical knowledge from the

courses such as Educational and Developmental Psychology, Teaching Principles and Methods in the pedagogical training certificate program.

Although previous research suggests that TCs can make better connections between theoretical knowledge and field experiences in teacher education models based on university-school partnerships (Allsopp et al., 2006), the results of our study suggest that TCs in the UwS program had difficulty applying or expressing how coursework affected their planning and online mathematics teaching. An argument could be made for improving teacher education courses by incorporating core practices (Grossman et al., 2009) to facilitate TCs' ability to connect theoretical knowledge with actual classroom practice. Our results indicated that courses with more embedded core practices (such as Methods of Teaching Mathematics) yielded better results towards this goal. Further research is needed to understand how to better support TCs in their theoretical knowledge or to make them aware of how to use it. Furthermore, teacher educators may need to consider different ways of designing courses in teacher education programs. In addition, this observation provides an opportunity for teacher educators to self-study their own practices.

There could be several reasons for the difficulties in TCs' ability to make connections between coursework and online mathematics teaching field experiences. As discussed in the literature, it may be easier for TCs to transfer some types of theoretical knowledge to practice than others, such as knowledge about core practices. Core practices are practices that are deeply rooted in teaching, such as knowledge about planning, questioning, preparing tasks, constructing norms, and so on. Since TCs may find it easier to integrate this type of theoretical knowledge into their practice, teacher educators may strive to make their theoretical courses more meaningful and relevant to TCs. The difference may also be due to the methods used to investigate the extent of the connection between coursework and practice. Previous studies have focused on TCs' self-reports (e.g., Allsopp et al., 2006; Jenset et al., 2018) about making connections, whereas we analyze the actual connections TCs make in their short-written reflections supported by lesson planning before their teaching and whole group meetings after their teaching.

The findings of this study suggest that the role of coursework in teacher education programs, especially in mathematics teacher education programs, should be reconsidered. There should be more discussion and research on how TCs construct their own theories related to learning and teaching. It is evident that readings related to student psychology can guide them, but as TCs gain more experience in teaching and interacting with students, they would construct theories that are closer to what they read in their course assignments. Therefore, it is also possible that developmentally, TCs may not form or be explicitly aware of the guiding principles provided by theories and make connections to their practice, as we found in our study. This situation does not mean that teacher education programs should not include theoretical knowledge, but it may suggest that it may not be realistic to explicitly observe such connections during a 4-year program. We hypothesize that making such a connection may require years of teaching practice in parallel with reading and discussing current and past theories in education in well-organized and supportive settings. Therefore, incorporating theory into teacher education may provide opportunities to explore this connection further and from multiple perspectives.

The frequency of TCs' excerpts about the connection between coursework and their field practice was seen in the tally sheet table in Appendix 2. Among this coursework, Educational Psychology course, which TCs take in their sophomore year, was not mentioned at all. It could be expected that the TCs would at least address cognitive and language development and individual differences according to the age, cognitive level, motivation, and affect of the middle school students (Ormrod et al., 2017) during and after the online mathematics teaching. The instructors of some core courses related to mathematics education in the department may collaborate with the instructor of Educational Psychology course and work on integrating the significant content of this course into other courses in mathematics education and educational science. That is, a study on the reflection of the important topics of this course in other courses may be helpful to accelerate the TCs' connections between coursework on which to base their activities (Crichton et al., 2021) and online mathematics teaching practice.

Finally, the results of the present study showed that TCs internalized the contents and practices of the courses offered in the semester of their practicum and reflected more on their written reflections. Their tendency to reflect more on the Methods of Teaching Mathematics course may be related to the recency effect, which is based on the principle of "the tendency to remember the most recently presented information best" (Baddeley & Hitch, 1993). In addition, the integration of videos in courses by instructors could be a valuable tool to connect coursework to practice (Gaudin & Chaliès, 2015). The results also suggest that TCs may find it difficult to make explicit connections without instructor guidance.

A limitation of the present study is the study setting and sample size. This study was conducted in a mathematics teacher education program at a private foundation, technological, and innovative university in Türkiye. Unlike other universities in Türkiye, our TCs have received extensive practicum experiences since their freshman year under the UwS model (Tunç-Pekkan et al., 2019). Future research should examine the connections between coursework and practicum in different teacher education programs with a larger sample size, both in online and face-to-face settings. In addition to the data sources used in this study, conducting interviews with TCs would provide further in-depth qualitative evidence. Longitudinal studies that include all cohorts in a teacher education program would provide a better picture of such connections between coursework and practice.

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APPENDICES

Appendix 1: ICOS Questions

Dear Teacher Educators,

As the Middle School Mathematics Education Undergraduate program in the Department of Mathematics and Science Education, we [the researchers] are examining how our TCs use theoretical knowledge they learned in the courses in the OLS. Please review the course learning outcomes below (If needed, you can add your suggestion) from 1 to 3.

How much do you think that the junior and senior TCs have achieved the learning outcomes of the courses you offered? (1: Low, 2: Medium, 3: High)

Who were the two most significant theorists you talked about in this course? Please write their names by providing the references.

Appendix 2: Tally Sheet: Course Connections

Courses*	Number of connections	Data sources**	Sample examples
Classroom Management (e.g., time management, classroom rules) [Junior year, Spring]	///// //	LPM, WGM, SWR	"The first weeks in the OLS were for meetings. Classroom rules **[the connection with the course]** were mentioned in these weeks." (Teacher candidate D, junior)
Foundations of Teaching Geometry, Probability and Statistics [Sophomore year, Spring]	//	LPM, WGM	".... One of my students drew a square, but I asked them to draw a rectangle. She said, 'I saw it wrong, teacher. That's why I need to draw a rectangle.' So, I asked the class if a square isn't a rectangle?" (Teacher candidate G, senior)
Foundations of Teaching Numbers, Operations and Algebra [Sophomore year, Spring]	//	WGM, SWR	"In the previous weeks, I had read an article in Instructor A's class **[connection with the course]** and tried to ask questions to the students according to it…" (Teacher candidate B, senior)
Instructional Technology and Materials Design (e.g., mathematical tools such as Geoboard, Nearpod, web 2.0 tools, mathematics online tools) [Sophomore year, Spring]	////	LPM, WGM, SWR	"My students divided the fractions into equal parts in the Nearpod **[the connection with the course]** and I focused on this part. I misrepresented it on the number line and we argued over it…" (Teacher candidate E, senior) "When I showed the number line in Geogebra **[the connection with the course]**, we compared the fractions ⅙ and ½…" (Teacher candidate F, senior)
Introduction to Mathematics Teaching [Freshman year, Fall]	//	LPM, WGM	"....After all, we experience the situation at a very early level since we have experienced communicating with students since freshman year **[the connection with the course]**..." (Teacher candidate A, senior)
Method of Teaching Mathematics I & II (e.g., questioning styles, students solution process and thinking, designing the flow of the lesson, microteaching, history of mathematics, NCTM) [Junior year, Fall and Spring]	///// ///// //	LPM, WGM, SWR	"The method course **[the connection with the course]** is really the most useful for us….Techniques of asking questions in the teaching we learned there, such as how the flow should be, or where and how we should ask questions…" (Teacher candidate C, junior)
Principles and Method of Instruction [Junior year, Fall]	///	WGM, SWR	"....we tried to use them as much as we could, you know 'apply', 'understanding' etc. **[connection with the course by expressing Bloom Taxonomy's (Bloom et al., 1956) cognitive dimensions]**. So I studied by myself." (Teacher candidate A, senior)

Note. *The courses arranged in alphabetical order and brackets indicate the year and semester TCs completed based on the curriculum. **LPM= Lesson plan meetings, SWR= Short written reflections, WGM= Whole-group meetings.

TÜRKÇE GENİŞLETİLMİŞ ÖZET

Alan deneyimleri, öğretme ve öğrenme teorileri ve pratikleri arasında önemli bir görev üstlenmektedir. Öğretmen eğitiminde alan deneyimleri, mentör öğretmenler ve öğretmen eğitimcileri tarafından rehberlik edilen öğretmen adaylarının staj okul ortamında gerçekleşen etkinliklerini ve deneyimlerini içermektedir. Bu deneyimler, öğrenme ortamı, öğretmenler, öğrenciler ve müfredat içerikleri arasındaki karmaşık etkileşimleri gerektirir (Darling-Hammond, 2006a, 2006b; Guler & Celik, 2022). Teori, dünya genelindeki öğretmen eğitimi programlarında kritik bir öneme sahiptir ve alanyazındaki çalışmalar, öğretmen adaylarının teori ve pratiği birleştirme becerisinin, derste öğrendiklerini pratiğe dökebilmek için artan öneminden bahsetmektedir (Kvam vd., 2023). Türkiye'nin müfredatında teorik bilginin yüzdelik değerleri bilinmesine ragmen, öğretmen eğitimi programlarında bu teorik bilginin ne ölçüde alan deneyimine aktarıldığını belirlemek zordur. Öğretmen adaylarının öğrendiklerini her zaman pratiğe dökemedikleri süregelen bir konudur (Hirshberg vd., 2020). Bu noktada, üniversite-okul işbirliği modelleri bir gereklilik olarak görülebilir (Allsopp vd., 2006; Grinshtain vd., 2024; Lavonen vd., 2019) çünkü üniversiteler öğretmen adaylarının staj okullarında pratik yapmalarını desteklemektedir. Öğretmen adayları, staj okullarında deneyimleri üzerine düşünümde bulunma ve bu düşünümleri öğretmen eğitimi derslerinde edindiği bilgilere ilişkilendirme fırsatına sahip olur.

Bu çalışma, Türkiye'de 2014 yılından beri uygulanan Okulda Üniversite modeli bağlamında, 23 matematik öğretmenliği öğretmen adayının bir öğretmen eğitimi programındaki ders ve çevrim-içi matematik öğretimi alan deneyimlerini birleştirme becerisini incelemiştir. Okulda Üniversite modeli, öğretmen adaylarının teori ve pratik bilgileri arasındaki mesafeyi kapatarak öğretmen eğitimi programlarının kalitesini artırmayı amaçlayan bir modeldir. Bu modelde, öğretmen adayları dört yıllık programın ilk iki yılında temel olarak teorik bilgi ve derslere odaklanırken, son iki yılda da alan deneyimlerine yoğunlaşırlar (Özcan, 2013). Bu çalışmadaki araştırma sorumuz şudur: Okulda Üniversite modeli bağlamında, öğretmen adayları ders ve çevrim-içi alan deneyimlerini nasıl birleştirmektedir?

Geçmiş çalışmalar, nicel ve nitel yöntemler kullanmış ve bir üniversite-okul iş birliği modeline geçmeden önce ve geçtikten sonrasınında öğretmen adaylarının deneyimlerini tartışmıştır (Allsopp vd., 2006; Canlıer vd., 2020; Cross & Bayazit, 2014). Ancak, bilgimiz dahilinde olan ve ders hocalarının amaçları, öğretmen adaylarının notları, ders planları ve tüm sınıfın dâhil olduğu tartışma toplantıları gibi birden fazla veri kaynaklarını kullanan bir çalışma bulunamamıştır.

Bu çalışmanın verisini, öğretmen adaylarının bir dönem boyu süren ders verme deneyiminden önce gerçekleşen 24 video-kayıtlı ders planlama toplantısının transkriptleri, yeni tasarlanmış Çevrim-içi Laboratuar Okulu'ndaki çevrim-içi ders anlatmalarından sonra gerçekleşen 9 video-kayıtlı tüm sınıfın dahil olduğu tartışma toplantılarının transkripleri ve 100'ün üzerinde öğretmen adayı yazılı kısa notlarıdır. İçerik analizi kullanarak veri analizi yapılmış ve öğretmen adaylarının ne ölçüde teori ve pratiği birleştirebildiği incelenmiştir.

Öğretmen adaylarının ders planlama toplantılarının ve ders planlarının analizlerine göre, çoğu öğretmen adayı ders planlarına teorik bilgileri içeren kaynakça bilgilerini eklemiştir. Ancak, öğretmen adaylarının hazırladıkları ders planları ve aldıkları dersler arasında (Örneğin, Eğitime Giriş dersi) anlamlı bağlantılar kurmakta zorlandıkları gözlenmiştir (Ek 2).

Öğretmen adayı yazılı kısa notları sonuçlarına göre, 23 matematik öğretmenliği öğretmen adayının dördü teori ve pratik bilgisini birleştirebilmiştir. Bu öğretmen adayları, genellikle öğrencilerin kavram yanılgıları, matematiksel düşünmeleri, soru sorma tarzları, çevrim-içi araçları, öğretmen yöntemleri, sınıf ve zaman yönetimi üzerine düşünümde bulunmuşlardır. Bu konular, Matematik Öğretim Yöntemleri, Öğretimsel Teknoloji ve Materyal Tasarımı ve Sınıf Yönetimi derslerindeki teorik bilgilerle ilişkili olabilir (Ek 2).

Öğretmen adaylarının çevrim-içi ders vermelerinden sonra gerçekleşen 9 video-kayıtlı tüm sınıfın dahil olduğu tartışma toplantılarının sadece üç tanesi (onlar da toplantıların görece kısa zaman dilimlerinde olmak üzere) teori ve pratik arasındaki muhtemel bağlantıları içeren tartışmalardan oluşmuştur. Bu tartışmalarda, 23 öğretmen adayının sadece beşi, Matematik Öğretim yöntemleri, Öğretimsel Teknoloji ve Materyal Tasarımı ve Sınıf Yönetimi derslerindeki teorik bilgilerle alan deneyimleri üzerine düşünümde bulunmuşlardır (Ek 2). Bu durum, öğretmen adaylarının, ya dersler ve pratik arasındaki bağlantılarla (Örneğin, derslerde öğrendiklerini ne ölçüde ders anlatımlarında uygulayabildikleri) ilgili farkındalığının olmadığını, ya da bu bağlantılar üzerine görüş bildirme eğiliminde olmadıklarını göstermektedir.

Özetle, her bir veri kaynağının analizi, sadece az sayıda öğretmen adayının teori ve pratik bilgiler arasındaki bağlantıları kurabildiğini, yani öğretmen adaylarının sıklıkla bu bağlantıları kurmakta zorlandıklarını göstermektedir. Ders hocalarının amaçları, öğretmen adaylarının düşünümleri, ders planları ve tüm sınıfın dahil olduğu tartışma toplantıları gibi birden fazla veri kaynaklarını kullanan bu öncü çalışma, öğretmen eğitimcilerinin alan eğitimi derslerinde, öğretmen adaylarına teori ve pratik bilgiler arasında daha fazla bağlantılar kurabilecekleri fırsatlar sunulmasını önermektedir. Bu çalışma, aynı zamanda öğretmen eğitimcilerinin öğretmen eğitimi programlarındaki derslerini tasarlamada farklı yöntemler denemelerine ihtiyaç olduğunu göstermektedir. Bu derslerde öğretmen adaylarının kendi öğrenme ve öğretme teorilerini belirlemede daha fazla araştırma yapması ve tartışma ortamı sağlanması önerilebilir. Öğrenci psikolojisi üzerine okumalar öğretmen adaylarına yol gösterebilir. Öğretmen adaylarının staj okullarında öğrencilerle yoğun etkileşim içerisinde olması, teori ve pratiği birleştirmelerine katkıda bulunacaktır. İlerde yapılacak çalışmalar, farklı öğretmen eğitimi programlarındaki öğretmen adaylarının teori ve pratik bilgileri arasındaki bağlantıları, hem çevrim-içi hem yüz-yüze sınıf ortamlarında, daha geniş bir örneklemle incelemelidir. Bu çalışmada kullanılan veri kaynaklarına ek olarak, öğretmen adaylarıyla görüşmeler yapılması daha detaylı nitel kanıtlar elde edilmesini sağlayacaktır.