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Research Article

The impact of reflective practices on pre-service science teachers' classroom teaching practices

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This case study attempts to explore the impact of the reflective practices (reflection in, on, and for action) on pre-service science teachers' (PSTs') classroom teaching practices. To this end, ten PSTs majoring in Science Teacher Education Program participated in this study. In the study, the author designed a classroom teaching practice process based on reflective practices. This process was carried out during the teaching practicum course with the pre-service teachers participating in the research. At the beginning and end of the study, classroom observations, field notes, classroom observation instruments, teaching video records, and lesson plans were used as data collection tools in determining PSTs' classroom teaching practices. The qualitative and quantitative results of this study indicated that there was a significant change in favor of post-classroom practice results between PSTs' pre- and post-classroom teaching practices. Given these results, the classroom practice process based on the reflective practices carried out in the research plays an important role in the development of PSTs' classroom teaching practices.

Keywords: Classroom teaching practice; Reflective practice; Reflection in, on, and for action; Pre-service teacher education

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1. Introduction

Teachers need support and professional development to ameliorate their lesson plans and classroom teaching practices (Parra, 2010). The general purpose of professional development activities for teachers is to improve their classroom teaching practices and professional skills (Loizou, 2008; Osterman & Kottkamp, 1993). These professional development activities could be listed as keeping a diary, being observed by or observing a peer, exchanging ideas with the peers or colleagues, analyzing and evaluating teaching practices (Farrell, 2008; Harmer, 2001; Yanping & Jie, 2009). These activities aim to help pre-service and/or in-service teachers to reflect on their teaching practices (Özsoy, 2020). Reflective practices significantly affect the development of teachers' teaching practices (Bubnys & Zavadskienė, 2017; Osterman & Kottkamp, 1993) because reflective practices enable teachers to reflect on their teaching experiences and to question their experiences with a critical approach (Amobi, 2005; Murray, 2010). Deliberate and more detailed reflection empowers teachers to question teaching practice more systematically and improve teaching practice (Brown, 2002). In this study, an approach was adopted in which pre-service

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teachers were allowed to self-analyze and improve their teaching practices in line with a structured framework for reflection. In this sense, the study aims to examine how classroom teaching practices develop when pre-service science teachers are provided with the opportunity to reflect on their science learning-teaching experiences.

1.1. Reflective Practice

Schön (1983) defined reflective practices as techniques that help improve the teaching and performance of pre-service and/or in-service teachers (Canning, 2011). Reflective practice is a compass that "enables teachers to stop, look, and discover where they are at that moment and then decide where they want to go (professionally) in the future" (Farrell, 2012, p.7). Killion and Todnem (1991) specified the types of reflective practice in three ways to improve the teaching skills of pre-service and/or in-service teachers (Bubnys & Zavadskienė, 2017), namely reflection in action, reflection on action, and reflection for action. Reflection in action (thinking while doing) refers to reflecting the teacher on situations such as his or her experiences during the lesson, interaction with the students, etc. (Bubnys & Zavadskienė, 2017; Dinkelman, 2003). For example, pre-service or in-service teachers reflect on their practices in the face of an unexpected situation they encounter while teaching their lessons in the classroom setting and their feelings and thoughts about that situation. Reflection on action (thinking after the event) means teachers' thinking about situations such as how a teacher performs the lesson after the lesson ends, how he or she implements the activities specified in the lesson plan, etc. (Arslan, 2005; Bubnys & Zavadskienė, 2017). For instance, pre-service or in-service teachers reflect on situations such as how they use their activities in the classroom, whether they can use the teaching methods effectively and whether they are good at classroom management. Reflection for action (planning what you are going to do) is teachers' thinking about how to plan the next lesson based on the experiences that they gained from the reflection in action and reflection on action (Alp & Şahin-Taşkın, 2008; Ghaye, 2011) such as reflecting on the strategies and methods that will be used in the next lesson, what kind of activities will be used, which assessment approach will be adopted, and which assessment tools will be administered, among many others.

Nowadays, reflective practice is considered a "required curricular element" in pre-service teacher education programs in many countries (Houde, 2018, p. 29). Studies are available in the literature on the definition of the concept of reflective practice, types of reflection, levels of reflection, developing reflective skills, etc. (Akbari, 2007; Burhan-Horasanlı & Ortaçtepe, 2016; Farrell, 2008; 2012; 2016; Grushka et al., 2005; Hatton & Smith, 1995; Larrivee, 2008; Mathew et al., 2017; Öner & Adadan, 2011; Özsoy, 2017; Özsoy, 2020). These studies are mainly based on the idea that reflective practices are essential in developing pre-service and/or in-service teachers' classroom teaching practices (Bubnys & Zavadskienė, 2017; Houde, 2018; Korucu-Kis & Demir, 2019). In addition, when it is carried out systematically, reflective practices contribute to many issues, such as teachers' becoming cognizant of their teaching practices and self-analysis (Houde, 2018). Brown (2002) stated that self-reflection would become a habit of mind when teachers were encouraged to practice reflective practices in his study. Loughran (2002) also argued, "if learning through practice matters, then reflection on practice is crucial, and teacher preparation is the obvious place for it to be initiated and nurtured" (p. 42). Within this framework, teacher education programs need to offer especially instructional practices courses in line with reflective practices in terms of developing pre-service teachers' classroom teaching practices. Reflective practice, "one of the most popular theories of professional knowledge" in recent years, has been widely adopted in pre-service teacher education, and it should be examined in higher education studies (Bubnys & Zavadskienė, 2017, p. 91). However, although reflective practices are recommended "as a means" to improve pre-service teachers' teaching experiences, there is little "empirical evidence" showing their impact on the development of classroom teaching practices (Moradkhani, Raygan & Moein, 2017, p. 1). Accordingly, this study aimed to unearth the effect of reflective practices (reflection in, on, and for action) on pre-service science teachers' classroom teaching practices. Thus, it is thought

that this significant gap in the literature will be eliminated.

2. Method

This research is a case study that combines qualitative data collection, qualitative and quantitative data analysis, and inference processes. The author collected detailed qualitative data on PSTs' classroom teaching practices using different data collection tools in this study. These qualitative data were analyzed both qualitatively and quantitatively. In this process, qualitative and quantitative research approaches allowed the research question to be examined from different perspectives (Morse, 1991). This research study addressed the following research question: What are the pre-service science teachers' classroom teaching practices before and after reflective practices (reflection in, on, and for action)?

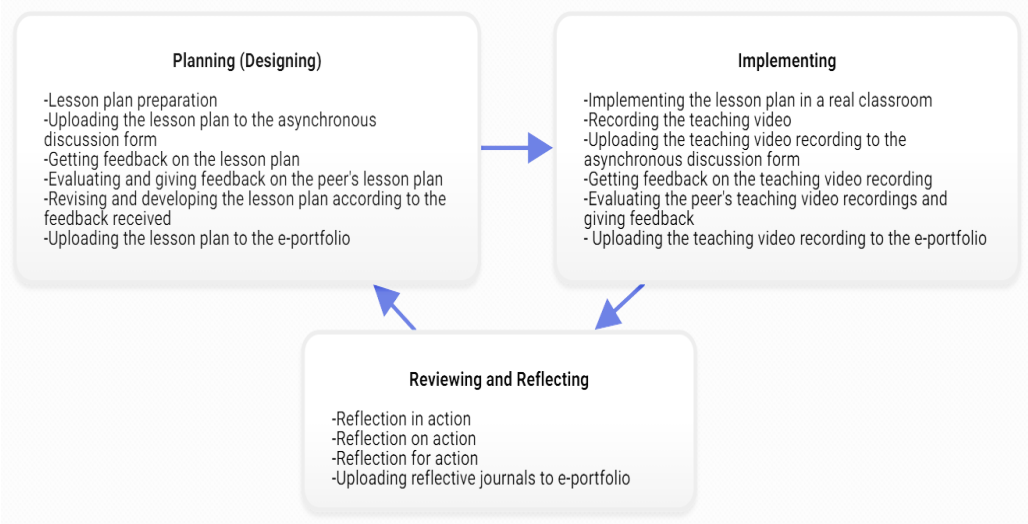
2.1. Participants

The participants were ten fourth-grade pre-service teachers (all female) studying at the Department of Science Teaching in the Faculty of Education at a state university in eastern Turkey, and they were enrolled in the practicum course in the last semester of their study program. They were 21-23 years old and had previous classroom teaching experiences (three 40 minutes lessons at most). For confidentiality, the disclosure of the identity of the participants was taken into consideration, and pseudonyms were used.

2.2. Reflective Practices-based Classroom Teaching Practice Process

This study took place in a teaching practicum course which was a semester-long offered course at a state university in Turkey. During the course, which is completed in the fourth year of the teacher education programs, pre-service teachers practice in elementary schools to gain experience. The pre-service teachers practice teaching in the real classroom to gain experience in the teaching profession. They also carry out classroom observations considering the topics assigned by the university supervisor. In this study, the content and activities of the teaching practicum course were rearranged within the framework of the purpose and design of the research. In this sense, many types of research in the literature on classroom teaching practices of pre-service teachers were examined and analyzed (e.g., Bulunuz & Bulunuz, 2015; Fox et al., 2011; Kaya et al., 2013; Kılıç et al., 2019; Kurt et al., 2014; Öner & Adadan, 2011; Park & Oliver, 2008; Yiğit et al., 2010). In the study, the teaching practicum course was conducted throughout 12 weeks based on the process given in Figure 1. The author designed the process to develop classroom teaching skills based on reflective practices (reflection in, on, and for action). The researcher carried out online activities over the Moodle Learning Management System (Moodle LMS). More specifically, first of all, the course sections to be offered in the Moodle LMS were activated in line with the purpose of the research, and a user name and password were provided for each pre-service teacher to log in the system securely. Then, using the features of Moodle LMS, online asynchronous discussion forums and e-portfolios belonging to each pre-service teacher were created. Through asynchronous discussion forums, pre-service teachers discuss lesson plans, teaching videos, and teaching skills in the real classroom at the schools, where they do their internships with the support of the author/researcher and their peers. On the other hand, e-portfolios are individual portfolios in which pre-service teachers record their knowledge and experiences about practices such as lesson plans, teaching videos, and reflective journals on classroom teaching skills during their practicum. This e-portfolio system was created specifically for each pre-service teacher participating in the research and was kept open to use for each pre-service teacher.

Figure 1
Reflective practices-based classroom teaching practice process



In the first week of the study process, pre-service teachers were introduced to their mentor teachers in elementary schools, and they were informed about the activities to be carried out. In the second week, the pre-service teachers observed the students, the classroom setting, and other physical conditions in which they were expected to implement their lessons. For the other ten weeks, the activities continued based on the process given in Figure 1. Accordingly, pre-service teachers carried out reflective practices on the lessons they taught in a real classroom in the stages of "planning (designing)," "implementing," and "reviewing and reflecting." In the first week of these ten weeks, pre-service teachers prepared their lesson plans in their practicum schools. Then, each pre-service teacher uploaded their lesson plan to their asynchronous discussion form and received feedback from their peers and supervisor (the author) about their lesson plan and joined an asynchronous peer discussion group randomly and gave feedback on their peer's lesson plan. Pre-service teachers revised and developed their lesson plans considering the feedback they received from their peers and supervisor. In addition, pre-service teachers uploaded their lesson plans to their e-portfolios in both first and finalized versions. Afterwards, pre-service teachers performed and video-recorded their lessons in their practicum schools under the supervision of their mentor teachers. Likewise, pre-service teachers uploaded their video-recorded lessons to their e-portfolios. In the second week of these ten weeks, the pre-service teachers uploaded the video recordings to their asynchronous discussion forum. Then, the pre-service teachers evaluated their own video-recorded lesson and then their peers' lesson by discussing it with their peers and supervisor. In addition, this week, pre-service teachers completed their reflective journals by completing the "reflection in action" and "reflection on action" tasks related to their lesson. Then, after doing the "reflection for action" task for the next lesson, they prepared their lesson plans for the next week. In the third week, the pre-service teachers completed the same activities as they did in the first week, and in the fourth week, they completed the same activities as they did in the second week. In the other weeks, this process continued as shown in Figure 1. This process was carried out by the pre-service teachers throughout a total of five times. In this study, the author created reflective journals on classroom teaching skills filled out by pre-service teachers based on the relevant literature. There are guiding questions to stimulate PSTs' reflective thinking in the reflection in, on, and for action sections in these reflective journals. In essence, these reflective journals were a semi-structured guide for reflective practices (reflection in, on, and for action). Pre-service teachers uploaded these completed journals to their e-portfolios.

2.3. Data Collection Tools

In the data collection process carried out at the beginning and at the end of this research, different data collection tools in both qualitative and quantitative nature were used to obtain more comprehensive data in order to reveal the PSTs' classroom teaching practices. The author collected data from multiple sources including classroom observations, researcher's field notes, classroom observation instruments, teaching video records, and lesson plans.

2.3.1. Classroom observations, field notes, and teaching video records

The author observed PSTs' teaching practices in real classroom settings. The author's role was more of a participant as an observer (LeCompte & Goetz, 1982). To this end, at the beginning and at the end of the research, the author directly observed the classroom practices of each pre-service teacher regarding two 40 minutes science lessons in the real classroom and took down detailed field notes. In these field notes, situations such as the structure of the questions asked by the pre-service teachers to the students, in which instructional strategies and methods they taught, what assessment approaches and tools they used, and how they identified and eliminated the students' misconceptions and/or prior knowledge were written. The classroom observation was used to unveil PSTs' teaching practice development process. Field notes were used to note down relevant issues concerning classroom events. In addition, video recordings of the lessons were kept to unearth the classroom teaching practices of pre-service teachers in a real classroom setting in more detail and to be able to watch and examine them repeatedly.

2.3.2. Classroom observation instruments

In this study, Reformed Teaching Observation Protocol (RTOP) and Technology Integration Observation Instrument (TIOI) were used. RTOP was developed as part of The Arizona Collaborative for Excellence in the Preparation of Teachers (ACEPT) project in 1999 (Piburn et al., 2002). This protocol is a widely used observation form to explore pre-service teachers' classroom practice levels (Park et al., 2011). RTOP consists of three main factors that are "lesson design and implementation (what teacher intended to do)," "content-propositional knowledge (what the teacher knows, and how well they are able to organize and present material in a learner-oriented setting), and procedural knowledge (what students did)," "classroom culture-communicative interactions (student-student interaction) and student/teacher relationships," and a total of 25 items (Motloung, 2019). This observation protocol was translated into Turkish in 2008 by Türel, and it was also revised in terms of Turkish language and cultural features by two Turkish scholars that completed post-graduate abroad (Türel, 2008). In addition, TIOI was used in this study to search how pre-service teachers integrate technology into their lessons. TIOI is designed to focus on using technology integration knowledge in classroom teaching by Hofer et al. (2011). This observation instrument consists of six main factors that are "curriculum goals and technologies (matching technology to curriculum)," "instructional strategies and technologies (matching technology to instructional strategies)," "technology selection (matching technology to both curriculum and instructional strategies)," "fit (considering curriculum, pedagogy, and technology all together)," "instructional use (using technologies effectively for instruction)," and "technology logistics (operating technologies effectively)" (Hofer et al., 2011). TIOI is a scale open to everyone (Kokoç, 2012) and it was translated into Turkish by Kokoç (2012).

2.3.3. Lesson plans

The lesson preparation method developed by Van der Valk and Broekman (1999) was used in the study. Accordingly, PSTs were asked to prepare a lesson plan for two 40 minutes science lessons they would teach in a real classroom setting at the beginning and at the end of the research.

2.4. Data Analysis

In this study, classroom observations, field notes, teaching video records, and lesson plans were analyzed with a holistic approach by analyzing the pre- and post-data obtained regarding the classroom teaching practices of each pre-service teacher. Qualitative data obtained from these data collection tools were analyzed using content analysis (Yıldırım & Şimşek, 2013). In this context, main themes including sub-themes and codes related to PSTs' classroom practices were determined, and the qualitative data obtained were examined in detail by the author at least twice, and the sub-themes and codes under each main theme were found by arranging them (Table 1). For the trustworthiness of this process, these themes and codes were examined by a researcher specialized in classroom practices, and his opinions were taken. As a result of the interviews between the researcher and the author, this process was reviewed, and a list of themes and codes was created to analyze the data obtained. In addition, in this study, pre- and post-classroom observations, field notes, teaching video records, and lesson plans were simultaneously reviewed in detail at least twice, and the author filled in classroom observation instruments. The RTOP was created to evaluate the frequently observed behavior (4 points) and the unobserved behavior (0 points) in classrooms. In RTOP, the highest score is "100" whereas the lowest score is "0". The TIOI, on the other hand, has been developed in such a way that the behavior levels related to the effective integration of technology into the classroom setting are evaluated between “1” and “4”. In addition, the pre- and post-scores from each PSTs' classroom observation instruments and the mean values of each factor of these classroom observation instruments were also calculated. All data from multiple data collection tools were triangulated to assure the trustworthiness of this study. In addition, to ensure reliability in data analysis, assistance was obtained from an independent researcher who is an expert in the relevant subject (Huberman & Miles, 2002). Within this framework, the pre- and post-data of four randomly selected PSTs participating in the research were reanalyzed by this researcher based on the same criteria, and the agreement between the author and this researcher's analyses was approximately 92%.

3. Results

At the beginning and at the end of this study, the qualitative and quantitative findings which were obtained from data collection tools are presented in this section.

3.1. Qualitative Results

This section presents qualitative results from PSTs in classroom observations, field notes, teaching video records, and lesson plans. As a result of the content analysis of the qualitative data obtained regarding the classroom practices of PSTs, the following themes were reached: Lesson introduction process, teaching process, assessment process, technology integration, communication, and classroom management (Table 1).

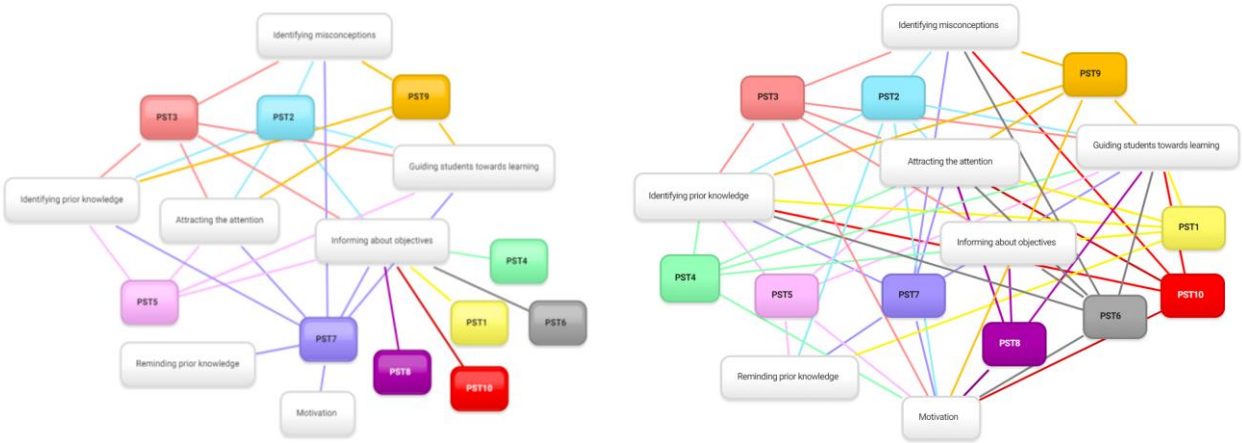
3.1.1. Lesson introduction process

There are findings related to the lesson introduction process of PSTs in pre- and post-classroom teaching practices in Figure 2. Accordingly, when the pre-data were closely examined, most pre-service teachers shared their opinions about their lesson's objectives they would reach at the beginning phase of the lesson. PST2, PST3, PST5, PST7, and PST9 tried to determine their students' prior knowledge about science topics by asking various questions. However, PST5 continued the lesson without considering the students' prior knowledge on the topic, and it was observed that she did not also notice the students' misconceptions about this science topic. PST2, PST3, PST7, and PST9 also identified students' misconceptions about the science topics, but they could not continue their lessons effectively considering these misconceptions. During the introduction to the lesson, some pre-service teachers drew the students' attention and encouraged them to express their ideas about the science topic they covered. Only PST7 activated the students' prior knowledge about the science topic at this stage and motivated them for the lesson.

Table 1
Themes, subthemes, and codes were obtained regarding the classroom teaching practices of PSTs

Themes	*Subthemes*	*Codes*
Lesson introduction process		Identifying prior knowledge Motivation Identifying misconceptions Guiding students towards learning Reminding prior knowledge Informing about objectives Attracting the attention
Teaching process	Eliminating students' misconceptions	
	Instructional methods and activities	5E Predict-Observe-Explain (POE) Class discussion Question-Answer Straight expression
	Qualification of instruction	Corrective feedback Positive reinforcement Student participation
	Instructional technology/materials	Slide/presentation Video Concept cartoon Smartboard/Writing board Worksheet Three-dimensional material Images (pictures, schemes) Textbook
Assessment process	Assessment approaches	Traditional assessment Alternative assessment
	Assessment methods and tools	Self-assessment Peer-assessment Concept cartoon Assessment worksheet Diagnostic branched tree Short-answer test Fill-in-the-blank test True-false test
Technology integration		
Communication		
Classroom management		

Figure 2
Pre- and post-findings on PSTs' lesson introduction process



Pre-Classroom Practice Post-Classroom Practice

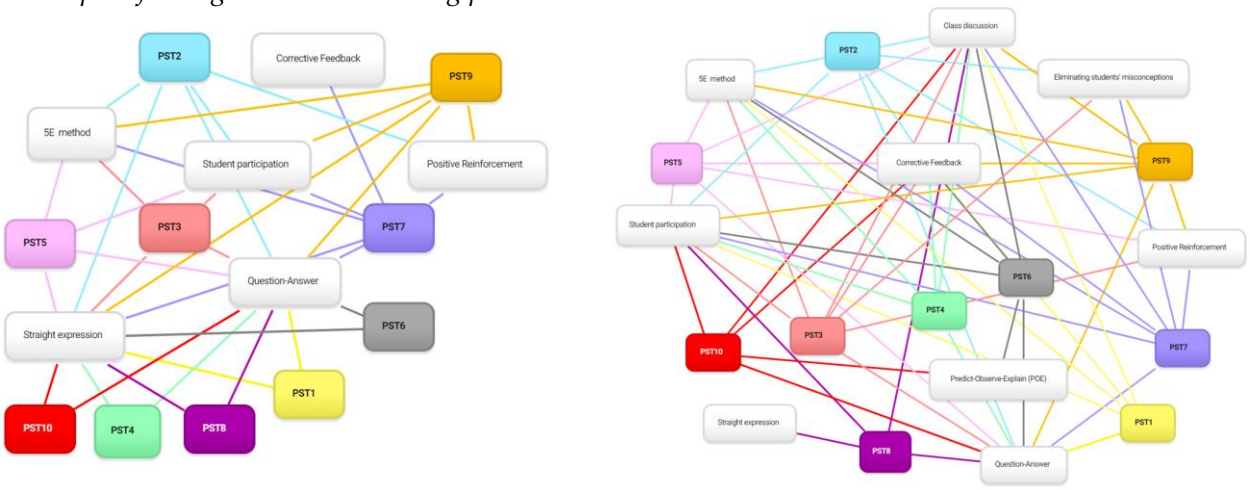
When the post-data on the PSTs' lesson introduction process is examined in Figure 2, it could be seen that all pre-service teachers performed activities to draw attention, identify prior knowledge and encourage the active participation of students in learning process. Contrary to the pre-classroom practices, in the post-classroom practices, PST1, PST2, PST5, and PST7, activated the students' prior knowledge with regard to the science topics. Furthermore, most pre-service teachers identified the students' misconceptions about the science topics and continued their lessons by taking these into account. Finally, contrary to the pre-classroom practices, in the post-classroom practices, most of the pre-service teachers ensured that the students were motivated for the lesson while some pre-service teachers did not share the objectives of the lesson they would teach with their students.

3.1.2. Teaching process

In Figure 3 and 4, there are findings related to PSTs' teaching process in pre- and post-classroom teaching practices. Accordingly, when the pre-data were examined, PST2, PST3, PST5, PST7, and PST9 taught their lessons using the 5E method. However, it was observed that these pre-service teachers could not fully implement the 5E method in the real classroom. For example, it was clear that they were not thoroughly successful in applying the 5E method, especially the "explore" and "elaborate" stages, in terms of students' success in meaningful and permanent learning. In addition, it was found that all of the pre-service teachers used question-answer and straight expression (direct explanation) methods while teaching their lessons. As shown in Figure 2, although PST2, PST3, PST7, and PST9 identified the students' misconceptions about the science topics, it was observed that they were not successful in eliminating these misconceptions during the teaching process, and they had difficulties in this situation. While PST2, PST3, PST5, PST7, and PST9 enabled students to participate in the teaching process, only PST7 provided corrective feedback for her students. Pre-service teachers used slide/presentation, picture, video, concept cartoon, and writing board materials in the teaching process of their lessons. For example, all of the PSTs used videos on science topics (Figure 4). This part is expressed in more detail under the theme of technology integration.

When the post-data on the teaching process were examined in Figure 3, many pre-service teachers tried to create effective learning environments using the 5E method. When we consider the post-classroom practices as opposed to the pre-classroom practices, it was seen that the pre-service teachers were more effective in applying the "explore" and "elaborate" stages of the 5E method. For example, PST6 performed an effective learning-teaching process using the predict-observe-explain method in the "explore" phase of the 5E method by enabling her students to

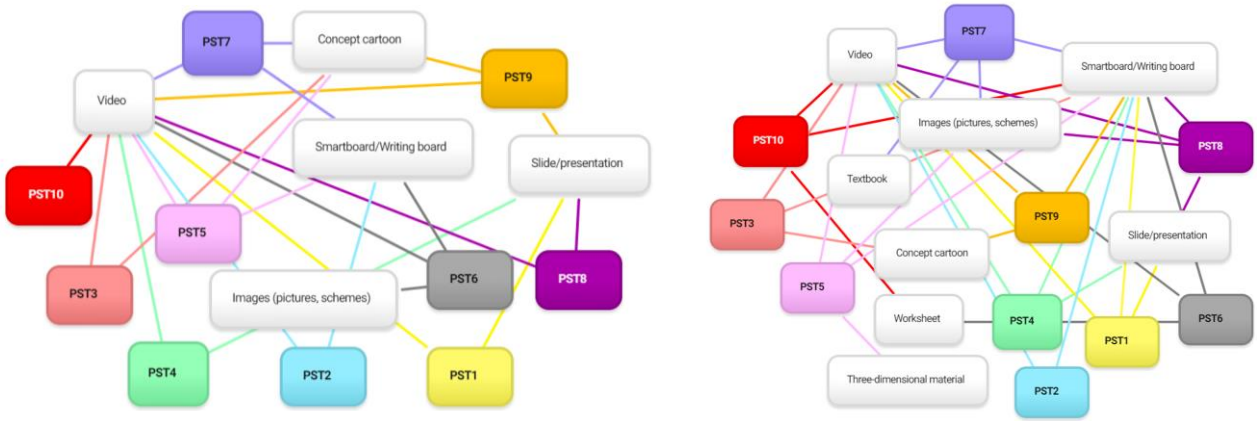
Figure 3
Pre- and post-findings on PSTs' teaching process



Pre-Classroom Practice Post-Classroom Practice

predict, observe, question, and explain their opinions with reasons. It was also found that all pre-service teachers used question-answer and discussion methods effectively in the teaching process in the real classroom. It was observed that PST2, PST3, PST5, PST6, PST7, and PST9 created more effective classroom discussion settings where student-student interaction occured compared to other pre-service teachers. In addition, it was observed that some of these pre-service teachers (PST2, PST3, PST7, and PST9) attempted to identify and resolve students' misconceptions about the science topic they taught. For example, PST2 eliminated students' misconceptions by enabling students to observe a science event with a video, or PST7 eliminated students' misconceptions by drawing and explaining figures on the writing board. Contrary to the pre-classroom practices, all of the pre-service teachers ensured the students' active participation in the teaching process in the post-classroom practices. All pre-service teachers also gave effective corrective feedback regarding the students' learning during the teaching process. Pre-service teachers benefited from worksheets, slide/presentations, smart boards/writing boards, images (pictures, schemes), videos, concept cartoons, textbooks, and three-dimensional instructional materials during the teaching process of their lessons (Figure 4). This part was fleshed out under the technology integration theme.

Figure 4
Pre- and post-findings on the instructional technology/materials

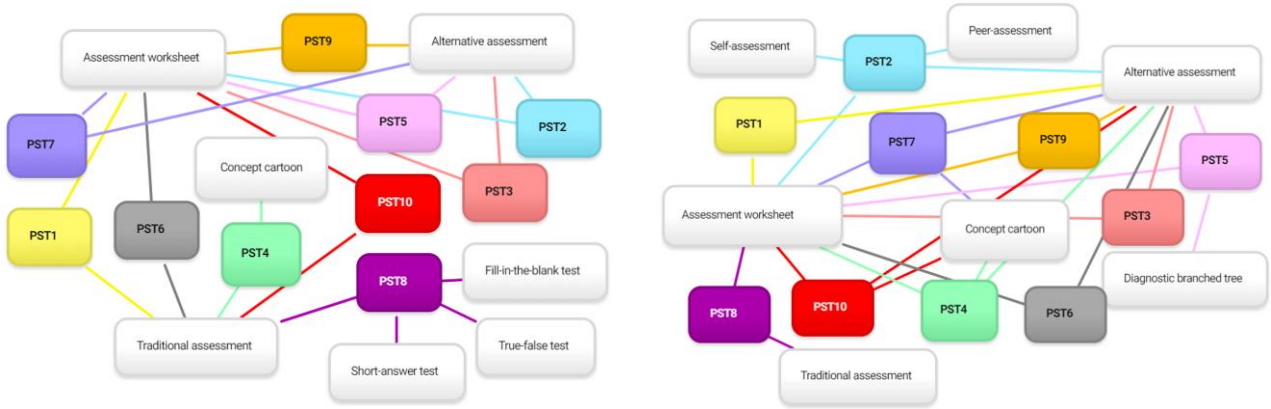


Pre-Classroom Practice Post-Classroom Practice

3.1.3. Assessment process

There are findings regarding the PSTs' assessment process in pre- and post-classroom teaching practices in Figure 5. Accordingly, when the pre-data were examined, PST1, PST4, PST6, PST8, and PST10 tried to determine what the students learned at the end of their lesson. For example, PST8 evaluated what her students learned about a science topic at the end of the lesson using fill-in-the-blank, short-answer, and true-false tests. PST4 tried to determine what the students learned using the concept cartoons she distributed to the class at the end of the lesson. PST2, PST3, PST5, PST7, and PST9 evaluated what students learned according to the alternative assessment approach. These pre-service teachers tried to assess what the students learned from the beginning to the end of the lesson. Most pre-service teachers used the assessment worksheets they designed to determine what the students learned about the science topics (electrical energy, climate change, celestial objects, etc.).

Figure 5
Pre- and post-findings on PSTs' assessment process



Pre-Classroom Practice Post-Classroom Practice

Post-data on the assessment process in Figure 5 reveals that most pre-service teachers evaluated their students according to the alternative assessment approach. For example, PST2, PST3, PST5, PST7, and PST9 tried to determine students' prior knowledge and/or misconceptions about science topics and their learning at the end of the teaching process, starting from the beginning period to the end of the lesson (see Figure 2). When we examined the post-classroom practices, it was seen that PST1, PST4, PST6, and PST10 also evaluated students' learning more effectively in the science topics. Moreover, most pre-service teachers effectively used concept cartoons, diagnostic branched trees, assessment worksheets, and self-peer assessment methods and tools designed according to the learning outcomes of their lessons in the real classroom. PST2 and PST5 carried out this process more effectively than other pre-service teachers.

3.1.4. Technology integration

In terms of pre- and post-classroom teaching practices, PSTs benefited from various instructional technology/materials in their lessons (Figure 4). Additionally, PSTs stated in their pre- and post-lesson plans why and how they would use these instructional technology or materials in a real classroom. PSTs searched and downloaded some of the materials (such as videos) used in pre- and post-classroom teaching practices from various internet sites, prepared some of them (such as slide/presentation, worksheet) by developing existing instructional materials, and designed some of them (such as concept cartoons) by herself (see Figures 4 and 5). At this point, it was clear that the instructional technology/materials that PSTs used in their post-classroom practices were more effective in terms of their curriculum and instructional strategies than those used in pre-classroom practices. Accordingly, it was found that the technologies (slide/presentation, video, etc.) used by PSTs in pre-classroom practices were partially compatible with the lesson's learning outcomes and

the instructional methods and activities used. However, it was obvious that PSTs were not fully effective in using these technologies for instructional purposes in the real classroom. It was also seen that most of the PSTs used instructional technologies and materials to inform students about a science topic, explain the topic or summarize the information about the topic, and repeat the topic. For example, it was seen that PST1 and PST8 could not fully integrate technology into their lessons by making various explanations about the topic, by using the straight expression (direct explanation) method on a slide containing information, figures, and visuals related to the science topic.

Given post-classroom teaching practices, it was found that the instructional technology and materials that most of the PSTs used in the real classroom were more compatible with the learning outcomes of the lesson and the instructional methods and activities applied. Additionally, it was seen that PSTs were more effective in using technologies for instructional purposes. It was revealed that PSTs used presentations, videos, concept cartoons, worksheets, etc. to draw students' attention, to identify prior knowledge and/or misconceptions, to ensure active participation in the lesson, to eliminate students' misconceptions about a science topic, to create a discussion atmosphere, to assess their students' knowledge, and to give feedback. For example, it has been observed that PST2 and PST7 integrated instructional technology/materials into their lessons to explain scientifically a science topic, to enable students to observe a science event (such as lunar and solar eclipse) more realistically, and PST9 integrated instructional technology and materials into the lesson to present a problem situation related to a science topic (such as climate change) at the "elaborate" stage of 5E method. In addition, PSTs used smartboard/writing board instructional materials to express students' or PST's ideas by drawing figures/pictures or reflecting students' misconceptions to the class and discussing these ideas.

3.1.5. Communication and classroom management

When the pre-classroom teaching practices were examined, it was seen that most of the PSTs had poor classroom management skills, and they could not successfully perform their teaching process as described in the lesson plan, mostly due to the noise in the classroom. Besides, it was found that half of the PSTs had limited communication with their students in the real classroom. These findings could be attributed to several reasons such as PSTs not motivating students, not attracting attention (see Figure 2), not using appropriate instructional methods and activities (see Figure 3), students adopting PSTs as not a teacher or the reason that PSTs' are not using tone of voice and body language effectively in the real classroom. For example, it was observed that PST8 mostly stood at the teacher's desk while teaching in the classroom, and her voice did not reach the students in the back row. It was revealed that PST1, PST4, PST6, PST10, and PST8 have difficulties in adjusting the tone of their voice while teaching their lessons, sparking students' interest in the learning process, and providing clear explanations and instructions to the students in the classroom. It was observed that other PSTs communicated better with their students compared to these pre-service teachers. The findings also showed that PST2, PST7, and PST9 were more successful in classroom management than other PSTs.

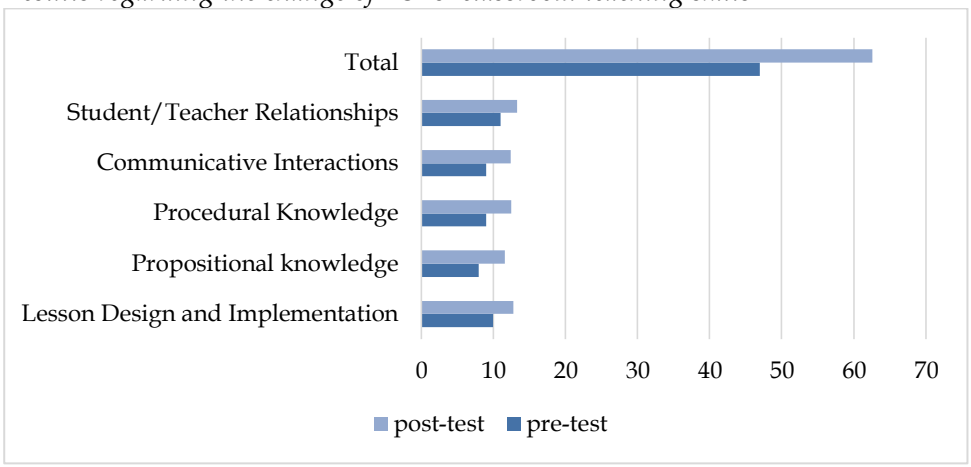
Contrary to pre-classroom teaching practices, when post-classroom teaching practices were examined, it was seen that most of the PSTs were more successful in classroom management, and they were able to carry out the teaching process as delineated in their lesson plans. It was also found that most of the PSTs were able to communicate effectively with students. For example, it was evident that PST2, PST3, PST5, PST7, and PST9 were more effective in supporting students' active participation in the lesson by asking thought-provoking and questioning questions appropriate to a science topic they taught, expressing students' opinions without hesitation, and providing student-student communication. Most of the PSTs explained the classroom rules to the students in a real classroom setting, encouraged them to participate in the lesson, tried to reinforce the students' positive behaviors, and motivated them (see Figure 3). For example, in the first 5-6 minutes of the lesson introduction, PST2 reminded the students of the classroom rules to be

followed during the lesson such as what students can do during the lesson, how to take turns (by raising their hands), she also added that everyone could express their opinions comfortably and answer after listening to the opinions of their peers, among many others. It was clear that her students followed these rules during her lesson. In addition, in post-classroom practices, most of the PSTs tried to be more patient with the students considering their gestures and facial expressions.

3.2.Quantitative Results

In this section, quantitative results from PSTs in classroom observation instruments were presented. The findings regarding the change of PSTs' classroom teaching skills during the study were given in Figure 6.

Figure 6
Results regarding the change of PSTs' classroom teaching skills



In Figure 6, a significant increase in favor of the post-test was observed when the post-test mean score results were compared to the pre-test mean scores of each subscale of RTOP.

Accordingly, it was determined that PSTs' classroom teaching skills related to content (propositional and procedural knowledge) and classroom culture-communicative interactions improved more than teaching skills germane to their lesson design and implementation and classroom culture-student/teacher relationships. PSTs' pre- and post-scores obtained from RTOP were given in Table 2.

The findings with regard to the change of PSTs' skills to integrate technology into classroom teaching during the study were provided in Figure 7.

Figure 7
Results regarding the change of PSTs' skills to integrate technology into classroom teaching

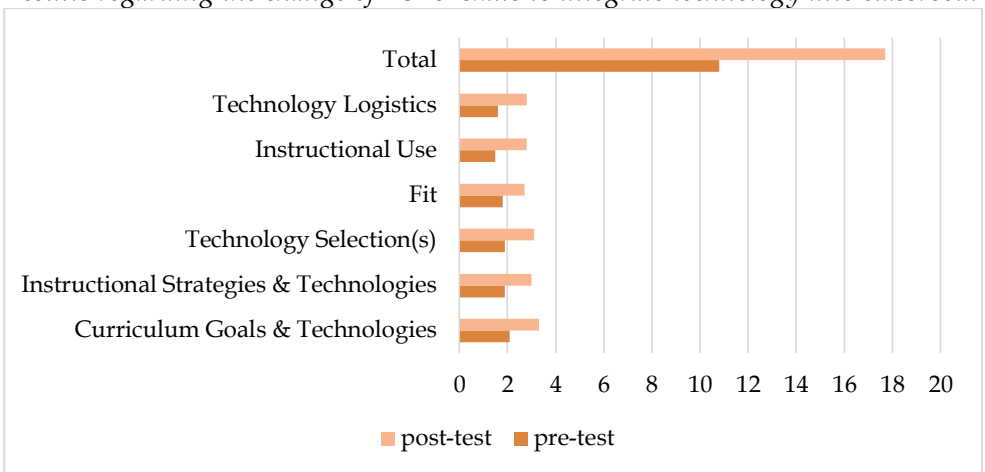


Table 2
Pre and post scores obtained from the RTOP

		PST1	PST2	PST3	PST4	PST5	PST6	PST7	PST8	PST9	PST10
Lesson Design and Implementation	Pre-test	9	12	13	7	12	8	15	3	12	9
	Post-test	11	17	16	9	15	12	16	7	14	11
Content-Propositional Knowledge	Pre-test	6	11	9	9	11	8	10	5	9	6
	Post-test	9	18	11	11	17	8	16	6	11	9
Content-Procedural Knowledge	Pre-test	8	13	10	5	11	7	13	4	8	8
	Post-test	9	20	14	8	14	11	18	8	13	10
Classroom Culture-Communicative Interactions	Pre-test	7	14	12	6	9	6	13	6	11	7
	Post-test	12	19	14	7	16	10	16	7	14	9
Classroom Culture-Student/Teacher Relationships	Pre-test	9	15	11	11	17	6	15	5	11	7
	Post-test	12	17	14	11	17	11	16	8	14	13

Table 3
Pre and post scores obtained from the TIOI

		PST1	PST2	PST3	PST4	PST5	PST6	PST7	PST8	PST9	PST10
Curriculum Goals and Technologies	Pre-test	2	3	2	2	2	2	2	2	2	2
	Post-test	3	4	3	3	4	3	4	3	3	3
Instructional Strategies and Technologies	Pre-test	2	3	2	2	2	1	2	1	2	2
	Post-test	3	4	3	3	3	3	3	2	3	3
Technology Selection(s)	Pre-test	2	3	2	2	2	1	2	1	2	2
	Post-test	2	4	4	3	4	2	4	2	3	3
Fit	Pre-test	2	2	2	2	2	1	2	1	2	2
	Post-test	3	3	3	2	3	3	3	2	3	2
Instructional Use	Pre-test	1	2	1	1	2	2	2	1	2	1
	Post-test	3	4	3	2	3	3	4	2	2	2
Technology Logistics	Pre-test	1	2	2	2	2	1	2	1	2	1
	Post-test	3	3	3	2	4	3	3	2	2	3

In Figure 7, a significant increase in favor of post-test was observed when the post-test mean score results were compared to the pre-test mean scores of each sub-component of the TIOI. Accordingly, it was found that PSTs' skills of integrating technology into classroom teaching related to instructional use, technology logistics, and technology selection improved more than their skills related to fit, curriculum goals and technologies, and instructional strategies and technologies. PSTs' pre- and post-scores obtained from TIOI were given in Table 3.

4. Discussion and Conclusion

This study attempted to unearth the impact of the reflective practices (reflection in, on, and for action) on PSTs' classroom teaching practices. Based on the qualitative and quantitative findings of the present study, it could be argued that there was a significant change in favor of the post-classroom practice results between the pre- and post-tests regarding the classroom teaching practices of the PSTs. The findings obtained from pre-classroom practices indicated that half of the pre-service teachers taught their lessons by using traditional teaching approaches and traditional assessment approaches whereas others taught their lessons by using the 5E method and alternative assessment approaches partially in the classroom setting. It was clear that pre-service teachers benefited from various instructional technologies and materials in their lessons, but they used them in a teacher-centered real classroom setting. In many studies in the literature, it was also claimed that pre-service teachers cannot perform effective technology integrations into their learning-teaching process (Kaya et al., 2013; Kılıç et al., 2019; Windschitl & Sahl, 2002). It was seen that half of the PSTs had limited communication with the students, and most of the PSTs were weak in classroom management in the real classroom setting. It was stated that the classroom practices of the pre-service teachers were not sufficient in the research (Kaya et al., 2013; Kılıç et al., 2019). The general reasons for this situation could be explained based on the fact that pre-service teachers did not carry out teaching practices related to their field in a real classroom setting in sufficient time, and they did not make reflections or self-evaluations regarding classroom teaching processes (Hew & Brush, 2007; Kaya et al., 2013; Loughran, 2002).

On the other hand, according to the qualitative and quantitative findings obtained from the post-classroom practices, it was determined that the classroom teaching skills of PSTs improved significantly. Accordingly, it was seen that most of the pre-service teachers made use of mostly student-centered activities introduction to the lesson, teaching, and assessment processes of their lesson, and they taught their lessons by applying these processes more effectively in the real classroom compared to the pre-classroom practices. In addition, it was found that pre-service teachers integrated various instructional technologies and materials into their lessons more effectively with instructional purposes and were more successful in classroom management. The general reason behind this situation was that they carried out activities based on the classroom practice process given in Figure 1. Because pre-service teachers carried out many activities such as reflective practices (reflection in, on, and for action) about their teaching skills and experiences especially in their classroom practices. In many studies in the literature, it was stated that reflective practices exerted an important effect on the development of pre-service teachers' classroom teaching practices (Bubnys & Zavadskienė, 2017; Farrell, 2013; Korucu-Kis & Demir, 2019; Pitsoe & Malla, 2013) and that reflective practices should be the basis of teacher education (Öner, 2010). It was stated that reflective practices played an essential role in stimulating pre-service teachers to question and reflect on themselves about "actions, behaviors, habits, decisions, and plans" (Özsoy, 2020, p.17). In their study, Wubbels and Korthagen (1990) predicted that there were significant differences between the reflective curriculum for pre-service teacher education and the traditionally conducted programs, and that more qualified teachers could be trained with curriculums in which reflective activities were carried out in general. It was also stated that the development of classroom practices of pre-service teachers could only be achieved by consciously and actively reflecting on their own teaching experiences (Farrell, 2013). In this sense, in the study, it could be said that the reflective practices carried out by the pre-service teachers in the process of

"reviewing and reflecting," in which they reflected their knowledge and skills about their experiences in the "planning" and " implementing" processes of the lessons they would teach in the real classroom, might contribute to the development of their classroom teaching skills and their skills for integrating technology into their classroom teaching. Studies have corroborated these findings (e.g., Kaya et al., 2013; Köksal & Demirel, 2008; Yiğit et al., 2010).

Another reason for the development of classroom practices of PSTs participating in the research might be in this process (see Figure 1), having discussions together with their peers and instructor in asynchronous online discussion forums on situations such as pre-service teachers' classroom teaching skills and their ability to integrate technology into classroom teaching. In addition, another reason might be that performing activities such as each pre-service teacher could be evaluated by their peers and instructor regarding their lesson plan and video-recorded lesson and receiving feedback from them and evaluating their peers and giving feedback. This situation enabled the pre-service teachers to participate in the research to communicate and interact more with their peers and instructor in small groups, to be aware of the weaknesses and strengths of both themselves and their peers, and to receive or provide appropriate feedback (Arkorful & Abaidoo, 2014; Ekiz, 2006; Milman, 2018; Yiğit et al., 2010). For instance, pre-service teachers exchanged ideas with their peers in these online discussion forums on many issues such as designing an activity to be implemented in the classroom, producing a solution to a problem related to teaching material, and discussing how technology can be effectively integrated into the teaching process or assessment process of the lesson, etc. This collaborative peer-feedback and peer-mentoring have also benefited in many ways as pre-service teachers develop their self-analysis (Farrell, 2016; Houde, 2018) and gain different perspectives (Burhan-Horasanlı & Ortaçtepe, 2016). Burhan-Horasanlı and Ortaçtepe (2016) emphasized that "online discussion forums can be designed to promote collegiality and mutual support so that pre-service and/or in-service teachers can engage in teacher interaction and collaboration within a professional learning community" (p.380). They also put forward that online discussion forums were an effective educational tool that could be used to support pre-service teachers' reflective practices (Burhan-Horasanlı & Ortaçtepe, 2016). In this regard, it could be claimed that not only the self-reflections of the PSTs about their classroom practice in the collaborative reflection process in Figure 1 but also the reflections and/or evaluations made by their peers and instructor about themselves might contribute to the development of pre-service teachers' teaching practices in the real classroom and might become effective. The literature emphasizes that it is essential for pre-service teachers to receive constructive feedback from their peers and instructor during the teaching practice process and exchange ideas about their teaching experiences in discussion settings (Bulunuz & Bulunuz, 2015; Farrell, 2016; Houde, 2018; Yiğit et al., 2010). In addition, another reason for developing classroom practices of PSTs in the real classroom setting might be the e-portfolio. Because in the present study, pre-service teachers uploaded lesson plans, their video-recorded lessons, instructional materials, and their reflective journals which they created by performing reflective practices during the classroom practice process (see Figure 1) into their e-portfolios. It could be addressed that this situation might contribute to the fact that pre-service teachers realized their professional development levels and/or deficiencies by evaluating the knowledge and skills they gained in this process and that they could take responsibility for their learning in the classroom practice process (Ekşioğlu, 2014; Hewett, 2004). In the literature, it is also recommended to use traditional tools such as reflective journals and technology-oriented tools such as online asynchronous discussion forums and web-based portfolios to promote pre-service teachers' reflective practices (Burhan-Horasanlı & Ortaçtepe, 2016; Houde, 2018; Öner & Adadan, 2011).

In recent years, it has come to the fore that teachers should be trained to take lessons about their classroom teaching practices. Therefore, it is suggested that they should be provided with the opportunity to reflect on their own teaching experiences and to question their experiences with a critical approach (Özcan, 2011). In addition, it is suggested in the literature that teachers should continue reflective practices (reflection in, on, and for action) throughout their careers (de Lima,

2014). It is also emphasized that process-based reflective practices might improve classroom teaching practices of pre-service and/or in-service teachers (Bubnys & Zavadskienė, 2017; Erginel-Şanal, 2006; Houde, 2018; Yiğit et al., 2010). From these perspectives, it can be suggested that courses such as teaching practicum, which aims to develop classroom teaching practice skills in teacher training programs (Öner, 2010), should be developed and conducted in line with reflective practices. In this study, it has also been found that the skills of PSTs to integrate technology into classroom teaching have improved along with their classroom teaching skills. Accordingly, reflective practices could improve pre-service and/or in-service teachers' skills to integrate technology into the learning-teaching process effectively. Kimmons et al. (2015) also suggested that "self-assessment on technology competency should be intertwined with reflective practices on how technology might be applied in classroom settings and with what outcomes" (p.827). The findings of this study provided necessary information on how to improve pre-service teachers' classroom teaching practices with reflective practices (reflection in, on, and for action). In this sense, we hope that this research study will contribute to the literature in terms of presenting concrete examples to researchers working in the field of teacher education on the development of classroom teaching practices of pre-service teachers.

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