

FACTORS OF PRE-SERVICE, NOVICE, AND EXPERIENCED CHEMISTRY
TEACHERS' SENSE OF EFFICACY BELIEFS: A QUALITATIVE STUDY

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ABSTRACT

FACTORS OF PRE-SERVICE, NOVICE, AND EXPERIENCED CHEMISTRY TEACHERS' SENSE OF EFFICACY BELIEFS: A QUALITATIVE STUDY

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This study aimed to explore the factors of pre-service, novice, and experienced chemistry teachers' sense of efficacy beliefs. For this purpose, a basic qualitative research design was utilized. Data were collected from eight pre-service chemistry teachers attending the chemistry education program at two different public universities in Ankara, seven novice and ten experienced chemistry teachers working in public and private schools through semi-structured interviews. For data analysis, content analysis and constant comparative methods were conducted. Two main themes that are internal and external factors emerged from the data. Results indicated that most pre-service and in-service chemistry teacher self-efficacy beliefs, which are situation- and context-specific, are affected by "mastery experience," one of Bandura's suggested four sources of self-efficacy. Moreover, results revealed that two other sources suggested by Bandura, which are "vicarious experience" and "verbal persuasion", were the influential factors of chemistry teachers' sense of efficacy beliefs. In addition to the sources suggested by Bandura, the other influential factors of chemistry teachers' sense of efficacy beliefs were explored as "knowledge," "disposition," "feedback," "student-related," "teacher-related," and "social environment in teaching."

The most frequently reported factors were "teacher preparation quality" for pre-service chemistry teachers and "pedagogical content knowledge" for novice teachers. On the other hand, "content knowledge" was frequently reported factor by experienced teachers. Compared with pre-service and experienced teachers, "student-related" and "social environment in teaching" factors were reported more frequently by novice teachers. Furthermore, the study findings have demonstrated that remote education during the COVID-19 pandemic has influenced pre-service teachers' sense of efficacy since it impacted "subject matter knowledge" and "pedagogical content knowledge" factors. Implications for teacher preparation and teacher professional development programs, and suggestions for future research in chemistry teacher education were addressed.

Keywords: Teacher self-efficacy, chemistry teaching, basic qualitative research

ÖZ

ÖĞRETMEN ADAYI, MESLEĞE YENİ BAŞLAYAN VE DENEYİMLİ KİMYA ÖĞRETMENLERİNİN ÖZYETERLİKLERİNİ ETKİLEYEN FAKTÖRLER: NİTEL BİR ÇALIŞMA

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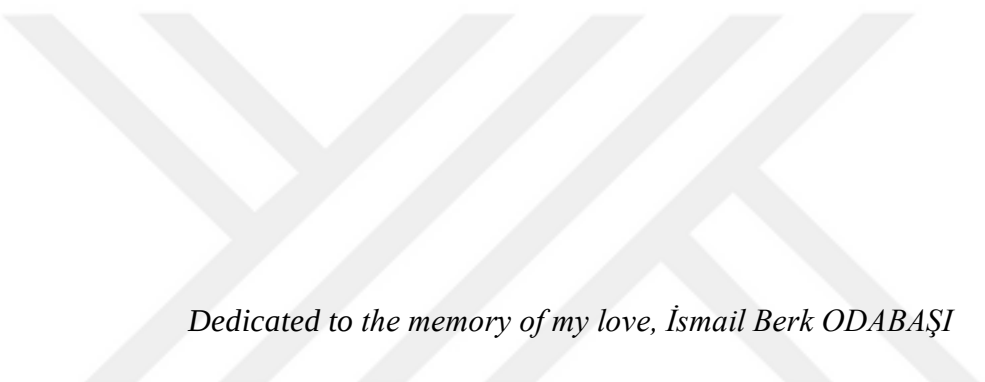
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Bu çalışma, öğretmen adayı, mesleğe yeni başlayan ve deneyimli kimya öğretmenlerinin özyeterliklerini etkileyen faktörleri belirlemeyi amaçlamaktadır. Bu amaçla temel nitel araştırma deseni kullanılmıştır. Araştırma için gerekli olan veriler, Ankara'da iki farklı devlet üniversitesinde kimya öğretmenliği programında öğrenim görmekte olan sekiz kimya öğretmen adayı ile devlet ve özel okullarda görev yapan mesleğe yeni başlamış yedi kimya öğretmeni ve deneyimli on kimya öğretmeni ile yapılan yarı yapılandırılmış görüşmeler yoluyla toplanmıştır. Verileri analiz etmek için içerik analizi ve sürekli karşılaştırmalı yöntemlerinden yararlanılmıştır. Çalışma sonuçlarına göre öğretmen adayı, mesleğe yeni başlayan ve deneyimli kimya öğretmenlerinin özyeterliklerini etkileyen faktörler "içsel" ve "dışsal" faktörler olmak üzere iki ana tema şeklinde ortaya çıkmıştır. Sonuçlar, öğretmen adayları ve hizmet içi kimya öğretmenlerinin çoğunun özyeterliklerinin, Bandura'nın öne sürdüğü dört özyeterlik kaynağından biri olan "doğrudan yaşantılar" dan etkilendiğini göstermektedir. Bandura'nın dört özyeterlik kaynağından "dolaylı yaşantılar" ve "sosyal ikna" da öğretmenlerin özyeterliğini en fazla etkileyen faktörler olarak belirlenmiştir. Ayrıca, çalışma sonuçları "öğretmen bilgisi," "yönelim," "geri bildirim," "öğrenci ile ilişkili," "öğretmen ile ilişkili" ve

"öğretimde sosyal ortam" faktörlerinin Bandura'nın dört özyeterlik kaynağı dışında öğretmen özyeterliğini etkileyen faktörler olduğunu göstermektedir.

Öğretmen adaylarının en sık belirttiği faktör “öğretmen ile ilgili faktörler”den "öğretmen yetiştirme programının kalitesi" olurken; "alan bilgisi" faktörü deneyimli kimya öğretmenlerinin ve "pedagojik alan bilgisi" faktörü de mesleğe yeni başlayan kimya öğretmenlerinin daha sık belirttiği faktörler olmuştur. "Öğrenci ile ilişkili" ve "öğretimde sosyal ortam" faktörleri, diğer öğretmen gruplarına göre mesleğe yeni başlayan öğretmenler tarafından daha fazla belirtilmiştir. Ayrıca, çalışma bulguları COVID-19 pandemi dönemi uzaktan eğitim sürecinde “alan bilgisi” ve “pedagojik alan bilgisi” faktörlerinin öğretmen adaylarının özyeterliğini etkilediğini göstermiştir. Çalışma kimya öğretmeni yetiştirme programları ve mesleki gelişim programlarına yönelik uygulamalar ve kimya eğitimi araştırmaları için öneriler sunmaktadır.

Anahtar Kelimeler: Öğretmen özyeterliği, kimya öğretimi, temel nitel araştırma



Dedicated to the memory of my love, İsmail Berk ODABAŞI

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CHAPTER 1

INTRODUCTION

This study aimed to explore the factors of pre-service, novice, and experienced chemistry teachers' sense of efficacy beliefs through basic qualitative research. This chapter includes the background of the problem, the significance of the study, and definitions of key terms.

1.1 Background of the Problem

Although chemistry as a branch of science is vital, learning chemistry has some difficulties because of its abstract nature (Taber & Garcia-Franco, 2010). In the process of learning science, the qualification of science teachers is as essential as the role of students (Fraser et al., 2012). The qualifications of teachers, encompassing their skills and knowledge, are one aspect, while their belief in their ability to effectively fulfill their duties indicates teacher quality (Çapa-Aydın et al., 2013). Bryan (2012) points out that "ignoring or marginalizing the role of teachers' beliefs in improving science education is essentially the same as ignoring the role of students' existing beliefs and knowledge in learning science" (as cited in Fraser et al., 2012, p.477). Regarding these notions, teachers' sense of efficacy is one of the key constructs influencing students' learning outcomes, such as their success in chemistry.

A teacher's sense of efficacy which is teacher efficacy, in short, is "the teacher's belief in his or her capability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context" (Tschannen-Moran et al., 2001, p. 233). Teacher efficacy is a construct grounded in Bandura's social cognitive theory (1986). In this theory, a triadic reciprocity model was proposed, an emergent interactive agency (Bandura, 1986). Self-

efficacy is defined by Bandura (1982) as stated, "perceived self-efficacy is concerned with judgments of how well one can execute courses of action required to deal with prospective situations" (p. 122). Unlike self-concept and self-esteem, self-efficacy is a task and context-specific construct (Bandura, 1997). According to Bandura (1997), self-efficacy is developed by cognitive evaluation of four primary sources: *mastery experiences* (past accomplishments and failures), *vicarious experiences* (observation of models), *verbal persuasion* (feedback that convinces one's ability), and *physiological and emotional arousal* (interpretation of somatic indicators). Social cognitive theory emphasizes that teachers' self-efficacy is as crucial as student self-efficacy in achieving success because teachers' self-efficacy beliefs affect what they do before, during, and after their teaching (Ashton & Webb, 1986; Tschannen-Moran et al., 2001).

The four sources put forward by Bandura (1997) as sources of self-efficacy are suggested by researchers to be effective in explaining the sources of teacher self-efficacy (Tschannen-Moran et al., 1998). However, researchers have been attempting to find other possible sources and factors affecting teachers' self-efficacy. For example, knowledge of the teachers, personal motivation, personality characteristics, school context variables, and teacher education programs have been found to be important sources of teacher efficacy (Ramey-Gassert et al., 1996; Palmer, 2006; Paulo, 2007; Cheung, 2008; Can, 2015).

A large body of literature has investigated science teachers' efficacy beliefs by comparing pre-service and in-service teachers' years of teaching experience (e.g., Azar, 2010; Batool & Shah, 2018; Penter & Garvis, 2011; Wenner, 2001). Previous studies have revealed contradictory findings regarding the relationship between teaching experience and teaching efficacy. While some studies indicate that experienced teachers demonstrate higher teaching efficacy than pre-service and novice teachers, other studies suggest that pre-service teachers exhibit higher levels of teacher efficacy. This study aims to comprehensively examine the factors influencing self-efficacy in chemistry teaching among chemistry teachers based on their years of teaching experience. With this aim, qualitative data were collected

from pre-service, novice, and experienced chemistry teachers to compare the factors of their sense of efficacy beliefs. . Therefore, this study aims to pursue the answer to the research question stated below.

What are the factors of pre-service, novice, and experienced chemistry teachers' sense of efficacy beliefs?

1.2 Significance of the Study

In Organisation for Economic Co-operation and Development (OECD) countries, approximately 20% of 15-year-old students are enrolled in schools with a shortage of qualified science teachers (OECD, 2012). This scarcity of teachers has significant consequences as it poses a societal challenge. The demand for well-educated science educators is crucial for the future global workforce; thus, it is essential to have competent science teachers to raise scientifically literate people. (e.g., Cheng et al., 2020; Rooij et al., 2019; Wang et al., 2017). There is evidence that teacher self-efficacy plays a pivotal role in learning and teaching (e.g., Gibson&Dembo, 1984; Usher & Pajares, 2008; Regier, 2020); in other words, teachers with high teacher self-efficacy is the necessary step for effective science teaching practices. Examining the factors that influence chemistry teaching efficacy is crucial for understanding how to motivate teachers to effectively teach science and overcome barriers in science education (Palmer, 2006).

Regarding the notion that teacher self-efficacy is a situational or contextual construct rather than a global personality trait (Tschannen-Moran et al., 1998), existing research on chemistry teachers' self-efficacy primarily centers around their overall belief in chemistry (e.g., Uzuntiryaki, 2008) or specific skills like ICT proficiency (Blonder et al., 2013), leaving a significant gap in understanding secondary chemistry teachers' self-efficacy specifically related to chemistry instruction (Krause et al., 2017). The current study offers a fresh perspective on factors that influence chemistry teaching efficacy.

According to Tschannen-Moran (1998), gaining a deeper understanding of the factors that either facilitate or hinder the formation of efficacy beliefs among teachers at different career stages would be precious. Hence, teacher efficacy research shows a need for more qualitative research studies to delve into the significance teachers attribute to teacher efficacy and examine sources and factors of teachers' sense of efficacy beliefs. Although researchers have called for investigations on sources of efficacy information (e.g., Henson, 2002; Tschannen-Moran & Woolfolk Hoy, 2002), scant qualitative studies have been done on the factors of teachers' sense of efficacy (e.g., Klassen et al., 2011; Wang et al., 2017; Wyatt, 2014). Accordingly, this study uses a qualitative study approach to explore factors of pre-service and in-service chemistry teachers' sense of efficacy beliefs.

When the relevant literature is reviewed, many studies have compared the teacher efficacy beliefs of pre-service and in-service teachers (e.g., Azar, 2010; Putman, 2007; Wenner, 2001). On the other hand, very little is currently known about factors of pre-service and in-service teachers' sense of efficacy beliefs and the comparison based on those factors. Moreover, there is a call for future investigation focusing on how the contribution of each source, or the integration of the information from each source on teacher self-efficacy, changes with career stage (e.g., Pfitzner-Eden, 2016; Tschannen-Moran et al., 1998). Therefore, this study attempts to explore and compare the factors of the sense of efficacy beliefs of pre-service, novice, and experienced chemistry teachers.

The results of this study offer a deeper understanding of the process by which secondary school chemistry teachers develop their beliefs in chemistry teaching efficacy. Accordingly, the implications derived from this study provide valuable guidance for teacher preparation and professional development programs to enhance chemistry teaching self-efficacy, ultimately leading to improved chemistry instruction. Since teacher efficacy beliefs were shaped in early career stages (Tschannen-Moran et al., 1998), the findings of this study can help teacher educators to design the contents of courses and focus on practices to enhance teacher efficacy of pre-service teachers. Moreover, examining factors that support

or inhibit novice teachers' sense of efficacy beliefs would benefit practitioners and educational policymakers to reinforce their sense of efficacy which resists change after it is formed. Since the results provide valuable insights into novice and experienced chemistry teachers' professional growth experiences and other factors which led to highly efficacious chemistry teaching, professional development programs can be designed to improve both novice and experienced chemistry teachers' sense of efficacy in chemistry teaching by considering their needs which may differentiate at different career stages.

Furthermore, the study aims to contribute to the relevant literature by examining the factors of pre-service, novice, and in-service chemistry teachers' sense of efficacy beliefs in depth. Researchers can conduct quantitative and qualitative studies based on the results of this study providing new insights into pre-service, novice, and experienced chemistry teachers' efficacy beliefs.

1.3 Definitions of key terms

Self-efficacy: The term self-efficacy will be used in this thesis to refer to people's beliefs in their own capabilities to achieve a specific task (Bandura, 1986,1997).

Teachers' sense of efficacy: While a variety of definitions of the term teachers' sense of efficacy have been suggested, this study will use the definition suggested by Tschannen-Moran et al. (1998) as the teacher's belief in his or her capability to organize and execute the course of action required to accomplish a specific teaching task in a particular context.

Chemistry teaching efficacy: In this study, it refers to chemistry teachers' beliefs in their ability to teach chemistry (Rubeck & Enochs, 1991).

Pre-service teachers: Chemistry teacher candidates studying at the education faculties of universities will be described as pre-service teachers (Goulette & Swanson, 2018).

Novice teachers: Chemistry teachers with five years or less than five years of teaching experience will be described as novice teachers (Kim & Roth, 2018).

Experienced teachers: Chemistry teachers with more than five years of teaching experience will be described as experienced teachers (Kim & Roth, 2011).

Mastery experience: In this study, the term mastery experience will refer to chemistry teachers' interpretations of their past enactive teaching experience regarding their achievements and failures (Bandura, 1997).

Vicarious experience: The term vicarious experience will describe chemistry teachers' judgments of their experiences gained by observing the achievements and failures of the models while doing similar tasks (Bandura, 1997).

Verbal persuasion: Verbal encouragement that chemistry teachers receive from significant others about their teaching performance will be defined as verbal persuasion (Bandura, 1997).

Physiological and emotional arousal: Teachers' interpretation of somatic indicators and emotional states such as fear, anxiety, mood, and stress influence their efficacy beliefs will be defined as physiological and emotional arousal (Bandura, 1997).

Cognitive processing: Throughout this paper, the cognitive processing term will refer to selecting, weighing, and integrating different sources of efficacy information (Bandura, 1997).

CHAPTER 2

LITERATURE REVIEW

In this chapter, theoretical framework of this study and related literature will be presented. Under the theoretical framework, Bandura's social cognitive theory which comprehends self-efficacy, and its sources was given. Moreover, teacher efficacy beliefs constructed by these theories and integrated model of teacher efficacy were described in detail. In the last part, related literature about the teacher efficacy and factors affecting teacher efficacy will be followed theoretical framework.

2.1 Social Cognitive Theory

Social cognitive theory is a theory that was developed to explain how the individual learns since human behavior cannot be fully explained by behaviorist theories arguing that only external factors shape behavior (Bandura, 1986). The origin of social cognitive theory dates back to the 1970s. In the past, it is often labeled as a social learning theory highlighting that motivation and social variables were also vital in human behavior (Schunk & DiBenedetto, 2019). According to Bandura's earlier social learning theory (1977), "behavior is learned, at least in rough form, before it is performed by observing a model of the desired behavior" (p. 8). For observational learning to take place, people need to pay attention to a model, cognitively retain what the model did, be able to replicate the action they saw and be motivated (Bandura, 1977). Bandura's research had taken a more holistic focus by the mid-1980s, and his analyses tended to provide a more inclusive overview of human cognition in the context of social learning.

By expanding social learning theory, Bandura (1986) developed social cognitive theory, which provides a framework for understanding, predicting, and changing

human behavior (Green & Peil, 2009; Nabavi & Bijandi, 2011). In social cognitive theory, Bandura modified social learning theory by focusing heavily on cognitive concepts. Moreover, Bandura (1986) explained the social cognitive theory in terms of a model of *triadic reciprocity* where "behavior, cognitive, and environmental events all operate as interacting determinants of each other" for humans (p.18). The determinants in this model given as a triangle are presented in Figure 2.1.

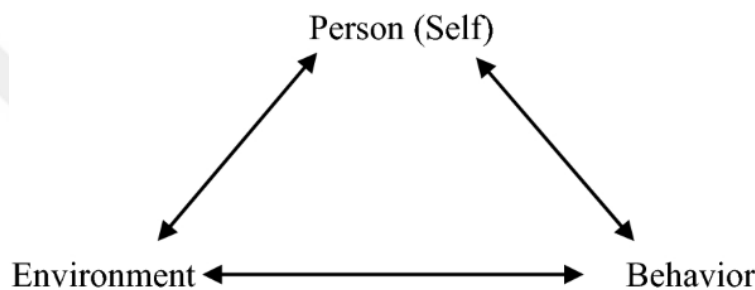


Figure 2.1 Representation of the "triadic reciprocal model" (Bandura, 1986, p.4)

In this model, cognitions, beliefs, biological properties, emotions, and goals are examples of personal factors comprising processes that aid in initiating and maintaining motivational outcomes (Schunk & Usher, 2019). Moreover, behavioral factors have been considered as the choice of activities, effort, persistence, achievement, and regulation of the environment (Schunk & DiBenedetto, 2019). Finally, the environment is composed of social factors (e.g., social models, feedback) and situational factors (e.g., task characteristics, standards) (Carillo, 2010; Schunk & DiBenedetto, 2019). Apart from one-sided determinism, where behavior is formed by either internal disposition or environmental factors, all personal, behavioral, and environmental factors interact to create a desired effect in human behavior in this model of triadic reciprocity. That is, social cognitive

theory acts according to the basic principle of mutual determination. This model consists of two-way mutual interactions between the person, his behavior, and his environment. Firstly, the mutual interaction between person-behavior is explained as what people believe, expect, and desire influences their actions, whose results also affect personal characteristics, which are beliefs, goals, and expectations (Bandura, 1986). In turn, the natural and extrinsic effects of people's actions partly determine their thought patterns and emotional reactions (Bandura, 1989). For example, learners' efforts to complete a task successfully can be focused on and maintained by setting goals which are personal processes. As learners work on tasks, they observe their progress toward their goals, developing their beliefs about their competence for further tasks (Schunk, 2012).

Secondly, a bi-directional interaction occurs between the person and the environment. In this two-way interaction, personal characteristics, which are cognitive competencies, beliefs, and expectations of people, can be enhanced and changed by environmental factors, such as social factors that convey information and stimulate emotional responses through instruction, modeling, and social persuasion (Bandura, 1989). At the same time, socially conferred roles and statuses of people can activate different social reactions elicited to affect the peoples' conceptions of themselves (Snyder, 1981 as cited in Bandura, 1989). Finally, according to Bandura (1989), the environment always affects behavior, which is not a fixed entity. However, most aspects of the environment do not operate as a factor until they are activated by appropriate behavior. That is, the reciprocal determinism of behavior and environment is stated as people are not only producers of their environment but also products of their environment (Bandura, 1986).

In social cognitive theory, it can be concluded that all three types of mutual interactions affect behavior. Nonetheless, the effects of these interactions on human behavior may not be the same. It is argued that the effect of any interaction depends on the individual, the behavior being investigated, and situational and social factors (Bandura, 1986). Bandura (1989) explained that "Reciprocal

causation does not mean that the different sources of influence are of equal strength. Some may be stronger than others. Nor do the reciprocal influences all occur simultaneously. It takes time for a causal factor to exert its influence and activate reciprocal influences" (p.3). For example, three factors typically interact with each other in the classroom, but environmental factors predominate when there are many rules and regulations (Schunk & Pintrich, 2014).

Social cognitive theory subscribes to a model of *emergent interactive agency* where people are neither driven by inner forces nor automatically shape their behavior regarding external stimuli (Bandura, 1986). People contribute to their behavior, development, and motivation within a network of reciprocal interactions; thus, Bandura (1997) proposes the idea of human agency as a crucial aspect of reciprocal determinism. For Bandura (1997), "people can exercise influence over what they do," and he introduces human agency as "acts done intentionally" (p.3). Therefore, intentionality, which is related to the representation of a future course of action to be performed, is one of the core features of human agency (Bandura, 2006). Within this theoretical framework, people are described in terms of six fundamental capabilities, which are central to their functioning and characterize them as human, -can be listed as (i) *symbolizing capability*, (ii) *forethought capability*, (iii) *vicarious capability*, (iv) *self-regulatory capability*, and (v) *self-reflective capability* (Bandura, 1986; Bandura, 1989).

Symbolizing capability is defined as the capability of humans to use symbols as a powerful tool that helps them understand and manage their environment. Cognitive processes play a significant role in determining how external influences affect behavior. People use symbols, such as verbal and imaginal, to transform experiences into cognitive models of reality, which serve as guides for decision-making and action. Symbols provide meaning, form, and continuity to experiences and serve as the "vehicle of thought" (Bandura, 1989, p.9). By symbolically manipulating information derived from personal and vicarious experiences, people gain an understanding of causal relationships and expand their knowledge.

Forethought capability is the capacity to envision and plan for future events or possibilities by considering the potential consequences of actions or decisions. It involves anticipating challenges, setting goals, and developing strategies to achieve them. Individuals with a high level of forethought capability can think ahead and consider multiple scenarios, weighing the risks and benefits of each and making informed decisions based on this analysis. By considering the possible consequences of their actions, people are able to make decisions that are more likely to lead to positive outcomes rather than negative ones. In other words, people set goals and use their anticipatory abilities to guide their actions toward achieving them (Bandura, 1989; Bandura, 2005).

According to Bandura's social cognitive theory (1986), *vicarious capability* refers to the ability to learn and develop skills by observing the behavior of others and the consequences of that behavior and then modeling those behaviors. Through vicarious capability, people can learn without the need for trial and error, which can often have costly consequences (Bandura, 1989). Humans have evolved an advanced capacity for observational learning that enables them to expand their knowledge and skills based on information conveyed by modeling influences. Bandura (1989) asserts that the four main processes governing observational learning are attentional span, retention, behavioral production, and motivational processes. First, how people pay attention to modeling influences and extracting information from them is determined by attentional processes. Retention involves actively transforming and restructuring the information conveyed by modeled events into rules and conceptions in memory using symbolic information. The third subfunction is the behavioral production process, where symbolic conceptions are translated into appropriate courses of action. Finally, motivational processes are the fourth modeling subfunction concern (Bandura, 1989). According to Bandura (1986), social cognitive theory differentiates between acquisition and performance because individuals do not necessarily perform everything they learn. Instead, individuals are more likely to exhibit modeled behavior if it leads to positive outcomes as opposed to negative consequences. Therefore, individuals tend to adopt behaviors associated with favorable results in terms of their observations.

People can manage their motives and behaviors through self-regulation, which includes setting goals, monitoring progress, and adjusting behavior as needed to achieve desired outcomes. In other words, people establish personal standards, regularly assess their performance compared to these standards, and use this information to motivate themselves to improve their performance and adopt new habits in subsequent acts (Bandura, 1986; Bandura, 1989).

Self-Reflective capability is the capacity for self-reflective awareness (Bandura, 1989). Specifically, it is the ability of people to analyze their experiences, keep track of and assess their cognitive processes, and adjust their thinking and behavior accordingly. Bandura (2001) notes that "people are not only agents of action but self-examiners of their own functioning" (p.3). The notion of self-efficacy is the most significant type of self-reflection. In social cognitive theory, self-efficacy is viewed as a crucial determinant of human agency, which refers to the capacity of individuals to shape their own lives and the events that affect them. Since human agency manifests itself in intentional acts, cognitive and affective processes, and self-regulation, it is affected mainly through self-efficacy (Schunk & Pintrich, 2014).

2.1.1 Self-efficacy

Self-efficacy is the key construct grounded in social cognitive theory. Bandura (1997) defined self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p.3). According to Bandura (1986), an individual's self-efficacy influences motivation, thought patterns, and behavior. Self-efficacy judgments are "concerned not with the number of skills you have, but with what you believe you can do with what you have under various circumstances" (Bandura, 1997, p. 37). Accordingly, self-efficacy affects the goals individuals set for themselves, how much they strive to achieve these determined goals, their persistence, how they perceive success, how much they will struggle against negativities, and their behaviors in case of failure (Bandura, 1997). According to Pajares (1996), an individual's subsequent

performances are affected by their level of self-efficacy. At the same time, an individual's self-efficacy beliefs are also influenced by how they interpret the results of their past performance achievements. In other words, an individual's belief in their ability to perform a task influences their subsequent performances, and their interpretation of their performance results affects their self-efficacy beliefs.

In accordance with social cognitive theory, self-efficacy as a personal factor interacts with environmental and behavioral factors. It can be exemplified within the educational context, self-efficacy, can influence students' choice of tasks, persistence, and effort in their academic work. As students work on tasks, their progress toward their goals can enhance their self-efficacy for further learning. Moreover, the interaction between personal and environmental factors can impact students' self-efficacy and academic performance. For instance, students with learning disabilities may have lower self-efficacy about performing well (Licht & Kistner, 1986 as cited in Schunk & Pintrich, 2014), and the environment can influence this, including how teachers perceive and respond to them (Schunk & Pintrich, 2014).

None of the mechanisms by which human activity is brought to life is more tangible than people's belief about their personal competence to exercise control over events that affect their lives (Bandura, 1989). If people do not believe their actions can produce the desired results, they have little courage to resist or take action in the face of difficulties (Bandura, 1997). Four basic psychological mediating processes in which self-efficacy beliefs affect human behavior are (i) *cognitive processes*, (ii) *motivational processes*, (iii) *affective processes*, and (iv) *selection processes* (Bandura, 1989; Bandura, 1997).

Self-efficacy beliefs influence thought patterns which can enhance or undermine performance (Bandura, 1997). For instance, human behavior is primarily regulated by the importance of achieving valued goals. An individual's perceived ability to achieve these goals strongly influences personal goal setting. The stronger an individual's self-efficacy, the higher the goals they set for themselves and the more

committed they are to achieving them. Individuals' beliefs about their competence can also shape their expectations and thought processes. People with strong self-efficacy beliefs envision success scenarios that provide positive guidance and support performance, while those with doubts tend to visualize failure scenarios and focus on potential obstacles (Bandura, 1989). Moreover, self-efficacy beliefs play a crucial role in the self-regulation of motivation. Most human motivation is generated through cognitive processes and self-evaluation, with individuals motivating themselves and directing their actions based on their expectations and beliefs about what they can do. For instance, individuals with high self-efficacy attribute their failures to insufficient effort, whereas those who doubt their abilities attribute their failures to a lack of ability (Bandura, 1997).

Furthermore, beliefs in one's capabilities impact the stress, depression, and motivation experienced in challenging situations. These emotional reactions can influence actions by affecting the individual's thoughts. For example, people who believe they can control threats do not think about disturbing thought patterns. On the other hand, people who believe they cannot manage threats experience high levels of anxiety stimulation. People can withstand challenges and difficulties when they develop a resilient sense of competence (Bandura, 1989; Bandura, 1997). Finally, self-efficacy affects individual choices of continuity, effort, and activity. Humans are partly the product of their environment. Their beliefs of personal competence shape the life process by influencing the behaviors people choose and their environment. People avoid activities and situations that they think will exceed their ability to cope, and they choose and undertake challenging activities that they think they can overcome. Any factor affecting selection behavior affects the direction of personal development (Bandura, 1997).

Several noteworthy characteristics of self-efficacy should be emphasized. Firstly, the definition of self-efficacy can be challenging to understand due to the presence of similar concepts such as self-concept, self-esteem, and outcome expectancy. However, according to Bandura (1997), self-efficacy is distinct from these other constructs as it involves judgments about one's abilities for a particular task.

Therefore, self-efficacy differs due to its context and task-specificity rather than being a global construct (Bandura, 1997). On the other hand, self-concept is a broad term that encompasses people's beliefs and attitudes about themselves, including their abilities, traits, and values, and it affects their general outlook on life. Bandura (1997) clarified this difference as "even if the global self-conception is tied to certain areas of functioning, it does not do justice to the complexity of efficacy beliefs which vary across different domains of activities, within the same activity domain at different levels of difficulty and under different circumstances" (p.11). Moreover, self-efficacy, which is concerned with evaluating one's capacity to carry out specific activities in particular contexts, differentiates from self-esteem, which is related to judgments of self-worth (Bandura, 1997). According to Bandura (1997), beliefs about people's capabilities do not necessarily determine whether they like or dislike themselves. For example, even if one thinks she cannot teach a chemistry subject, she might not experience any loss in her self-esteem.

According to social learning theory, behavior depends on self-efficacy and *outcome expectancy*. While personal self-efficacy is an individual's beliefs about their ability to perform, outcome expectancy is defined as "a person's estimate that a given behavior will result in certain outcomes." (Bandura, 1997, p.193). Although people believe certain behaviors lead to specific outcomes, they may not have confidence in their ability to perform the behavior. Self-efficacy and outcome expectancy can influence each other. For instance, someone with low self-efficacy may expect negative outcomes from a particular behavior, while someone with high self-efficacy may expect positive outcomes from the same behavior (Bandura, 1999).

Secondly, the social cognitive theory asserts that all forms of self-efficacy constructs, personal and collective are future-oriented judgments about one's capability to execute a specific action (Bandura, 1997). Future-oriented characteristics of self-efficacy are clarified by Hoy (2004) as "self-efficacy beliefs are about the future, about what I will be able to do in a particular situation, not what I already accomplished or why I accomplished it in the past" (p.3).

Finally, Bandura (2006) stated that there could not be a single criterion to determine self-efficacy due to its domain specificity. For this reason, it is necessary to adapt self-efficacy measurements accordingly. In other words, self-efficacy measurements require multidimensional assessment methods rather than a single scale. After Bandura introduced self-efficacy to psychology, researchers examined its role in various fields such as education, work, athletics, career, and health (Schunk & Pajares, 2009). For example, students' self-efficacy beliefs in the context of science education, particularly in the field of chemistry, were examined by different scales (e.g., Alkan, 2016; Scherer, 2013; Uzuntiryaki-Kondakci & Capa-Aydin, 2008).

2.1.1.1 Bandura's Sources of Self-efficacy

Bandura (1997) pointed that the self-efficacy beliefs are developed and influenced by four main sources: (i) *mastery experiences*, (ii) *vicarious experiences*, (iii) *verbal persuasion*, and (iv) *physiological/ emotional arousal*. Self-efficacy beliefs are developed in progress of time, after developing they resist to change. These information sources are processed cognitively to develop efficacy beliefs. Bandura (1997) suggested efficacy beliefs as "the product of cognitive processing of diverse sources of efficacy information conveyed enactively, vicariously, socially, and physiologically" (p.115). He argues that two separate functions are involved in the cognitive processing of efficacy information. The first function involves selecting and using specific types of information as indicators of personal efficacy, which varies for each of the four sources of efficacy information. The second function focuses on the rules and heuristics individuals use to weigh and combine efficacy information to form personal beliefs about efficacy. The capacity to effectively assess and incorporate relevant sources of efficacy information is enhanced by developing cognitive skills, which allow individuals to process information. These skills involve attentional, memory, inferential, and integrative cognitive capabilities that facilitate the formation of self-conceptions of efficacy. For instance, it is necessary to compare self-appraisals to actual accomplishments to verify the

accuracy of one's self-assessment. If the self-appraisals align with actual achievements, it validates one's self-appraisal skills. However, if there are repeated mismatches, it raises questions about one's ability to judge their competencies accurately (Bandura, 1997).

2.1.1.1.1 Mastery Experience

Enactive mastery experience is considered the most effective source of self-efficacy beliefs among the other sources proposed by Bandura (1997), as they provide tangible evidence of an individual's capabilities. Successful performances contribute significantly to forming a solid belief in one's self-efficacy. On the other hand, failures can undermine an individual's self-efficacy beliefs if self-efficacy belief is not established firmly. An individual's successful performance of a particular task is likely to enhance their self-efficacy beliefs, which, in turn, increase their anticipation of success in the future. The extent to which people change their efficacy beliefs through their mastery experience is dependent on several factors, including the preconceptions of their capabilities, the perceived difficulty of the task, the amount of effort they expend, the amount of support they receive, the circumstances where they perform, the pattern of their successes and failures, and how these experiences are cognitively organized and constructed (Bandura, 1997; Poulou, 2007).

Furthermore, it is essential to note that not all successful performance necessarily leads to increased self-efficacy. Individuals must attribute their success to their efforts and abilities rather than external factors such as luck or chance (Bandura, 1997; Pajares, 1996). Individuals are more likely to experience a boost in self-efficacy if they encounter challenges and overcome them rather than if the task is too easy or difficult. It is worth noting that an individual can perform and achieve a task effortlessly, which can easily undermine their efficacy beliefs after failing the task. Therefore, a reinforced sense of self-efficacy requires experience in overcoming obstacles with determined efforts. Individuals resist failure or problems when they believe they have enough power to succeed (Bandura, 1997).

In educational context, a large body of research shows that mastery experience is the most influential source of self-efficacy (e.g., Arslan, 2012; Britner& Pajares, 2006; Capa-Aydin et al., 2018; Wallace & Mulholland, 2001; Uzuntiryaki, 2008).

2.1.1.1.2 Vicarious Experience

Bandura (1997) claimed that mastery experience does not affect self-efficacy solely. Another source of efficacy introduced by Bandura (1997) is vicarious experience, gained by observing others while experiencing. People with limited enactive experience in a specific task use vicarious experience judgments to develop their sense of efficacy. Bandura (1997) suggested that when individuals observe others achieving success, they cognitively process their own performance in similar circumstances. As a result, modeling is an effective tool that enhances one's sense of efficacy beliefs.

Modeling is a form of social comparison and can take several forms: *effective actual modeling*, where models are actual performers (e.g., chemistry teachers observe other teachers' successful performance in a classroom setting); *symbolic modeling*, where the models are performers in visual media (e.g., chemistry teachers observe other teachers' successful performance in a classroom setting); *self-modeling* (e.g., chemistry teachers videotape their teaching performance and reflect on their performance); *cognitive self-modeling* (e.g., chemistry teachers imagine that they perform teaching successfully) (Bandura, 1997).

People cognitively process what they observe; in judging personal efficacy through social comparisons, performance similarity is highlighted as "one factor that increases the personal relevance of modeled performance information to observers' beliefs of their own efficacy" (Bandura, 1997, p.96). If people observe a similar model (e.g., age, gender, or experience) who can achieve a given task, they believe they can perform it well. On the other hand, if they observe a similar model that fails in the performance, although they put in an effort, their sense of efficacy may lower (Bandura, 1986). Moreover, observing competent models raise self-efficacy

beliefs regardless of perceived dissimilarities in personal attributes (e.g., age, gender, or experience) since they provide information about how to cope with difficulties and what are the necessities of mastery performance (Bandura, 1997). Several studies show that vicarious experience is an influential source in the educational context (e.g., Bartsch et al., 2012; Capa-Aydin et al., 2018; Phan, 2012).

2.1.1.1.3 Verbal Persuasion

Verbal persuasion encompasses verbal encouragement, appraisal, and performance feedback provided by significant others, which serves to strengthen individuals' beliefs in their capabilities to achieve tasks. Bandura (1997) acknowledged that verbal persuasion alone might not be enough to establish long-lasting self-efficacy beliefs, but it can reinforce self-efficacy by stimulating effort and persistence. The most effective utilization of verbal persuasion occurs when it is combined with an assessment of actual performance, fostering a positive sense of efficacy. Several factors influence the effectiveness of verbal persuasion, including the framing of performance feedback, the persuader's credibility, and the alignment between the appraisal and actual performance (Bandura, 1997).

In framing performance feedback, efficacy beliefs are strengthened through evaluative feedback emphasizing personal capabilities. While effort attributions play a role in the development of efficacy beliefs, feedback regarding one's abilities has a greater impact on enhancing self-efficacy (Schunk, 1984). Moreover, individuals are likely to resist verbal persuasion when they perceive themselves as having superior knowledge of both their capabilities and the task requirements compared to the persuader. Bandura (1997) notes that significant others highlighting persuaders' credibility and expertise show persuasion's power. In other words, people cognitively weigh verbal information they receive from a persuader regarding the persuader's credibility, trustworthiness, and expertise. For example, in an educational context, it is crucial to recognize and respect the expertise and

knowledge of the supervisor, mentor, or consultant for performance feedback to enhance personal efficacy beliefs (Labone, 2004).

Finally, verbal persuasion should be given within realistic boundaries to enhance one's self-efficacy. On the other hand, unrealistic boosts are readily disconfirmed by the results of one's action. Thus, people quickly reject illusory increases in their competence (Bandura, 1986; Bandura, 1997). Therefore, verbal appraisals that aim to persuade someone are most effective when they slightly surpass the person's current performance level rather than being too far beyond it. For these appraisals to positively impact one's sense of efficacy, the individual should already possess a sufficient skill foundation. Much of the literature on academic self-efficacy is concerned with verbal persuasion as one of the influential sources (e.g., Arslan; 2012; Britner, 2008; Phan 2012).

2.1.1.1.4 Physiological and Emotional Arousal

People judge their skills based on somatic information derived from physiological and emotional states, including sweating, excitement, fear, anxiety, and mood, mainly related to personal accomplishments and health functioning. Bandura (1997) argues that efficacy beliefs are not solely determined by physiological or affective states but are influenced by cognitive processes and the integration of efficacy-related information from various sources (Poulou, 2007). Accordingly, when people form judgments about their efficacy, they must consider multiple sources of information related to efficacy. That is, individuals need to integrate efficacy information from multiple sources and convey it to cognitive, motivational, affective, or decision-making processes (Milner & Hoy, 2003). In other words, forming efficacy judgments involves synthesizing information about one's capabilities, experiences, emotions, and decision-making processes.

Correct interpretation of bodily responses along with strengthening the physical condition, reducing stress and negative emotional tendencies will enhance one's self-efficacy perception (Bandura, 1997). Studies conducted in educational settings

have revealed various scenarios that shed light on the relationship between physiological and affective states and efficacy beliefs. For instance, when individuals experience an elevated heart rate during a task, it may be perceived as a signal of inadequate ability to perform that particular task (Schunk, 1991). On the other hand, combining a positive mood and achieving success can strengthen students' beliefs in their efficacy (Usher & Pajares, 2008). Conversely, students with low self-efficacy tend to experience anxiety in academic situations (Pintrich & De Groot, 1990).

2.2 Teachers' Sense of Efficacy

Possessing the necessary knowledge and abilities does not ensure that a performer can act successfully (Bandura, 1997). Effective action instead relies on the individual's belief to use their knowledge and abilities in various situations successfully. Bandura (1997) refers to this as self-efficacy; in educational contexts, it manifests as *teacher efficacy*. The concept of teacher efficacy was first studied by RAND researchers (Armor et al., 1976; Berman et al., 1977), and the measurements of teacher efficacy beliefs in these studies were based on Rotter's (1966) locus of control theory. According to their studies, RAND researchers defined teacher efficacy construct as "the extent to which teachers believed they could control the reinforcement of their actions" (Tschannen-Moran et al., 1998, p. 202). Under the influence of Rotter's theory, other researchers developed various scales, which were more comprehensive than RAND items, to measure and clarify teacher efficacy construct (Ashton & Webb; 1986, Guskey, 1982; Rose & Medway, 1981).

While one line of teacher efficacy research emerged from Rotter's (1966) locus of control theory, another line originated from Bandura's (1986) social cognitive theory and his concept of self-efficacy. According to Bandura (1997), self-efficacy and outcome expectation were distinct constructs; the researchers extended their studies on teacher efficacy by using the elements of Bandura's social cognitive theory (Ashton et al., 1982; Ashton & Webb, 1986; Bandura, 2001; Gibson &

Dembo, 1984). For example, Gibson and Dembo (1984) developed the Teacher Efficacy Scale, where they differentiated two factors: one referred to as *personal teaching efficacy*, which was believed to reflect self-efficacy, and another referred to as *general teaching efficacy* (GTE), which was assumed to represent outcome expectancy. The first serious discussions and analyses of teacher efficacy emerged during the early 2000s with the studies of Tschannen-Moran and Woolfolk Hoy (2001), where they extensively explored the history of teacher efficacy measurements and highlighted the absence of a reliable or valid measure. As a result, they developed a new teacher efficacy scale, building upon Bandura's (2001) instrument as a foundation. Their efforts resulted in the Ohio State Teacher Efficacy Scale (OSTES), later called the Teachers' Sense of Efficacy Scale (TSES), which they believed encompassed a broader spectrum of teaching tasks. The factor analysis produced three dimensions which were called as *efficacy for student engagement*, *efficacy for instructional strategies*, and *efficacy for classroom management* (Tschannen-Moran & Woolfolk Hoy, 2001). TSES has been widely recognized as the most comprehensive conceptual framework for measuring teacher efficacy. It is considered to encompass the extensive scope of teachers' work and the demands of effective teaching in both pre-service and in-service settings (Poulou, 2007, p. 199).

In the literature, there is still no complete consensus on the conceptual content and indicators of teacher efficacy. It is seen that different scales are developed and used to measure teacher competence (Fives, 2003). Using many different scales in research in this field leads to various interpretation differences and incompatibilities. In this study, the following definition is intended to be more precise about the teacher efficacy construct "teacher's belief in his or her capability to organize and execute courses of action required to successfully accomplishing a specific teaching task in a particular context" (Tschannen-Moran et al., 1998, p.233). Moreover, the *integrated model* proposed by Tschannen-Moran et al. (1998) is presented in Figure 2.2.

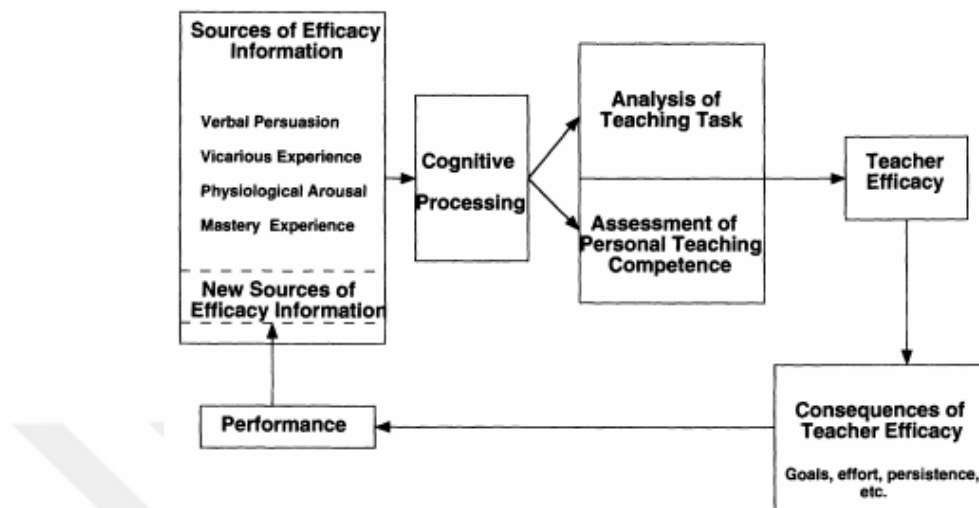


Figure 2.2 The cyclical nature of teacher efficacy

In this model, the sources of efficacy information, parallel to Bandura (1997), consist of mastery experiences, vicarious experiences, verbal persuasion, and psychological arousal. It is argued that the information obtained from these sources constitutes teacher efficacy by running processes called cognitive processing (Tschannen-Moran et al., 1998). In the model, the term cognitive processing is intended to be explained by examining and evaluating the work to be done and one's competencies together. In conclusion, the judgment about the ability to plan and perform the necessary actions to achieve the desired results also constitutes the individual's belief in teaching competence. This belief emerges as the goals, effort, and determination, which, by influencing the act, provides mastery experiences that are the source of later efficacy beliefs (Tschannen-Moran et al., 1998).

Tschannen-Moran and Woolfolk Hoy (2001) described teacher efficacy as a decisive factor because of its cyclical nature. In other words, it directs the individual with strong self-efficacy belief to exert more effort and show more

patience. In this case, effort and patience cause better performance; better performance would also enhance self-efficacy beliefs. Otherwise, teachers with low self-efficacy give up tasks easily, do not make an effort, and come to the fore with a low threshold of resistance to difficulties. That is teachers' high level of efficacy, considering that experiencing success in challenging tasks or difficult circumstances could significantly boost their sense of efficacy (Tschannen-Moran et al., 1998). Over time, this process reaches a stagnation that will affect certain teacher behaviors, such as the implementation of new teaching and techniques, the management of the classroom, and the attitude towards the profession (e.g., Caprara et al., 2006; Guskey, 1988; Hatlevik, 2017; Paraskeva et al., 2008; Kaya et al., 2020). In contrast, teachers with low self-efficacy have a weaker commitment to the profession, avoid using innovative teaching methods in the classroom, and spend less time on academic subjects (Gibson & Dembo, 1984).

2.2.1 Science Teaching Efficacy

Extending Bandura's (1997) reasoning that self-efficacy is a task- and domain-specific construct to educational research, previous studies have demonstrated that teacher efficacy is also domain-specific (e.g., Seidel & Shavelson, 2007; Simsek & Yazar, 2019). For example, teachers who have a confidence in mathematics teaching may not feel competent themselves when teaching science. From this point of view, Riggs and Enochs (1990) have developed STEBI, Science Teaching Efficacy Belief Instrument, to measure teachers' science-teaching efficacy beliefs. Based on the study conducted by Gibson and Dembo (1984), two uncorrelated factors were identified within STEBI. These factors were science teaching self-efficacy (STSE), referring to a science teacher's belief in his/her ability to perform science teaching. In contrast, science teaching outcome expectancy (STOE) refers to the teachers' belief that student behaviors can be influenced by effective science teaching (Riggs & Enochs, 1990). In the study where Rubeck and Enochs (1991) examined the factors affecting the self-efficacy beliefs of chemistry and science teacher candidates, they applied the word "science" by replacing the word

"chemistry" in the STEBI-CHEM scale to determine the self-efficacy of chemistry teacher candidates by increasing the degree of specificity and utilizing STEBI as a foundation. In their study, chemistry teaching self-efficacy (CTSE) is defined as "a science teacher's belief in his/her ability to teach chemistry" and chemistry teaching outcome expectancy beliefs (CTOE) referred "a science teacher's expectations of students' achievement in chemistry" (Rubeck & Enochs, 1991).

The existing literature on science-teaching efficacy beliefs is extensive and focuses particularly on pre-service teachers' science-teaching efficacy beliefs (e.g., Al Sultan et al., 2018; Arigbabu & Oludipe, 2010; Aurah & McConnell, 2014; Çakıroğlu et al., 2005; Küçükyılmaz & Duban, 2006; Menon & Sadler, 2016) rather than that of in-service science teachers.

2.3 Pre-service and In-service Teachers' Sense of Efficacy

Previous studies have attempted to compare pre-service and in-service teachers' self-efficacy in terms of their years of experience. There are inconsistencies between the results of studies conducted previously. Some studies demonstrated that experienced teachers have higher teaching efficacy (e.g., Birenbaum & Rosenau, 2006; Campbell, 2006; Şen, 2019; Yaylı & Ekizler, 2015). However, other studies revealed that pre-service teachers have higher teacher efficacy (e.g., Brousseau et al., 1988; Cannon, 1992; Hoy & Wool-folk, 1990; Ismailos et al., 2019) or there is no difference between pre-service and in-service teachers for their teacher efficacy (e.g., Azar, 2010). Moreover, Soodak and Podell (1997) have reported that among elementary teachers, personal teaching efficacy was very high during the pre-service period, declined sharply in the first years of teaching, and then somewhat increased with more years of experience; there were no significant changes among secondary teachers in terms of years of experience.

For instance, Azar (2010) conducted a study with Turkish secondary science teachers to compare pre-service and in-service secondary science teachers' teacher efficacy beliefs. This study admitted the STEBI (Riggs & Enochs, 1990) adapted

into Turkish by Hazır-Bıkmaz and Kiremit (2006) to the 50 pre-service and 75 in-service Turkish secondary science teachers. This study's results revealed no significant difference between pre-service and in-service teachers' personal self-efficacy beliefs and outcome expectations about science teaching (Azar, 2010).

On the other hand, as a result of a longitudinal study, Wenner (2001) found that in-service teachers' personal self-efficacy beliefs are higher than pre-service teachers. The study was conducted over five years to compare the pre-service and practicing teachers' beliefs toward math and science education. STEBI (Riggs & Enochs, 1990) was administered to 187 student teachers whose majors were mathematics and science. There were three exceptions in which pre-service teachers had greater self-efficacy than in-service ones. These are the ability to explain math and science strategies, being more welcoming of students' science-related questions, and the belief in finding better ways to teach science in the future.

Different from the studies utilizing STEBI (Riggs & Enochs, 1990) for the measurement of teacher efficacy, several studies (e.g., Duffin et al., 2012; Fives & Buehl, 2009; Putman, 2007; Şen, 2019) administrated TSES (Tschannen-Moran & Woolfolk Hoy, 2001) to compare the pre-service and in-service teachers' sense of efficacy. In a study conducted by Putman (2007), 484 in-service and pre-service teachers from different subject areas were divided into four groups: junior and senior pre-service teachers and novice and experienced teachers. According to the results, more experienced teachers' sense of efficacy beliefs was significantly greater than those of teachers with less or no teaching experience in classroom management, instructional strategies, and student engagement (Putman, 2007). However, the results of the study conducted to compare the sense of efficacy beliefs of chemistry and mathematics pre-service and in-service teachers revealed that the only difference between them was found in the efficacy of classroom management in favor of in-service teachers (Şen, 2019).

2.3.1 Factors of Teacher Efficacy

Although the main factors of teacher self-efficacy are associated with Bandura's (1997) sources (e.g., Tschannen-Moran & McMaster, 2009), other sources and factors of teacher self-efficacy were suggested by the researchers (e.g., Klassen et al., 2011; Morris et al., 2017; Palmer, 2006; Poulou, 2007; Wyatt, 2014). For instance, Palmer (2006) proposes additional sources of teacher efficacy: "cognitive content mastery," "cognitive pedagogical mastery," and "simulated modeling." According to Palmer (2006), mastery experience is related to enactive teaching experiences. However, other forms of mastery experience could be possible sources of efficacy information concerning pre-service primary teachers' science teaching efficacy beliefs. Therefore, Palmer (2006) introduces the terms "cognitive content mastery," which is mastery experience in the form of understanding science content, and "cognitive pedagogical mastery," which is understanding some motivating and practical techniques for teaching science. In addition, he suggests a "simulated modeling" source by extending the scope of modeling types in vicarious experience. Simulated modeling refers to observing role-play situations where the tutor acts as the primary teacher, and pre-service teachers imagine themselves as students. Poulou (2007) made a notable contribution to the field through the development of the "Teaching Efficacy Sources Inventory (TESI)," which expanded upon Bandura's (1997) sources of efficacy where mastery experience and verbal persuasion items are integrated as one source and additional sources involving personal traits, capabilities/ skills, motivation, and university training, specifically relevant to the pre-service context. In extensive research on teacher efficacy, specific endeavors have aimed at understanding the factors that impact the formation of teacher efficacy. Some studies have focused on factors of in-service teachers, while others have examined that of pre-service teachers across multiple contexts.

2.3.2 Factors of Pre-service Teachers' Sense of Efficacy

Much of the literature on factors of teachers' sense of efficacy is concerned with factors of pre-service teachers' sense of efficacy since the sense of efficacy beliefs may be the most malleable early in the career and resist change after it is developed (Tschannen-Moran et al., 1998). As a result, finding which factors enhance efficacy beliefs has become essential to inform pre-service teachers and teacher educators. For pre-service teachers, the studies primarily focus on factors from Bandura's sources as enactive mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states.

For example, Aydın and Boz (2010) have investigated the science teaching efficacy beliefs and the sources of self-efficacy beliefs of pre-service elementary teachers. They administered STEBI (Riggs & Enochs, 1990) to 492 pre-service elementary science teachers to determine whether there was a difference between the pre-service teachers with different grade levels. They conducted semi-structured interviews with 14 participants to explore their sources of science-teaching efficacy beliefs. The quantitative data analysis of their study revealed that pre-service teachers in the final year had significantly greater science teaching efficacy beliefs, and the analysis of qualitative data revealed that the most significant sources were mastery and vicarious experience. Only a few participants reported verbal persuasion and physiological/ emotional arousal sources. In contrast to Aydın and Boz (2010), Wah (2007) conducted a study with pre-service science, math, and English language teachers to explore sources of their sense of teacher efficacy by administering a survey. According to the results of this study, mastery experiences, verbal persuasion, and physiological arousal directly affect the teacher efficacy of pre-service teachers. In contrast, vicarious experiences do not affect teacher efficacy.

Moreover, Arslan and Bulut (2016) investigated the relationship between the dimensions of teacher sense of efficacy beliefs and the hypothesized sources of efficacy by administering the Turkish version of TSES (Capa et al., 2005;

Tschanen-Moran & Woolfolk Hoy, 2001) and Turkish version of SOSI-Sources of Self-efficacy Inventory (Capa-Aydın et al., 2013; Kieffer & Henson, 2000) to 187 pre-service mathematics teachers. Among the other hypothesized sources (Bandura, 1997), mastery experiences made the most substantial contribution, and physiological and affective states contributed more than verbal persuasion and vicarious experiences to explain overall teaching efficacy and TSES dimensions. Moreover, Cansız and Cansız (2019) attempted to determine pre-service elementary teachers' sources of self-efficacy and their constructivist and traditional beliefs related to teaching by utilizing SOSI (Capa-Aydın et al., 2013; Kieffer & Henson, 2000). The results reveal that mastery experience significantly contributed to pre-service elementary teachers' constructivist beliefs related to teaching, while their traditional teaching beliefs were mainly affected by physiological/emotional arousal.

In addition to Bandura's (1997) hypothesized sources, teacher education programs, teaching practicum, knowledge, the role of instructors and cooperating teachers, personality traits, and motivation have emerged as significant factors influencing the development of teacher efficacy during the pre-service years. For instance, Poulou (2007) have examined the factors preceeding 198 pre-service teachers' personal teaching efficacy beliefs by administrating -that she developed through sets of interviews with 32 pre-service teachers. The analysis revealed that the most influential factor was motivation whereas the less influential one was physiological/ emotional arousal.

Moreover, Can (2015) explored the sources of science teaching efficacy beliefs of five senior pre-service science teachers through semi-structured interviews. Results of this qualitative study have revealed additional factors of pre-service teachers' sense of efficacy beliefs. In addition to major sources contributing to pre-service science teachers' teaching efficacy beliefs, categorized as teaching experiences, affective states, social support, and vicarious experiences, pre-service teachers reported science content, knowledge, personality traits, and resource provision as factors influencing their sense of efficacy beliefs.

Some studies have investigated the effect of teaching practicum experience (e.g., Karalis-Noel, 2020; Klassen & Durksen, 2014; Pfitzner-Eden, 2016), and others have determined the effect of method courses (e.g., Bautista & Boone, 2015; Palmer, 2006) on teacher efficacy. For example, Pfitzner-Eden (2016) designed an instrument to explore how Bandura's (1997) sources predict the change in teacher self-efficacy during the teaching practicum. In this study, the instrument was administered to German pre-service teachers; 359 were beginning pre-service teachers who completed the observation practicum, and 395 were advanced pre-service teachers who completed their teaching practicum and aimed to find how they integrated the sources of self-efficacy. According to the results of the study, teacher-self efficacy in both groups was mainly affected by mastery experiences. Moreover, beginning pre-service teachers' ratings of their mastery experiences were mainly affected by physiological and affective states, vicarious experiences, and verbal persuasion by the mentor teacher. Mastery experience was a more compelling factor in advanced pre-service teachers than beginning ones, and their ratings of mastery experience were affected by verbal persuasion by the mentor teacher, physiological and affective states, and verbal persuasion by others. Moreover, Klassen and Durksen (2014) conducted a study that explored the relationship between teacher efficacy beliefs and work stress among preservice teachers during teacher practicum. Their study has shown that mentors can significantly impact early beliefs about teaching efficacy. Through qualitative analysis, it was found that mentors had a positive or negative considerable impact on the changes in efficacy beliefs and stress experienced by the pre-service teachers.

Palmer (2006) explored how pre-service teachers' efficacy beliefs and various sources of efficacy change after taking a science method course by administering surveys. He reported positive changes observed in both pre-service teachers' efficacy and self-reported teacher outcome expectations during the course itself and even after a delay period. Moreover, the survey responses have demonstrated that cognitive mastery was the most influential source of their teaching efficacy beliefs. In contrast, the results did not indicate any evidence supporting the notion that

enactive mastery was a source of self-efficacy in the course. Similarly, Bautista and Boone (2015) and Yeşilyurt et al. (2021) found that cognitive content mastery and cognitive pedagogical mastery were the most significant sources of science teaching efficacy beliefs of early childhood and engineering teachers.

2.3.3 Factors of In-service Teachers' Sense of Efficacy

A relatively small body of literature is concerned with in-service teacher self-efficacy (Morris et al., 2017). The literature has focused mainly on teaching experience, professional development activities, and contextual variables as contributing factors to the teacher efficacy of in-service teachers. For example, Cheung (2008) conducted a comparative study between Hong Kong and Shanghai primary school teachers, focusing on their teacher efficacy and the factors influencing it. The findings revealed that primary in-service teachers in Shanghai exhibited higher levels of teacher efficacy than their Hong Kong counterparts. Furthermore, the study identified several critical factors to teacher efficacy among primary in-service teachers, including the level of respect received from students and parents, the quality of university training, and teaching experience. Cheung (2008) indicated that the duration of teaching experience significantly correlated with teaching efficacy beliefs. Specifically, it was observed that teachers with longer experience tended to have more positive efficacy beliefs. Cheung (2008) proposed that spending more time in the classroom exposes teachers to various situations, allowing them to gain mastery experience and critically reflect on their performance. This reflective process enables teachers to approach similar situations differently, enhancing their perceived efficacy.

In the same vein, Tschannen-Moran and Woolfolk Hoy (2007) conducted a quantitative survey research study comparing the sources of efficacy beliefs between 255 novice and experienced teachers. The results indicated that social persuasion had a significant impact on the efficacy beliefs of novice teachers. However, it did not show a significant relationship with the efficacy beliefs of experienced teachers. However, social persuasion positively influenced the

experienced teachers' satisfaction regarding their teaching performance. Another notable difference between novice and experienced teachers was the influence of contextual factors. The efficacy beliefs of novice teachers were linked to the availability of resources, while this factor did not affect experienced teachers' efficacy beliefs. Regarding support for Bandura's theory (1986), the study found mastery experiences were the most crucial source of efficacy beliefs for novice and experienced teachers. However, mastery experiences were particularly salient for novice teachers.

In addition to comparing novice and experienced teachers, there are other studies comparing the pre-service and novice teachers' efficacy and factors affecting teacher efficacy during the transition from pre-service to novice teachers. For example, Mulholland and Wallace (2001) conducted a one-person case study with a novice elementary science teacher to explore the potential sources that influenced her self-efficacy beliefs during the transition from pre-service to in-service teaching. Written journals and interviews were analyzed by qualitative approach. Upon analyzing the data, the researchers found that during both the pre-service and novice years, the primary sources of self-efficacy were enactive mastery experiences and verbal/social persuasion in the form of support and feedback from others. These sources had a positive impact on the development of self-efficacy beliefs. However, the study also revealed that self-efficacy was negatively influenced by vicarious experiences (e.g., observing others' failures or struggles) and physiological/affective states such as anxiety or stress. These factors had a detrimental effect on her self-efficacy.

Capa (2005) conducted a study focused on the sources of efficacy among first-year teachers in the United States. She developed a scale specifically designed to measure the variables that influenced the efficacy of novice teachers. According to Capa's (2005) scale, several factors were associated with teacher efficacy, including personal/school characteristics, self-efficacy, teaching assignment, principal support, mentor support, colleague support, and the quality of the teacher education program. The study's findings revealed that teacher efficacy was

significantly predicted by three main factors: the quality of the teacher education program, principal support, and teaching assignment. These factors played a crucial role in shaping the efficacy beliefs of first-year teachers.

In the in-service teacher setting, the qualitative part of a mixed study, whose participants were secondary school teachers in Singapore, revealed the sources of teacher efficacy in teaching low-achieving students (Wang et al., 2017). The researchers noted that "psychological sources of information postulated by Bandura (1997) are valid but insufficient to explain high teacher efficacy" (p.140). They proposed additional nonpsychological sources of information enhancing teacher self-efficacy, which are "teachers' knowledge about students," "rapport with students," and "previous working experiences" (p.143).

Lastly, Ramey-Gassert et al. (1996) carried out a mixed study with 23 experienced elementary classroom teachers who participated in a long-term teacher professional development project in the United States to determine factors affecting those teachers' science teaching efficacy beliefs. After STEBI (Riggs & Enochs, 1990) was utilized, researchers selected ten participants representing different science teaching efficacy and science teaching outcome expectancy levels from the original participants to conduct interviews. The analysis of interview data revealed two main factors, which are internal and external. In this study, internal factors referred to factors teachers had some level of influence or agency over them. These factors encompassed teacher characteristics and antecedent science-related experiences, such as teacher preparation and professional development experiences influencing interest in science and science teaching. On the other hand, external factors in this study were defined as variables beyond the direct or immediate control of the teacher. These primarily included factors related to the school workplace environment. These external factors could involve principal support, mentor support, colleague support, and the overall quality of the teacher education program.

Overall, these studies indicate variations in the factors of self-efficacy among in-service and pre-service teachers. In the case of in-service teachers, factors such as

years of teaching experience, principals/administrators, colleagues, parents, and the local community tend to have a greater impact. On the other hand, factors like teacher preparation programs, practicum experiences, cooperating and supervisor teachers, as well as individual traits such as personality and motivation, are more closely associated with the efficacy perceptions of pre-service teachers.



CHAPTER 3

METHODOLOGY

This chapter shows how the research was systematically carried out. The following chapter introduces the research question, design of the study, participants, data collection tools and procedures, validity and reliability issues of the study, and limitations and assumptions of the study in the given order.

3.1 Research Question

The aim of the study was to explore factors affecting teacher self-efficacy beliefs of pre-service, novice, and experienced chemistry teachers. Therefore, the study was guided by the following research question:

What are the factors of pre-service, novice, and experienced chemistry teachers' sense of efficacy beliefs?

3.2 Design of the Study

In this study, qualitative research was conducted to acquire more detailed information about factors affecting teacher efficacy of pre-service, novice, and experienced chemistry teachers. Since one of the strengths of qualitative research is in detail and in-depth investigation of the issues under study (Patton, 2015), the qualitative research method was utilized in this study.

There are several types of qualitative research. In this study, basic qualitative research design was carried out. Among others, Merriam (2009) stated the purpose of the basic qualitative research design; how people interpret their experiences, how these experiences shape their world, and how they make sense of these experiences. Although other qualitative research designs incorporate all these traits,

they also have additional characteristics which are not aligned with the nature of this study's research question. For example, phenomenological research design intends to understand how individuals make meaning of phenomena (Patton, 2002). Moreover, Merriam suggests that phenomenology is suitable for studying "affective, emotional, and often intense human experiences" (Merriam, 2009, p. 26). In this study, the phenomenon was not identified.

As a result, the basic qualitative research design was employed since this study aimed to understand how the participants interpret their experiences working as chemistry teachers and apply meaning to that interpretation in terms of their self-efficacy beliefs.

3.3 Participants

In this study, participants were selected by using a purposeful sampling strategy. In purposeful sampling, researchers "use their judgment to select a sample that they believe, based on prior information, will provide the data they need" (Fraenkel et al., 2023, p.100). According to Merriam (2009), the researcher has to choose a sample from which the most information can be collected since it is a way of gaining insight and understanding their experiences. The criteria established for purposeful sampling was years of experience since the aim of the research was to investigate factors affecting teacher efficacy beliefs of pre-service, novice, and experienced teachers. As a result, the participants consisted of a total of 25 volunteer chemistry teachers, including eight pre-service teachers, seven novice teachers, and ten experienced teachers.

Firstly, pre-service chemistry teachers who are described as teacher candidates (Goulette & Swanson, 2018) were the 3rd or 4th-grade students of the chemistry education department at two different state universities in Ankara. The criteria were that all of them should have taken the Teaching Practice course offered by their department. Among the pre-service teachers, there were no male students. Of the participants, six out of the eight pre-service teachers stated that they had the

opportunity to work as chemistry teachers rather than teaching practice, such as being tutors or teachers in private teaching institutions. Pre-service teachers who are the participants of this study were studied at chemistry education departments in A and B Universities. These universities are well-known public universities located in Ankara. Before the data collection procedure, all pre-service teachers completed Teaching Practice I and II courses. One of the cooperating schools was the same as the A and B universities. However, the other cooperating school was a private high school for A University and public science high school for B University. A summary of demographic information of pre-service teachers will be presented (see Table 3.1).

Secondly, novice teachers having five or less than five years of teaching experience (Kim & Roth, 2018) were private school teachers working in Ankara, Turkey. Participants' years of teaching experience vary from one to five years. Among seven novice teachers, three of them were male teachers. In this study, all novice teachers graduated from the chemistry education department at A University and have worked as chemistry teachers in private schools. Novice teachers' other demographic information will be given (see Table 3.2).

Finally, experienced teachers who have been working as chemistry teachers for more than five years (Kim & Roth, 2018) were selected from both private and public-school teachers. Their length of experience varies from fifteen to thirty-five years. Half of those experienced teachers were male, and the other half were female chemistry teachers. Moreover, five of them were public school teachers, and the others were private school teachers. Other demographic information, such as their degree and duties other than teaching, will be presented. (see Table 3.3)

Table 3.1 Demographic Information of Pre-service Teachers

Pseudo name	University	GPA	Teacher trainee experience	Teaching experience
Zehra	B University	3.15	Yes	Yes
Sena	B University	3.50	Yes	Yes
Sıla	A University	2.57	Yes	Yes
Helin	B University	3.40	Yes	No
Ebru	A University	2.82	Yes	Yes
Cansu	A University	3.10	Yes	No
Sümeyye	A University	2.67	Yes	Yes
Çağla	B University	3.21	Yes	Yes

Table 3.2 Demographic Information of Novice Teachers

Pseudo name	Years	School Type	Degree	Faculty graduated	Other Duties
Elif	4	Private	BS	Education	No
Nuray	4	Private	BS	Education	No
Beşir	1	Private	BS	Education	No
Tuna	3	Private	BS	Education	No
Yağmur	2	Private	BS	Education	No
Gözde	4	Private	BS	Education	No
Uğur	5	Private	BS	Education	No

Table 3.3 Demographic Information of Experienced Teachers

Pseudo name	Years	School Type	Degree	Faculty graduated	Other Duties
Müjgan	27	Private	PhD	Education	Head of Chemistry Department
Taha	25	Private	MS	Education	Book Author
Enes	33	Public	MS	Arts and Science	School Principal
Duygu	35	Public	BS	Education	No
Şule	25	Public	BS	Education	Book Author
Selma	22	Public	BS	Education	No
Yunus	17	Public	MS	Education	Book Author
Emre	18	Private	BS	Education	Book Author
Mehmet	20	Private	BS	Education	Assistant Principle
Burçin	15	Private	MS	Arts and Science	No

3.4 Data Collection Tool

Interviewing is considered a crucial component of qualitative research designs conducted in the field of educational research setting (Weiss, 1994; Merriam, 2009). *Interview* is defined by Kvale (1996) as "a conversation, whose purpose is to gather descriptions of the [lifeworld] of the interviewee" in terms of one's understanding of "described phenomena" and extended this definition by adding that the interview aims to gain an understanding of the interpretation of phenomenon with "in-depth information" (p.174).

According to Merriam (2009), interviewing gains importance when people's behaviors, feelings, and interpretations cannot be observed. The interviewees' feelings, opinions, and beliefs about the researched subject can be examined through interviews. Since this study aims to explore the factors behind the self-efficacy beliefs of participants, interviewing was conducted as a data collection tool. Although there is a group or collective format of interviewing, the person-to-person interview was utilized to understand the self-efficacy beliefs of the participants.

Interviewing can be categorized in terms of structure as highly structured, semi-structured, and unstructured. In the current study, semi-structured interviews were employed due to altering and modifying predetermined questions. That is, semi-structured interviews are not firm as structured ones allowing only predetermined questions, and not flexible as unstructured ones forming open-ended questions (Merriam, 2009). Moreover, when the interviewee's response is remarkable, a semi-structured interview provides considerable leeway to ask follow-up questions (Wishkoski, 2020). That is why semi-structured interviewing was utilized in this study.

According to Merriam (2009), getting high-quality data from interviewing is only possible when good questions are asked, but it requires practice. Pilot interviews are crucial to evaluate the quality of the questions. In this way, it is possible to

understand "which questions are confusing and need rewording, which questions yield useless data, and which questions, suggested by your respondents, you should have thought to include in the first place" (p. 95).

Regarding all this information, interview questions were prepared considering the research question and theoretical framework (Bandura, 1997; Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). After the first sets of questions were constructed, the questions were revised according to whether they were understandable and compatible with the aim of the study by cooperating with two experts in the field of education. In the first question form, there were 17 questions for pre-service teachers and 23 questions for in-service teachers. The questions constructed for pre-service teachers were the same as those constructed for in-service teachers, which differed by six questions related to the students and school context variables such as *"Which grade level is the level that you feel more confident in teaching?"*

After the first question form had been developed, pilot interviews were conducted with two in-service teachers and one pre-service teacher on an online meeting platform. The in-service teachers were novice teachers working in a private school different from the participants' schools. In addition, the pre-service teacher was a senior student studying chemistry education department at B University. After pilot studies, interviews were transcribed verbatim. Transcriptions of pilot interviews were examined by the experts and the researcher. As a result, two questions in the in-service question form were discarded, and some of the questions were merged and clearly written by consensus with the experts. On the other hand, the content of the question form of pre-service teachers did not alter. Therefore, the number of questions in the final form of pre-service and in-service teachers were 17 and 20, respectively (see Appendix A and B).

Some examples of the interview questions which are common for pre-service and in-service teachers are as follows:

Do you believe that you can teach chemistry concepts effectively? Why?

What is/are the chemistry topic(s) that you believe you can teach more effectively? Why?

What is/are the chemistry topic(s) that you do not feel competent in while teaching it? Why?

Did you observe other chemistry teachers' performance? What were your observations? Have these observations affected your confidence in teaching? Why? Can you give an example?

Sample interview questions constructed for pre-service teachers are as follows:

What feelings do you have when teaching chemistry at the trainee school? In which situations do you feel these feelings and why? Did this affect your confidence in your teaching? How?

A sample interview question constructed for in-service teachers is as follows:

Do you believe that you can implement effective teaching in a laboratory context?

So far, this section has focused on the data collection tool, which is a semi-structured interview protocol, the next section will discuss how data were collected through semi-structured interviews.

3.5 Data Collection Procedure

After determining the research problem, descriptors that are "chemistry teaching self-efficacy," "teacher efficacy beliefs or the sources of self-efficacy beliefs and pre-service and in-service teachers," "teacher efficacy beliefs and chemistry teaching experience," "sources of self-efficacy beliefs and teaching experience," "factors and chemistry teaching self-efficacy" are searched by ERIC (Educational Resources Information Centers), Google Scholar and YÖK National Thesis Center. Therefore, the related literature review was done. Then, interview questions were

constructed by the researcher. After pilot studies had been conducted, the interview questions of this study were finalized.

Data were collected from senior pre-service teachers and in-service teachers. At the beginning of the semester, pre-service teachers registered Teaching Practice course offered by the chemistry education department. Those students were informed about the study and asked whether they would be interested in participating via their instructors. It was stated that the study's findings would not be shared and used for grading purposes. Interviews were held through online meetings after making an appointment with pre-service, novice, and experienced chemistry teachers. Interviews were held for approximately one hour with the participants. Before conducting interviews, the permissions of participants were granted for the audio recording. The recorded interviews were transcribed and analyzed later.

3.6 Data Analysis

In qualitative research, data analysis is methodically reviewing and organizing the interview transcripts, observation notes, or other non-textual resources the researcher gathers to further their understanding of the phenomena (Bogdan & Biklen, 1982). Data analysis refers to the process of "working with data, organizing them, breaking them into manageable units, coding them, synthesizing them, and searching for patterns" (Bogdan & Biklen, 1982, p. 159). According to Merriam (2009), data analysis involves making sense of data and drawing a valid conclusion by interpreting data.

In qualitative research, content analysis is defined as "the data analyses technique of that research and refers to searching a text for and counting recurring words or themes" (Patton, 2015, p. 541). After collecting and preparing data for the qualitative content analysis (e.g., interview transcription), data were reduced into themes by the iterative coding process (Cresswell, 2007). Coding is the analytical process where data is assigned with shorthand designations called code, such as single words and phrases, to retrieve specific parts of data. Then, categories and

themes can be constructed by grouping the related codes (Merriam, 2009). There are two approaches to content analysis: an inductive approach, where codes emerge from data, and a deductive approach, where researchers examine data using a framework that already exists (Patton, 2002).

This study utilized content analysis to identify the factors affecting teacher efficacy beliefs of pre-service and in-service teachers. After audio records of the interviews were transcribed verbatim, the participants' answers were read several times, and then the whole text was analyzed using a deductive and inductive approach. In the first phase, deductive analysis was employed, where the data were treated according to the existing framework, which was Bandura's suggested four sources of self-efficacy (1997). Nonetheless, related literature (Tschannen-Moran et al., 1998; Klassen et al., 2011) and data obtained from this study proved that there is a need for further exploration of factors affecting teacher efficacy by expanding Bandura's (1997) suggested sources. Therefore, the second phase of data analysis was the inductive phase. To determine the consistencies and coherences, a coding protocol was formed to describe factors affecting pre-service and in-service chemistry teachers' sense of efficacy beliefs (see Table 3.4). Then, all the interviews were coded again following the coding protocol involving themes, sub-themes, and codes. In this phase, the constant comparative method (Strauss & Corbin, 1990) was utilized to compare pre-service, novice, and chemistry teachers' sense of teacher efficacy beliefs. The constant comparative method involves following steps "comparing incidents applicable to each category" and "integrating categories and their properties" (Strauss & Corbin, 1990, p.439). Moreover, the constant comparative method is applicable when comparing different people (e.g., their views and experiences). In the present study, the participants' teacher self-efficacy beliefs were compared around the emerging themes and between the pre-service, novice, and experienced teachers.

Table 3.4 Coding Protocol

Theme	Sub-theme	Code	Explanation
Internal	Experience	Mastery Experience	Pre-service or in-service chemistry teachers' enactive and previous teaching experiences gained by their teaching performance.
		Vicarious Experience	Pre-service or in-service chemistry teachers' experiences gained by observing teaching performance of models such as peers and other chemistry teachers.
	Knowledge	Content Knowledge	Subject matter knowledge of pre-service and in-service chemistry teachers and their understanding of chemistry concepts, terms, and theories.
		Pedagogical Content Knowledge	Pedagogical and chemistry knowledge of using effective teaching methods and strategies to teach chemistry such as making abstract concepts into concrete ones and explaining daily life examples.

Table 3.4 (continued)

Theme	Sub-theme	Code	Explanation
Internal		Pedagogical Knowledge	Knowledge of teachers for creating effective teaching and learning environments for all students such as knowledge of classroom management techniques and feedback.
		Physiological and emotional arousal	Level of emotional and physiological arousal that a pre-service or in-service chemistry teacher experiences in a teaching situation such as health functioning.
	Disposition	Effort	Endeavor how hard chemistry teachers or pre-service teachers work on, study and how well they prepare, plan, and organize their tasks before teaching.
		Ability	Talent, capability, skills, and tendency toward teaching chemistry

Table 3.4 (continued)

Theme	Sub-theme	Code	Explanation
Internal	Disposition	Interest	Feelings of pre-service and in-service chemistry teachers' such as sense of engagement, curiosity, liking to chemistry and other related branches such as physics and mathematics.
		Personality Traits	Individual characteristics and qualifications such as communication skills of chemistry teachers or student teachers.
	Feedback	• from course instructors • from peers • from colleagues • from administrators • from students	Evaluative feedback that pre-service and in-service chemistry teachers receive on their teaching and classroom performance.
External	Persuasion	• from cooperating teachers • from peers • from colleagues • from administrators • from students • from parents	Conviction that approves or/and encourages pre-service and in-service chemistry teachers to their teaching performance.

Table 3.4 (continued)

Theme	Sub-theme	Code	Explanation
		Student Participation Behavior	Observation of students' level of participation and their reactions during teaching chemistry.
	Student-related	Learner Profile	Learners' age, characteristics, academic strengths and weaknesses and background of their life.
		Student Grades	Assessment results of exams, quizzes etc. earned by the students.
	Teacher -Related	Teacher Preparation Quality	Evaluation of the quality of the teacher education programs completed at a university.
		Teacher Professional Development	Evaluation of the in-service teacher training programs.
		Support	Getting help and advice from mentors or colleagues for teaching chemistry.
	Social Environment in Teaching	School Facilities	Physical conditions of classroom laboratories and class size of the school where chemistry teachers work.

This coding protocol described the factors affecting the sense of efficacy beliefs of pre-service, novice, and experienced chemistry teachers. Based on data and related literature, all possible instances counted as evidence for factors affecting the teacher efficacy beliefs of participants were defined in the coding protocol. The coding protocol was finalized by discussing and negotiating with two experts who had studied teacher efficacy. Finally, two main themes were revealed in the coding table: internal and external factors. Sub-themes of internal factors were knowledge and disposition constructed inductively. While codes emerged under experience, mastery, vicarious experiences, and physiological and emotional arousal under disposition subtheme were constructed according to social cognitive theory (Bandura, 1997). Sub-themes of external factors were feedback, persuasion, student-related, teacher-related, and social environment in teaching factors. Except for persuasion (Bandura, 1997), all sub-themes and codes under these subthemes emerged from the data. Moreover, there was no need to construct different coding protocols for pre-service teachers regarding data.

This section has demonstrated how data analysis was conducted by content analysis and the constant comparative method. It is now necessary to explain the course of validity and reliability issues of the study.

3.7 Trustworthiness of the Study

Similar reliability and validity criteria are applied in qualitative and quantitative research when assessing the study's credibility (Schreier, 2012). However, compared to quantitative research, qualitative investigations utilize distinct vocabulary (Shenton, 2004). Researchers generally agree to use *trustworthiness* more broadly to describe qualitative investigations (Lou, 2013). The phrase "trustworthiness" guarantees that the study's conclusions are "worth paying attention to" (Lincoln & Guba, 1985, p.290). Rather than the terms internal validity, external validity, reliability, and objectivity used in quantitative research, credibility, transferability, dependability, and confirmability were listed as the four

requirements for trustworthiness in qualitative research by Lincoln and Guba (1985).

3.7.1 Credibility

Credibility substituting the term internal validity in the quantitative research method ensures data quality by showing to what extent research findings align with reality (Merriam, 2009; Patton, 2015). That is, "credibility requires establishing results in a way that is credible from the perspective of participants, and the goal is to demonstrate that the study was conducted in such a manner as to ensure that the subjects were appropriately identified and described" (Marshall & Rosmann, 2006, p. 201). Merriam (2009) suggested several strategies to ensure credibility: *triangulation*, *member check*, *adequate engagement in data collection*, *researcher's position*, and *peer review*. Among these strategies, triangulation, member checks, and peer review were utilized to deal with credibility issues.

Triangulation means collecting data using different sources; Denzin (1978) suggested four ways of triangulation to ensure credibility: "(i) the use of multiple methods, (ii) multiple sources of data, (iii) multiple investigators, or (iv) multiple theories to confirm emerging findings." (Denzin, 1978, as cited in Merriam, 2009, p.244). In these ways, investigator triangulation means that multiple researchers collect and analyze data. Patton (2015) proposes a related strategy, "*triangulating analysts*—that is, having two or more persons independently analyze the same qualitative data and compare their findings" (p.655). In this study, three researchers familiar with teacher efficacy studies independently coded two participants' transcriptions of interview responses to explore factors affecting teacher efficacy inductively. After forming the coding protocol, they coded different participants' transcription of interview responses by using the coding protocol. Finally, negotiation and discussion were employed to solve the discrepancies among the researchers.

Secondly, member checks are seen as the critical stage for ensuring credibility since it provides getting feedback from participants to eliminate any misinterpretation (Maxwell, 2013). In other words, participants check findings and interpretations within this strategy. In this study, participants were asked to check their interview transcripts, codes, and interpretations.

The final strategy was peer review to ensure credibility. Peer means a committee member or colleague who is at least knowledgeable in the subject and research methodology (Merriam, 2009). During the data analysis stage, the findings of this study were shared with a researcher who had conducted a qualitative study. Findings were examined and evaluated whether they were appropriate by the researcher. Moreover, the researcher's supervisors monitored all data collection and analysis processes.

3.7.2 Dependability

Dependability which corresponds to reliability and consistency (Merriam, 2009), can be handled within two contexts; whether multiple data used are consistent with each other and whether data were analyzed consistently by different coders called intercoder agreement. The intercoder agreement is a strategy where data are categorized at a nominal level. Thus, it differs from the interrater agreement in which data are rated on some ordinal or interval scale (O'Connor & Joffe, 2020). As mentioned in the credibility section, triangulating analysts corresponds to the intercoder agreement. In fact, triangulation can be considered a way of obtaining consistent and dependable data (Merriam, 2009). In this study, the only data source was the semi-structured interviews; a second context, an intercoder agreement, was utilized. After data were coded by two researchers independently for two participants, interrater reliabilities were utilized to ensure that data analysis was consistent between researchers. Then, negotiations were employed to resolve the inconsistencies between the researchers.

Moreover, assessing intracoder reliability is a valuable exercise to promote researcher reflexivity contributing enhancement of credibility and dependability (Joffe & Yardley, 2003). Intracoder reliability was employed in this study. That is, the researcher coded data for five participants after four month's breaks to ensure whether data were coded consistently. Then, discrepancies between intracoder reliability were resolved by advising two experts.

3.7.3 Transferability

Transferability means the generalizability of the findings of the study to other similar research questions (Fraenkel et al., 2023). Even if it corresponds to external validity in quantitative research, its meaning differs from generalizability in quantitative approaches. In qualitative research, transferability refers to *a rich and thick description* of the context, participants, and findings by providing sufficient evidence gathered through instruments (Merriam, 2009). The profile of the participants, the context of schools where in-service teachers work, and the universities that pre-service teachers studied were described in detail to ensure credibility and transferability.

3.8 Ethical Considerations

Ethics in research concerns whether participants suffer physical or psychological harm (Fraenkel et al., 2023). Some of the ethical issues were addressed in this study to protect the rights of the participant and prevent any possible damage caused by the research,

Firstly, Human Subjects Ethics Committee (HSEC) permissions in the Middle East Technical University and MoNE were applied, and permissions were taken before collecting data (see Appendix D and E). Volunteer participants were informed about the general aim of the study in writing and orally. Before starting each interviewing section, the researcher expressed that the study was on a voluntary basis; if the participants did not want to answer any questions or did not want to

continue interviewing, they could withdraw from participation at any time. All the participants voluntarily agreed to participate in the study by signing a consent form. Participants were informed that their answers to the questions would be kept confidential to ensure the data's confidentiality. Furthermore, only the researcher and researchers' advisor had access to the data in both oral and written ways.

In addition, the anonymity of the participants, the schools and the universities were ensured—random pseudonyms which cannot relate to the identity of participants were used for all the participants.

3.9 Limitations of the Study

There are several limitations of this study. Firstly, the researcher was a novice without experience conducting qualitative research. In order to overcome this limitation, extensive preparation processes were employed by reading qualitative research books and articles in educational research journals. The interview questions were prepared considering the suggestions in the "ask good questions" section of Merriam (2009). Moreover, three pilot studies were conducted to test the quality of questions and researcher skills. In all the stages of this qualitative study, the researcher consulted experts experienced in conducting qualitative research. As a result, the researcher could enhance her skills in conducting qualitative research.

Secondly, the researcher position is a factor affecting the credibility of the finding. According to Merriam (2009), credibility would increase when the researcher's "biases, dispositions, and assumptions" were explained (p. 16). One of the limitations was that the researcher graduated from the same teacher education program as some of the participants and colleagues of three experienced teachers. The researcher was aware that she might interpret the findings subjectively. That is, the researcher monitored the subjectivities and biases to clarify how they could influence data collection and analysis. Furthermore, knowing the participants' context allows the researcher to prepare a semi-structured interview form and elicit their ideas deeply.

Finally, there was only one data collection tool. In other words, semi-structured interviewing was the only data collection tool to explore factors affecting pre-service and in-service chemistry teachers' sense of self-efficacy beliefs. Therefore, triangulation needed to be ensured in terms of multiple data sources.

3.10 Assumption of this Study

In this study, there were two main assumptions. Firstly, participants were considered *information-rich cases* since purposeful sampling was employed (Patton, 2015). Moreover, they answered the interview questions sincerely and honestly.

CHAPTER 4

RESULTS

This chapter gives results under the themes of internal and external factors affecting teacher efficacy. In Figure 4.1, subthemes, and codes under the main themes of external and internal factors revealed by the content analysis of interview data were given.



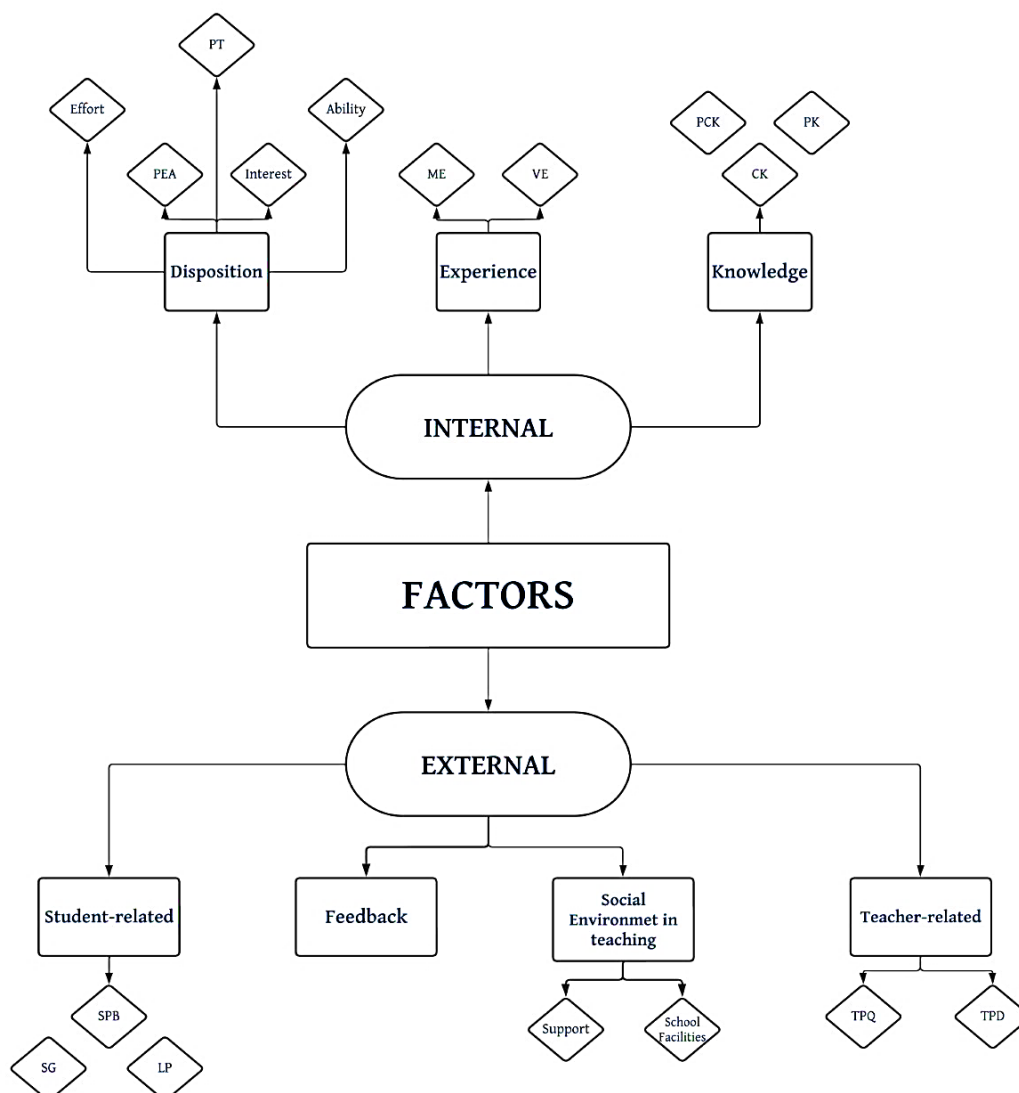


Figure 4.1 Results of the study: Factors affecting chemistry teacher efficacy of pre-service, novice, and experienced chemistry teachers' teacher efficacy beliefs. *Note: PEA: Physiological and Emotional Arousal, PT: Personality Traits, ME: Mastery Experiences, VE: Vicarious Experiences, PCK: Pedagogical Content Knowledge, CK: Content Knowledge, PK: Pedagogical Knowledge, SG: Student Grades, SPB: Student Participation Behavior, LP: Learner Profile, TPQ: Teacher Preparation Quality, TPD: Teacher Professional Development*

4.1 Internal Factors

Internal factors were associated with the background of the participant's life, their characteristics, their choices, and their innate features. The subthemes under this theme were experiences, knowledge, and disposition involving personal traits, effort, ability, interest, and physiological and emotional arousal. Mastery and vicarious experiences and physiological and emotional arousal were the sources of self-efficacy proposed by Bandura, while the others emerged from the data (Bandura, 1997).

4.1.1 Experiences

Mastery experiences and vicarious experiences were presented under this subtheme.

4.1.1.1 Mastery Experience

As it is seen in Figure 4.2, the majority of the participants from all groups, pre-service (seven out of eight), novice (six out of seven), and experienced (nine out of ten) chemistry teachers, stated that mastery experience affects their chemistry teaching efficacy.

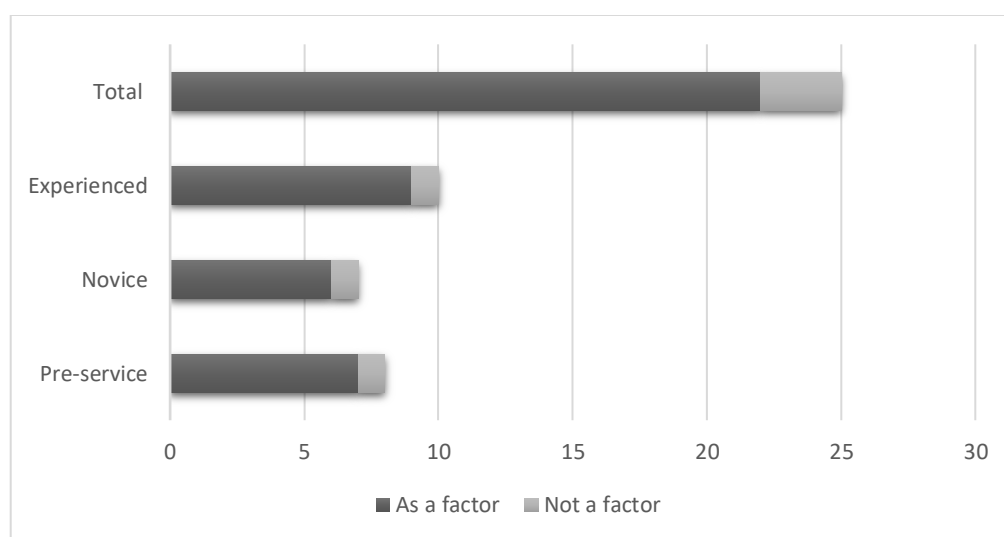


Figure 4.2 The comparison of results of mastery experience as a factor affecting pre-service, novice, and experienced chemistry teachers. Vertical axis shows the number of participants.

In addition to that, they reported that their classroom practices show them how they can manage a class. A pre-service teacher stated, *"During my experience at school, I realized how classroom management could be done and that I could do it too."* (Sümeyye)

Most of the pre-service teachers stated that they had gained informal teaching experience before teaching practicum. These teachers reported that a working experience made them more confident in teaching. They mentioned they have advanced at the expense of the other pre-service teachers who do not have informal teaching experience.

Two of the pre-service teachers explained it with the following quotes:

"In fact, before I started working, I worried about whether teaching would be for me. But from the moment I started working, all my hesitations, such as whether I could answer their questions, were shattered. I thought that teaching was the best profession for me because I had seen I could answer their questions. As I see they can understand, I want to endow them with

more. So, I study a lot, and I improve myself. In teaching practicum, I feel more competent than my friends who do not have teaching experience. That's why this working experience was perfect for me." (Zehra).

"Researcher: ...you said that you are confident in teaching. Why?

Ebru: Since I have a working experience, I can say it. For example, some of my friends cannot control their voices during instruction. I remember that I did not also control my voice, but it was a very long time ago. After gaining experience, I have learned how to control my voice and a class..."

Secondly, novice chemistry teachers stated how their teaching experiences influence their teaching efficacy beliefs. Their experiences include teaching a topic for the first time in general. One of the novice teachers explained it:

"I think there is a difference between explaining a topic for 3 years in a row and explaining the topic for the first time. I may not feel competent if I teach a topic for the first time. But then I remind myself that I taught many of the topics for the first time in the past, and I was not bad at all. Then, I feel confidence" (Gözde)

On the one hand, some of the novice chemistry teachers mentioned how their successful past experiences improved their teaching efficacy. On the other hand, some of the novice teachers reported how their experiences undermined their teaching efficacy beliefs in their first years. For example:

"During the lesson, there were many situations where I felt incompetent with the things that happened. For example, when the children asked something, I couldn't find an explanation that would answer the question clearly. So, this caused me to think that I cannot do it or that I am incompetent." (Beşir)

Moreover, most of the novice and experienced teachers stated that before starting teaching in the laboratory, they did not believe that they were capable of doing it.

They explained that gaining experience in the laboratory makes them more confident. One of the novice teachers reported that:

"In my first year, I was worried about teaching chemistry in the lab. I mean that I was unfamiliar with chemicals, techniques, and how to implement a lesson in the lab. Because my school wants to use it every time, the chemistry club is already very active. We are trying to connect what we see there. We are always in the lab, and in terms of lessons, I try to do even small, tiny demo experiments. I think I can teach effectively in the lab. (Nuray)

Also, an experienced teacher explained it:

"Why can you teach effectively in the lab?

Mehmet: I mean, doesn't it know what to do? When you go there, you know what to do, how to solve a problem, the content of the experiments, and so on. Because I have done it many times, I am very effective in the lab."

Finally, experienced teachers stated that the length of their teaching experience enabled them to modify their teaching style in terms of student needs. They reported that they felt more competent thanks to their teaching experiences.

"I think that teaching well is all about the experience because the more you do it, the better you get. Over the years, I have modified my teaching style regarding student understanding. For example, if I teach the mole concept and a strategy works, I will use this strategy in the next year. Otherwise, I know how to modify it." (Şule)

"... For example, I tried to teach gases many times as it is given in the Ministry of National Education curriculum, and I had seen that students could not grasp the concept like that. Then, I tried to use deductive reasoning and realized I could teach gases well this way." (Taha)

To sum up, mastery experience was one of the dominant factors affecting the teacher efficacy beliefs of pre-service and in-service chemistry teachers. All

participants reported that their teaching performance was successful for them; thus, their teaching efficacy beliefs increased thanks to their enactive mastery experience.

4.1.1.2 Vicarious Experience

The number of participants whose teacher efficacy was affected by their experiences gained through observation is shown in Figure 4.3 (five out of ten experienced teachers, four out of seven novice teachers, and six out of eight pre-service teachers). Participants who had a chance to observe other chemistry teachers reported that it positively affected their efficacy.

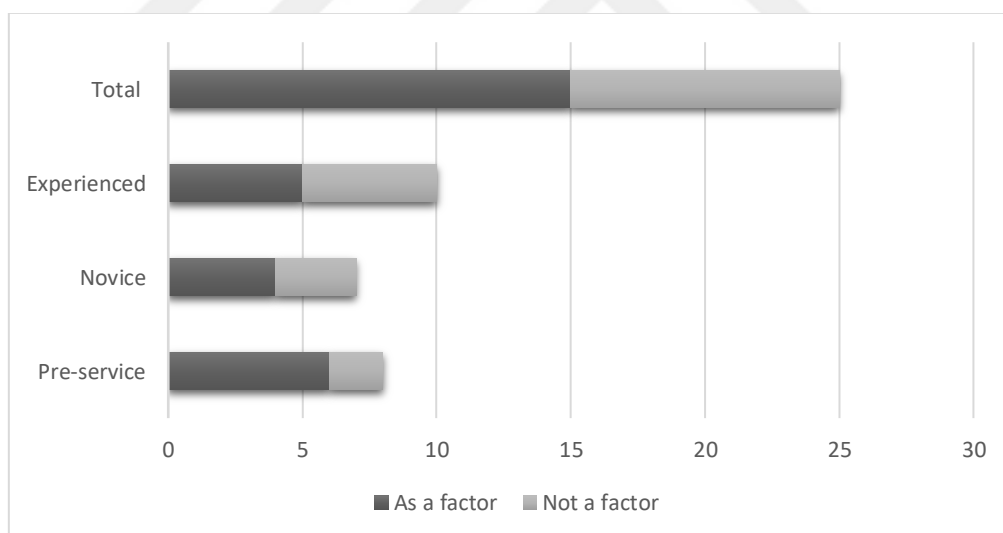


Figure 4.3 The comparison of results of vicarious experience as a factor affecting pre-service, novice, and experienced chemistry teachers. Vertical axis shows the number of participants.

Firstly, pre-service teachers mentioned that they had observed their peers' performance since it was stated as an obligatory part of their practice teaching and

method courses. Most pre-service teachers reported that peer observation made them more confident about teaching. For example, two pre-service teachers stated how their peer observations affected their teacher efficacy from two different perspectives:

"When I observe my peers' instruction, I can realize their mistakes. For example, the students could not understand the way that they teach. I learn from their mistakes."

Researcher: Well, did it affect your confidence in teaching?

Helin: Of course, it did. I believe that I do it better than them, and it increases my confidence in teaching."

"When my peers made mistakes, I would always say 'Yes, I am still learning as well as them, so I am not the only one who makes mistakes. They can make mistakes too.' In fact, I learned not to blame myself so hard since my peers were making mistakes as well. Therefore, we are actually helping each other by learning from our mistakes. Also, if one of my friends teaches well, I observe and I teach well for the next time. (Çağla)"

Likewise, novice teachers who observe their mentors and their experienced colleagues reported that it improves them and impacts their efficacy beliefs. The following statements show how the peer observation system for novice teachers affects their efficacy beliefs:

:"... In our school, peer observation is obligatory even if a teacher is experienced. For me, it was very helpful for the laboratory. At first, I was so scared of doing experiments in the lab. After observing my colleagues' lab sessions, I was sure that it isn't so hard. I tell myself if they can do it without any problem, I can do it as well. Then, I feel confident about it." (Elif)

"In my first year, I have a chance for observing an experienced teacher's classroom since my school does so. I cannot deny how it improves me as a

teacher since I use what I observe in my teaching. Moreover, I see that I am not very different from her. Thus, it increases my confidence." (Nuray)

Secondly, teachers from all groups stated that their own teachers influenced them as role models. Generally, the role models were their own chemistry teachers from their high school ages. In fact, they said that they feel competent since they had a chance to observe a good role model. The following quotation reported by a novice teacher reveals the effect of role models on teacher efficacy:

"...I think there are teachers who know chemistry but do not teach it.

Researcher: Do you believe that you can teach?

Uğur: Yes. Because my high school chemistry teacher inspired me. She loves teaching and knows how to teach. I observed her a lot and I realized that my teaching style resembles hers."

Otherwise, an experienced teacher claimed that she decided that she would be a good teacher by comparing herself with her teachers whose behavior is not appropriate:

"Müjgan: I thought that I can be a good teacher.

Researcher: Why did you think so?

Müjgan: I can say that my teachers, whom I did not like in terms of behavior, were more effective. I thought, If I was in their shoes, I would have behaved differently. Actually, I decided to be a teacher by thinking that I could do better than them."

Moreover, only some experienced teachers mentioned how they model the teachers in the instructional videos, and their efficacy can be affected by watching them. For example:

"I watch several instructional videos about the topic that I teach to utilize them. I try to understand in which way the subject is explained more clearly. If I can understand the topic by watching a teacher in a video, I can

teach my students in the way that the teacher presented in the video."(Burçin)

It can be concluded that both mastery and vicarious experience were found to affect chemistry teachers' teacher efficacy, and those experiences led to a development in their efficacy positively, as reported by the participants.

4.1.2 Knowledge

Knowledge was found to be another significant factor affecting chemistry teachers' efficacy. Under the knowledge subtheme, codes were classified as content knowledge, pedagogical content knowledge, and pedagogical knowledge.

4.1.2.1 Content Knowledge

Content knowledge (CK) was the mostly mentioned code among the other codes under the knowledge subtheme on teacher efficacy beliefs of participants. Well over half of those participants (five in eight pre-service teachers, five in seven novice teachers, and seven in ten experienced teachers) mentioned the effect of CK on their chemistry teaching efficacy.

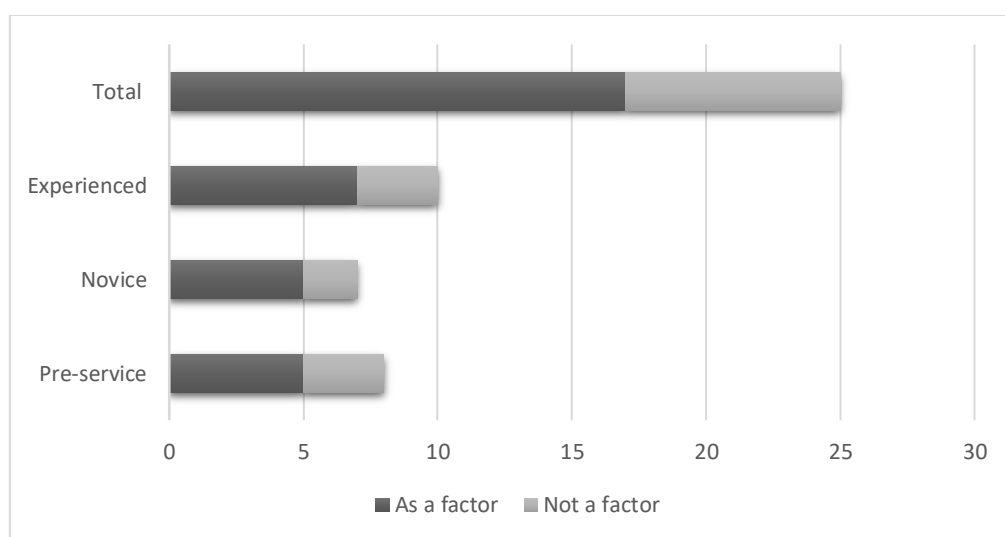


Figure 4.4 The comparison of results of content knowledge as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

Chemistry teachers' subject matter knowledge positively and negatively impacted their teacher efficacy. Participants expressed that if they feel confident about knowledge in a particular topic, they feel more efficacious when teaching it. Even teachers' lack of subject-matter knowledge in a particular topic makes them feel incompetent.

To start with the positive effects of CK, one of the experienced teachers said that CK was essential for teaching effectively with the following quotation. *'I think mastering subject matter knowledge is crucial to being a good teacher. Otherwise, you cannot be a good teacher even if you know the numerous methods and strategies. Since I know chemistry well, I believe that I am a good teacher.'*(Müjgan)

In addition, most of the experienced teachers stated the positive effect of CK on teacher efficacy as their ability to answer possible questions coming from students as the following statement: *"I am a good teacher because I think I have an excellent command of the subject. So, I can answer almost all questions coming*

from the students, and my answers can satisfy their curiosity."(Mehmet)

Moreover, some experienced chemistry teachers highlighted their ability to teach complex chemistry topics. They stated that they believe they are good teachers since they can teach those topics, and the factor that they can do this is given as CK. For instance:

"I believe that I am a master in teaching electrochemistry which is a challenging topic for most chemistry teachers but not for me. Because electrochemistry has a different terminology and logic behind that, it is not easy at all, I can do it because I know every detail of the topic."(Taha)

On the other hand, a novice teacher stated that teaching relatively simple topics enhanced her chemistry teaching efficacy by saying *"I feel competent about 9th-grade topics. As they are so simple, I know these topics well. So, I believe that I am capable of teaching 9 graders."*(Yağmur)

Although some of the teachers mentioned CK's positive impacts, some explained why CK undermined their efficacy beliefs. Novice and pre-service teachers stated they felt they had not mastered the subject-matter knowledge yet because of their lack of experience. Tuna, who is a novice teacher, explained the effect of content knowledge as the following: *"I know that I do not have a command of all chemistry topics. I feel incompetent if I don't know the subject as I should. (Tuna)*

Pre-service, novice, and experienced teachers stated that if they do not have a deep understanding of a particular topic, they expressed themselves as inefficacious in teaching those topics. From this point of view, pre-service, novice, and experienced teachers underlined the lack of content knowledge. To illustrate:

"I think I could not teach the chemical equilibrium topic.

Researcher: Why?

Sena: I could not understand the concept, it is very hard for me. I don't know how I can teach the topic that I am not fully understood'' (Pre-service Teacher)

"I don't feel competent in teaching gases. Because I have not grasped the topic since my high school years. Since I know what I'm missing, I could not teach this topic effectively." (Yağmur, Novice Teacher)

"I don't feel competent in teaching modern atomic theory. Especially, the orbitals and quantum numbers etc.

Researcher: Why?

Enes: I don't know the topic well. My knowledge of quantum numbers is superficial."(Experienced Teacher)

Moreover, most of the participants reported they teach the topic better in a way that they understand. For example,

"Researcher: What is the reason that you are good at it?

Burçin: I know these topics well. So, I teach the topic in the way that I have learned."(Experienced Teacher)

As for classroom management, some participants stated that content knowledge affected their teacher efficacy. The sample comment is given:

"Researcher: Do you feel confident about classroom management?

Taha: In my first years, I could not decide how I should react to my students' behaviors. Over years, I realize that authority in the classroom can be established by knowledge. As my chemistry knowledge expands, I feel more confident about classroom management."(Experienced Teacher)

Similarly, pre-service teachers claimed that they believe they will be good teachers in terms of classroom management by using their extensive subject matter knowledge. The following statement exemplifies this situation:

"What kind of chemistry teacher would you like to be?

Helin: How can I say, you may have had a teacher that had a reputation for being much disciplined but also the one you loved very deeply. That is the

kind of teacher I would like to be since they possess content knowledge as well as an impervious stance. Besides, students respect your authority when you have competence in your branch."

In conclusion, content knowledge was found as a factor of teacher efficacy and can increase or decrease teacher efficacy beliefs of chemistry teachers. Furthermore, it tended to affect teachers' efficacy beliefs regarding classroom management.

4.1.2.2 Pedagogical Content Knowledge

Figure 4.5 shows the number of participants who expressed that pedagogical content knowledge (PCK) affects their teaching efficacy. Although most preservice teachers (six out of eight) said that PCK affects their teacher efficacy beliefs, only three out of ten experienced chemistry teachers reported how PCK affected their teacher efficacy beliefs. In addition, PCK is a factor of teacher efficacy for more than half of novice chemistry teachers (four out of seven).

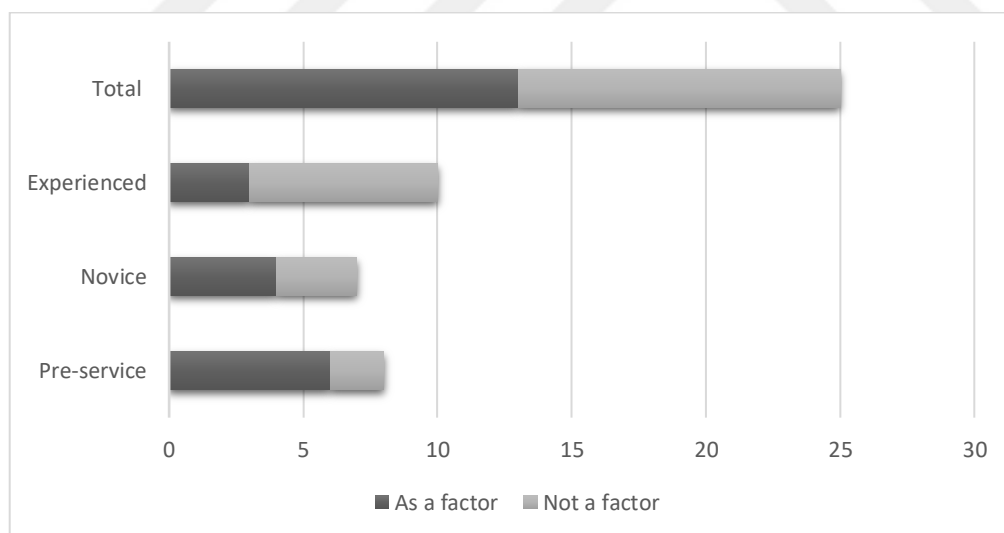


Figure 4.5 The comparison of results of pedagogical content knowledge as a factor affecting pre-service, novice, and experienced chemistry teachers. Vertical axis shows the number of participants.

Pre-service teachers mentioned how their knowledge of teaching methods and strategies used in chemistry shapes their teaching efficacy beliefs. For example, Helin stated, *"I know the teaching strategies and methods used in chemistry teaching. So, I believe that I can teach chemistry effectively."*

Most participants used several teaching methods and strategies to emphasize how they made abstract chemistry concepts concrete. Zehra, who is a pre-service teacher, explained it as the following:

"... I am good at content knowledge. More importantly, I have mastered teaching methods used in chemistry. That is why I know how to teach chemistry. I believe I can make students grasp all the chemistry concepts using micro, macro, and symbolic representations. Hence, students can depict abstract concepts in their mind. For example, I use 5E learning cycle and it is very effective for students."(Zehra)

Moreover, Selma, who is an experienced teacher, advocated that she can transfer knowledge by knowing student misconceptions and teaching strategies to overcome these misconceptions:

"Selma: It doesn't matter which university you graduated from. I think what really matters is how you transfer knowledge. It is a different skill.

Researcher: Do you believe that you can transfer the knowledge?

Selma: Yes. Because I assume that the students do not know anything related with the topic. I know the misconceptions that students might have. Accordingly, I make the abstract concepts concrete for them by using teaching strategies such as using an analogy."

Not only Selma but also most of the chemistry teachers reported the importance of knowing students' preconceptions and misconceptions. They mentioned how they feel competent about their teaching topic if they know them. One of the novice teachers explained it *"To teach effectively, I believe that I should know different teaching methods and strategies. For example, I need to elicit their ideas before*

starting a topic, thus I learn their preconceptions and misconceptions. Otherwise, I cannot feel competent."(Beşir)

Moreover, teachers from all groups said they avoid teaching chemistry by memorization and rote learning. Therefore, they mentioned that their pedagogical content knowledge played a role in providing meaningful learning. According to those participants, they should translate their PCK by using inquiry-based teaching methods, micro, macro, and symbolic representations, and making a daily life connection into their lessons to provide meaningful learning. In-service chemistry teachers explained it as follows:

" Researcher: Do you believe that you can teach chemistry concepts effectively?

Uğur: If I want to compare myself to other teachers, they may not care to teach essence of the topics. For example, they give only quantitative relations but not the logic extensively. I use daily life examples, analogies and micro representations for almost every subject since I know how to use innovative teaching strategies."(Uğur, Novice Teacher)

"I think I am better at teaching 11 grade because of the subjects such as gases, energy, rate, equilibrium... Contextual learning is more important in those subjects. Because memorizing can work only on simple topics. Since I know how meaningful learning is provided, I am fully capable of teaching those topics. "(Müjgan, Experienced Teacher)

On the one hand, chemistry teachers and teacher candidates stated how they feel competent in teaching using their PCK. On the other hand, the following quotation from one of the novice teachers showed that a lack of PCK may diminish the teacher's efficacy *"I know chemistry from the lessons that I took from the chemistry department. Chemistry subjects I have learned there were harder than the ones I am currently teaching. If I had known how to teach compatible with their level, I could have been a better teacher."*(Tuna)

Therefore, PCK was a factor that strengthened the teacher efficacy beliefs of participants.

4.1.2.3 Pedagogical Knowledge

Only a small portion of participants reported that pedagogical knowledge (PK) is a factor that affects their chemistry teaching efficacy beliefs. When Figure 4.4 is examined, the results showed that two pre-service teachers (out of eight) and three novice teachers (out of seven) mentioned PK as a factor affecting their teaching efficacy beliefs. In contrast, none of the experienced teachers mentioned effect of pedagogical content knowledge on their efficacy beliefs.

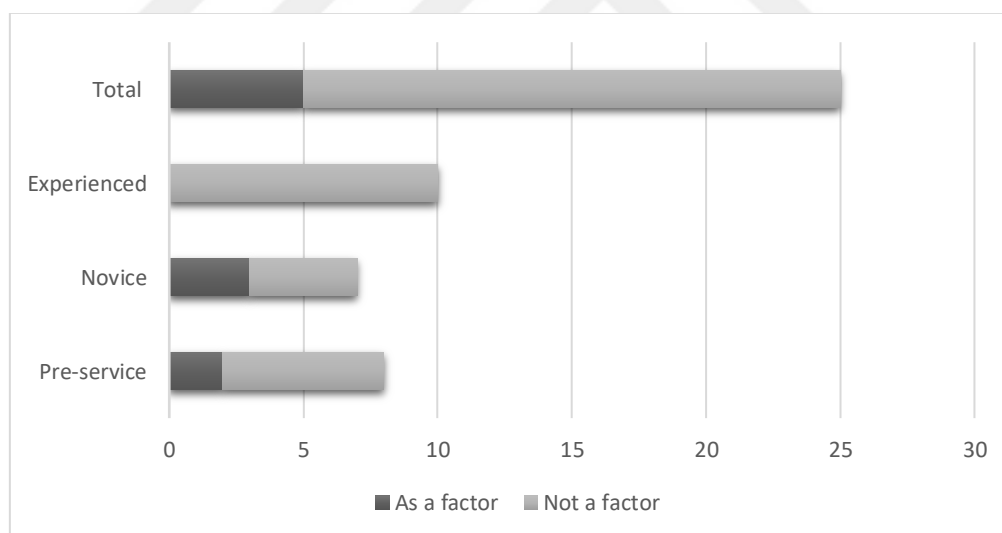


Figure 4.6 The comparison of results of pedagogical knowledge as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

For example, Sümeyye, a pre-service teacher, reported how PK plays a role in her feeling of competence in classroom management by saying the following quote.

... I feel confident about classroom management. I know a lot of techniques, such as reinforcements and punishments. I know that I will read articles and try different techniques. (Sümeyye)

Novice teachers stated that giving feedback is essential for both students and teachers. So, they reported that knowing how to give feedback makes them good teachers. For example:

... I know the importance of giving feedback to the students. Giving feedback makes me feel more confident in teaching. (Nuray)

...most teachers think that giving feedback is a burden. However, I believe that it is the most important thing for me because it is very beneficial for the students. I know how to give feedback to students; it makes me a good teacher. (Elif)

To conclude this section, CK, PK, and PCK were found as influential factors affecting the teacher efficacy beliefs of pre-service, novice, and experienced chemistry teachers emphasized by the participants.

4.1.3 Disposition

Under the disposition subtheme, physiological and emotional arousal, personality traits, interest, ability, and effort codes have emerged from data.

4.1.3.1 Physiological and Emotional Arousal

Less than a quarter of the respondents (five among twenty five participants) reported that physiological and emotional arousal was a factor affecting teacher efficacy beliefs of chemistry teachers and teacher candidates.

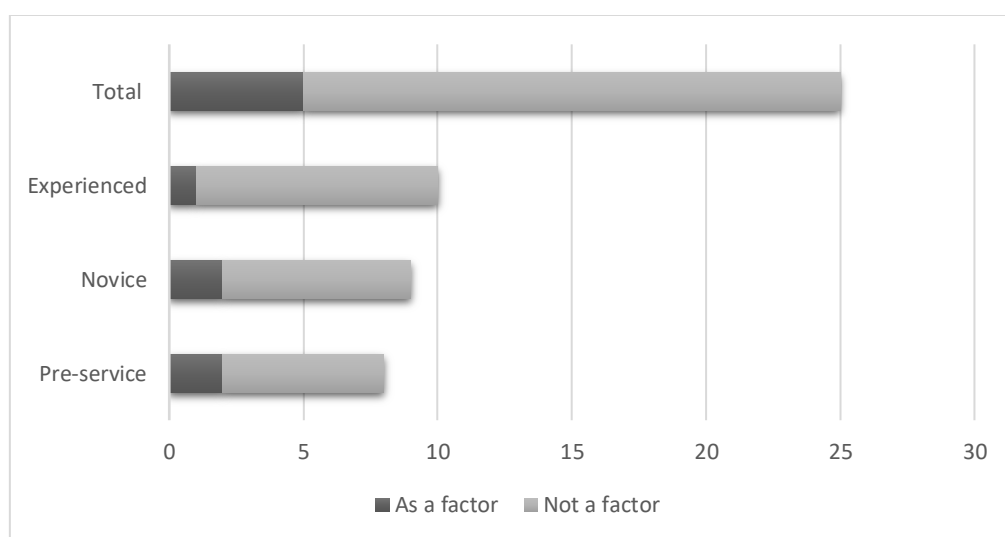


Figure 4.7 The comparison of results of physiological and emotional arousal as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

All participants stated that their physiological arousal affected their teacher efficacy negatively in their early experiences. For example, a pre-service teacher explained this situation with the following statement:

Why did you feel that you are incompetent in your first teaching experiences?

P: I was getting really nervous. I had problems like thrilling and hand shaking. (Cansu)

When reflecting on the communication with a student, a pre-service teacher stated:

When I felt that I was on the rocks, something like this happened. I focused to control my mimics so much not to offend or humiliate the student that I was not able to answer his question in a way that he could understand it since it was the first time that something like this was happening to me and at that moment, I really focused so much to my mimics and I cannot

remember how I explained the question to student and that really lowered my self-confidence. (Sena)

Like the pre-service teachers, novice teachers mentioned that their emotional and physiological arousal impacts their efficacy beliefs. Their concerns were generally about not being able to answer questions coming from students. For instance, *"Before I taught some classes I felt very nervous and sweat pouring out of me. I always think like ' what will happen or what kind of questions will they ask '. Moreover, I have concerns like ' will they be able to answer my question or will I be able to use time efficiently. "(Beşir)*

Nonetheless, the experienced teacher mentioned how he utilized his physiological arousal when he developed his efficacy in his favor with the following quotation:

"I said many times that I wish I had died due to the fact that I made a mistake. I would feel blushed, and I would sweat when I made a mistake. I always studied not to experience the situations again. That's why I am good at my job now. "(Enes)

In conclusion, pre-service and novice teachers reported that they were affected by their physiological and emotional arousal negatively. At the same time, the experienced teacher stated that his early experiences related to his physiological status made him a good teacher.

4.1.3.2 Personality Traits

As is seen in Figure 4.8, more than half of the participants stated that their personality played a role in their teaching efficacy beliefs. Half of the experienced teachers (five in ten), just over half of the novice teachers (five in seven), and only a few pre-service teachers (three in eight) agreed that their chemistry teaching efficacy beliefs were affected by their personality traits.

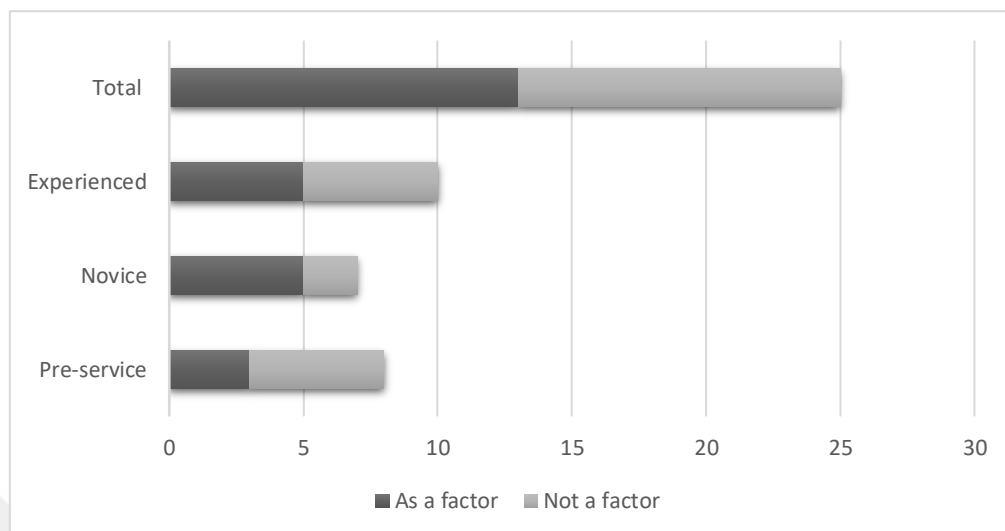


Figure 4.8 The comparison of results of personality traits as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

Firstly, participants from all groups mentioned their personality traits and their influences on communication skills, which increases their teacher efficacy. Participants mentioned the importance of communication skills originating from their personalities to build a good rapport with the students. The following quotations of pre-service, novice, and experienced chemistry teachers are given respectively to give sample quotes:

" Alright, do you think that you can teach chemistry concepts effectively?

Sümeyye: Yes

Researcher: Why do you think so?

Sümeyye: I mean I have couple of personal qualifications like my abilities, trainings and also, I have goals too. In fact, I can say that I shall be a good teacher with all of these. As I told you, when it comes to my personal traits,

I always try to be more sensible and tolerant. I try to make decent communication. I always try to be calm and professional and try not to take something personal."(Pre-service Teacher)

"Well, communication skills have to be at forefront when it comes to teaching both in face to face and group lessons. My skills help me a lot and I do believe that I am one step forward at this."(Gözde, Novice Teacher)

"Yunus: I believe that I have an ability to be sensible and empathic toward the person I am taking to.

Researcher: Do you think that these traits you mentioned make you a better teacher?

Yunus: Yes, I think it has contributed a lot. I think that emotional intelligence is essential in our area of work. In other words, being able to show empathy towards young children and trying to approach them without conventional methods and with modern methods are extremely mandatory."(Experienced Teacher)

The participants summarized the personality traits that made them good teachers as being emphatic, good listener, and respectful, which makes them good communicators. Moreover, there were other personality traits that chemistry teachers believed their positive effects on their efficacy beliefs. For example, Emre, who is an experienced teacher, explained it:

"I am not an agitated person. Generally, I am cold-blooded. I trust my rhetorical skills and even I have sung a song in public once, so I am self-confident in this extent. In other words, I am not afraid of public speaking or being humiliated. I am not the type of person who is concerned about the things which will happen in the future, so I can say that I have a low level of anxiety. For that reason, I have always trusted my competence in teaching."(Emre)

In the same way, personality traits that strengthened the teaching efficacy beliefs of chemistry teachers correlated personality with openness. A novice teacher explained it as:

"Uğur: I consider myself an innovative and a visionary person, so this makes me a good teacher.

Researcher: So, why do you think you are like that?

Uğur: The reason is I like investigating a lot and I am very open-minded. How I can say I like experimenting with new things. Also, I have a mentality like if I embark on an initiative, I really like to learn it from top to bottom."

Finally, perfectionism was stated as a personality trait that increased some of the participant's teacher efficacy beliefs but diminished others' teacher efficacy beliefs. Two opposite situations are reported in the following sample quotes:

"Yağmur: For example, I sometimes feel nervous when students say 'Can I ask you a question' since I have a fear of failure and that is why I do not feel competent as a teacher.

Researcher: What exactly is the reason for your discontent?

Yağmur: Perhaps, my perfectionist feeling because I always feel incomplete at everything."(Novice Teacher)

"Researcher: Why do you think you have forced yourself to become a good teacher?

Mehmet: It is a bit related to my personality. I would like to be the best at what I do, it is a sort of ambition. When I do not feel complete or competent, I am extremely triggered. If I love my job, I will do it in the best way I can since it is in my character."(Experienced Teacher)

Consequently, regarding the personality traits factor, in-service and pre-service chemistry teachers reported that they felt adequate or inadequate themselves in terms of their opinions about how they interpreted these traits.

4.1.3.3 Interest

Figure 4.9 shows the number of participants; five of ten experienced teachers, four of seven novice teachers, and five of eight pre-service teachers mentioned how interest affected their chemistry teaching efficacy beliefs.

Participants typically reported feeling competent and engaged when teaching about topics they enjoyed, driven by their personal interests. However, in contrast, they expressed a sense of inefficacy when teaching less interesting subjects to them.

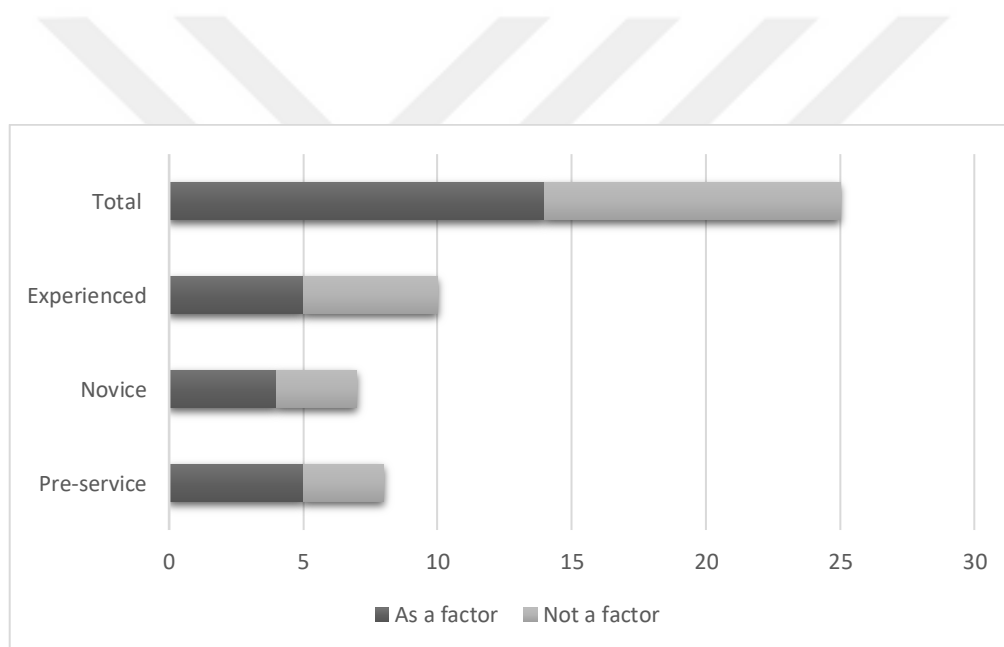


Figure 4.9 The comparison of results of interest as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

For example, the following statements showed the positive impact of interest factor:

"I do believe it is a fact that the more you like the topics the more you teach them well. For example, the topic that I am fully capable of teaching is rate

and equilibrium which are my favorite topic as well."(Sila, Pre-service Teacher)

From different point of view, the negative impact is shown in the following quotation:

"I don't feel confident when I teach the topic that I do not like. For example, I am really not interested in the biochemistry, thus teaching biochemistry is not easy for me."(Yunus, Experienced Teacher)

Apart from the topics of the chemistry, participants reported their interests in chemistry in general affected their chemistry teaching efficacy positively. A novice teacher explained her interest in chemistry and how her interest increased her efficacy beliefs. She said: *"The most enjoyable topics for me was always chemistry. Chemistry has been aroused my interest since my high school years. So, I believe I am good at teaching, but chemistry is the area that I am best as a teacher."* Moreover, participants mentioned that their interests in other branches of science or mathematics also influenced their chemistry teaching efficacy beliefs. For example, a novice teacher stated:

"Tuna: I am better at teaching quantitative chemistry.

Researcher: Why so?

Tuna: I deal with mathematics. It is my personal interest. I prove the formulas used in chemistry by using different mathematical equations. Only then, I satisfy my teaching and reflect it to students."

Furthermore, participants reported they believe they can engage students thanks to their interests. They emphasized that the chemistry facts take place in daily life. Thus, their hobbies, such as cooking or cars, helped them while engaging students. For example:

"Researcher: Why do you believe you can teach chemistry?

Emre: I have a wide range of interests. It helps me a lot in terms of engaging students. For example, I emphasized octane number when I teach organic nomenclature thanks to my curiosity of cars."

After all, as highlighted by the participants, interest has a generally positive impact on chemistry teachers' chemistry teaching efficacy beliefs.

4.1.3.4 Ability

As is seen in Figure 4.10, only two of ten experienced teachers and two of eight pre-service teachers stated that ability was a factor of their teacher efficacy beliefs. In contrast, none of the novice teachers mentioned the effects of ability on their teacher efficacy beliefs.

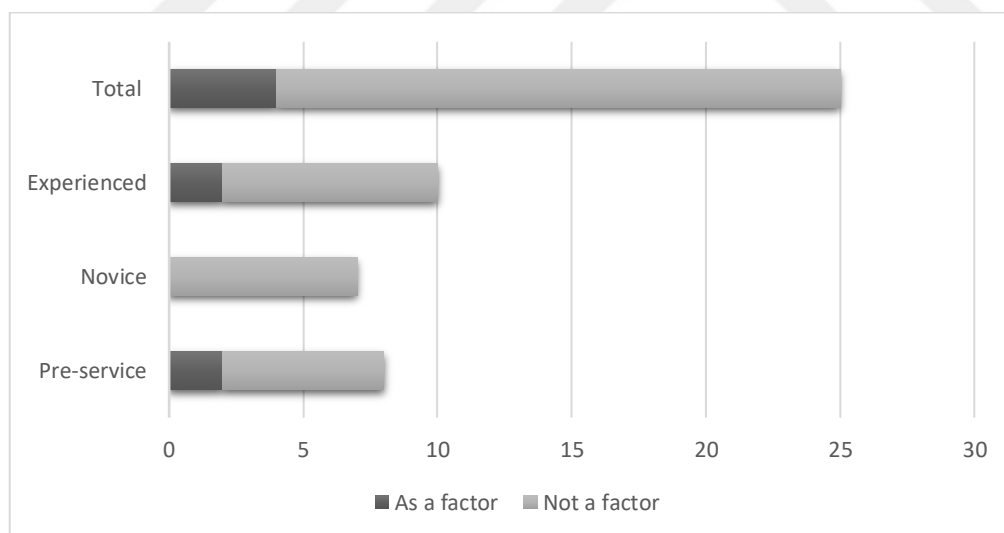


Figure 4.10 The comparison of results of ability as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

Participants in question stated that teaching is a talent and only some are capable of teaching. Also, they defined what they meant by talent in their own words. A pre-service and an experienced teacher respectively reported the following statements:

"Ebru: I do believe that being able to teach is all about talent..."

Researcher: What do you mean by talent?

Ebru: My course instructor always says that knowing chemistry is not an essential to teach chemistry, what matters most is how you teach chemistry. I really agree with her. For example, our chemistry professors know chemistry much better, although they are not able to teach us. So that, it is a different kind of talent. For instance, you should be able to understand whether you teach well by looking at the faces of the students. At this point, I believe that not everybody can achieve it. Even though, they know hundreds of teaching methods, they may not be successful. " (Pre-service Teacher)

"Researcher: What is the reason why it has gone well so far after you gave your first lesson?

Emre: It is not only my university education but also natural talents that I have.

Researcher: Like what?

Emre: How I can say... Well, having an ability to conceptualize information, making it easier for students to understand and teaching them in a comprehensible way are talents in my point of view."(Experienced Teacher)

It can be concluded that only a few participants believed that teaching was a natural ability they had. They also believed they were capable of teaching thanks to their natural ability.

4.1.3.5 Effort

All the experienced teachers (ten out of ten) and a few novice teachers (two out of seven), and only one pre-service (out of eight) teachers stated that making an effort to teach increased their chemistry teaching efficacy beliefs.

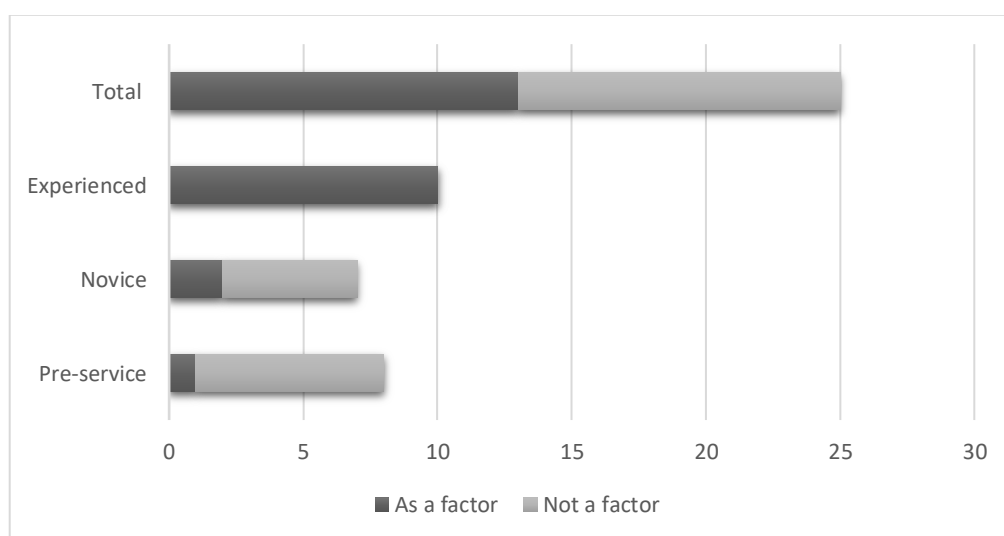


Figure 4.11 The comparison of results of effort as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

Firstly, the pre-service teacher mentioned how she felt confident in teaching by making an effort in the future with the following statement.

"Before teaching, I will study the topic and prepare a lesson plan for every lesson. I can take notes including the important point. I have already known basic chemistry principle, but I can improve myself by studying a lot. By this way, I believe I can be a good teacher."(Çağla)

Secondly, in-service teachers advocated that their effort made them good at teaching in the laboratory. They mentioned their attempts to improve themselves in the laboratory. As an example, a novice teacher explained:

"Researcher: Do you believe that you provide an effective teaching in the laboratory?"

Uğur: 100%, yes. I am better than most of the chemistry teachers in Turkey. Because I have learned something in faculty. However, what I learned in faculty was superficial. I improved myself own my own. For example, I prepared my own material in summer vacation. I have never used the experiments in the textbook directly. To sum up, I puzzled my brain and worked hard."

Finally, most experienced teachers reported believing they were competent chemistry teachers thanks to their past endeavors. They mentioned how they had studied hard, and made preparation and plans before teaching the topic. To illustrate, two of the experienced teachers explained it as the followings:

"I always study a topic extensively before teaching it. Then, I prepare my materials and think about the possible questions that the students could ask me during the lesson. Otherwise, I do not know what I encounter while I am teaching. If I am prepared, I feel confident in teaching."(Müjgan)

"...I believe that I teach these topics very well."

Researcher: Why do you think that so?

Taha: I have given an effort to these topics a lot. For instance, I think that I have given much more effort than a regular teacher might possibly give. Let me give you an example, a regular teacher may study only from one textbook before teaching these topics. I generally review all the textbooks about these topics. When I encounter with a different point of view towards the topic, I take notes."

All in all, all the experienced teachers agreed that making an effort developed their sense of efficacy beliefs. On the other hand, a small portion of novice and pre-service teachers stated that effort affected their teacher efficacy beliefs.

To sum up, participants mentioned that personal factors, which were their experience, knowledge, feelings, skills, and effort, were reported as significant factors affecting their chemistry teaching efficacy.

4.2 External Factors

The second main theme of this study was the external factors described as social and environmental influences on the participants' teacher efficacy. The subthemes that emerged under this category were feedback, persuasion, student-related, teacher-related, and social environment in teaching.

4.2.1 Feedback

The evaluative feedback teachers received about their teaching performance affecting teacher efficacy was coded under this subtheme. Pre-service teachers (five among eight) frequently mentioned the feedback that they received from their course instructors and peers, whereas novice (three among seven) and experienced teachers (four among ten) stated their efficacy beliefs were affected by the feedback coming from their students, colleagues, and school administrators. Participants pointed out that receiving feedback positively and negatively affected their teaching efficacy beliefs.

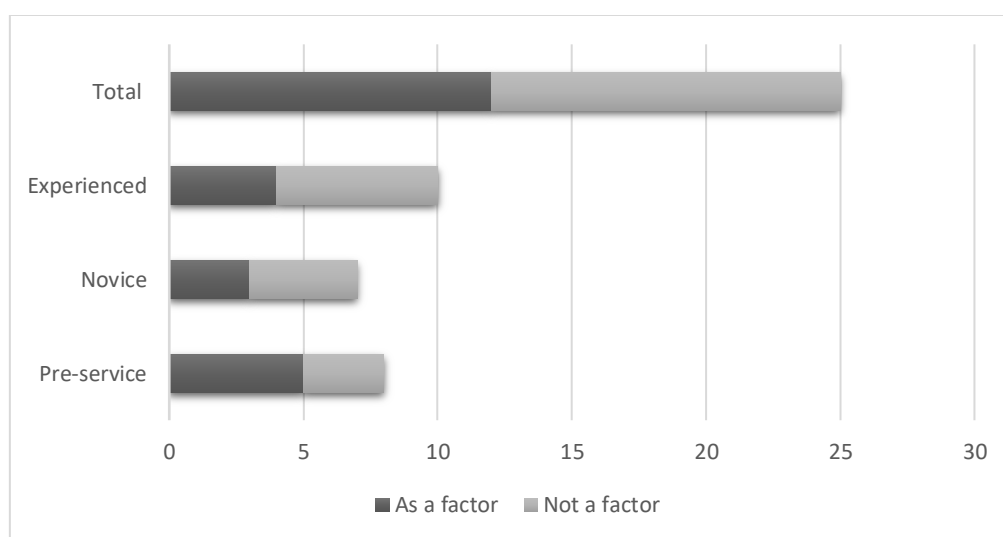


Figure 4.12 The comparison of results of feedback as a factor affecting pre-service, novice and experienced chemistry teachers.

Pre-service teachers reported that they received feedback after micro-teaching sessions at the faculty. They generally mentioned that course instructors criticized their performance. Some were perceived as positive and constructivist criticism, whereas others believed they were destructive. From a different perspective, a pre-service teacher highlighted how she improved her efficacy beliefs when she delivered the feedback that she perceived as a destructive criticism:

"When I received so much criticism, I really wondered if I was suitable for this profession, but it has driven me more to be better. Obviously, I need to do better in the other instruction. I thought I need to do it better and how I can do it better, and finally I ended up making the best presentation thanks to negative feedback that I receive. " (Cansu)

By contrast, a novice teacher stated that the instructors' feedback undermined her efficacy beliefs and that she evaluated them as criticism. She clearly explained:

"Because of what I went through in my school life at the time, because my instructors had criticized me and my performance, so I restricted myself

and this situation affects my teaching in a bad way, I feel I am not competent. (Yağmur)

In addition, some pre-service teachers emphasized that they get constructive feedback from their course instructors, who correct their mistakes and pave the way to improve themselves. To illustrate:

"Researcher: So why do you think these feedbacks pleased you?"

Helin: Because I am trying to be a teacher, so they should tell me what I am missing and what I am doing wrong. They will say to me my mistake so that I will not make that mistake again. Because chemistry is a study area where full of abstract concepts and misconceptions are very common. I needed to get feedbacks in order not to make misconceptions. You know, when they said that you gave this concept in a confusing way and explained how I can give it clearly. I learned it because I don't know how to do it own my own. If only they give me feedback, I will learn how to teach. I think it can progress in this way, honestly.

Researcher: What kind of a teacher will you be as a result of this feedback?"

Helin: I think I will not make those mistakes again, I think I will be good."

Apart from the course instructors, pre-service teachers mentioned that their peers gave feedback on their performance. Some of them mentioned that getting feedback from their peers positively affected their teaching efficacy. For example, a pre-service teacher compared the effectiveness of feedback coming from course instructors and her peers in terms of effects on her teaching efficacy beliefs:

"It is different when a teacher tells me what I did wrong and when a friend tells me what I did wrong. Because my friend is in my position, she tells me what I should do and how I can be better. Obviously, in this way, we improve each other more in teaching."(Çağla)

Likewise, novice teachers mentioned how they improved their efficacy beliefs when they delivered feedback from their colleagues. They mentioned the importance of getting instant feedback to evaluate their performance. For instance:

"After peer observation, we have meetings where head of department and other experienced teachers gives feedback. They talk what went well, what did not go well, what could have gone well, or for the classroom environment, it seems to be evaluated not only in terms of instructional strategies but also in terms of classroom management. When I receive constructive feedback in these sessions, I feel that I am doing well."(Elif)

Moreover, some in-service teachers highlighted the importance of getting positive feedback from their colleagues and school administrators. They mentioned how their efficacy beliefs were reinforced through positive feedback. For example, a novice teacher mentioned this process in the following situation:

"Researcher: Do feedbacks that you receive also affect your self-confidence in teaching?

Uğur: It does, of course. In our institution, there is actually a condition that they hire teachers with at least 5 years of experience. But when I started at this institution, I was in the second year of my profession and there were very experienced teachers when I entered the school. I was actually quite ostracized because I was one of the very young teachers at the school. Everyone was thinking, "How was he hired?" But then, they observed my class and I think they realized my potential, both the administrators and experienced teachers changed their perceptions by expressing my strengths. Of course, it improved my self-confidence. In other words, it increased the thought that I can do it. As such, I became more attached to the profession and thought of myself in a more competent teacher.

Similarly, experienced teachers mentioned how feedback could be evaluated to indicate their performance and how they processed feedback to improve their

efficacy beliefs. Experienced teachers generally comment on students' and administrators' feedback and how they shape their efficacy beliefs. For instance:

"I can say that the feedback from the students is entirely thanks to the feedback from the students I think I am doing well, and this is also the same for the administration. For example, the administration did not allow me to attend the courses that used to be very high-priced at the school because they did not think that I was a good teacher, but then they observed my classes and heard the student feedback about my classes, this situation changed, I broke this perception since I became a head of department and an assistant principal" (Mehmet)

Student feedback delivered in the form of verbal or written evaluation of teacher performance is reported as a factor affecting the efficacy beliefs of novice and experienced teachers. Müjgan, who is an experienced teacher, states that positive feedback from students evaluating her performance increased her belief in the capability of teaching by saying:

"Researcher: Did these feedbacks coming from students affect your self-confidence in terms of teaching?

Müjgan: Of course, you feel more comfortable when someone else approves that you are doing something right. You feel more that you are doing the right thing that you are on the right track. It gives more confidence."

Such statements showed that evaluative feedback received from course instructors, peers, colleagues, administrators, and students affected the teacher efficacy beliefs of pre-service, novice, and experienced teachers. They mentioned that the tone of the feedback shaped their efficacy beliefs positively or negatively.

4.2.2 Persuasion

Well over half of the participants mentioned how they were persuaded about their teaching performance. Five among eight pre-service teachers, four among seven

novice teachers, and seven among ten experienced teachers mentioned that social persuasion positively affected their chemistry teaching self-efficacy. Teachers and teacher candidates who experienced verbal persuasion from students reported that their efficacy beliefs were significantly influenced. For pre-service teachers, cooperating teachers and course instructors were also reported as persuaders. Moreover, administrators, colleagues, and parents were stated as persuaders for in-service teachers.

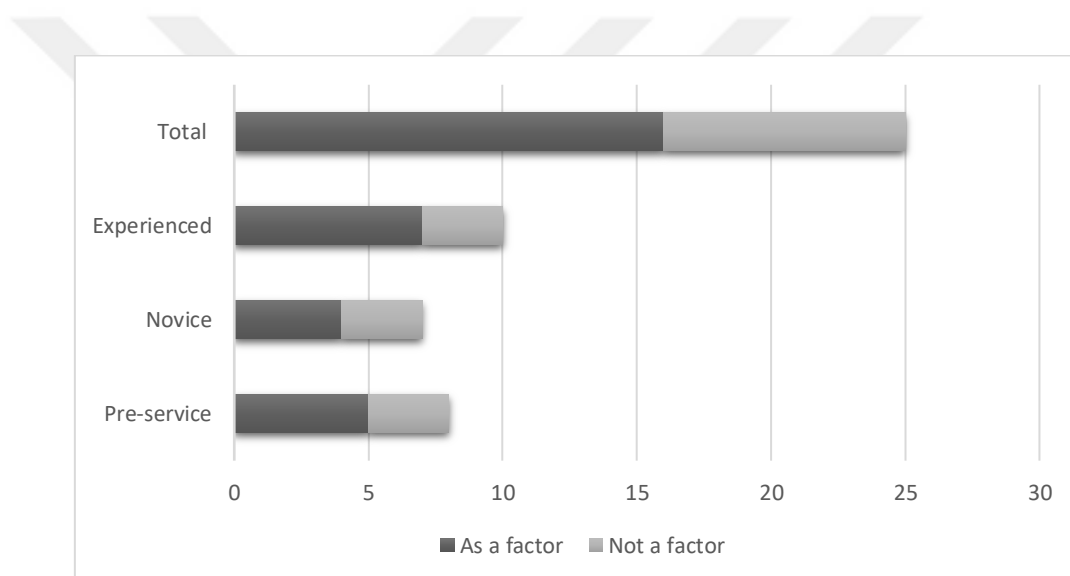


Figure 4.13 The comparison of results of persuasion as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

The pre-service teachers stated that their cooperating teachers in high school persuaded them to their capabilities in teaching. Therefore, they stated their efficacy beliefs were strengthened since the cooperating teachers were experienced. For example, a pre-service teacher drew attention to the credibility of the persuader by saying the following statement:

"Our cooperating teachers appreciated us much. They mentioned they had gained different point of view thanks to our instructions. Even, one of them said that you had been graduated for me and ready for becoming a teacher.

Researcher: How does this situation affect you?

Sıla: Despite their experience, the fact that they appreciated us and said such things affected my motivation in a good way. In other words, it increased my self-confidence."

Moreover, a pre-service teacher stated how students persuaded her during her informal teaching experience. Also, she mentioned how she weighed the verbal information coming from those students. To illustrate:

"Zehra: In the place where I have worked, students used expressions such as 'teacher, we do not understand from our teacher at school, we understand from you'. Although there are other, more experienced teachers - they even wanted to study with me, they wanted to ask me all their questions.

Researcher: Did these students' statements affect you?

Zehra: It means that I was able to teach them that they use that word. I said that means I can teach a subject, I have no problem in communication, so that they say these statements to me."

Likewise, in-service teachers pointed out that students affected their self-efficacy in chemistry teaching by persuading them. Besides verbal persuasion, they stated they believed students who preferred to study with them indicated their teaching capability. A novice teacher explained this situation as follows:

"For example, it satisfies me very much, for example, students always want to take study time with me after class, not from their own teachers. For example, they said that "you explain better, we can solve questions more comfortably since you explained with fewer sentences."(Uğur)

Similar to that, an experienced teacher explained how her efficacy beliefs were strengthened by persuasion of students. To illustrate:

"... for example, in our school, there are 3 teachers in the class, we take the classes in turns. Some of the students want me as their only teachers. They said that we understood from you, you were better. Then, I realize that the students prefer me that means they want me to teach them, and they understand from me."

Moreover, experienced teachers mentioned how the persuasion of their colleagues influenced their efficacy beliefs. They stated that the credibility of persuasion received from their colleagues had greater since they were also experts in teaching. For instance, an experienced teacher reported the situation clearly with the following statement:

"Once, I made a presentation for an online learning profile. I taught equilibrium topic and two of the chemistry teachers recorded my presentation. After all, they told me "we had never seen a teacher who explained equilibrium concept so well." Until that moment, maybe, I did not realize that I am so good. Then, I think that if I receive it from chemistry teachers, I can teach equilibrium well." (Mehmet)

Apart from the students and teachers, less than half of the experienced teachers mentioned the parents persuaded them; thus, their efficacy beliefs were increased by parents. To illustrate, an experienced teacher expressed:

"His parents called me privately and said that our child got full mark in the university exam, thanks to you. These types of feedback that appreciate my accomplishments affects my confidence very seriously. Also, they increase my performance as a teacher" (Taha)

Overall, teachers explained how their efficacy beliefs were reinforced by persuasion from students, teachers, and parents. Moreover, they commented on the credibility of persuaders and how they weighed verbal information.

4.2.3 Student-Related Factors

Factors related to the students affected the teacher efficacy beliefs. Student-related factors include student participation behavior, student grades, and learner profile.

4.2.3.1 Learner Profile

One of the most frequently mentioned student-related factors is the learner profile, described as the student's strengths, weaknesses, grade level, characteristics, and background. Two among eight pre-service teachers, four among seven pre-service teachers, and five among ten experienced teachers emphasized the effect of learner profiles on their teacher efficacy beliefs.

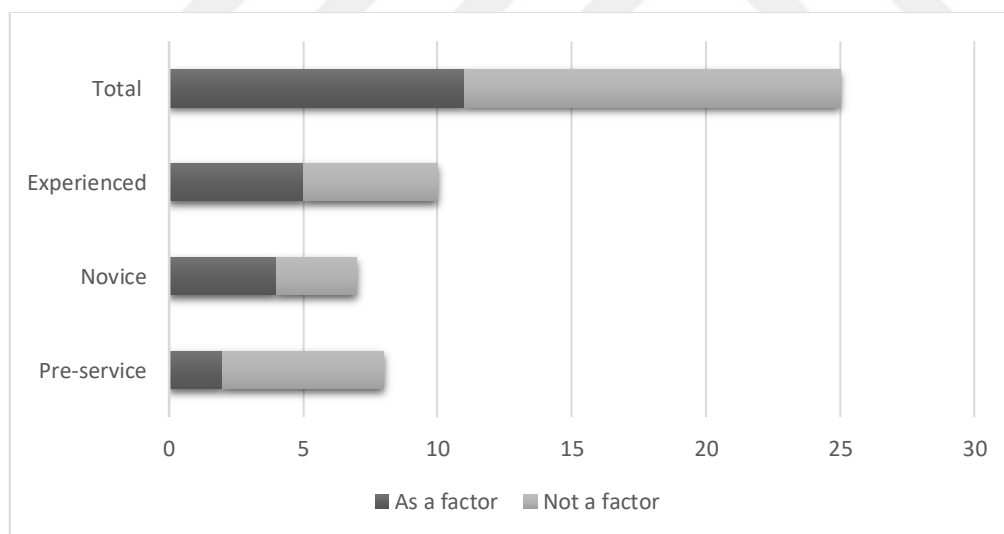


Figure 4.14 The comparison of results of learner profile as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

Firstly, participants mentioned that students with weak mathematics could decrease their chemistry teaching efficacy. They pointed out that they believed they could not teach a chemistry topic if students struggled to learn mathematics. For example, a pre-service teacher mentioned her teacher efficacy would be lowered in this situation as in the following statement: *"Well honestly, I don't think that I am capable of teaching effectively if the student does not have a mathematical background. This causes me to query about my teaching abilities."*(Ebru). Likewise, a novice teacher claimed her efficacy in teaching the mole concept was affected by students with poor mathematical skills. For example,

"I have a little difficulty in describing the mole concept. It is a subject that the student is also very afraid of. I don't have problems with good students, but sometimes even I am not sure whether I am explaining the chemistry of the mole with students who are not good enough at mathematics. Actually, I do not say that not learning mole is their problem because of their weak math. I just say that it is my problem, I could not find a way to teach those students."(Gözde)

Secondly, students' academic achievement is reported as a factor affecting the teachers' efficacy beliefs. Most of the in-service teachers stated that they feel themselves as better teachers when they teach high-achiever students. An experienced teacher said: *"I feel better when I teach high-achievers, even gifted students. I teach the lesson more effectively. Then I can convey exactly what I know. In this way, I can see the points where I am missing. I feel that they can understand from me better."*(Emre)

In contrast, a novice teacher reported that her efficacy beliefs were enhanced when she taught the topic to low-achiever students. She also reported her hesitation about possible questions coming from high-achiever students. She explained:

"There is an achievement level difference between A and B classes in my school. A is the high-achiever one. When I first teach the lesson to the B group, they are not as curious and inquisitive as the A class students."

Frankly, when I am explaining to class B, I learn with them while I am teaching the subject. When I enter A with the self-confidence of teaching in B, I do not have the feeling that I cannot explain this subject, or I will get excited. But if I'm going to talk about that subject in a first, I get nervous. I think of the possibility that I might not be able to do it in front of them because they are successful students."(Yağmur)

Teachers reported that students' grade level and age were responsible for affecting their teaching efficacy beliefs. Some in-service teachers mentioned they did not build a good rapport and create effective learning environments for ninth graders because of their age. For instance, one of the experienced teachers pointed out:

"The age group has a great influence on whether I feel competent in a subject or not. I explain the same atom and periodic system subject to 11th graders with that ease. But I don't think I am effective enough in ninth grade because of their age." (Burçin)

In addition, pre-service and novice teachers stated they felt inefficacious when teaching twelfth grade to own to their concerns about the university entrance exam. A novice teacher underlined this situation with the following quotation:

"There are situations where I feel inadequate in 12th grades. Because the concerns of 12th graders are more exam oriented. As a matter of fact, they need more exam tip, but I am not that teacher, I attach importance to conceptual knowledge, but none of the 12th grade students want to deal with questions such as what the pH range should be. For them, only the premises in those true false questions matter."(Beşir)

Moreover, student characteristics were reported as an influential factor affecting teacher efficacy beliefs of the teachers. They reported that students' characteristics (e.g., being responsible, self-motivated, and respectful) affected their teaching efficacy positively. In contrast, they claimed their teaching efficacy was affected negatively due to the lack of these characteristics. For example, an experienced teacher explained this situation clearly:

"Researcher: Do you think you can teach chemistry concepts effectively?"

Selma: So, this is a situation that varies from student to student. You can convey this very well to good students, but those students are not the case. There are times when I don't think I can teach. Because there are situations where students want someone else to do everything for them, they're not very self-disciplined. So, it is completely dependent on students' characteristics."

Lastly, just a few of the participants commented family background of students and its effects on their teaching efficacy. To illustrate this situation, one of the novice teachers mentioned the effect of the socioeconomic status of students on his teaching efficacy beliefs with the following quotation:

"I work at two different campuses. There are differences that I see as a teacher when I compare the two. Maybe this is related to the socioeconomic environment. Students who are close to the civil servants are more interested and I can better convey what I know to them. But I have a really hard time adapting children from higher socioeconomic backgrounds to the lesson."(Tuna)

It can be concluded that learner profile was reported as a factor that can lead to a rise and fall in the teacher self-efficacy beliefs of chemistry teachers.

4.2.3.2 Student Participation Behaviour

The other most frequently mentioned student-related factor was student participation behavior. The frequencies of participants were four among eight pre-service teachers, three among novice teachers, and four among ten experienced teachers. Under this heading, participants commented on the student's participation and their reactions to their instructions, which impacted their teaching efficacy beliefs.

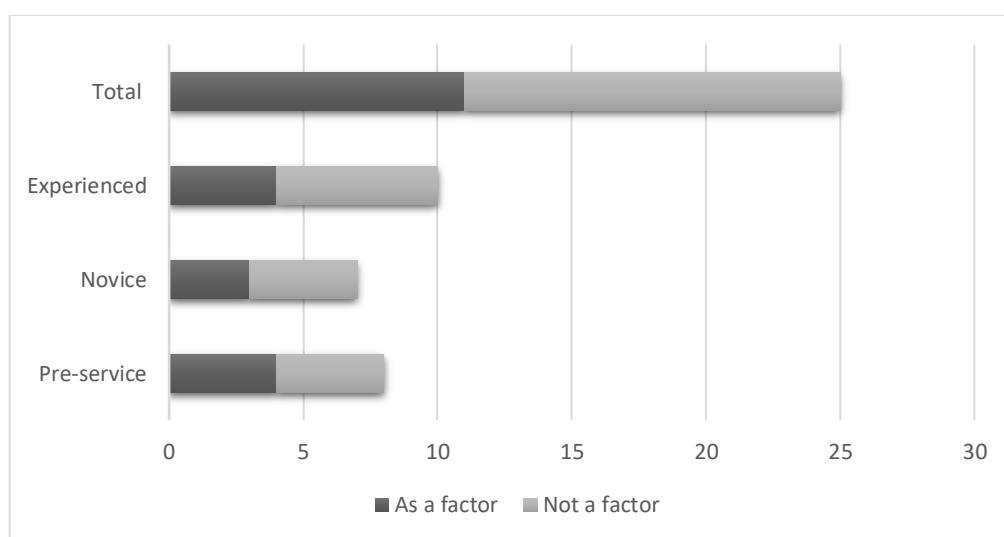


Figure 4.15 The comparison of results of student participation behavior as a factor affecting pre-service, novice and experienced chemistry teachers.

Participants mainly explained how their observations of student reactions while teaching affected their efficacy beliefs. They claimed they felt confident when the students participated in their lessons actively.

Firstly, pre-service teachers shared their experiences gained through teacher training and pointed out that their observation of students affected their efficacy beliefs. For example, two of them explained:

"In my teaching trainee experience, there were a group of students participated my lessons a lot. I can clearly see that they were listening to me so well, paying attention only to me. They answered all my questions. The students like them boost my self-confidence in teaching."(Sıla)

"For example, at the moment when I can create surprise on the student's face with something I show, this is a very nice feeling, it is something that seriously increases self-confidence. Because we have learnt so much, we have experienced so much and in return I can see it by observing my students." (Ebru)

By contrast, a pre-service teacher mentioned how her efficacy beliefs were affected negatively by observing students' reactions, indicating that students did not understand. She explained:

Some of the students looked at my face in a very absurd way. You know, at the point where he doesn't understand him and I believe I couldn't explain it, I guess it won't come out of me... I mean, when I think that he doesn't understand, it takes me a long time to recover myself because I fall down a lot... (Sümeyye)

Likewise, experienced teachers mentioned how their teaching efficacy was enhanced by observing student reactions indicating the participation of students. An experienced teacher explained this situation clearly with the following statement. *I can understand I can do my job well by evaluating students' behavior, their approaches during my lessons. (Emre)*

In addition, another experienced teacher reported how his efficacy beliefs were enhanced. To illustrate, the following quotation shows how his satisfaction with his performance is affected by the student's reactions.

"You can feel if you've explained something well or not. Yes, I explained this, or I couldn't; I think you feel it. For example, in the first years I entered, I did not command some subjects well. To be honest, I was not very satisfied with my performance. After all, I constantly make eye contact with the students; I check it in the classroom; that is, from the students' looks and movements, I can already guess whether they understand a subject or not. When I observe students, I feel that I am good at teaching.

Lastly, pre-service and in-service teachers mentioned their efficacy beliefs increased when they can provide an active learning environment for the students. They emphasized students participation in the activities that they designed have an effect on their satisfaction with their teaching performance. For instance, Elif who is a novice teacher explained this situation as the following: *"When I provide the*

involvement of the pupils and present the subject to them in an interactive way, I believe that I am effective at the point where the student is active."(Elif)

To sum up, students' active participation is reported as a contributing factor in the increment of teacher efficacy beliefs of the participants, whereas students' reactions indicating their lack of understanding or their unwillingness to participate led to a decline in teacher efficacy beliefs.

4.2.3.3 Student Grades

Under this heading, teachers' opinions about the assessment of students in chemistry and the effect of the assessment results were given. Among the participants, one of the pre-service teachers, five experienced teachers, and three experienced teachers reported the effect of student grades.

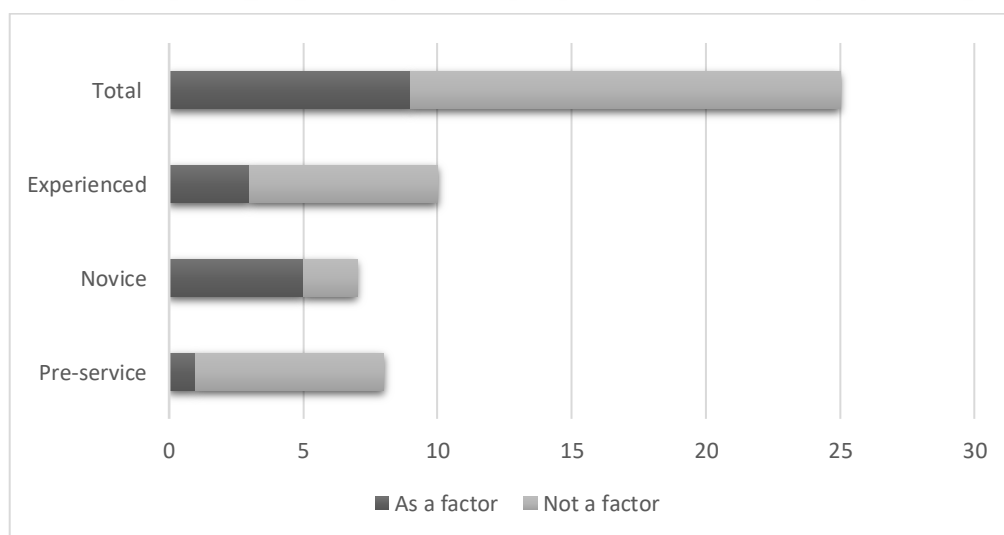


Figure 4.16 The comparison of results of student grades as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

Only one of the pre-service teachers mentioned she believed that a student took a high grade thanks to her. The following statement is also shown her cognitive process about the student grade *"For example, a student could not understand a subject in a lesson, and if I remember correctly, I taught him the subject in five minutes, and he said that he got a high grade on the exam, which made me very happy. So, I taught him, and he got high marks; that is an indicator of my capability" (Cansu)*

In general, experienced teachers did not mention the effects of high or low marks on their teacher efficacy. However, one of the experienced teachers who teach low-achiever students stated her efficacy beliefs were enhanced when the students got high marks, whereby students getting low marks did not affect her teaching efficacy beliefs. In addition, the cognitive evaluation is seen in the sample statement given as the following:

"Researcher: Do assessment results affect your self-confidence in teaching?

Duygu: Of course, it makes me happy if they succeed in an exam conducted objectively and without cheating attempts. I know my students who fail in exams because they have not revised or studied. Thus, when I see excellent exam papers, it feels me confident since I see that students have understood the subjects I have covered, so exam results are essential.

Novice teachers were the participants who most frequently mentioned the effects of student grades on their teacher efficacy. Most reported that their efficacy is affected parallel to the student's grades. For example:

It gives me confidence to see my students' success in exams and the way they solve the questions exactly what I have taught them. It leads me to the idea that I can teach the lesson exactly the same way as I am doing now. However, I have seen problems as well. For instance, even after I had clarified the key points in lessons and I had told them to revise for them, some students failed exams. At that point, I was unsure of myself, and I decided to conduct a quiz, yet some of the students were unsuccessful while

others were not. The results did not satisfy me yet again, so I was again unsure of myself. In short, I can say that I have had exams which affected me positively and negatively too in terms of their marks. (Beşir)

Also, they mentioned how they questioned themselves due to student grades. To illustrate this situation:

"Researcher: You make assessments like exams, quizzes etc. Are the results affecting you?

Elif: Believe me they are. I feel sorry as much as my students, maybe even sorrier than many of them. I feel sorry that they have failed in exam but sometimes I question myself like 'whether I am doing wrong or good enough."

To sum up, the pre-service and experienced teachers mentioned how their efficacy beliefs were improved due to the high marks of students. On the other hand, novice teachers stated that the high marks of students increased their efficacy beliefs while low marks caused the feeling of incompetence.

4.2.4 Teacher-Related Factors

Teacher preparation quality and professional development codes emerged under the subtheme of teacher-related factors. These external factors were related to pre-service and in-service teacher education.

4.2.4.1 Teacher Preparation Quality

As it is shown in Figure 4.17, all of the pre-service teachers (eight in eight) and well over half of the novice (five in seven) and experienced (seven in ten) teachers reported university training that those participants received to be a teacher played a vital role in their teaching efficacy beliefs. Pre-service teachers and in-service teachers who believe that they received a quality education pointed out that they

believed they were or would be good teachers. In general, they mentioned the effects of the content of courses such as chemistry, general pedagogical, and content pedagogical; most participants commented on how these courses affected their perceived self-efficacy in chemistry teaching.

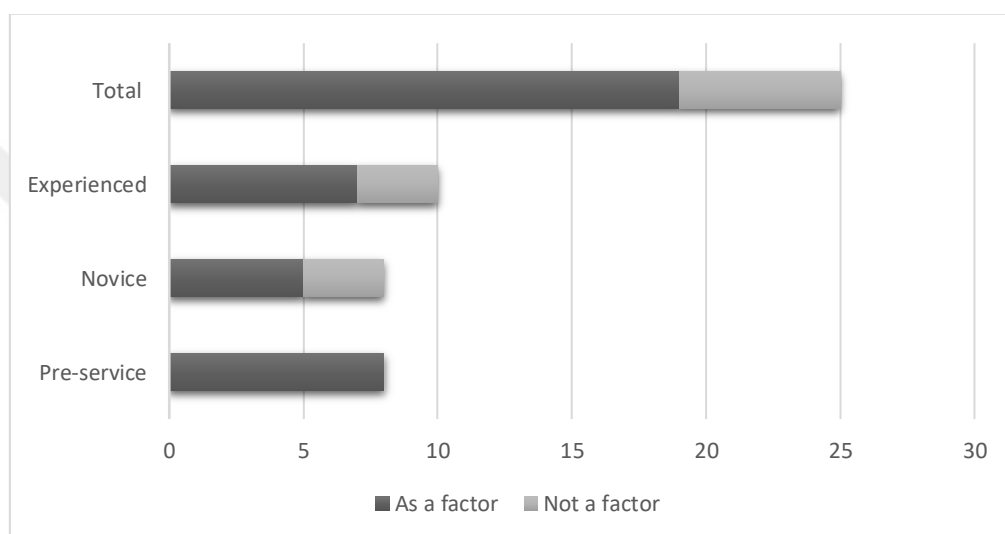


Figure 4.17 The comparison of results of teacher preparation quality as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

First, pre-service teachers commented on the quality associated with the university's reputation and its faculty. Those participants stated that studying at a reputable university meant receiving a high-quality education. A pre-service teacher said: *"I think that I will be a good teacher because I am capable of using everything, I have learned at my university which is one of the most reputable universities in Turkey."*(Ebru) Also, another pre-service teacher mentioned how she felt confident when she started teaching practice with the direct quotation:

"It will be a bit of a boast, but I was very confident when I went to teacher trainee. I know that being a student of my university is really a privilege at this point since we are the best education faculty in Turkey in terms of rankings. We have successful professors in their working area."

Secondly, pre-service and in-service teachers evaluated the content of the courses and their effectiveness. Most of the teachers pointed out that methodology courses where teaching methods and strategies used in chemistry were taught were the most influential, increasing the teaching efficacy beliefs. The participants expressed it very obviously with the following quotations:

"Frankly, I believe I can teach chemistry more after taking teaching methods, teaching trainee courses. Honestly, these lessons taught me a lot. I saw teaching techniques, what the student should see, how the subject should be grasped and what I should expect from the students in those lessons, and it helped me to become a teacher."(Cansu, Pre-service Teacher)

"When I compare myself with the other teachers, I realize my difference in a positive manner thanks to my education background. Among the other courses, method course that we have learned several teaching methods such as 5E and argumentation was the best. For example, helped me a lot on how argumentation is made, how to ask a question for critical thinking how to draw students' attention to the subject and how an interactive learning environment should be provided. I can put the theory into practice in my classroom. Other than that, the application lesson was very beneficial for me. Because I'm very obsessed with misconceptions, I have learned how to overcome the misconceptions. I think we learn them very well in education classes."(Beşir, Novice Teacher)

"In my opinion, a good teacher can teach both low-achievers and gifted students by regarding their levels. Thanks to the courses that I receive in faculty of education, I can teach the topic compatible with the level of the

students. For example, we have learned models and modelling in chemistry, our instructors asked us to develop models for teaching the topic. It helped me a lot to teach students with different level."(Taha, Experienced Teacher)

In addition, the quality of chemistry courses, teachers taken at the faculty, is also reported to influence teacher efficacy beliefs. Some teachers mentioned they had learned their subject matter well in the chemistry courses. For instance, a pre-service teacher stated it very obviously by saying *"I think I learned chemistry well in university, so I can teach it well."*(Sümeyye).

Moreover, experienced teachers who have a master's degree in chemistry stated that their teaching efficacy is higher in the topics that they studied in the master's program. To illustrate the situation, an experienced teacher stated:

"Researcher: Is there a topic that you think you are very good at teaching?

Enes: I mean I am more confident in teaching organic chemistry.

Researcher: Why do you think so?

Enes: Since my master study is on organic chemistry, I studied organic chemistry more intensely. When I was at university, I had an organic chemistry professor, we used to listen to her with admiration because she gave a very fluent, very in-depth lecture. I have learned organic chemistry deeply from her."

By contrast, some teachers claimed they did not get a good education at the university. Moreover, pre-service teachers mentioned feeling incompetent in teaching topics they learned during the pandemic because of distance education. A pre-service teacher reported:

"I think that it may be related with me due to my incompetence in quantitative part of chemistry. If you ask why, as I said, numerical issues are analytical, and we saw half of these issues in the pandemic. We could not learn effectively because it was online. I usually think that I will have difficulty teaching the subjects I took online in the future."(Zehra)

Also, pre-service teachers highlighted that they could not complete some courses due to the pandemic. They mentioned how their teaching efficacy beliefs were undermined since they did not learn some of the topics at the university. Sample statements were given from two different pre-service teachers' points of view:

"I can handle organic chemistry, but I'm not sure about electrochemistry. It was the subject of the last unit, and when the term ended, we moved to the next academic year, and they did not teach us about it. I studied chemistry education department, but I can say that I do not know electrolysis."(Zehra)

A pre-service teacher explained how the topics that were not covered within the academic year influenced her teaching efficacy beliefs with the following quotation:

"Because at this point, I appreciate my instructors because we did not go on to the next without understanding one subject. In other words, we learned very well the subjects at hand, but unfortunately some subjects remained incomplete. For example, we could not do any experiment in electrochemistry, I do not know how to make electroplating.

Do you think this will affect your confidence in teaching at future?

Unfortunately, it can. I feel anxious about it" (Çağla)

It can be concluded that participants' teacher efficacy beliefs were affected by the quality of teacher education. If they believed they got a good education, their efficacy beliefs would increase. At the same time, learning loss due to the pandemic or other reasons undermined their teaching efficacy beliefs.

4.2.4.2 Teacher Professional Development

In-service teacher education programs serving the professional development of teachers and their impacts on teacher efficacy of pre-service and in-service chemistry teachers were given under this code. Well under a quarter of the

participants reported that these activities and training programs developed their teacher efficacy.

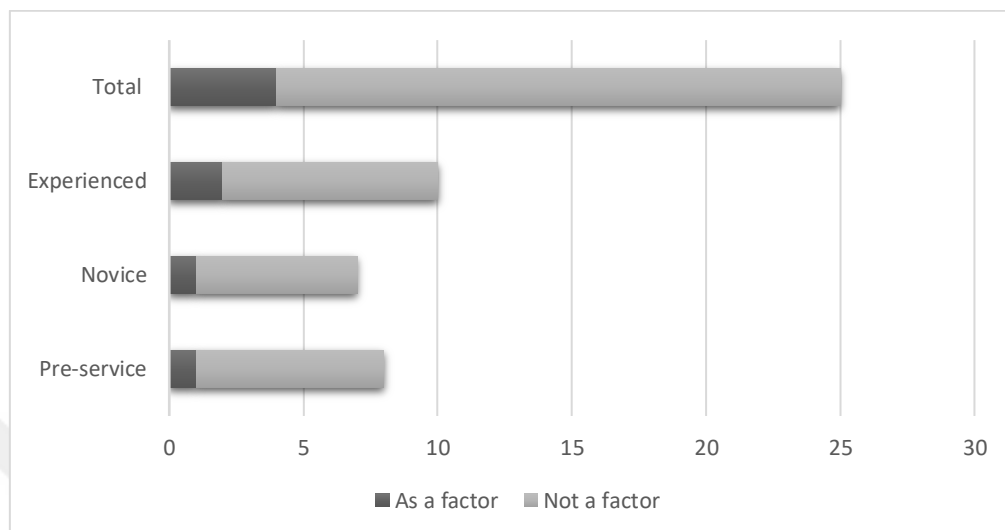


Figure 4.18 The comparison of results of teacher professional development as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

One of the pre-service teachers claimed that she believed that she would be a good teacher by participating in the activities providing professional development in teaching. She stated that:

I plan to participate trainings about education as much as I can. For example, there is a training that I am planning to attend after graduation. There are so many things I can do with these online trainings about technology usage and science teaching. I will be more effective owing to this professional training I have received. (Sena)

In addition, in-service teachers who were two experienced teachers, and one of the novice teachers mentioned his instructional efficacy beliefs were strengthened to a great extent after involving those training:

"P: I am able to implement all the modern teaching methods.

R: Why?

P: I can list several reasons. I have learned some of the methods in the faculty. However, I believe that I have been developed myself after graduation by participating many teacher training programs such as UbD, STEM. These were more effective for me" (Uğur, Novice Teacher)

Such statements highlighted that those participants' teacher efficacy beliefs increased thanks to professional development programs.

4.2.5 Social Environment in Teaching

This subtheme presented the effects of support and interactions between teachers and school facilities on teacher efficacy beliefs of pre-service and in-service teachers.

4.2.5.1 Support

In Figure 4.19, the number of teachers who believed their teaching efficacy beliefs enhanced by getting help and support was given. Pre-service teachers (two out of eight), novice teachers (three out of seven), and experienced teachers (four out of ten) mentioned the role of support as an external factor affecting their efficacy beliefs.

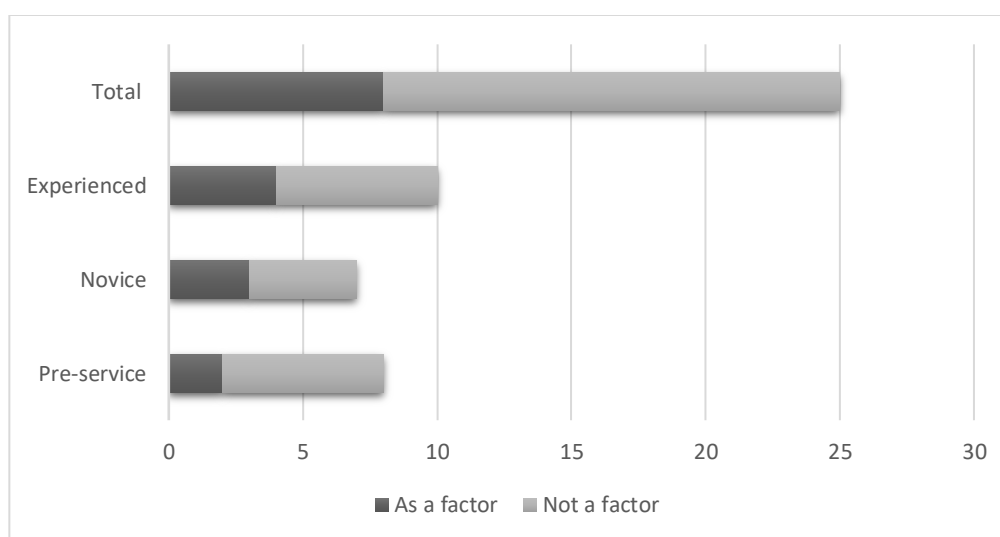


Figure 4.19 The comparison of results of support as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

Firstly, the pre-service teachers claimed they believed they could fix the possible problems with teaching by getting advice from their mentors or experienced teachers to work together. As an example:

"I trust myself and I will always trust myself even if I make mistakes in future. The reason is that I know that I can get some help beforehand and that is not a thing that shatters my self-confidence. One way or another, I have to receive some help from others because I will be a novice one. For example, I can connect with my instructors or ask my colleagues to help me. I know that I can do better with their support."(Helin)

Secondly, novice teachers reported that they sometimes needed help understanding some chemistry subjects to teach them effectively. They claimed that their content knowledge was enhanced thanks to the support that they got from their colleagues. Notably, teachers who supported them were the more experienced ones. Therefore, they mentioned how their efficacy beliefs were increased with the support of the other chemistry teachers:

"When I do not understand something, I always ask my experienced colleagues or head of our department to acknowledge the reason. Thanks to discussing with them I can understand it and I feel competent at teaching it in front of the classroom. (Tuna)

Besides, experienced teachers stated the importance of getting support from each other and collaboration. According to those experienced teachers, support significantly influences their self-efficacy beliefs in teaching. For example:

"I believe that being able to move on by yourself is hard work so I will always need support no matter how experienced I am. I have a group of friends including only chemistry teachers. I know that I can handle any problem with the help of them." (Yunus)

From a different point of view, an experienced teacher mentioned the effect of not getting support from his colleagues on his perceived teacher efficacy and how he turned it to his advantage with the following statement:

"In my first years I struggled a lot since I did not have support from my department. They were experienced and I could not ask them when I had problems. It made me feel inferior sometimes, but I learnt to use it as a fuel to push myself. You may not believe but I have not asked anyone anything. I tried to ask them, but they were underestimating me so much that they could intimidate me with their gazes which makes you really demotivated, so I started to find my own way out."(Mehmet)

To sum up, participants mentioned the effect of support that they get from their colleagues. Mainly, they claimed that getting support would raise their efficacy beliefs.

4.2.5.2 School Facilities

Finally, this study revealed that school facilities, such as classrooms and mostly science laboratories, affected teachers' efficacy beliefs. Nearly half of the

experienced teachers (four in ten) and just over half of the novice teachers (four in seven) mentioned school facilities affecting their chemistry teaching efficacy beliefs.

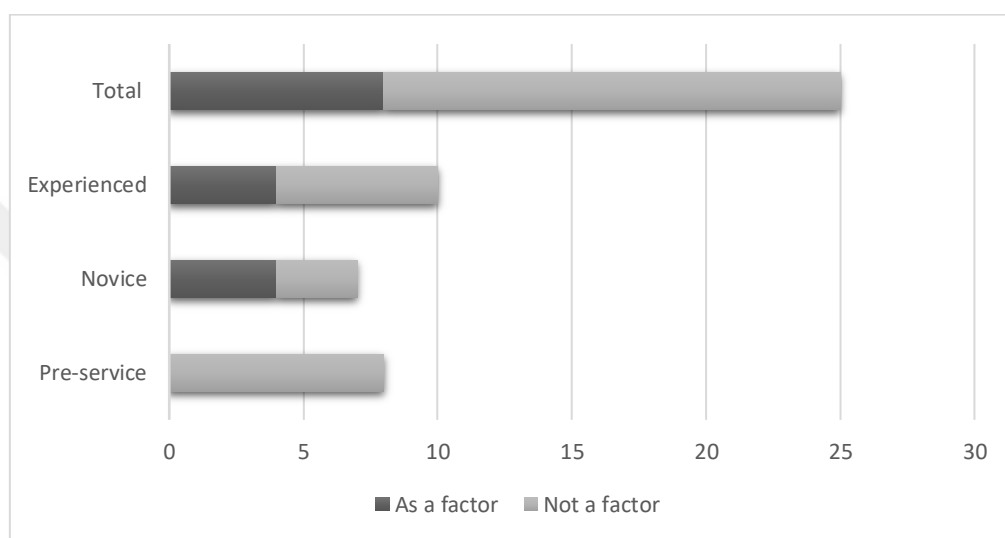


Figure 4.20 The comparison of results of school facilities as a factor affecting pre-service, novice and experienced chemistry teachers. Vertical axis shows the number of participants.

According to the participants, the physical conditions of their laboratories are the factor that diminishes their chemistry teaching efficacy when they teach in the laboratory. Novice teachers stated they could not use the teaching methods and strategies effectively because their school laboratories do not provide a conducive environment for learning. For example:

"Researcher: Do you think you can teach effectively in the laboratory?"

Gözde: I don't think so because our laboratory is a bit problematic, it is not suitable for an effective learning environment. I mean we don't really have an environment where we can bring students and say let's everyone do

experiments. If I work under ideal conditions, I may apply what I have learned at the university. However, I could not improve myself if this situation keeps up."

Secondly, the experienced teachers, who have been working in public schools, stated that their teacher efficacy is affected negatively because of school facilities. In particular, the teachers mentioned the lack of well-equipped science laboratories and its impacts on their teacher efficacy in instructional strategies. An experienced teacher explained this situation with the following quotation.

"I feel incompetent in using constructivist teaching method. If I worked a well-equipped school, I could be more successful. I had no opportunity to improve myself due to our school facilities."(Şule)

Moreover, class size was reported as another factor of school facility conditions affecting teacher efficacy regarding instructional strategies. Participants reported they believed they were more component with the small class size when they conducted different teaching methods rather than direct lecturing. To illustrate:

" I do not believe that I am always competent when teaching in laboratory. Actually, it depends on physical conditions which is not suitable for teaching large class size. For example, I am not good at engaging students for large class size. However, I feel successful when the class size is small in the laboratory."(Duygu, Experienced Teacher)

In conclusion, novice and experienced teachers mentioned that their chemistry efficacy beliefs were affected by the school facilities negatively due to the poor physical conditions of schools.

4.3 Summary of Results

This study explored factors of the pre-service, novice, and experienced chemistry teachers' sense of efficacy beliefs. The factors were grouped under two main themes that were internal and external factors that enhance or undermine

participants' sense of efficacy beliefs. The main findings of the study regarding the comparison of pre-service, novice, and experienced teachers' frequently mentioned factors were shown by the Venn diagram in Figure 4.21.

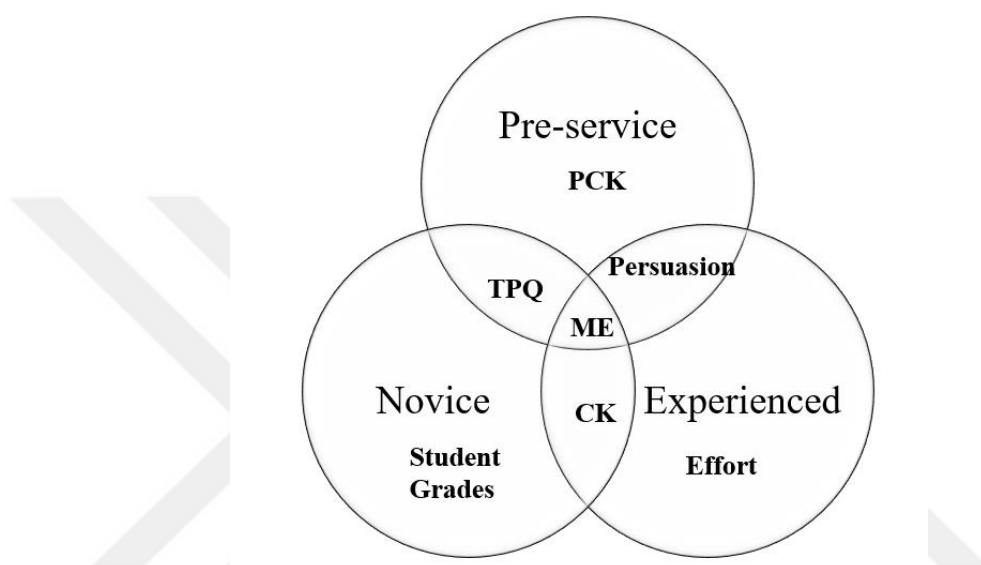


Figure 4.21 The comparison of frequently mentioned factors among pre-service, novice, and experienced chemistry teachers. *Note: ME: Mastery experience, PCK: Pedagogical content knowledge, CK: Content knowledge, TPQ: Teacher preparation quality*

As it is seen in the diagram, mastery experience was the common, most frequently mentioned factor for pre-service, novice, and experienced chemistry teachers. Although participants reported that successful teaching experiences enhanced their teacher efficacy, only some novice teachers reported that their failures undermined their teacher efficacy. Pre-service teachers highlighted their achievements in teaching practice experiences gained in faculty and cooperating schools. On the other hand, experienced teachers interpreted their successful teaching experiences regarding the length of their teaching experience. Furthermore, vicarious

experience was one of the most frequently mentioned factors for particularly pre-service teachers. They reported feeling efficacious by observing their peers and competent chemistry teachers. Similarly, novice teachers mentioned the positive impacts of vicarious experience from observing their colleagues.

The most frequently reported factor for both pre-service and novice chemistry teachers was teacher preparation quality. All pre-service teachers claimed that teacher preparation quality influenced their teacher efficacy mainly in a positive manner. However, they noted that their sense of efficacy beliefs was affected negatively during the pandemic due to school closures and distance education. All novice teachers, who mentioned teacher preparation quality as a factor, claimed that they felt efficacious thanks to the teacher education they received. In addition, over half of the experienced teachers stated teacher preparation quality as an influential factor in enhancing their sense of efficacy beliefs.

When Figure 4.21 was examined, the frequently mentioned factor for pre-service and experienced teachers was persuasion, increasing their sense of efficacy beliefs. Pre-service teachers specified the factor of persuasion as verbal encouragement from cooperating teachers, peers, and students. On the other hand, experienced teachers specified the persuaders as students, parents, and colleagues. Moreover, some novice teachers reported that their efficacy beliefs were enhanced thanks to the persuasion of their colleagues and students.

Content knowledge was frequently reported as an influential factor by novice and experienced teachers. Most experienced teachers reported that they could teach chemistry well since they had mastered the content. Like experienced teachers, some pre-service and novice teachers noted that their efficacy beliefs in teaching particular topics were strengthened thanks to their content knowledge. Nonetheless, some novice teachers claimed they felt inefficacious due to their lack of content knowledge. Similarly, some pre-service teachers mentioned that their efficacy in teaching particular chemistry topics was undermined because of a shortage of content knowledge. On the other hand, pedagogical knowledge and pedagogical content knowledge were the common, frequently mentioned factors for pre-service

and novice chemistry teachers. They reported that their teacher efficacy beliefs were enhanced thanks to their pedagogical and pedagogical content knowledge. In contrast, only a few experienced teachers explained the positive effects of pedagogical content knowledge on their teacher efficacy beliefs.

Experienced teachers distinguished themselves from pre-service and novice teachers by emphasizing the significance of the effort. Unlike their less experienced counterparts, experienced teachers frequently mentioned how their efficacy in teaching chemistry stemmed from the additional effort they invested in their instructional practices. Moreover, student grades were the significant factor influencing novice teachers' efficacy beliefs positively and negatively. They explained how they interpreted student grades as efficacy information. Compared with novice teachers, experienced and pre-service teachers less frequently mentioned the impacts of student grades on their efficacy beliefs.

Student participation behavior and learner profile were also reported as factors of pre-service, novice, and experienced teachers' sense of efficacy beliefs. Regardless of their years of experience, some participants evaluated student participation behaviors as efficacy information. Learner profile was also mentioned as a factor influencing participants' teacher efficacy. The characteristics of students were evaluated mainly by novice and experienced teachers. They claimed that students' academic backgrounds positively and negatively influenced their teacher efficacy. Some participants claimed that they felt more effective when teaching older students than younger ones.

Apart from experience and knowledge of teachers, disposition factors, including interest, and personality traits, were frequently mentioned by participants. Interest was stated as a factor enhancing teacher efficacy beliefs of over half of the participants. While participants acknowledged the positive influence of personality traits such as empathy and confidence on their efficacy beliefs, some participants identified perfectionism as detrimental to their teacher efficacy beliefs. Unlike interest and personality traits, participants less frequently mentioned the ability and physiological and emotional arousal. Some pre-service and experienced teachers

stated they were good teachers since they had teaching abilities. In contrast, physiological and emotional arousal was identified as a factor undermining the teacher efficacy beliefs of participants since they interpreted their body responses, such as an increase in heartbeat, negatively as a piece of efficacy information.

Finally, novice and experienced teachers reported support and school facilities as influential factors affecting teacher efficacy. Among all groups, novice teachers frequently mentioned that getting support from their colleagues enhanced their sense of efficacy beliefs. In contrast, some novice teachers and experienced teachers, mainly working in public schools, complained about school facilities and reported that their instructional efficacy beliefs were affected negatively by poor conditions. Furthermore, novice and experienced teachers noted that their sense of efficacy when teaching chemistry in the laboratory was affected by mastery experience, vicarious experience, pedagogical content knowledge, support, and school facilities factors. Among all these factors, only school facilities reported as detrimental to their teacher efficacy beliefs, while others enhanced their efficacy beliefs in teaching chemistry in a laboratory context.

CHAPTER 5

DISCUSSION

This chapter will discuss and compare the results of the study with the theory and other studies conducted before the current study. Then, a conclusion will be given based on the results of this study. Finally, implications and suggestions for further investigation will be presented.

5.1 Discusison

The study aimed to explore factors affecting the teacher efficacy beliefs of pre-service, novice, and experienced teachers. For this purpose, the basic qualitative research design was utilized. Results of this study showed that pre-service, novice, and experienced teachers' sense of efficacy beliefs were influenced by internal and external factors. Internal factors were experience, knowledge, and disposition. In contrast, external factors were feedback, persuasion, support, teacher-related, student-related, and social environment in teaching.

In this part, the study's results were compared with the theory (Bandura, 1997; Tschannen-Moran, Hoy, & Hoy, 1998) and other studies on pre-service and in-service teacher efficacy and factors affecting teacher self-efficacy. Results of this study revealed that although Bandura's suggested sources were found to be factors affecting the teacher efficacy beliefs of participants, additional internal and external factors emerged. Except verbal persuasion presented as an external factor, other hypothesized sources of efficacy will be discussed under internal factors. Therefore, Bandura's suggested sources and additional internal and external factors will be discussed under different headings.

5.1.1 Discussion of the Results for Internal Factors

In this part, results will be discussed regarding how and to what degree sources proposed by Bandura affected pre-service, novice, and experienced teacher self-efficacy. Moreover, knowledge and disposition will be discussed as internal factors.

Firstly, almost all pre-service and in-service teachers asserted that enactive teaching experiences affect their teaching efficacy. This finding echo Bandura's claim that the most influential source of self-efficacy is mastery experiences (Bandura, 1997). The notion of Bandura and the results of many qualitative and quantitative studies conducted in this field were consistent with this result (e.g., Bruce & Ross, 2008; Cheung, 2008; Pfitzner-Eden, 2016; Phan & Locke, 2015; Lawrent, 2022; Tschannen-Moran & McMaster, 2009; Wang et al., 2017).

In this study, all pre-service teachers reported that their successful teaching performance made them feel more competent. None of the participants mentioned their failure, which negatively affects efficacy beliefs (Bandura, 1997). A probable explanation is that all pre-service teachers gain real classroom experience during teaching practice, and there is evidence of how teaching practice positively impacts science teachers' sense of efficacy beliefs (e.g., Bautista & Boone, 2011; Gunning & Mensah, 2011; Hancock & Gallard, 2004; Leonard, Barnes-Johnson et al., 2011; Rooij, 2019). Although they mentioned that they failed in their early experiences, they reported that their efficacy beliefs were not undermined after they failed once. A possible explanation is that those teachers might be highly self-assured. According to Bandura (1997), self-assured individuals are better equipped to benefit from their own mistakes, "the failures of those who suffer from self-doubts are unlikely to serve as a fertile source of promoting strategies" (p.94).

It seems also possible that these results are due to cognitive processing that these sources of self-efficacy do not directly influence how teacher efficacy develops, but rather that their impacts are tempered by how individuals understand and reflect on their experiences (Bandura, 1997; Tschannen-Moran et al., 1998; Morris

et al., 2017). Accordingly, they may not associate teacher efficacy and failure in their early teaching experiences. For pre-service teachers, Tschannen-Moran and Woolfolk Hoy (2007) claimed that other sources than mastery experiences might be more critical since they might need more mastery experiences to develop their sense of efficacy. However, there is an inconsistency with this argument in the current study. This discrepancy could be attributed to several factors. In the current study, most pre-service teachers reported gaining authentic teaching experience before teaching practice such as working as a tutor or elementary science teacher in private schools. Moreover, data were collected at the end of the teaching practice course. As a result, they had an opportunity for authentic teaching experiences. In addition, they had experienced real teaching context in a limited time; few successful experiences for pre-service teachers teaching for the first time may already count as mastery experiences (Rooij et al., 2019).

Secondly, some of the novice teachers mentioned that they felt incompetent because of their authentic teaching experiences. It is congruent that novice teachers may suffer lower levels of teacher efficacy beliefs (Pendergast et al., 2011; Ingersoll et al., 2014; Tschannen-Moran & Woolfolk Hoy, 2007). There are two likely causes for the differences between novice and experienced teachers. Since novice teachers analyze teaching tasks differently than experienced ones, contextual factors affect novice teachers more than experienced ones (Tschannen-Moran & Woolfolk Hoy, 2007). Moreover, *reality shock* can affect novice teachers' beliefs when they change their student identity to the teacher (Chubbuck et al., 2001; Rooij et al., 2019). Reality shock is described as the "collapse of ideals formed prior to teaching as one experiences everyday classroom life" (Chubbuck et al., 2001, p. 367). On the other hand, some novice teachers did not express that they experience reality shock when they started working as a chemistry teacher. Therefore, reality shock was not a common phenomenon among novice teachers participating in this study.

Lastly, experienced teachers mentioned that they feel competent thanks to their accomplishments in teaching chemistry. It is consistent with the results of studies

examining teacher efficacy beliefs through years of teaching experience (Cheung, 2008; Ruble et al., 2011). Experienced teachers emphasized that they have had opportunities to experience success thanks to their years of experience. The result is consistent with the results of studies conducted by Cheung (2008) and Ruble et al. (2011), which found that length of teaching experience was related to teaching efficacy beliefs, with more experience corresponding to more positive efficacy beliefs. Nonetheless, Pfitzner-Eden (2016) has also questioned why teaching experience in years is accepted as mastery experience since it is an objective indicator that lacks an evaluative component. Since Bandura's (1997) notion that cognitive process is central to developing self-efficacy beliefs, teaching experience in years does not overlap with Bandura's conception as a factor of self-efficacy (Pfitzner-Eden, 2016). However, participants in this study mentioned how they analyze teaching tasks and modify them to achieve tasks over the years (Tschannen-Moran et al., 1998). Within this perspective, it is more convincing if teachers assess their length of experience with the achievement of teaching tasks.

The findings of several studies (Bruce & Ross, 2008; Hastings, 2012; Phan & Locke, 2015; Tschannen-Moran & Johnson, 2011) about pre-service and in-service teachers' vicarious experience are congruent with the results of the current study. All participants in this study claimed that vicarious experiences improved their teacher efficacy beliefs. Pre-service teachers have mentioned how they felt confident when they observe their peers since they observed their peers as models who share similar training experience with themselves (Bandura, 1997; Tschannen-Moran et al., 1998). On the other hand, Bandura (1997) claimed that one's efficacy beliefs might be lowered if she observed a similar model failed. Inconsistent with this notion, some pre-service teachers stated that their teacher self-efficacy beliefs were boosted when they observed their peers' poor teaching performance. At this point, referential comparison, where one compares himself with the group (Bandura, 1991; Bandura, 1997), occurs differently with cognitive processing. According to Bandura (1986), people compare themselves within a group considering three major information sources: "performance level, internal standards, and the performance of others" (p. 34). In this case, pre-service teachers

may feel better since they can feel superior themselves comparing the teaching performance of others. Therefore, pre-service teachers who feel confident about their performance utilize vicarious experiences to reinforce their teaching efficacy beliefs. In the existing literature, some qualitative studies indicate that observing mentor teachers affect the teaching efficacy beliefs of pre-service teachers (e.g., Bruce et al., 2010; Cakir & Alici, 2009; Gunning & Mensah, 2011). Nonetheless, none of the pre-service teachers mentioned the effect of a mentor teacher in the current study. Parallel to Bandura's theory (1986), mentor teachers, whose experience is quite different from pre-service teachers, may not be considered as similar models by pre-service teachers (Tschannen-Moran & Woolfolk Hoy, 2007). Accordingly, observing peers are more likely to increase teacher efficacy beliefs of pre-service teachers.

Unlike pre-service teachers, novice teachers mentioned that observing mentors and more experienced teachers enhanced their self-efficacy beliefs. Since those teachers are their colleagues who share similar working experiences, they might interpret their success as achievable (Bandura, 1997). A few experienced teachers (two out of ten) reported that symbolic modeling affects their teaching efficacy. This result aligns with the social cognitive theory, which indicates that positive personal efficacy beliefs may be developed after exposure to competent symbolic models through visual media (e.g., Bandura, 1982; Bautista & Boone, 2011; Palmer, 2006; Schunk, 1987). Moreover, all teachers mentioned effective actual modeling when they observed their teachers as role models. Most of them mentioned that observing a proficient model could make them more competent. It is parallel with the studies that claim that if the role model is proficient enough, the vicarious experience would be a source of information (e.g., Bandura, 1977; Berg & Smith, 2016; Yoo, 2016).

Surprisingly, an experienced teacher reported how she felt more competent in teaching by observing a model show how not to be a good teacher, which is consistent with pre-service teachers' statements in this study and a finding of a study conducted by Ramey-Gassert et al. (1996). In this case, self-modeling was

also highlighted. A likely explanation is that those participants benefit from the mistakes of others by evaluating why they fail regarding tasks and context. The results reveal that teachers can use vicarious information to affect their teacher efficacy mediated by cognitive processing.

Finally, physiological and emotional sources have been reported as one of the least influential factors affecting teacher self-efficacy beliefs of pre-service and in-service chemistry teachers. Moreover, only negative states, such as anxiety, were reported by participants. The result of the current study is comparable with the results of a few numbers of studies that investigated that mainly negative emotional states affect self-efficacy (e.g., Cakir & Alici, 2009; DeMauro & Jennings, 2016) or that their relationship to self-efficacy was substantially weaker than that of the other sources (e.g., Heppner, 1994; Mohamadi & Asadzadeh, 2012; Morris & Usher, 2011; Poulou, 2007).

In addition to Bandura's suggested sources, this study reveals that additional factors, knowledge and disposition, affect the teacher efficacy of chemistry teachers. Finding of knowledge factor are in accord with studies indicating that teacher knowledge, including teachers' content knowledge, general pedagogical knowledge, and pedagogical content knowledge, is claimed as closely associated with teacher self-efficacy (e.g., Can, 2015; Fives, 2003; Palmer, 2006; Zakeri & Alavi, 2011). In the related literature, one of the much-debated questions is whether teacher knowledge is a new source of teacher efficacy. Since it is neither psychological information nor experience, some researchers do not accept teacher knowledge as a new source for teacher efficacy (Fives, 2003; Wang et al., 2017). Another reason why knowledge is not a new source is that it is informed by previous experiences, such as mastery experiences, and vicarious experiences are influential in this previous experience (Morris et al., 2017).

Nonetheless, some studies proved that many teachers gained knowledge from books, research articles, and the internet (Buehl & Fives, 2009). The form of independent studies does not fit any of Bandura's sources. As mentioned in the literature review, mastery experiences could take various forms and go beyond the

actual performance during instruction. Palmer (2006) pointed out that cognitive content mastery, corresponding content knowledge in this study, and cognitive pedagogical mastery, corresponding pedagogical and pedagogical content knowledge, are influential factors in enhancing teacher efficacy of pre-service teachers who needed to experience more enactive mastery. In this study, pre-service teachers mentioned how their teacher efficacy beliefs developed by knowing content and teaching methods; their claims align with those of previous studies (e.g., Appleton, 1995; Can, 2015; Palmer, 2006; Polou, 2007; Wyatt, 2014). Different from experienced teachers, pedagogical knowledge and pedagogical content knowledge were the most influential factors for pre-service and novice teachers. These differences can be explained by similar practices in pre-service and novice teachers' teacher preparation programs. For example, the chemistry and method courses they took in the undergraduate program might be similar.

On the other hand, experienced teachers mentioned that content knowledge is a more influential factor influencing teacher self-efficacy. This finding was also reported by Odanga et al. (2022), where qualitative results reported that experienced teachers have greater teacher efficacy than novice ones due to higher levels of content mastery. Nonetheless, participants mentioned that their teacher efficacy varies regarding the chemistry topic. Results reveal that pre-service and in-service teachers may not feel efficacious in teaching all chemistry topics. These results can be used to explain the task-specific nature of self-efficacy since the participants emphasized that their confidence in their ability to teach depended on the topic.

This study confirms that teachers may interpret their mastery experience by attributing internal and external factors (Morris et al., 2017). In the current study, mastery experience was attributed to the effort of almost all experienced teachers. Likewise, teachers claimed that they could master their content due to their endeavors. Therefore, the effort is reciprocally interrelated with mastery experience and knowledge factors. It is consistent with studies where teachers who reported being well-prepared for the classroom were more likely to have a favorable

assessment of their skills (Darling- Hammond et al., 2002; Ross et al., 1996; Tschannen-Moran & Johnson, 2011)—compared to the experienced teachers, pre-service and novice teachers attributed effort less as a factor affecting their efficacy. The possible reason might be that they have less mastery experience than experienced teachers; they may not have a chance to interpret their mastery experience in terms of their effort.

Moreover, numerous participants reported that ability was a factor of teacher efficacy. Those participants attributed their mastery experience to their ability, which is an internal factor. The result also accords with the earlier observations, which showed that telling students their achievement is a result of their abilities boosts self-efficacy (Schunk, 1984). Another internal factor stated by participants was interest. In accordance with the present results, previous studies exploring factors affecting science teaching efficacy have demonstrated that having an interest in science translated into efficacious science teaching (Ramey-Gassert et al., 1996). Finally, personality traits were also found to be influential. This result aligns with other studies showing that perceived personality traits and good rapport with students could enhance teacher efficacy (e.g., Can, 2015; Ramey-Gassert et al., 1996; Poulou, 2007; Wang et al., 2017).

When analyzing teaching tasks, teachers' interpretation of the sources and conditions is vital (Tschannen-Moran et al., 1998). Since self-efficacy is a context-specific construct (Bandura, 1997), teachers who feel competent in the classroom might not feel competent while teaching chemistry in the laboratory. Most of the participants in this study mentioned that teaching chemistry in the laboratory is more difficult than classroom context due to its complexity and challenges (Yalcin-Celik et al., 2017). Most novice and experienced teachers mentioned that they felt efficacious thanks to authentic teaching experiences in the laboratory. Success in this context is essential in enhancing teacher efficacy beliefs since it is linked to a more significant effect of mastery experience on efficacy beliefs if a task is particularly demanding (Bandura, 1977; Morris et al., 2017).

5.1.2 Discussion of the Results for External Factors

Another source proposed by Bandura (1997) was verbal persuasion which is found as an influential external factor, which is parallel to the findings of numerous studies (Poulou, 2007; Bruce & Ross, 2008; Palmer, 2011; Tschannen-Moran & Johnson, 2011). As stated in theory and related studies on literature, credibility, proficiency, and reliability of persuaders play vital roles in developing teacher efficacy beliefs. Almost all teachers, who stated persuasion is a factor affecting their efficacy, pointed out that they weigh the credibility (e.g., when course instructors or cooperating teachers persuade pre-service teachers, they rely on them due to their experience and knowledge of teaching), proficiency (e.g., when experienced teachers convinced how they performed well about a topic by their colleagues who are also experienced teachers who know chemistry well), their teacher efficacy beliefs are strengthened. Pre-service teachers integrate sources of verbal persuasion and mastery experiences; their successful performance is appraised, and they feel competent for their future performance. Accordingly, such information affects efficacy beliefs by mediating cognitive processes (Morris et al., 2017). The mediation of cognitive processes for verbal persuasion is similar to the qualitative study conducted by Klassen and Durksen (2014) where pre-service teachers reported they need to know whether they are doing well by the appraisal of their mentors. Inconsistent with Tschannen-Moran and Woolfolk Hoy's (2007) study that pointed out social persuasion is not influential for experienced teachers; the results of the current study show that verbal persuasion is a factor in improving teacher efficacy beliefs of most experienced teachers. For novice teachers the results of the current study are congruent with the notion that persuasion was particularly influential for novice teachers (Tschannen-Moran & Woolfolk Hoy, 2007).

Evaluative feedback that is also found influential for pre-service and in-service teachers. Pre-service teachers reported that constructive feedback that they received from their peers and instructors made them feel competent by showing them their strengths and weaknesses. When feedback was perceived as destructive, two

different cases emerged. One of them was a pre-service teacher, she stated how she put an effort not to receive criticism again, and she succeeds in the task for the next time (i.e., mastery experience). Another was a novice teacher who mentioned how feedback she received after her performance lowered her teaching efficacy. There are two likely explanations for these differences. First, the pre-service teacher might develop high self-efficacy before the instruction; thus, she benefits from her mistake. That is why she evaluated destructive feedback as a positive factor affecting her teacher efficacy. Whereas the novice teacher who stated she is a perfectionist may evaluate feedback as a factor decreasing her self-efficacy. It can be supported by findings of the study conducted by Besser et al. (2004) "self-oriented perfectionism is a vulnerability factor involving negative cognitive and affective reactions following failure experiences" (p.301).

Furthermore, students and social teaching environment are found as other external factors affecting teacher efficacy beliefs of pre-service and in-service teachers. These factors are reasonable due to social cognitive theory involving personal, behavioral, and environmental factors (Bandura, 1986). Compared with in-service teachers, those factors were less influential for pre-service teachers. Since pre-service teachers did not have much practice classroom experience, they may have yet to have an opportunity to interact with environmental factors.

Prior studies have noted the importance of teacher efficacy on student behavior and achievement (e.g., Gibson & Dembo, 1984; Klassen & Tze, 2014). Results of this study show that student behavior and achievement might in turn improve teachers' sense of efficacy or vice versa. Therefore, it confirms the cyclical nature of teacher efficacy (Tschannen-Moran & Woolfolk Hoy, 1998). Especially, novice teachers mentioned student-related and social teaching environment factors, which are support and school facilities, were influential for them. The discrepancy between novice and experienced teachers can be explained by their cognitions which are "believed to change in the light of experience" (Feryok, 2010, p. 274 as cited in Karimi & Norouzi, 2018). In accordance with the present results, previous studies have demonstrated the superiority of expert teachers in various cognitive processes,

such as self-monitoring (Karimi & Norouzi, 2018). It might explain why experienced teachers' efficacy was not affected by student-related factors as much as novice teachers. As stated in Tschannen-Moran et al. (1998) model of teacher efficacy, contextual factors are part of the analysis of teaching tasks. This study confirms that support and school facilities can be effective when teacher efficacy is developed. Consistent with the literature, support was more influential for novice teachers than experienced teachers (e.g., Tschannen-Moran & Hoy, 2002). However, in the current study, novice teachers mentioned their mentor and collegial support rather than principal and community support. This finding is contrary to previous studies, which have found that mentor and colleague support did not explain the variance in teacher efficacy of novice teachers (e.g., Capa, 2005). In addition, experienced teachers reported support as a factor in their self-efficacy. It differs from the studies that showed that support was not found as an influential factor in teacher efficacy of experienced teachers (e.g., Tschannen-Moran & Hoy, 2002). In this study, school facilities were reported as a factor in decreasing the teacher efficacy beliefs of novice and experienced teachers due to limited resources. It is consistent with the study that reveals that teacher resources were influential for both novices and experienced teachers (e.g., Tschannen-Moran & Hoy, 2002). Nonetheless, the results were inconsistent with the study revealing that teaching resources accounted for variance in only novice teachers' efficacy (Tschannen-Moran & Woolfolk Hoy, 2007). Although some studies found that teaching resources were a source for pre-service teachers' efficacy (e.g., Can, 2015), none of the pre-service teachers in this study reported school facilities as a factor affecting their efficacy. This contradictory factor may be related to cooperating schools described as well-equipped by the pre-service teachers.

In this study, consistent with the literature, teacher professional development was reported as a factor in increasing participants' teacher self-efficacy (e.g., Tschannen-Moran & McMaster, 2009). Nevertheless, only a few participants mentioned the effect of participating in-service teacher training programs. This result may be due to the lack of in-service training programs that participants could participate. On the other hand, teacher preparation quality was one of the most

frequently mentioned factors increasing teacher efficacy for almost all participants. This result is in accord with many studies that reveal the effectiveness of teacher education programs in developing teacher efficacy (e.g., Capa, 2005; Cheung, 2008; Noel, 2020).

On the contrary, some studies showed a decline or no change in the pre-service teachers' efficacy beliefs (e.g., Lin & Gorrell, 2001; Woolfolk Hoy & Burke-Spero, 2005). In this study, participants found teacher education positively affecting their self-efficacy. Some pre-service teachers reported that teacher preparation quality was a factor in developing their teacher efficacy belief before teaching practice or any enactive mastery experience they gained. This result supports the notion of Tschannen-Moran (2007) other sources than mastery experience would be more critical for pre-service teachers' sense of efficacy beliefs. It could be explained by teacher education programs where they learn content knowledge, pedagogical knowledge, and pedagogical content knowledge and vicarious experiences, which is efficacy information for the pre-service teachers. Teacher preparation quality was one of the most influential factors for pre-service and novice teachers. This finding may be related to the similarity of teacher education programs that they currently receiving and being fresh graduates for novice teachers.

In the current study, the most striking finding is that some pre-service teachers reported that their teacher efficacy decreased due to the pandemic. These results can be attributed to the timing of data collection, which occurred during the post-pandemic period characterized by school closures and the widespread implementation of remote teaching. These findings align with recent research highlighting the significant challenges in achieving equity and the intended learning objectives associated with virtualizing courses and practicum experiences at education faculties in Turkey (Ersanli & Yakişik, 2022). Moreover, the results are consistent with those of current studies, which have demonstrated that the detrimental effect of transition from face-to-face learning to distance education was problematic for pre-service teachers (e.g., Hadar, 2020; White & McSharry, 2021). Pre-service teachers reported poor quality of remote instruction in chemistry

learning. Firstly, pre-service teachers might not master content and pedagogical content knowledge due to the challenges of the pandemic. For example, laboratory instruction in chemistry has been widely recognized as an essential component of the chemistry curriculum from high school through graduate school (Sheppard, 2006). However, the delivery of the laboratory experiments via remote education was the most challenging component of the chemistry course (Boschmann, 2003). Accordingly, teacher preparation quality may not be found satisfactory since it was limited laboratory instruction during the pandemic. Moreover, a previous study by Karatas (2022) revealed that pre-service teachers with high self-directed learning skills could maintain their academic self-efficacy at a high level during the pandemic. Therefore, participants reported that their efficacy decreased due to the pandemic and might need higher self-directed learning skills.

5.2 Conclusion

The present study was designed to explore the factors of pre-service, novice, and experienced teachers' sense of efficacy beliefs.

This study revealed that factors affecting pre-service, novice, and experienced chemistry teachers' sense of efficacy beliefs were compatible with each other. For pre-service teachers, experience gained in teacher preparation programs was an essential factor affecting their teacher efficacy. In addition to authentic teaching experiences that they gained in teaching practice, vicarious experiences, the content of the courses, constructive feedback, and persuasion were found as the influential factors affecting their teaching efficacy mediated by cognitive processing. One of the major findings was that their teacher self-efficacy was affected negatively because of the teacher education they received during the pandemic due to school closures and distance education. Moreover, contextual factors such as support from mentors and student participation behavior were the factors that may affect the construction of their teacher efficacy beliefs. Since self-efficacy is a construct that resists change after it is constructed (Bandura, 1997), understanding which factors affect the pre-service teachers' efficacy beliefs is essential.

Compared to the pre-service and experienced teachers, novice teachers were mainly affected by external factors such as student-related factors, support, school facilities, and mastery experience. Results revealed that a supportive environment for those teachers would be beneficial for them not to experience reality shock. Moreover, the earliest years of teaching may be crucial for the long-term development of teachers' sense of efficacy since efficacy may be most malleable at the early stages of learning (Bandura, 1986). Like pre-service teachers, the study contributes to our understanding of how internal and external factors affect novice teachers' sense of efficacy beliefs.

Finally, experienced teachers in this study reported how internal and external factors constructed their teacher efficacy beliefs. For experienced teachers, enactive teaching experiences, content knowledge, and effort they put in and how they integrate these three factors cognitively were the most effective process that enhanced their efficacy beliefs. Surprisingly, persuasion was found as an essential factor affecting experienced teachers' sense of efficacy. The insights gained from this study may be of assistance to understanding what factors make experienced teachers believe them to be more efficacious.

To sum up, this study appears to be the first study to compare the factors of the sense of efficacy beliefs of pre-service, novice, and experienced chemistry teachers. Evidence shows that some factors and how teachers at different stages of teaching integrate those sources. In contrast, interest and personality traits were also identified as significant factors regardless of teachers' years of teaching experience.

5.3 Implications

The current study provided new insight into chemistry teacher self-efficacy and factors of pre-service, novice, and experienced chemistry teachers' sense of efficacy beliefs.

Since the majority of participants, including even the experienced teachers, attributed their high sense of efficacy to teacher preparation quality, some of the issues emerging from this study relate specifically to teacher educators. Firstly, teacher educators should design chemistry teaching method courses that heavily rely on activity-based learning strategies such as hands-on activities and technology integration. Since some participants reported that one of the challenges of learning and teaching chemistry was the abstract nature of chemistry, activity-based learning strategies would be helpful to enhance student teachers' understanding of scientific concepts by manipulating objects making abstract knowledge more concrete (Holstermann et al., 2010). Moreover, more tremendous efforts are needed to ensure that learning environments where individual differences are considered are designed with various activities

This current study suggests that pre-service teachers should be provided with opportunities to gain enactive teaching experience to put their knowledge into practice in different contexts and situations. That is, the content of the courses should be focused on more practical issues. Although gaining teaching experience is essential for pre-service teachers, some issues should be taken into account for teacher educators. Firstly, it is crucial to ensure that teaching practice tasks are set at optimal difficulty. On the one hand, tasks should be within pre-service teachers' capabilities to experience a sense of success (Raoofi et al., 2012). On the other hand, tasks should also present a certain level of challenge to enhance pre-service teachers' self-efficacy beliefs. Therefore, teacher educators should carefully consider task difficulty, as it significantly facilitates gaining mastery experience for pre-service teachers. Secondly, feedback and persuasion were substantial factors in pre-service teachers' sense of efficacy beliefs. Accordingly, teacher educators should give more explicit and constructive feedback. Also, vicarious experiences were stated as an influential factor for pre-service teachers. As well as pre-service teachers observing their peers should also have a chance to observe an authentic classroom, which would be beneficial for them not to experience reality shock when they start teaching.

As one of the findings of this study revealed that inadequacies of remote teaching undermined teacher efficacy of pre-service teachers. Therefore, it is essential for teacher educators and policy makers to carefully consider strategies and approaches to effectively address this situation. Firstly, several implications based on results of this study for chemistry teacher educators have been presented. According to pre-service teachers in this study, laboratory instruction was critical to understand abstract chemistry concepts. Hence, teacher educators should consider the challenges of adapting their approach when delivering hands-on laboratory courses in the context of online teaching. For example, web-based teaching tools could be more utilized in chemistry method courses as laboratory instruction. Furthermore, self-directed learning skills, which might be helpful for distance education, should be promoted with various activities by teacher educators. Secondly, some issues emerging from this result relate specifically to policymakers. The Turkish Ministry of National Education (MoNE) might identify pre-service teachers suffering from learning loss due to the pandemic and develop in-service teacher training programs, including several hands-on activities and workshops for them when they start teaching. In addition, mentors who are more experienced teachers can be assigned to these teachers when they will start teaching.

Developing in-service teacher training programs, including several activities and workshops, would be helpful not only for pre-service teachers but also novice and experienced teachers. Moreover, some novice and experienced teachers stated there were resource-related issues that might make it difficult for those teachers to incorporate more hands-on learning activities into their courses. Since this situation may affect the teacher efficacy of novice and experienced teachers, resource-related issues should be considered by policymakers and stakeholders. In other words, continued efforts are needed to make well-equipped schools more accessible to all chemistry teachers.

Among the types of teacher professional development, "mentoring and/or peer observation and coaching, as part of a formal school arrangement" (OECD, 2009, p.50) was stated by novice teachers as a factor increasing their teacher efficacy.

Particularly for novice teachers, peer observation and mentoring should be promoted by MoNE. After observing the performances of novice teachers, mentor teachers should give constructive feedback to novice teachers. It may be helpful for novice teachers who may suffer from reality shock. Also, the study shows a need for professional development in the student behavior problems area for novice teachers. The study recommends that novice teachers participate in education conferences or seminars related to classroom management as participants. Furthermore, participating in a professional network such as an email discussion list (Taber, 2023) would be beneficial for them to discuss issues related to chemistry teaching and get consultancy about chemistry subject knowledge.

Finally, experienced teachers did not mention the effect of professional development as a factor of their sense of efficacy; thus, they may think there is no suitable professional development for experienced teachers. Ensuring appropriate in-service teacher training and workshops related to contemporary trends in education for experienced teachers should be a priority for MoNE. Moreover, experienced teachers could participate in a network of teachers and make observation visits to other schools.

5.4 Suggestions for Further Research

Factors of pre-service, novice, and experienced chemistry teachers' efficacy beliefs were explored in this current study. These results provide the following insights for future research. Since this study explored the factors of pre-service, novice, and experienced teachers' sense of efficacy, future studies should focus on the sources of chemistry teachers' sense of efficacy and how these sources can be integrated and interpreted by chemistry teachers. For these purposes, qualitative and mixed-method studies can be utilized by researchers. As mentioned earlier, triangulation was the limitation of this study. That is, mixed method studies involving teacher efficacy scales to determine the level of efficacy of participants can be helpful for understanding which sources lead to enhance teacher efficacy.

Moreover, longitudinal studies can be designed to understand how pre-service teachers experienced learning loss during the pandemic, shaping their efficacy at their career stages.

In hindsight of the findings, quantitative studies to determine the relationship between chemistry teaching efficacy and interest, chemistry self-efficacy, perceived personality traits, perceived knowledge, and contextual variables can be employed by researchers.



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APPENDICES

A. Interview Questions for Pre-service Teachers

1. Where do you study?
2. What is your grade level?
3. What is your GPA?
4. Do you have any teaching experience?
5. Can you explain the characteristics of cooperating school that you completed teaching practice? What did you do during teaching practice?
6. Why did you choose to study chemistry education department?
7. What do you think about the courses you took from your department? How did they affect your teaching experience during teaching practice? Please provide an example.
8. What kind of chemistry teacher do you believe you will be? Why?
9. Have you received any feedback about your teaching performance? From whom? What kind of feedback was it? Did this feedback affect your confidence in teaching? Why or why not? How?
10. Did you receive any feedback from students during your internship? How did this feedback affect your confidence as a teacher? Why?
11. Have you observed other chemistry teachers' classes? What were your observations? Did they affect your confidence in teaching? How?
12. Have you observed your classmates' classes? What were your observations? Did they affect your confidence? How?
13. How do you feel when teaching chemistry at your cooperating school? What emotions do you experience? In which situations do you experience these emotions? Why? Did these emotions affect your confidence in teaching? How?
14. Do you believe that you can teach chemistry concepts effectively? Why?
15. Which topics do you think you are effective at teaching? Why?
16. Are there any topics you think you are inadequate or struggling to teach? What are these topics? Why?
17. Do you think you effectively use daily-life examples in teaching chemistry? Why?

B. Interview Questions for In-service Teachers

1. How many years have you been working as a chemistry teacher?
2. Which school are you currently working at? What is your year of service in this school?
3. Which schools have you worked at before?
4. Which faculty did you graduate from?
5. Have you received any graduate education? If so, what is your degree?
6. What kind of school are you working at? Does the school have a laboratory? Do you use the laboratory in your classes?
7. Is there any duty assigned to you other than teaching in the school?
8. Why did you choose this profession?
9. Have you received any feedback about your teaching performance? From whom? What kind of feedback was it? Did this feedback affect your confidence in teaching? Why or why not? How?
 - a. Do you get feedback from your students? Does these feedbacks affect you and your confidence in teaching? How? Why?
 - b. Do measurements and evaluations affect you and your confidence in teaching? How?
10. Have you observed other chemistry teachers' classes? What were your observations? Did they affect your confidence in teaching? How?
11. Do you believe that you can teach chemistry concepts effectively? Why?
12. Which topics do you think you are effective at teaching? Why?
 - a. Which topics do you think you are effective at teaching? Why
 - b. Are there any topics you think you are inadequate or struggling to teach? What are these topics? Why?
 - c. Do you think you effectively use daily-life examples in teaching chemistry? Why?
13. When you are going to explain a topic for the first time, what do you do? How do you feel when you are going to explain a topic that you have never taught before?
14. Which grade level do you believe you are effective or ineffective in teaching them? Can you give an example? Why?
15. Which student groups (high/low achievers, high/low motivation, etc.) do you believe that you are effective or ineffective in teaching them? Can you give an example? Why?
16. Which teaching methods do you use effectively in chemistry class? Why?
17. Do you conduct different teaching methods and techniques? How do you decide? Why?
18. Do you conduct lessons/experiments in a laboratory environment? Do you think you can provide effective teaching in a laboratory environment? Why?

19. Do you use technology? How? Do you believe that you can use it effectively? How?
- a. What changes have occurred in your teaching during the pandemic? What are your positive and negative experiences Why?
20. What are your positive and negative experiences during your chemistry teaching career? Different from the early years, generally.
- a. Have you experienced any difficulties? How did it affect your teaching?
21. What did you experience in the early years?
- a. What kind of difficulties did you experience? How did you cope? What did you do?
 - b. What motivated you? What were positive experiences for you? Why?

C. Ethical Permisson

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Konu : Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi : İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof. Dr. Esen UZUNTİRYAKİ KONDAKÇI

Danışmanlığını yürüttüğünüz İrem İNCEÇAY'ın "Hizmet Öncesi, Mesleğe Yeni Başlayan ve Deneyimli Kimya Öğretmenlerinin Özyeterlik Kaynaklarının Belirlenmesi:Nitel Bir Çalışma" başlıklı araştırmanız İnsan Araştırmaları Etik Kurulu tarafından uygun görülmüş ve **0152-ODTÜİAEK-2022** protokol numarası ile onaylanmıştır.

Saygılarımızla bilgilerinize sunarız.

Prof.Dr. Mine MISIRLISOY
İAEK Başkan



T.C.
ANKARA VALİLİĞİ
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Sayı : E-14588481-605.99-55631271
Konu : Araştırma İzni

22.08.2022

ORTA DOĞU TEKNİK ÜNİVERSİTESİ REKTÖRLÜĞÜNE
(Öğrenci İşleri Daire Başkanlığı)

İlgi: a) MEB Yenilik ve Eğitim Teknolojileri Genel Müdürlüğünün 2020/2 sayılı Genelgesi.
b) 16.08.2022 tarihli ve 315 sayılı yazınız.

Üniversiteniz Matematik ve Fen Bilimleri Eğitimi Anabilim Dalı Fen Bilimleri Eğitimi yüksek lisans programı öğrencisi İrem İnceçay'ın "**Hizmet Öncesi, Mesleğe Yeni Başlayan ve Deneyimli Kimya Öğretmenlerinin Özyeterlilik Kaynaklarının Belirlenmesi:Nitel Bir Çalışma**" konulu çalışması kapsamında İlimize bağlı tüm okullarda uygulama yapma talebi ilgi (a) Genelge çerçevesinde incelenmiştir.

Yapılan inceleme sonucunda, söz konusu araştırmanın Müdürlüğümüzde muhafaza edilen ölçme araçlarının; Türkiye Cumhuriyeti Anayasası, Milli Eğitim Temel Kanunu ile Türk Milli Eğitiminin genel amaçlarına uygun olarak, ilgili yasal düzenlemelerde belirtilen ilke, esas ve amaçlara aykırılık teşkil etmeyecek, eğitim-öğretim faaliyetlerini aksatmayacak şekilde okul ve kurum yöneticilerinin sorumluluğunda, gönüllülük esasına göre uygulanması Müdürlüğümüzce uygun görülmüştür.

Bilgilerinizi ve gereğini rica ederim.

Harun FATSA
Vali a.
Milli Eğitim Müdürü