PRESERVICE MATHEMATICS TEACHERS' PROMOTION OF SELF-REGULATION (PSRL) IN TIME: A MIXED-METHOD STUDY

by

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Dedicated to my story…

The strongest and stubborn woman I had ever known,

the love of my life,

to me…

&

for all of my genuine supporters…

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ABSTRACT

PRESERVICE MATHEMATICS TEACHERS' PROMOTION OF SELF-REGULATION (PSRL) IN TIME: A MIXED-METHOD STUDY

These two-phased mixed method quasi-experimental study was conducted to investigate preservice mathematics teachers' promotion of self-regulated learning (PSRL) with respect to time through participation in a self-regulated learning (SRL) Enriched Seminar Course. Preservice teachers' self-efficacy beliefs for promotion of self-regulation (SE-PSRL) over time was also investigated. 44 senior preservice mathematics teachers at a university in Istanbul participated for the first phase of the study. They were divided into two sections for a practice teaching seminar course before the onset of the research, constituting the experimental (intervention) and control (no intervention) groups. The SRL Enriched Seminar Course was implemented with the intervention group for one academic term. The participants in the control group were enrolled in the seminar course without a particular focus on SRL. Participants were administered two different scales that measured their SE-PSRL and PSRL at four different time points, associated with their teaching experiences at their practice teaching schools. Qualitative data were also gathered through semi-structured interviews. Mixed design ANOVA was used to analyze the differences between SE-PSRL and PSRL scores of the groups with respect to time. The second phase of the study was conducted to investigate inservice mathematics teachers' (PSRL) as a follow up study. Thirty inservice teachers who participated the first phase of the study was selected for the follow-up study and participants were administered SRLIT scale that measured their PSRL at once. Preliminary results of the study indicated that while participants' SE-PSRL scores differed statistically, PSRL scores did not differ statistically according to time and group. Interview data point towards various reasons for such unanticipated findings.

Key Words: Self-Regulated Learning, Promotion of Self-Regulated Learning, Teacher Training.

ÖZET

MATEMATİK ÖĞRETMENİ ADAYLARININ ÖZDÜZENLEMELİ ÖĞRENMEYİ DESTEKLEYİCİ SINIF İÇİ UYGULAMALARININ ZAMAN İÇİNDE İNCELENMESİ: KARMA YÖNTEMLİ BİR ÇALIŞMA

Bu iki aşamalı karma dizayn yarı deneysel çalışma, özdüzenlemeli öğrenme (SRL) içerikli bir seminer kursu kapsamında öğretmen adaylarının özdüzenlemeli öğrenmeyi destekleyici sınıf içi uygulamalarını (PSRL) zamana bağlı olarak incelemek için yürütülmüştür. Öğretmen adaylarının PSRL'yi kullanmaya yönelik öz yeterlilik inançları da (SE-PSRL) zamana bağlı olarak incelenmiştir. Araştırmanın katılımcıları İstanbul'da bir üniversitede matematik öğretmenliği programı son sınıf öğrencisi 44 öğretmen adayından oluşmaktadır. Araştırma öncesinde öğretmenlik uygulamaları seminer dersi kapsamında iki gruba ayrılan katılımcılar araştırmanın deney ve kontrol grubunu oluşturmaktadır. Özdüzenlemeli öğrenme (SRL) içerikli seminer kursu bir akademik dönem boyunca deney grubuyla yürütülmüştür. Kontrol grubu SRL içerikli olmayan seminer kursuna katılmıştır. Katılımcılar PSRL ve SE-PSRL'yi ölçen iki farklı anketi (TSES-SRL ve SRLIT) dört farklı zaman diliminde staj okullarındaki öğretmenlik uygulamaları deneyimlerine dayalı olarak doldurmuşlardır. Gruplardaki SE-PSRL ve PSRL skorları farkının zamana bağlı değişimini analiz etmek için karma desenli ANOVA kullanılmıştır. Nitel araştırma verileri yarı yapılandırılmış gözlemlerle toplanmıştır. Araştırmanın ikinci aşaması bir takip çalışması olarak matematik öğretmenlerinin PSRL skorlarını incelemek için yürütülmüştür. Araştırmanın ilk aşamasına katılan 30 matematik öğretmeni takip çalışması için seçilmiş ve katılımcılar PSRL skorlarını ölçen SRLIT anketi bir kere doldurmuşlardır. Araştırmanın ön bulguları zaman ve gruba göre katılımcıların SE-PSRL skorlarının istatistiksel olarak farklılaştığını; PSRL skorlarının ise istatistiksel olarak farklılaşmadığını göstermiştir. Görüşme sonuçları beklenilmeyen bulgulara yönelik çeşitli açıklamalar sunmaktadır.

Anahtar Kelimeler: Özdüzenleyici Öğrenme, Özdüzenlemeli Öğrenmeyi Destekleyici Sınıf İçi Uygulamalar, Öğretmen Eğitimi.

LIST OF ACRONYMS/ABBREVIATIONS

PSRL	Promotion of Self-Regulated Learning
SE-PSRL	Self-Efficacy for Promotion of Self-Regulated Learning
SRL	Self-Regulated Learning
SRLIT	Self-Regulated Learning Inventory for Teachers
TSES-SRL	Teacher Self-Efficacy Scale to Implement Self-Regulated Learning

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1. INTRODUCTION

As the current educational reforms emphasized the importance of "learning to learn", self-regulated learning (SRL) has turned into one of the most studied research topics in the recent years (Dignath, Büttner & Langfeldt, 2008; Winne, 2005). Self-regulation is a process of one's control, monitoring and reflection over his or her learning. It is rooted in constructivist theories which support that learners should be responsible for his or her learning (Zimmerman, 2001). As one self generates his or her thoughts, feelings and actions to achieve a learning goal, he or she is "metacognitively, motivationally, and behaviorally active in his or her learning process" (Dignath & Büttner, 2008; Zimmerman, 1989, p. 4).

In the related literature, there are many positive findings on SRL. Several studies have revealed that students who demonstrate self-regulatory skills and adjust their own learning are more successful than the students who do not (Bol & Garner, 2011; Hacker, Bol, & Bahbahani, 2008; Nietfeld, Cao, & Osborne, 2005; Spruce & Ball, 2015). Although the importance of SRL is emphasized in several research studies, many students cannot demonstrate self-regulatory skills (Ganda & Boruchovitch, 2018). Students who are self-regulated learners show more academic success than others, however some studies also show that even good students do not always show self-regulatory skills (Housand & Reis, 2008; Peverly, Brobst, Graham, & Shaw, 2003; Spruce & Ball, 2015). In this respect, researchers have tried to investigate the ways of enhancing students' self-regulatory skills (Dignath & Büttner, 2018).

Although SRL concept has been investigated with reference to students, this concept is strongly related to teaching and instruction (Chatzistamatiou, Dermitzaki, & Bagiatis, 2014). Many researchers have examined SRL concept for teachers and focuses on teachers' self-regulatory processes in many ways. Some studies examine teacher knowledge and beliefs on SRL (Lombaerts, *et al*., 2009; Spruce & Ball, 2015; Wilson & Bai, 2010), while others focus on teaching practices on SRL (Kistner *et al*., 2010) and others bring these different components together (Artzt & Armour-Thomas, 1998; Dignath & Büttner, 2018). It has also been revealed that teachers' SRL strategies support their instruction and thus enhance their students' self-regulated learning (Chatzistamatiou *et al*., 2014; Capa-Aydin *et*

al., 2009; Davis & Gray, 2007; De Corte *et al*., 2011; Delfino *et al*., 2010; Kramarski & Revach, 2009; Tonks & Taboada, 2011). As students need instructional support when they learn SRL, aiming to promote students' SRL can be crucial for enhancing their SRL skills (Spruce & Ball, 2015).

However, most of the teachers do not have a chance to take any training program about SRL in their teacher education programs and in-service trainings; they do not tend to use and reflect their SRL skills in their instruction. In this respect, it is significant to provide SRL knowledge for teachers in their teacher education programs (Cleary, 2011; Lee *et al*., 2010; Middleton *et al*., 2011; Schunk & Zimmerman, 2008).

Current educational reforms have emphasized the importance of preservice teacher education (National Council for Accreditation of Teacher Education, 2002). In the SRL context, although many researchers have carried out studies that foster preservice teachers' SRL during training period (Little, 2002), it is found that developing preservice teachers' self-regulation skills is challenging (e.g., Kramarski & Michalsky, 2010; Perry *et al*., 2007; Randi, 2004). In this respect, preservice teachers need to be supported by SRL courses in which they can learn, apply and reflect SRL skills in their instruction (Ganda & Boruchovitch, 2018). To meet the increasing demands of SRL in today's education system, a closer investigation of the efficiency of trainings for fostering preservice teachers' self-regulation skills is deemed necessary (Kramarski & Michalsky, 2010).

In this study, self-efficacy beliefs are targeted as an influencing factor of teachers' promotion of self-regulation. In the related literature, self-efficacy beliefs are considered to crucial in affecting promotion of self-regulation (Chatzistamatiou *et al*., 2014; Dignath & Büttner, 2018; Dignath-van Ewijk, 2016; Tanrıseven, 2013). Additionally, some studies have examined teachers' self-efficacy beliefs for promotion of self-regulation (PSRL) in different contexts and these studies consider self-efficacy beliefs as a rather stable/fixed variable. SRL theorists, on the other hand, have asserted that learners' motivational, cognitive and metacognitive processes display fluctuations in time (Zimmerman, 2000). Therefore, self-efficacy beliefs need to be examined within a process and as a dynamic variable. When the literature is reviewed, there is a scarcity in studies considering self-efficacy beliefs as a dynamic variable (Bernacki, 2015).

In light of the current literature, it can be said that there is a need for preservice teachers to develop their promotion of SRL skills for developing their students' SRL. For this reason, they can benefit from effective SRL enriched modules or interventions in their teacher education programs. This study mainly aims to examine the effectiveness of an SRL Enriched Seminar Program which is designed to develop preservice teachers' PSRL. While looking at the progression of promotion of self-regulation under an SRL enriched program, the progression of self-efficacy for promotion of self-regulation is also investigated.

2. LITERATURE REVIEW

2.1. Self-Regulation

Humans have the capacity to regulate their actions in the necessary situations. This capacity leads to being adaptive to changing conditions and is good for their survival. A person's sense of self affects his or her perception of personal agency which also determine his or her regulatory skills. In this respect, these skills vary among people. According to Zimmerman (1995), self-regulation means one's planned thoughts, feelings and actions toward reaching a specific goal. During the self-regulation process, one's feelings, thoughts and actions are affected from various domains: e.g., metacognitive, cognitive, motivational (Zimmerman, 2000). In this process, as these factors are continuously changing, one monitors his or her actions, thoughts and feelings according to the feedbacks from prior performance and make some arrangements on his or her current effort for developing the current performance. One's performance needs to be observed and monitored progressively in self-oriented-feedback loops. Therefore, self-regulation is considered in a cyclical process (Zimmerman, 2000). This multicomponent and cyclical nature of Self-Regulation makes its structure complicated (Panadero, 2017). In this respect, self-regulation concept goes beyond a single definition accepted by all and its expression as a specific trait or feature is difficult (Zimmerman, 2000).

2.2. Self-Regulated Learning (SRL)

Self-regulation is a broad term and related to "attainment of personal goals" (Zimmerman, 2000, p. 14). Self-regulated learning (SRL) is a specific domain of self-regulation and it is mostly related to educational goals (Burman, Green, & Shanker, 2015; Panadero, 2017) In the most general sense, SRL is a kind of learning that a person takes control of evaluating and regulating his or her learning and behavior. For a learning to be considered as a self-regulated learning, learning should take place with some active processes like metacognition, strategic action, and motivation (Ormrod, 2009). In this respect, SRL reflects motivational, behavioral, and metacognitive aspect of learning and is examined within in a holistic and comprehensive framework (Panadero, 2017). Zimmerman

(2000) has expressed that self-regulated learners use self-regulatory strategies effectively like monitoring, controlling and reflecting and the effective usage of self-regulatory strategies is very significant in educational settings (Alexander *et al*. 1998; Chatzistamatiou *et al*., 2014; Efklides, 2011; Weinstein *et al*., 2000). Due to the holistic and multicomponent structure of SRL and its significance in the field of education, it is considered as one of the most important topics in the educational sciences in the last years (Panadero, 2017).

2.3. Different Models of SRL

There are numerous researchers who have studied SRL. Although these researchers developed different SRL models, their frameworks have some common characteristic (Panadero, 2017). First of all, in all models, the nature of self-regulation is considered in a cyclical process. Another common characteristic of SRL remarked in all models is that self-regulated learners actively manages their learning by monitoring their progress and selecting appropriate cognitive strategies to accomplish their academic goals. Lastly, all models accept that one's self beliefs and motivation are affected by social factors (Spruce & Ball, 2015).

Zimmerman's SRL framework is the most commonly used one in the literature when it comes to application of SRL in classroom settings (Spruce & Ball, 2015). In this study, Zimmerman's self-regulation framework was used because of its wide use and detailed focus on various components within SRL.

Several research studies have argued that everyone could use self-regulation process to some extent to reach a goal in their lives. However, the quality or efficiency of their self-regulation is discussed by researchers. In this point, it is important to understand how the SRL processes are interrelated in the structure and cyclical in the progress (Zimmerman, 2000). In this study, Zimmerman's *second* SRL framework was used, to understand the framework better, and to investigate all the components.

2.4. Zimmerman's Social Cognitive Perspective of SRL

Zimmerman believed that one can acquire knowledge through observing behaviors of others and social interaction. In this respect, Zimmerman can be considered as a supporter of social cognitive theory (Panadero, 2017).

Zimmerman has developed three different SRL models. His second model called "Cyclical Phases of SRL". Zimmerman's cyclical model covers cognitive, behavioral and motivational aspects of SRL. Compared with other models, Cyclical Model is comprehensive as it includes various key processes that need to be found in one's studying process and all the aspects that are needed to develop one's self-regulation (Panadero, & Alonso-Tapia, 2014). Therefore, in self-regulation studies, Cyclical Model is one of the most commonly used frameworks. To examine the SRL from a broad perspective, Cyclical Model is adopted for use in this study.

Zimmerman's (2000) Cyclical Phases of SRL, consists of three different stages and these are forethought, performance and volitional control and self-reflection. Forethought phase consists of task analysis and self-motivational beliefs components. The task analysis component is also consisting of goal setting and strategic planning. In the task analysis component, one can set a goal which is to be achieved. Goal setting is a very important aspect of tasks analysis since a goal is also influential in determining the outcomes of a specific performance. Several research studies show that highly self-regulated people set their goals hierarchically, which means they set first proximal goals and then set distal goals. The hierarchical structure of this process is beneficial for them to check their progress.

Table 2.1. Phase structure and subprocesses of self-regulation.

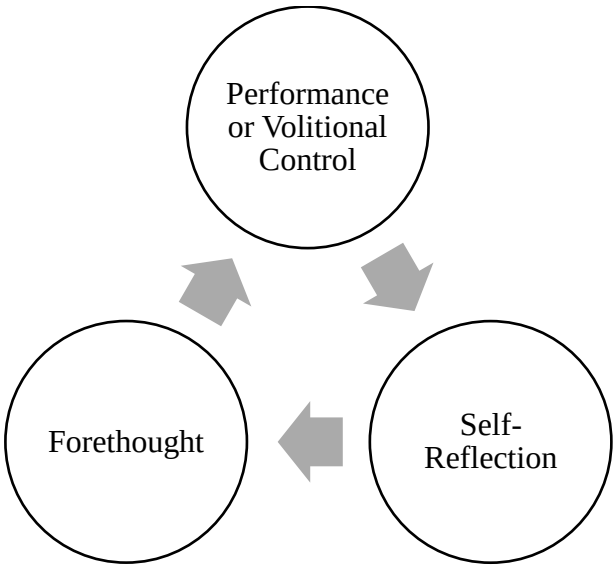

Figure 2.1. Cyclical phases model (Zimmerman, 2000).

Cyclical self-regulatory phases		
Forethought	Performance/volitional control	Self-reflection
Task analysis Goal setting Strategic planning	Self-control Self-instruction Imagery Attention focusing Task strategies	Self-judgment Self-evaluation Causal attribution
Self-motivation beliefs Self-efficacy Outcome expectations Intrinsic interest/value Goal orientation	Self-observation Self-recording Self-experimentation	Self-reaction Self-satisfaction/affect Adaptive-defensive

After goal setting, one should plan their actions in the task analysis, and this is called strategic planning. For a specific skill to be developed, there should be congruence between methods and chosen task and setting. As the self-regulation strategies also serve for gaining or displaying skills, selection of strategies and planning come to be important manner.

Planned and selected strategies affect the performance. Planning and selection of strategies are used in all processes of self-regulation and affected from any fluctuation in behavioral, environmental, and personal situations. Therefore, one plans and selects appropriate strategies by doing required adjustment in whole cyclical process. The efficiency of chosen strategy changes from one person to the other (Sakız & Özdemir, 2014; Zimmerman, 2000).

In the forethought process, apart from the goal setting and strategic planning, there are motivational factors that affect the phase itself and cyclical structure of self-regulation process. These factors are called self-motivational beliefs and can be examined under four different titles which are self-efficacy, outcome expectations, intrinsic interest and value, and goal orientation (Zimmerman, 2000).

Self-efficacy concept is one's beliefs on his or her capabilities and related organized performance toward reaching a specific goal (Bandura, 1997; Pajares & Miller, 1994; Zimmerman, 1995). Outcome expectancy is related to one's beliefs about the outcome a specific performance. Intrinsic and interest values are related to one's source of motivation and reward expectations of related goal. People who have intrinsic value are not motivated by extrinsic motivational factors like winning, money or sense of success when they are trying to reach a goal. Instead, they are motivated by intrinsic factors like acquiring mastery skills when they perform a specific goal. There are two different types of goal orientation, one is a learning or a mastery goal orientation and the other is performance goal orientation. In the first one, a person is motivated by learning and mastering new skills whereas in the latter, one is motivated by demonstrating his or her abilities (Zimmerman, 2000).

In the performance and volitional control phase, self-control and self-observation processes are observed. Self-control and self-observation processes helps a person to focus on a targeted task and increases his or her task efficiency. Self-control processes are self-instruction, imagery, attention focusing, and task strategies. Self-instruction means one's self-verbalization when managing a learning process. Imagery is forming mental pictures to improve and assist performance. Attention focusing is related to directing one's attention toward a specific performance and eliminating other factors that negatively affect the performance. Task strategies are other self-control processes that diminish the task into small

pieces and give way to organizing these parts and managing easily so that one can increase the task efficiency (Sakız & Özdemir, 2014).

Self-observation processes are related to one's monitoring specific aspects of his or her performance. Selecting hierarchical goals in this respect, is important as it facilitates self-observation. Self-observation processes involves self-recording and self-experimentation (Sakız & Özdemir, 2014). In the self-recording, one monitors his or her performance and controls the performance effect level and records what he or she performs. During this process, monitoring takes place systematically and consciously. When the consequences of the recording process do not give adequate answers about the one's performance or behavior quality, that person seek for personal trying and this is called self-experimentation. These self-monitoring processes then underpin the basis of self judgement that one can judge his or her performance as a result of his or her performance (Sakız & Özdemir, 2014; Zimmerman, 2000).

In Zimmerman's self-regulation model, last phase is self-reflection phase. This phase consists of self-judgement and self-reaction subprocesses. In this phase, one compares his or her performance with previous standards and then he or she re-regulates the performance according to the intended level (Zimmerman, 2000). Self-judgement process consists of self-evaluation and causal attribution. During the self-evaluation process, one regularly and systematically compares his or her performances with personal goals. Causal attribution is, on the other hand, related to where one attributes to the result of their performance such as effort, intelligence of environmental conditions (Sakız & Özdemir, 2014). These attributions are found to be very important for a learning process. Attributional errors also result in negative outcomes like underestimation of effort or unsustainable motivation in one's learning process (Weiner, 1979; Zimmerman & Kitsantas,1997; Zimmerman, 2000).

In the self-reaction process, self-satisfaction and adaptive-defensive inferences are observed. In this process, one evaluates his or her progress and regulates the learning behavior according to his or her evaluation. Self-satisfaction in this context, refers to one's satisfaction or dissatisfaction toward the outcomes of his or her performance. If a person is satisfied with the result of a goal and the process when he or she performs a task, he or she more probably acts in similar way for further goals (Sakız & Özdemir, 2014; Schunk, 2001).

The level of satisfaction or dissatisfaction can also change according to one's intrinsic value or the importance of the task (Sakız & Özdemir, 2014; Zimmerman, 2000).

After performing a specific goal, one makes some inferences about process and goal. These inferences help him or her to decide what should be avoided or what should be done for the further goals. These inferences serve for two different aims. One is for the adaptive inferences and the other is defensive inferences. Adaptive inferences are motivating inferences that direct one to show new and more effective self-regulated behaviors for the further goals. For example, one can decide to set his or her goals hierarchically or use effective strategies (Zimmerman & Martinez-Pons, 1992). Defensive inferences are restrictive inferences that prevent one from the unintended consequences (Zimmerman, 2000). In a learning situation, procrastination or cognitive disengagement can be given as examples to defensive inferences as they serve for protecting one's self-esteem (Sakız & Özdemir, 2014).

In brief, Zimmerman's Social Cognitive Perspective of SRL is a comprehensive framework as it embodies important variables that affect learning and clearly demonstrates the interaction between each component (Panadero, 2017). As the framework explains SRL processes in both general and specific ways, it is beneficial for comprehending the structure of SRL very well. Applying the practice of this framework in the learning environments is very important for developing students' and teachers' SRL (Sakız & Özdemir, 2014). This study also aims to promote directly preservice teachers' SRL and indirectly students' SRL strategies, it has great importance in this study.

2.5. Self-Regulated Learning (SRL) as A Determinant of Student Outcomes

Several research studies show that SRL strategies influence young children's academic achievement and behavior and is considered an important factor for life success. Especially, in the school settings, students develop their social, motivational and problem-solving skills when they effectively use self-regulation strategies (Dignath & Büttner, 2018; Cleary & Zimmerman, 2004; Zimmerman, 2002). Many research studies show that SRL also affects learning efficiency (Dignath & Buttner, 2008). Due to these advantageous aspects, self-regulation has become one of the most studied topics in the field of education. Researchers

have examined SRL processes on students and seek answers for how students can learn these skills as SRL directly affects their school success.

For developing one's self-regulation processes, there are some activities which are found to be effective. For example, "self-reflective activities, self-assessment questionnaires, structured diaries" (Ganda & Boruchovitch, 2018, p. 2) can be helpful for developing one's self-regulation processes. It has been shown by several research that the students can learn SRL skills and apply them in their academic life. These skills can also be thought in both primary and secondary levels (Dignath & Büttner, 2018).

When self-regulation strategies are attained by students, teachers have a vital role in promoting these skills among their students. Teachers' role in supporting students' SRL is examined in different ways, through classroom observations, by studying teachers' knowledge and beliefs about SRL, and through intervention studies in which teachers are thought some techniques about self-regulated learning (Spruce & Ball, 2015). At this point, teachers should have self-regulation knowledge, strategies and skills to develop students' self- regulatory skills.

Since increasing the quality of students' learning and academic life is one of the important educational aims, teachers' promotion of their students' self-regulation (PSRL) is an important element in the development of students' self-regulation (Dignath & Büttner, 2018). When the related literature about SRL is reviewed, it is seen that studies are often related to how SRL influences achievement, or how SRL strategies can be learnt. However, studies focusing on teachers' PSRL is relatively limited (Dignath, Büttner & Langfeldt, 2008; Hattie, Biggs & Purdie, 1996).

2.6. Teachers' Promotion of Self-Regulated Learning (PSRL)

Researchers have become concerned with teachers' self-regulatory processes that develop students' self-regulated learning in the recent years. As a result, studies examining teachers' self-regulatory processes that affects students' self-regulatory processes prevail (Capa-Aydin *et al*., 2009; Chatzistamatiou *et al*., 2014; Davis & Gray, 2007; De Corte *et al*., 2011; Delfino *et al.*, 2010; Kramarski & Revach, 2009; Tonks & Taboada, 2011). Efficiency

of teachers' promotion of self-regulated learning (PSRL) depends on teachers' self-regulation and the need to use different strategies to increase their teaching efficiency (Andreassen & Braten, 2011; Dignath & Buttner, 2008; Stoeger & Ziegler, 2011; Tonks & Taboada, 2011). For effective instruction, teachers need to actively control and manage their metacognitional, motivational and instructional strategies (Chatzistamatiou *et al*., 2014; Hartman 2001; Manning & Payne, 1996).

Dignath-van Ewijk (2016) has asserted that PSRL can be achieved by two ways. First one is related to teaching self-regulation strategies to students and the other one is related to managing the classroom environment by using constructivistic educational strategies. In addition to these, teaching self-efficacy beliefs and value beliefs are also found to be influencing factors on teachers' PSRL skills (Chatzistamatiou *et al*., 2014).

Although, there was evidence that self-regulation has a significant effect on students' success, teachers cannot always promote students' self-regulation. Some studies examining teachers' PSRL in the classroom observations revealed that teachers focus more on the teaching content knowledge rather than teaching self-regulation skills (De Kock, Sleegers, & Voeten, 2005). Some studies which focus on teachers' instruction of self-regulation in the classrooms have also shown that teachers did not allocate enough time to teach self-regulatory strategies and did not teach how students can learn on their own.

Perry *et al.* (2008) have found that teachers have positive ideas toward developing their students' self-regulation, but they do not know how they can enhance it. In this context, if a teacher wants to develop their students' self-regulation skills, he or she should be proficient in self-regulated learning, then he or she also should know how to teach self-regulation skills and practices. Therefore, teachers should learn self-regulation strategies and how to use them effectively for students in the classrooms to increase students' self-regulation (Bolhuis & Voeten, 2001; Dignath & Büttner, 2018; Perry, Phillips, & Dowler, 2004).

In a teacher education context, although school-based personnel and teachers are aware of the efficiency and educational benefit of SRL, many teachers have asserted that they do not have an opportunity to receive training on SRL for their professional development.

(Cleary, 2015; Wehmeyer *et al*., 2000; Zimmerman, 2006). Additionally, in a study which was conducted by Wehmeyer (2000), it has been reported that almost half of the teachers do not receive necessary any SRL trainings and skills to teach SRL to students. Zimmerman (2006) has also noted that teachers are enthusiastic about receiving SRL training and they are aware of the significance of SRL on students' outcomes. However, they reported that they rarely have these opportunities (Cleary, 2015). In this regard, professional development opportunities about SRL can be a crucial means to promote teachers' self-regulatory capabilities.

In many studies it is suggested that SRL skills increase teaching efficiency when they are integrated with the subject-matter knowledge (Butler & Cartier, 2004; Perry *et al*., 2006; Schraw, Crippen, & Hartley, 2006). Thus, the teacher education programs should enhance the promotion of preservice teachers' SRL skills as well as develop SRL knowledge and SRL skill (Perry *et al*., 2006; Randi, 2004; Randi & Corno, 2000).

Little (2002) emphasized that fostering preservice teacher SRL via training program is very difficult. At this point, preservice teachers have difficulty in applying SRL strategies as they have not much teaching experience (e.g., Butler *et al*., 2004; Kauffman *et al*., 2008; Kramarski & Michalsky, 2010; Peeters *et al*., 2013). However, as SRL is an important component of learning and considering the fact that preservice teachers will engage with student learning in their future profession, preservice teachers need sustained professional support on attaining the necessary knowledge and skills that enable them to promote their students' SRL (Pintrich 2002; Veenman *et al*., 2006).

2.7. Self-Efficacy Beliefs as a Motivational Determinant of Teachers' Self-Regulatory Strategies

Albert Bandura defines self-efficacy as one's belief about his or her capacity to perform a specific goal or accomplish a specific task. One's self-efficacy can influence one's perception and approach on goals, tasks and challenges (Luszczynska & Schwarzer, 2005). Self-efficacy is one of the cure concepts in Bandura's social cognitive theory. According to his theory, it is asserted that people who have high self-efficacy beliefs are probable to cope

with difficult tasks and problems as they believe their capability to handle with them (Bandura, 1986).

Zimmerman (2000) has asserted that a person who is a self-regulated learner uses many self-regulatory strategies. More than that, a self-regulated learner believes to be able to use these strategies effectively and to perform a targeted goal. In many different SRL models, self-efficacy beliefs are stated as an influencing factor of self-regulation (Wigfield & Eccles, 2001). According to Schunk and Ertmer (2000) positive self-efficacy beliefs also activate self-regulation processes.

Teachers' self-efficacy is found to be an important factor for educational processes. Teacher self-efficacy beliefs in this context, is related to teachers' beliefs about their capacity to successfully perform a specific teaching task. Teachers who have high self-efficacy beliefs show high motivation, effort, resilience and persistence. Teachers' positive self-efficacy beliefs also influence their implementations of instructional innovations (Dignath-van Ewijk, 2016). Such factors lead to improvement on their instruction (Tschannen-Moran *et al*., 1998; Yost, 2002).

Teachers' self-efficacy beliefs are also considered among the motivational and affective factors of teachers' self-regulatory strategies. There are many studies that show the positive linkage between teachers' self-efficacy and their self-regulation (Capa-Aydin, *et al*., 2009; Ghonsooly & Ghanizadeh, 2011). Teachers who have positive self-efficacy beliefs about teaching have more instances of self-regulatory processes -forethought, performance and self-evaluation- in their teaching (Allinder, 1994; Bandura, 1993; Schunk & Ertmer, 2000; Zimmerman, 2000).

Additionally, high self-efficacy beliefs of teachers tend to use effective strategies for achieving their instructional objectives, planning and organization to support their students' learning (Allinder, 1994; Bandura, 1993; Schunk &Ertmer, 2000; Zimmerman, 2000). Similarly, Chatzistamatiou *et al*. (2014) found that mathematics teachers' SRL strategies on developing their students' self-regulation (promotion of self-regulation) is related to their self-efficacy beliefs in teaching mathematics.

Although self-efficacy beliefs are considered as more general and stable concept, it can change in different contexts and tasks. (Dellinger *et al.*, 2008). For example, teachers' self-efficacy beliefs for teaching mathematics is different from the teachers' self-efficacy for teaching SRL. Therefore, teacher self-efficacy beliefs should be examined according to the context that are considered (Dignath-van Ewijk, 2016). There are some studies that investigate self-efficacy beliefs in specific to promotion of self-regulation (Chatzistamatiou *et al*., 2014; Tanrıseven, 2013). Dignath-Van Ewijk (2016) has revealed that the self-efficacy beliefs for PSRL can be considered as one of the most influencing factors on promotion of self-regulation (Dignath & Büttner, 2018; Dignath-Van Ewijk, 2016). Additionally, studies show that teachers who have high self-efficacy beliefs about SRL implementation are more competent to promote SRL strategies. These teachers also have shown higher results on their self-reported SRL implementation (De Smul, *et al*., 2018).

The dynamic structure of the self-efficacy can also be observed in the SRL processes. In a remarkable number of studies, motivational aspects of SRL have been investigated, and self-efficacy is found as a key predictor of cognitive and metacognitive behaviors in one's learning processes (Pajares, 2008). In most studies, motivational factors are considered as a stable factor in the SRL process. In other words, these factors are measured one time without bearing in mind the possible changes on these factors during the process. However, this conflicts with the SRL frameworks which strictly emphasizes the changeable nature of each components in the self-regulation process. As one of the SRL components, self-efficacy variable needs to be examined as a dynamic variable (Bernacki, 2015). In this study, the self-efficacy beliefs of preservice mathematics teachers' promotion of self-regulation (SE-PSRL) is also considered as a dynamic variable since preservice teachers' self-efficacy beliefs are expected to change and affect their PSRL during the intervention process.

2.8. Significance of the Study

This study is mainly conducted to investigate the effectiveness of an intervention course designed to develop preservice teachers' promotion of self-regulated learning (PSRL). Second aim of this study is to examine the effectiveness of the SRL enriched intervention course on preservice mathematics teachers' self-efficacy beliefs for promotion of self-regulation (SE-PSRL). In addition to these, the study is also aiming to examine

promotion of self-regulated learning (PSRL) of inservice teachers who participated in the SRL enriched intervention after the intervention process.

As it is stated in the literature review, both teachers and preservice teachers need professional development courses in SRL to develop their PSRL. The study is significant as it is expected to contribute to the understanding about self-efficacy for promotion of self-regulation (SE-PSRL) and promotion of self-regulation (PSRL) concepts in a preservice teacher education context and develop insights about the contribution of interventions related to SRL context on preservice teachers' professional development. Additionally, in this study as self-efficacy for promotion of self-regulation (SE-PSRL) is examined as a dynamic variable, it fills one of the gaps in the related literature.

2.9. Statement of the Problem

In this study the research questions are stated as:

2.9.1. Research Question 1

Is there a significant difference between the mean scores of self-efficacy for promotion of self-regulated learning (SE-PSRL) of presercive mathematics teachers with respect to participation in a SRL enriched intervention program and time?

Hypothesis 1: It is hypothesized that there will be a significant difference between the mean scores of self-efficacy for promotion of self-regulated learning (SE-PSRL) of presercive mathematics teachers with respect to participation in a SRL enriched intervention program and time.

2.9.2. Research Question 2

Is there a significant difference between the mean scores of promotion of self-regulated learning (PSRL) of presercive mathematics teachers with respect to participation in a SRL enriched intervention program and time?

Hypothesis 2: It is hypothesized that there will be a significant difference between the mean scores of promotion of self-regulated learning (PSRL) of preservice mathematics teachers with respect to participation in a SRL enriched intervention program and time.

2.9.3. Research Question 3

3.a What are the thoughts of preservice mathematics teachers participating in the study on self-regulated learning (SRL), promotion of self-regulated learning (PSRL) and self-efficacy for self-regulated learning (SE-PSRL)?

3.b What are the participating preservice mathematics teachers' perceptions on how the programme influenced their promotion of self-regulated learning (PSRL) and self-efficacy for self-regulated learning (SE-PSRL)?

2.9.4. Research Question 4

Is there a significant difference between the mean scores of promotion of self-regulated learning (PSRL) of inservice mathematics teachers in the follow-up phase with respect to participation in a SRL enriched intervention program in the first phase.

Hypothesis 4: It is hypothesized that there will be a significant difference between the mean scores of promotion of self-regulated learning (PSRL) of inservice mathematics teachers in the follow-up phase with respect to participation in a SRL enriched intervention program in the first phase.

2.9.5. Research Question 5

Is there a significant difference between the mean scores of promotion of self-regulated learning (PSRL) of inservice mathematics teachers in the follow-up phase with respect to participation in a SRL enriched intervention program in the first phase and time.

Hypothesis 5: It is hypothesized that there will be a significant difference between the mean scores of promotion of self-regulated learning (PSRL) of inservice mathematics

teachers in the follow-up phase with respect to participation in a SRL enriched intervention program in the first phase and time.

3. METHODOLOGY

3.1. Research Design

This study consisted of two phases. For the first phase of the study, data were collected from preservice mathematics teachers in 2019-2020 academic term and for the follow-up phase of the study, data were collected from the participants who took part in the first phase and were working as teachers during the time of data collection in 2021.

In the first phase of the study, mixed method research design was used. First, collecting quantitative data and then gathering qualitative data sequentially, the study was considered as an explanatory sequential mixed methods design. Quantitative part was a quasi-experimental study. Two different scales were used repeatedly in order to measure preservice mathematics teachers' promotion of self-regulation (PSRL) and their self-efficacy for promotion of self-regulation regulation (SE-PSRL) at different times. Qualitative part was a case study. After quantitative data were gathered, various participants were selected for follow-up interviews. Qualitative data were then coded, categorized and interpreted.

In the follow-up study phase, quantitative research method was used. For collecting quantitative data, a questionnaire was conducted. A scale was used in order to measure in-service mathematics teachers' promotion of self-regulation (PSRL).

3.2. Population and Sample

As the participants of this study, the preservice mathematics teachers who were final year undergraduate students in 2018-2019 academic year at a university in İstanbul which was one of the public state universities in Turkey, was selected. Specifically, the university selected its students with the highest points in the university entrance exam in this field. The language of education is English and mathematics teaching program is committed to teacher training with constructivist principles of learning. As this study was an experimental one study, the population can be considered as the universities that have programs and students with similar features. Preservice mathematics teachers participated the study in their second

academic term in 2019. A majority of the participants graduated from their programs at the end of the semester.

Totally, 44 (36 female and 8 male) preservice mathematics teachers (ages: M = 23.45 years and SD = 0.67 years) participated in the study and class was divided in two sections according to their choice of time and instructor for a seminar course. Therefore, convenience sampling method was used to determine participants of the study. The participants taking the SRL enriched program in their SCED 416 Seminar on Practice Teaching in Mathematics course composed the experimental group of the study, while the participants enrolled in the section of the seminar course not following the SRL enriched program composed the control group of the study. The experimental group consisted of 21 and the control group consisted of 23 preservice mathematics teachers. The comparison of university education achievement scores (i.e., GPA scores with a maximum of 4) of the participants in the experimental group (M = 2.80, SD = 0.30) with the GPA scores of the participants in the control group (M = 2.77, SD = 0.27) showed that there was not a significant difference, $t(42) = 0.32$, $p = 0.38$. This indicates that at the beginning of the study, the groups did not differ from each other according to GPA scores, which could otherwise be a potential confounding variable.

For the follow-up study part, the participants were chosen as the graduates who took part in the first phase and were teaching mathematics at middle schools. Totally, there were 30 in-service mathematics teachers (24 female and 6 male) who participated the follow-up study and they had teaching position in government and private schools. 23 of the participants were working at private and 7 of the participants were working in state schools. 17 of the participants participated from the experimental group and 13 of the participants participated from the konrol group. All participants were graduates of 2018-2019 academic year from their university and they had participated in the first phase of the study.

In this study, permission was obtained from the ethical committee of the university to collect data from the participants (see Appendix F). For both phases of the study, the participants were informed about the research process, procedures, and their rights for withdrawal from the study in at any time. All of the 44 participants for the first phase volunteered to take part in the study and they gave their written consent and all of the 30

participants for the second phase volunteered to take part in the study and they gave their online consent (see Appendix C).

3.3. Interventions

3.3.1. SRL Enriched Seminar Program

Within the context of an intervention study, SRL enriched program was integrated in the Seminar on Practice Teaching in Mathematics Course. This was one of the undergraduate courses for senior students of mathematics and science education department at a state university. Two different instructors gave two sections of the course and the group of participants were divided into two sections. One instructor designed the course syllabus by integrating SRL content. The other instructor did not include any SRL intervention, as confirmed through personal conversations between the researcher and the instructor and he followed the regular schedule of the course. As the two instructors followed a common schedule and a similar approach to teaching in their lectures, the only major difference between the design of the two sections of the course stemmed from the SRL intervention.

The SRL content was spread across the 13-week semester, consisting of 13 weeks. The instructor scheduled SRL content to be addressed at various weeks of semester and participants were informed about the planned times when the content would be covered. Although the SRL content was not explicitly addressed every week of the course, i.e. approximately in every two weeks, preservice mathematics teachers in the experimental group were exposed to varying SRL content.

The book “Developing Self-regulated Learners: Beyond Achievement to Self-efficacy” by Barry Zimmerman, Sebastian Bonner and Robert Kovach was used as a course book. The book includes some theoretical knowledge about SRL and its classroom applications. However, classroom applications were heavily emphasized and there were many classroom episodes related to SRL in the book. For the intervention in this study, as the preservice mathematics teachers’ PSRL was examined, the content which included practical classroom applications of SRL was chosen rather than just providing theoretical knowledge of SRL. In the scope of Seminar on Practice Teaching in Mathematics Course,

preservice mathematics teachers in both the experimental group and the control group, were responsible for conducting a microteaching, in which they gave a mini lecture toward a specific mathematics topic to other classmates and received feedback in the scope of the course. In the experimental group, one of the criteria for evaluating preservice mathematics teachers' microteaching performances was use of SRL strategies in their instructions. After the first three weeks of the course, preservice teachers started micro-teaching practices. Related to microteaching performances, the preservice mathematics teachers were also given SRL-focused feedback and evaluated according to their teaching practices targeted PSRL. Preservice mathematics teachers also did their four different teaching practices at their internship schools during the intervention. They were also given SRL thematic feedback and evaluated with their teaching practices targeted PSRL. During the intervention process, presevice mathematics teachers had an opportunity to learn theoretical framework of PSRL and apply this theory to the practice in their internship schools. In Table 3.1 and Table 3.2, the SRL intervention program is provided in detail.

Table 3.1. SRL intervention program.

Week	**Course Activities**
1st Week, Feb 7th, 2019	-Participants are informed about the research and SRL intervention. -There is no specific SRL interaction.
2nd Week, Feb 14th, 2019	-Informed consent forms are distributed and gathered. -Detailed information about the research is given. -Reading assignment is given.
3rd Week, Feb 28th, 2019	-Research policies (EG&CG) are discussed. -The course book is introduced. -SRL and Self-efficacy concepts and their theoretical implications are mentioned. -Case examples of PSRL strategies in classrooms are discussed. -Microteaching – 1 (1 students)
4th Week, March 7th, 2019	-There is no specific SRL interaction. -Microteaching–2 (3 students)

Table 3.2. SRL intervention program (cont.).

Week	**Course Activities**
5th Week *March 14th, 2019*	-SRLIT items are analyzed. -Classroom discussions are made. Some discussed questions are as follows: • "How well do you address this in your lessons in forty minutes?" • "What kind of mechanism can you use to make this happen?" -Microteaching–3 (2 students)
6,7,8,9,10,11, 12th Weeks	-Every week, microteaching sessions are implemented. Microteaching practices are analyzed according to PSRL strategies. -In some weeks, teaching practices in internship school are analyzed according to PSRL strategies. -Classroom discussions are made. Some discussed questions are as follows: • What specific actions about SRL can you use to develop students' SRL? • Why do you think these actions (self-attention focusing strategies, self- reflection strategies) can reach students? • What do you have experience at your internship schools? • Which one do you think easy to implement for the future? -6th log entries is given for course assignment. In this assignment, preservice teachers are supposed to write their PSRL actions in their practice teachings and also future plans for applying PSRL when they a become a teacher.
13th Week *May 9th, 2019*	-Classroom discussions on 6th log entries are made. Some discussed questions are as follows: • Which part of the SRLIT items seems to have more examples in your own experiences? • Who seems to have the highest dominance in …. Stage? (Forethought, Performance and Volitional Control, Self-Reflection)

3.4. Instruments

3.4.1. Teacher Self-Efficacy Scale to Implement Self-Regulated Learning Scale (TSES-SRL)

The Teacher Self-Efficacy Scale to Implement Self-Regulated Learning (TSES-SRL) was developed by De Smul *et al*. (2018), for assessing teachers' perceptional views about their ability of implementing SRL (see Appendix A). In this study, the scale was used for measuring preservice mathematics teachers' self-efficacy beliefs on promotion of self-regulation (SE-PSRL). The scale consists of four factors addressing both direct and indirect promotion of SRL; "1) teacher self-efficacy for direct instruction, 2) teacher self-efficacy for providing choices (indirect instruction), 3) teacher self-efficacy for providing challenges and complex tasks (indirect instruction), and 4) teacher self-efficacy for building in evaluation (indirect instruction)" (De Smul *et al.,* 2018, pp. 10-11). There are 21 items on a five-point Likert-scale with 1 representing "cannot do at all", 2 representing "can do limitedly", 3 representing "can do moderately" 4 representing "can do certainly", 5 representing "highly certain can do". The scores preservice mathematics teachers could get ranges between a possible minimum score of 21 and a maximum score of 105. A sample item for each factor from the scale is listed below:

"How well can you express your thought process aloud when demonstrating self-regulated learning strategies?" (factor 1)

"How well can you make decisions with your students about when they learn?" (factor 2)

"How well can you challenge your students to achieve more than they initially thought (e.g., by determining with what additional help they can solve an exercise)?" (factor 3)

"How well can you let your students reflect on their own learning process?" (factor 4)

The researchers who developed the TSES-SRL conducted a series of factor analysis for checking the validity of the scale. First, two sets of exploratory factor analyses (EFA) were conducted to investigate the factor structure of the items in the scale. A confirmatory factor analysis (CFA) was then conducted to check whether the theoretical factor structure matched the structure from the data. The results showed an adequate fit based on the ratio $\chi 2/df$ ($\chi 2 = 358.5$, $\chi 2/df = 1.98$, $p < 0.001$), and various other fit indices (CFI = 0.92, TLI = 0.91, RMSEA = 0.08, SRMR = 0.06). This was taken as evidence for validity of the scale (De Smul *et al*., 2018, p. 13). Reliability analysis was also conducted during the development of the scale. The researchers investigated the internal consistency of all factor, using Bentler's ρ coefficients. Each subscale showed high reliability values, 0.91, 0.87, 0.80 and 0.88 respectively according to the criteria for acceptable internal consistency levels: Bentlers's $\rho \geq 0.80$ (De Smul *et al*., 2018).

3.4.2. Self-Regulated Learning Inventory for Teachers (SRLIT)

Self-Regulated Learning Inventory for Teachers (SRLIT) was developed by Lombaerts *et al*. (2007) for assessing teachers' instructional strategies for promoting SRL of their students (see Appendix B). In this study, it was particularly used for measuring preservice mathematics teachers' promotion of self-regulation (PSRL). The scale consists of 23 items measuring both subcomponents of SRL: "1) forethought, 2) performance and volitional control, 3) self-reflection" (Lombaerts *et al*., 2007, p. 34). For the first phase of the study, 2 items from forethought phase, 2 items from volitional and control phase and 1 item from self-reflection phase were removed from the scale. A close number of items were removed from each sub-category so that the scale integrity did not change.

These items were related to the statements which required long process like:
"Pupils receive tasks they can work on for several lesson periods."

They were inappropriate for use with preservice teacher conducting practice teaching in classrooms since the items addressed the classroom environment created by the teachers over a sustained period of time. Some items and expressions were adapted to the context of the current study. These changes were done by receiving expert opinion since the original scale was suitable for primary school context. For example, instead of the expressions

“pupils”, “a deadline” in the in the original scale, the expressions “students”, “in a set time frame” were used. These adaptations were done in order to measure the variable in more valid way. In this instrument, there are 18 items on a five-point Likert-scale with 0 representing “never”, 1 representing “rarely”, 2 representing “sometimes”, 3 representing “regularly”, 4 representing "always”. The scores preservice mathematics teachers could get ranges between a possible minimum score 0 and a maximum scores of 72. A sample item for each factor from the scale is listed below:

“I tell my students to ask questions in order to find answers to task problems.” (factor 1)

“Students determine the order in which they complete their tasks.” (factor 2)

“I teach my students how to provide feedback to classmates.” (factor 3)

For the follow up part of the study, SRLIT scale was also used to investigate inservice mathematics teachers’ promotion of self-regulation (PSRL). In the follow-up study, since the scale aimed to assess teachers’ PSRL for a longer time, all the items in the original form were used. Some small changes were conducted by taking expert opinion. The expression “pupils” in the in the original scale, was changed to the expression “students”. The expression “a deadline”, was changed to the expression “a set of frame” and the item “Students make decisions about which information to use during tasks.” was changed to “Students gather information independently on subjects we deal with during lessons.” as in the original scale. The participants were asked to respond to 23 items on a five-point Likert-scale with 0 representing “never”, 1 representing “rarely”, 2 representing “sometimes”, 3 representing “regularly”, 4 representing "always”. In total, preservice mathematics teachers could get maximum 92 and minimum 0 point from the scale.

The researchers who developed the SRLIT conducted a series of factor analysis for checking the validity of the scale. First, two sets of exploratory factor analyses (EFA) were conducted to investigate the factor structure of the items in the scale. Secondly, Rash analysis was conducted to confirm fitness of the items. Then, separability of the items was examined to control hierarchy of the items. Mean values of items and item fit were also controlled.

Pearson correlations were calculated between subscales and found ranges between 0.50 to 0.55. In addition to these, SRLIT scores in each subscale were compared to teachers' descriptions the occurrence of SRL to support construct validity. The correlational analysis between the SRLIT scores and teachers' self reports demonstrated large effect size which means SRLIT was a highly valid measuring tool (Lombaerts *et al.*, 2009). Reliability analysis was also conducted during the development of the scale. The researchers investigated the internal consistency of all factors, using Cronbachs' α coefficients. The whole scale showed and each subscale showed high reliability values, 0.91, 0.78, 0.83 and 0.88 respectively according to the criteria for acceptable internal consistency levels: Cronbach' s $\alpha > 0.70$. All in all, the results of the scale's development study showed that there was preliminary support for the reliability and validity of SRLIT scores and the scale was suitable for assessing teachers' instructional strategies for promoting SRL (Lombaerts *et al.*, 2009).

3.4.3. Semi Structured Interviews:

An interview is a data collection technique that participants explain their knowledge, feelings, thoughts, and life stories related to the research topics. Interviews enable to reach participants' unobservable attitudes, thoughts, intentions, goals, tastes, perceptions, and reactions (Bengtsson, 2016; Seidman, 2006). There are different types of interview techniques like structured, semi-structured and unstructured interviews (Marshall, 1996). In semi-structured interviews, researcher prepares the interview form that includes interview questions he or she plans to ask during the interview (Smith, 2003). On the other hand, researcher can affect the interview flux by asking different or sub questions and enabling participants to elaborate their responds. The participants also have some control over the research (Yalçıner, 2006). In this study, nine participants were selected according to their SE-PSRL and PSRL scores for the interviews. In general, the interview questions were prepared for understanding preservice mathematics teachers' experiences on the intervention process and their conceptions about SE-PSRL and PSRL concepts. The interview questions were created by taking expert opinion and 8 questions were directed to students. In addition to these 8 questions, some sub-questions were emerged according to participants' responds during the interviews. The interview protocol is given in Appendix D and Appendix E.

3.5. Procedures

For the first phase of the study, the SRL enriched intervention program was implemented during one academic term in order to examine how preservice mathematics teachers' promotion of self-regulation (PSRL) and self-efficacy for promotion of self-regulation (SE-PSRL) evolved with respect to time spent in the program. Along with the course in which the intervention program was implemented, the participating preservice teachers also did their internship in different schools, and they were responsible for practice their teaching at their internship schools during four middle school mathematics lessons. In the context of this study, preservice teachers were asked to respond to two different scales immediately before and after they finished their teaching practices. The same procedure was repeated for each teaching practice of the participants.

Most of the data collection procedures took place during the implementation of the intervention program. However, for some of the participants, the last applications of the scales were done within a week after the class meetings of the intervention program finished. As the self-efficacy concept was related to one's beliefs about his or her capacity to perform a specific task and it was considered a more general concept (Bandura, 1977, 1986, 1997), preservice mathematics teachers' self-efficacy for promotion of self-regulation (SE-PSRL) was measured before the intervention actually started. By this means, any change in preservice mathematics teachers' self-efficacy beliefs for their promotion of self-regulation (SE-PSRL) during the intervention process was targeted for analysis from the onset of the intervention. On the other hand, promotion of self-regulation (PSRL) was not measured before the onset of the intervention. The participants had to fill in the scale measuring their PSRL in relation with their teaching practices and their practice teaching started after the third week of the semester. Consequently, preservice mathematics teachers were expected to fill in the self-efficacy (SE-PSRL) and the promotion of self-regulation scales (PSRL) at four different times during the course of the study.

Preservice mathematics teachers in both the experimental and the control groups filled in the scale at four different time points. First measurement time point was before the intervention process. Second and third measurements took place during the intervention. Fourth measurement occurred after the intervention terminated. Data collection extended

over the intervention program, and it took place for specific preservice teachers one or two days before their teaching practices in their internship schools. In this way, it was planned to reach each participant without undue delay after their teaching practices. Preservice mathematics teachers in both the experimental and the control groups were asked to fill in the SRLIT scale at four different time points. The data collection for preservice mathematics teachers' SE-PSRL was also paralleled measuring their PSRL and it was done simultaneously. In this way, it was planned to reach each participant without undue delay after their teaching practices.

For the qualitative part of the first phase, data were collected with semi-structured interviews lasting approximately 20-30 minutes. A total of 9 preservice mathematics teachers were selected for interviews. Participants were selected predominantly from the experimental group and also the control group for comparison. Interviews were carried out face to face and individually. These participants were selected according to their SE-PSRL and PSRL results which showed different changing pattern. For example, some participants' scores were showing gradually increasing pattern, some participants' scores were showing a gradually decreasing pattern and some participants' scores were showing no variance. By collecting richer and more detailed data from participants having different progressions according to their scores and the subsequent analysis, a thorough understanding of participants' PSRL and SE-PSRL experiences in the intervention was targeted.

For the follow-up phase of the study, SRLIT scale was also used for measuring the inservice mathematics teachers' PSRL. Participants were contacted and informed for the follow-up phase of the study via online platform. Since the global COVID-19 pandemic occurred between the first phase and second phase of the study, participants had started face to face education after two years of the intervention. 30 inservice mathematics teachers filled in the SRLIT scale once and quantitative data were collected.

3.6. Data Analysis

3.6.1. Analysis of Data for Research Question 1 & 2

For the first and second research questions, statistical significance tests were conducted in order to examine whether there was a significant difference between the SE-PSRL and PSRL scores of preservice mathematics teachers in both groups (the experimental and the control groups). Both descriptive and inferential statistical analyses were used. For the descriptive analysis, frequency, percentage, mean and standard deviation were calculated. For the inferencial statistics a mixed ANOVA was used. Cronbach's alpha values were also considered for internal consistency of the SE-PSRL and PSRL scores of the preservice mathematics teachers.

In this study, the aim was to find out whether there was a significant difference between the SE-PSRL and PSRL scores of preservice mathematics teachers in both groups over time. Therefore, for the first research question, the dependent variable was "self efficacy promotion of self-regulation (SE-PSRL) scores", whereas the within-subjects factor was "time" and the between-subjects factor was "condition of participation in the program", namely whether the participant was exposed to the intervention or not. For the second research question, the dependent variable was "promotion of self-regulation (PSRL) scores", whereas the within-subjects factor was "time" and the between-subjects factor was "condition of participation in the program". A mixed analysis of variance (ANOVA) test is used when analysing between subjects designs and repeated measures designs in one study (Pallant, 2010). Therefore, as an inferential statistical analysis, a mixed ANOVA was used for the first and second research questions.

3.6.1.1. Assumptions of Mixed Anova. In a mixed ANOVA design, there are various assumptions to be met. First of the assumptions is that the dependent variable should be a continuous one and measured at interval or ratio level. Second assumption is independence of observation assumption. According to this assumption, observations should not influence each other. Another assumption of mixed ANOVA is the assumption of homogeneity of variances which means that each group scores should be similar according to variance of data. Homogentiy of variances assumption is tested with the Levene's Test of Equality of

Error Variances. If the significance value was greater than 0.05, this means that the assumption is met, if the significance value was smaller than 0.05, this means that the assumption is not met. Another assumption is normal distribution of scores for each study group. This assumption indicates that the data are assumed to have come from a normal population (Pallant, 2010). The Shapiro-Wilk Test is the test suggested for use with small sample sizes (< 50 samples). If the test is not significant (i.e significance value is greater than 0.05) the null hypothesis is retained and the normality assumption is met; if the test is significant (i.e significance value is smaller than 0.05) the null hypothesis is not retained and the normality assumption is not met (Field, 2009). For normality check, kurtosis and skewness values can also be controlled. If values of kurtosis and skewness between -2 and +2 are seen as acceptable for assuming that data are approximately normally distributed and parametric tests can be used. The normality can also be represented visually in Q-Q, Box Plots and histograms in order to see the distribution of the data (Field, 2000 & 2009; Gravetter & Wallnau, 2014). Homogenity of covariances and sphericity assumption are also other assumptions in mixed ANOVA. Box's Test of Equality of Covariances is conducted to test the assumption of homogeneity of covariance matrices. If the siginificance value is greater than 0.05, this means that the assumption is not violated, if the value is smaller than 0.05, this means that this assumption is violated. Maucly's Test of Sphericity is conducted to test the sphericty assumption. If the siginificance value is greater than 0.05, this means that the assumption is not violated if the value is smaller than 0.05, this means that this assumption is violated. If the sphericity assumption is not met, use of Greenhouse–Geisser correction is suggested (Field, 2009; Howell, 2010).

3.6.2. Analysis of Data for Research Question 3

This study included qualitative research design. For the third research question, in order to investigate the thoughts of preservice mathematics teachers participating in the study on self-regulated learning (SRL), promotion of self-regulated learning (PSRL) and self-efficacy for self-regulated learning (SE-PSRL) and their perceptions on how the programme influenced promotion of self-regulated learning (PSRL) and self-efficacy for self-regulated learning (SE-PSRL) content analysis method was used.

Content analysis is a kind of inductive analysis method that focuses on the origins of phenomenon and facts. Underlying concepts and underpinning relationships are revealed through decoding process. In qualitative research, the researcher has an effort to discover the themes related to the problem and to transform the data obtained into a meaning related to the research question. After gathering and making sense of the data, the researcher tries to turn these findings to meaningful and systematic structures and reach a theory. If the data are not transformed to a theory, inductive analysis -content analysis built upon coding- is required (Baltacı, 2017; Şimşek & Yıldırım, 2011). In the qualitative data analysis, open coding approach is adopted and codes are deduced from the underlying phenomena of the data (Baltacı, 2019, pp. 377-378). Codes are organized under categories and categories according to underlying themes. All the codes, categories, themes that are related to data are gathered and interpreted (Bengtsson, 2016; Crabtree &Miller, 1999; Merriam & Grenier, 2019).

In this study, the qualitative data that were collected from the 9 preservice mathematics teachers' semi-structured interviews were analyzed and transcribed first. After transcription process, the data were divided into small meaningful parts. These parts were tried to be understood with their underlying conceptual meanings. This process was coding process. As the interviews were done without a specific theorical basis, data were coded openly which meant that codes were only composed from the data. Then, the congruent parts were coming together and named with a general title. This process was categorization process. Lastly, all categories that were obtained from the codes converted to appropriate themes with most general title. Related codes, categories and themes that emerged from qualitative data are demonstrated in Table 3.3.

Table 3.3. Codes, categories, and themes revealed from qualitative data.

Codes	**Categories**	**Themes**
- referring components of SRL definitions	Preservice Teachers' SRL Definition	Preservice Teachers' Thougths on SRL
- comprehending SRL concept		
- bringing life success	Preservice Teachers' Positive Opinions On SRL	
- supporting success		
- SRL as useful concept		
- being related to real life		
- teachers as role model	Factors for Developing PSRL	Preservice Teachers' Thoughts on PSRL
- time & process		
- classroom		
- lesson topic		
- school type		
- students		
- not taking risks	Limitations on Applying PSRL	
- teaching crowded classes		
- limited time		
- priority aims		
- giving initiatives to students	Methods of Developing PSRL	
- giving independent time to students		
- taking and giving feedback		
- further plans for using PSRL	Affects of the Intervention Program	Changes in Preservice Teachers' Thoughts During Intervention Program
- rising awareness for		
- PSRL changing SE-PSRL beliefs		
- changing PSRL perspectives		

3.6.3. Analysis of Data for Research Question 4 & 5

For the fourth and fifth research questions, statistical significance tests were conducted in order to examine whether there was a significant difference between the PSRL scores of inservice mathematics teachers in both groups (the experimental and the control groups) and whether there was a significant difference between the PSRL scores of inservice mathematics teachers in both groups according to Time 4 and Time follow-up. Both descriptive and inferential statistical analyses were used. For the descriptive analysis,

frequency, percentage, mean and standard deviation were calculated. For the inferencial statistics, Mann-Whitney U Test was used for the fourth research question and a mixed ANOVA was used for the fifth research question. Cronbach's alpha values were also considered for internal consistency of PSRL scores of the inservice mathematics teachers.

For the fourth research question, the aim was to find out whether there was a significant difference between PSRL scores of two groups of in-service mathematics teachers or not. Participants in the follow-up phase grouped according to their participation in the intervention program in the first phase. An independent-samples t-test is used when comparing the mean scores of two different groups of participants on a continuous variable (Field, 2009). As in-service teachers' PSRL constituted a continuous variable and the mean scores of PSRL were compared for two different groups, independent-samples t-test was an appropriate inferential statistics method to analyze the related data. However, as the study consist of 30 inservice teachers and these number of participants were very limited for conducting a parametric test, non-parametric form of independent samples t-test, Mann-Whitney U Test was selected as appropriate inferential statistics method.

3.6.3.1. Assumptions Mann-Whitney U Test. In Mann-Whitney U Test, there are not as many assumptions as in independent samples t-test, since the test is in non-parametric form. There are two main assumptions to be met. Samples should be selected randomly and observations should not influence each other (Pallant, 2010).

For the fifth research question, the study was compared with the first phases of the study to understand how PSRL scores of in-service mathematics teachers were evolving in time. For this reason, the PSRL scores of 30 in-service mathematics teachers in the follow up part were compared to the PSRL scores of 30 pre-service teachers (only follow-up participants' previous scores) in time 4 measurement. In this analysis, the dependent variable was "promotion of self-regulation (PSRL) scores", whereas the within-subjects factor was "time" and the between-subjects factor was "group as a condition of participation in the program". A mixed analysis of variance (ANOVA) test is used when analysing between subjects designs and repeated measures designs in one study. (Pallant, 2010). Therefore, as an inferential statistical analysis, a mixed ANOVA was used for the fifth research question.

4. RESULTS

The aim of the first phase study was to investigate the difference in pre-service mathematics teachers' promotion of self-regulation (PSRL) and self-efficacy for promotion of self-regulation (SE-PSRL) separately by group and in time within the scope of an intervention. Related to this aim, an answer for the first and second research questions was sought. In addition to these, another aim of the first phase of the study was to investigate the thoughts of preservice mathematics teachers participating in the study on self-regulated learning (SRL), promotion of self-regulated learning (PSRL) and self-efficacy for self-regulated learning (SE-PSRL) and the perceptions on how the program influenced their promotion of self-regulated learning (PSRL) and self-efficacy for self-regulated learning (SE-PSRL). Related to this aim, an answer for the third research question was sought. For the follow-up study, the aim was to investigate the in-service mathematics teachers' promotion of self-regulation (PSRL) after the intervention process and to compare inservice mathematics teachers' PSRL that were measured in the follow-up phase of the study and their last PSRL measurement in the first phase of the study by groups. Related to this aim, an answer for the fourh and fifth research questions were sought.

4.1. Results of The First Phase of The Study

4.1.1. Comparison of Self Efficacy for Promotion of Self-Regulation (SE-PSRL) of Groups in Time

For the first research question whether there was a significant difference between self-efficacy for promotion of self-regulated learning (SE-PSRL) of senior pre-service mathematics teachers participating in a SRL enriched seminar on practice teaching and senior pre-service mathematics teachers not participating in a SRL enriched intervention program with respect to time spent in the program or not was investigated.

Pre-service mathematics teachers made self-judgments about their self-efficacy for promotion of self-regulation (SE-PSRL) performances four times during the intervention process. Table 4.1 shows the number of participants (n), the mean (M), and standard

deviation (SD) of pre-service mathematics teachers' SE-PSRL scores for each measurement for the experimental and the control groups.

Table 4.1. Descriptive statistics for self-efficacy for promotion of self-regulation (SE-PSRL) scores and the number of participants for each group.

Measurement	**Group**	**Mean**	**Std. Deviation**	**N**
SE-PSRL Time 1	Experimental Group	72.00	7.26	21
	Control Group	72.52	10.82	23
	Total	72.26	9.04	44
SE-PSRL Time 2	Experimental Group	69.71	8.02	21
	Control Group	76.13	10.60	23
	Total	72.92	9.31	44
SE-PSRL Time 3	Experimental Group	67.05	6.77	21
	Control Group	75.70	10.07	23
	Total	71.38	8.42	44
SE-PSRL Time 4	Experimental Group	64.19	10.31	21
	Control Group	79.39	11.85	23
	Total	71.79	11.08	44

There were two independent variables which were within and between factors according to the design of the study. Within subjects factor was time (with four different measurement points) and between subjects factor was group type (participation in the intervention or not). Self-efficacy for promotion of self-regulation (SE-PSRL) scores of the participants was the dependent variable. As it can be seen in Table 4.1, under the measurement heading, there were four different time measeument for the SE-PSRL scale. The highest point of the experimental group participants' SE-PSRL mean scores was in the first measurement whereas the highest point of the control group participants' SE-PSRL mean scores was in the fourth measurement.

Considering the mixed Anova assumptions, SE-PSRL scores of the participants was a ratio measurement at a continuous level, first assumption was met. SE-PSRL scores were

measured in four different points in time, independence of observation assumptions was also met. For normality assumptions, test of normality was conducted. The Shapiro-Wilk test was analysing the normality of "SE-PSRL" on the data of preservice mathematics teachers that were classified as both the experimental and the control groups with four different time points. As almost all of the significance value was greater than 0.05, it can be concluded that "SE-PSRL" for this particular subset of individuals was normally distributed. In the experimental group participants, two of the SE-PSRL scores are normally distributed as the significance value was greater than 0.05. However, for SE-PSRL Time 1 and SE-PSRL Time 3 the significance values were smaller than 0.05, so these data are not normally distributed (see Table 4.2). The SE-PSRL Time 1 and SE-PSRL Time 3 from the same individuals were analysed to find out a Normal Q-Q Plot (see Figure 4.1 and 4.3). As the graphs showed that, the data seemed to be normally distributed since the plots were not far away from the diagonal line. In the control group participants, all of the SE-PSRL scores were normally distributed as the significance value was greater than 0.05 (see Table 4.2).

Table 4.2. Normality of distribution of SE-PSRL scores for groups.

Measurement	**Group**	**Significance Value in Shapiro-Wilk Test**
SE-PSRL Time 1	Experimental Group	0.04
	Control Group	0.13
SE-PSRL Time 2	Experimental Group	0.08
	Control Group	0.64
SE-PSRL Time 3	Experimental Group	0.01
	Control Group	0.11
SE-PSRL Time 4	Experimental Group	0.30
	Control Group	0.94

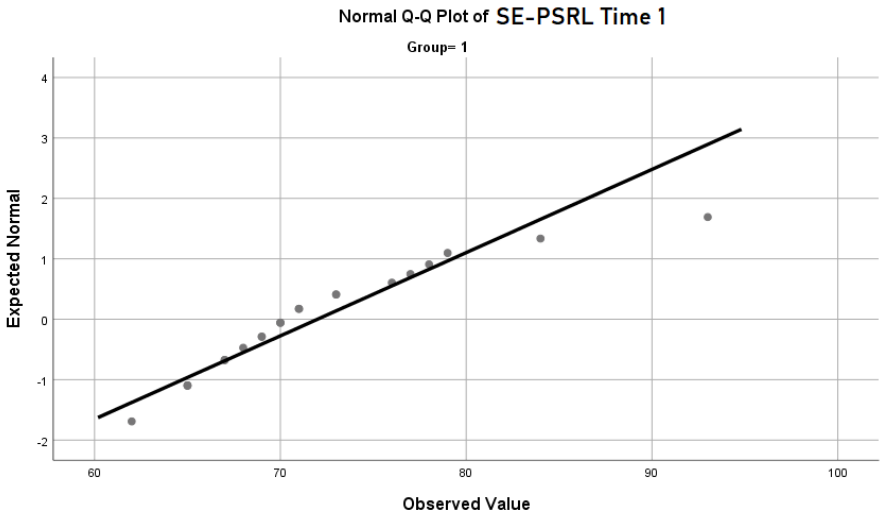

Figure 4.1. Normal Q-Q plot of SE-PSRL time 1 measurement.

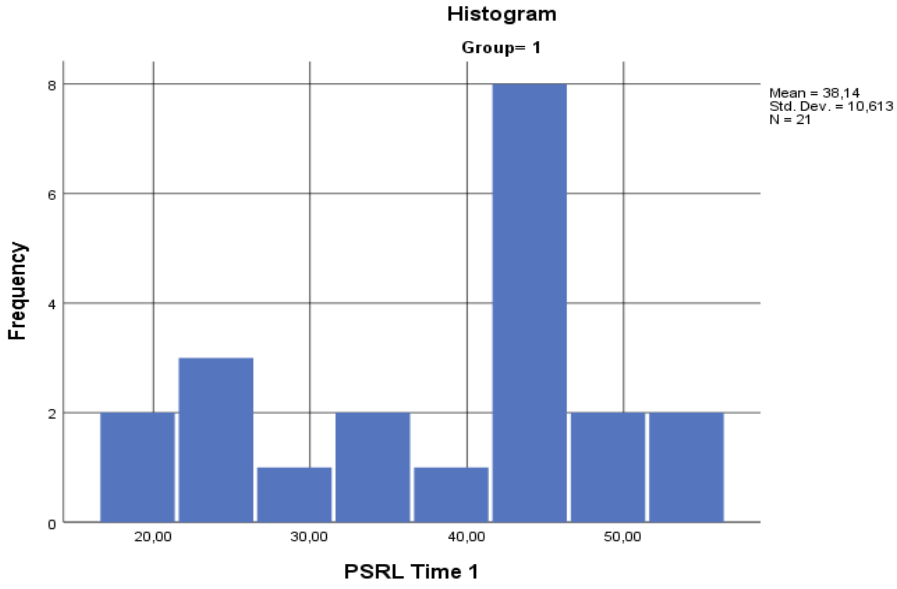

Figure 4.2. Histogram of SE-PSRL time 1 measurement.

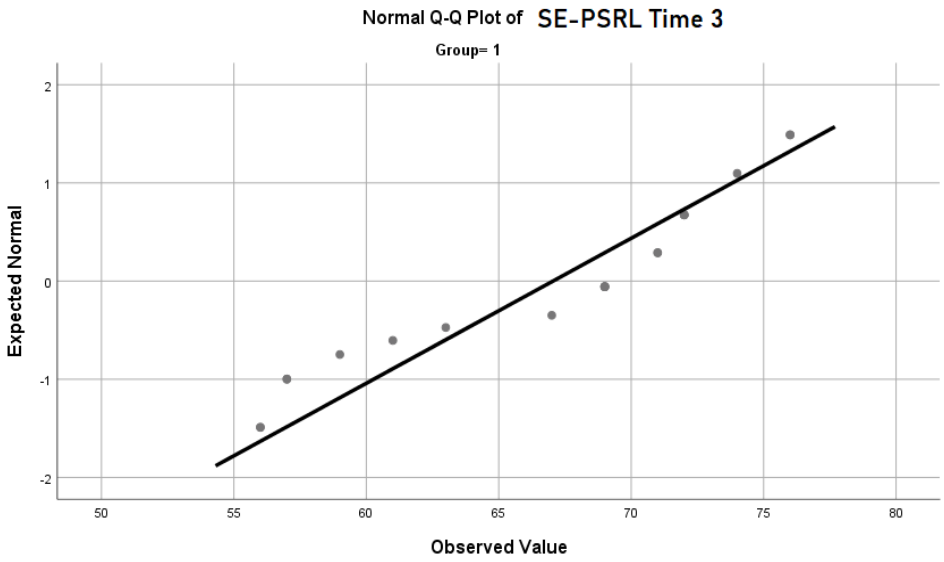

Figure 4.3. Normal Q-Q plot of SE-PSRL time 3 measurement.

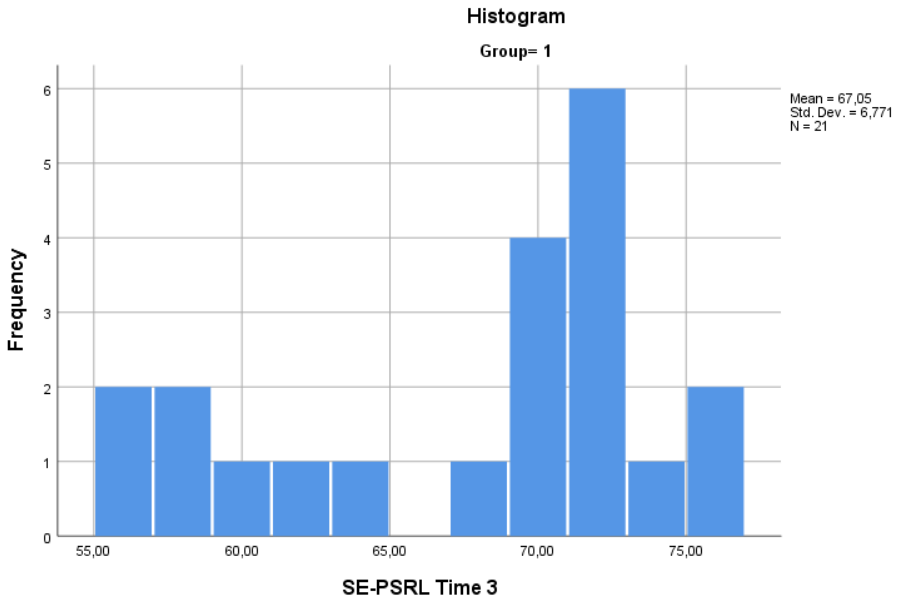

Figure 4.4. Histogram of SE-PSRL time 3 measurement.

Skewness and kurtosis values of the graph of the SE-PSRL scores in the experimental group at Time 1 and Time 3 were examined to assess whether parametric tests could be used or not. The experimental group had SE-PSRL scores with 1.35 skewness value and 2.30 kurtosis value at Time 1 and with 0.32 skewness value and 1.31 kurtosis value at Time 3. It

was concluded that SE-PSRL Time 1 data were not normally distrusted since the skewness and kurtosis values were not between -2 and + 2; whereas SE-PSRL Time 3 data were normally distrusted since the skewness and kurtosis values were between -2 and + 2.

For the homogeneity of variances assumption, Levene's Test of Equality of Error Variances was examined and the signicance values for each time measurement were respectively, 0.21, 0.10, 0.50 and 0.87 and greater than 0.05. Therefore, the assumption was met. The Box's Test of Equality of Covariance Matrices was applied to test the homogeneity of covariances matricies and the significance value was 0.48. As this value was greater than 0.05, the assumption was met. For the sphericity assumption, Mauchly's Test of Sphericity was conducted and as the significance value was found as 0.06 and greater than 0.05, the assumption of sphericity was also met. All assumptions were met for the data on SE-PSRL.

The aim of this study focuses on examining the joint effects of two independent variable (time and group) on one dependent variable (SE-PSRL score). Just looking at the results of main effects did not give the adequate findings. Therefore, firstly the interaction effect was examined and then the main effects were examined to interpret the changes in the dependent variable. Mixed ANOVA was conducted to assess the difference in SE-PSRL scores of preservice mathematics teachers between four different time points. There was a significant interaction between time and group type on preservice mathematics teachers' SE-PSRL scores. ($F(3,126) = 9.13$, $p = 0.00$, $\eta^2 = 0.18$). This finding showed that SE-PSRL measurements in time displayed differing progressions according to groups. While the values for the EG showed a decreasing pattern, measurements for CG showed that they increased in time (see Figure 4.5). The eta squared value indicated that the effect size of this interaction on SE-PSRL was large. There was a significant main effect of group type on preservice mathematics teachers' SE-PSRL scores. ($F(1,42) = 10.73$, $p = 0.00$, $\eta^2 = 0.20$). The eta squared value for the main effects of group indicated that the effect size on SE-PSRL was also large. There was not a significant main effect of time points on preservice mathematics teachers' SE-PSRL scores ($F(3,126) = 0.44$, $p = 0.73$, $\eta^2 = 0.01$).

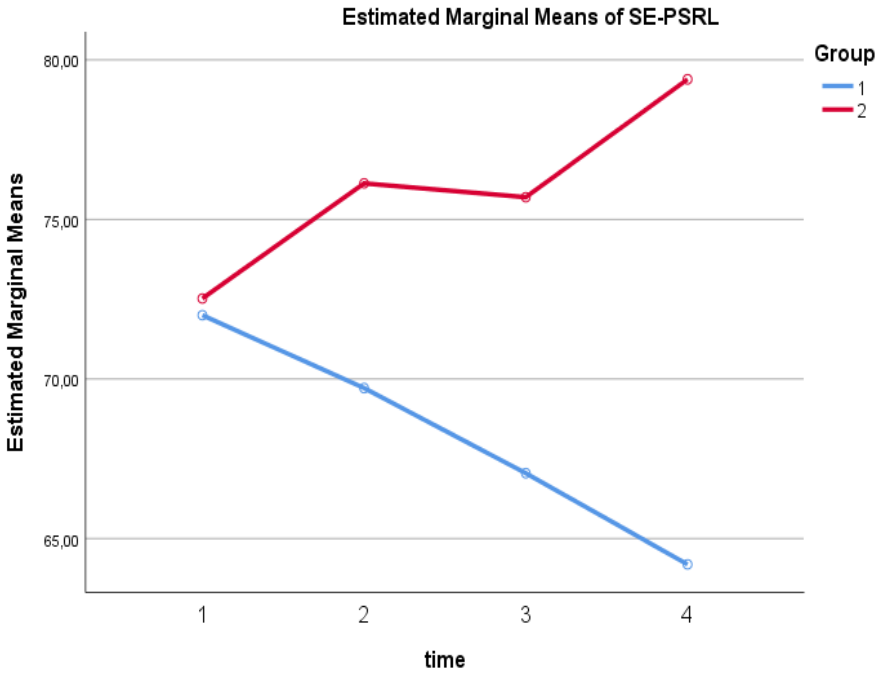

Figure 4.5. Estimated marginal means of SE-PSRL in time by groups.

4.1.2. Comparison of Promotion of Self-Regulation (PSRL) of Groups in Time

For the second research question whether there was a significant difference between promotion of self-regulated learning (PSRL) of senior pre-service mathematics teachers participating in a SRL enriched seminar on practice teaching and senior pre-service mathematics teachers not participating in a SRL enriched intervention program with respect to time spent in the program or not was investigated.

Pre-service mathematics teachers made self-judgments about their promotion of self-regulation (PSRL) performances four times during the intervention process. Table 4.3 shows the number of participants (n), the mean (M), and standard deviation (SD) of pre-service mathematics teachers' PSRL scores for each measurement for the experimental and the control groups.

Table 4.3. Descriptive statistics for promotion of self-regulation (PSRL) scores and the number of participants for each group.

Measurement	Group	Mean	Std. Deviation	N
PSRL Time 1	Experimental Group	38.14	10.61	21
	Control Group	47.22	9.28	23
	Total	42.68	9.95	44
PSRL Time 2	Experimental Group	38.62	9.97	21
	Control Group	44.48	10.28	23
	Total	41.55	10.13	44
PSRL Time 3	Experimental Group	38.86	8.87	21
	Control Group	45.78	12.34	23
	Total	42.07	10.60	44
PSRL Time 4	Experimental Group	36.81	10.98	21
	Control Group	47.22	10.01	23
	Total	42.01	10.50	44

There were two independent variables which were within and between factors according to the design of the study. Within subjects factor was time (with four different measurement points) and between subjects factor was group type (participation in the intervention or not). Promotion of self-regulation (PSRL) scores of the participants was the dependent variable. As it can be seen in Table 4.3, under the measurement heading, there were four different time measeument for the PSRL scale. The highest point of the experimental group participants' PSRL mean scores was in the third measurement whereas the highest point of the control group participants' PSRL mean scores was in the first and fourth measurement.

Considering the Mixed Anova assumptions, PSRL scores of the participants was a ratio measurement at a continuous level. Hence, the first assumption was met. PSRL scores were measured in four different points in time, independence of observation assupmtions was also met. For normality assumptions, test of normality was conducted. The Shapiro-Wilk test was analysing the normality of PSRL on the data of preservice mathematics

teachers that were classified as both the experimental and the control groups with four different time points. As almost all of the significance value was greater than 0.05, it can be concluded that PSRL for this particular subset of individuals was normally distributed. In the experimental group participants, three of the PSRL score was normally distributed as the significance value was greater than 0.05. However, for PSRL Time 1 as the significance value was smaller than 0.05, so these data were not normally distributed (see Table 4.4). The PSRL Time 1 measurement was analysed to find out a Normal Q-Q Plot (see Figure 4.6). As the graph showed that, the data seemed to be normally distributed since the plots were not far away from the diagonal line. In the control group participants, all of the PSRL scores were normally distributed as the significance values were greater than 0.05 (see Table 4.4).

Table 4.4. Normality of distribution of PSRL scores for groups.

Measurement	**Group**	**Significance Value in Shapiro-Wilk Test**
PSRL Time 1	Experimental Group	0.03
	Control Group	0.56
PSRL Time 2	Experimental Group	0.77
	Control Group	0.83
PSRL Time 3	Experimental Group	0.38
	Control Group	0.43
PSRL Time 4	Experimental Group	0.15
	Control Group	0.25

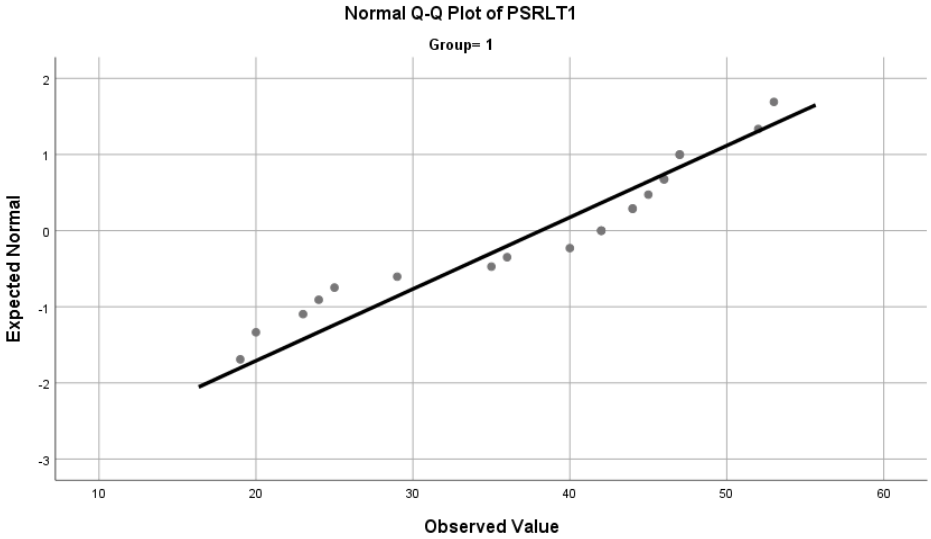

Figure 4.6. Normal Q-Q plot of PSRL time 1 measurement.

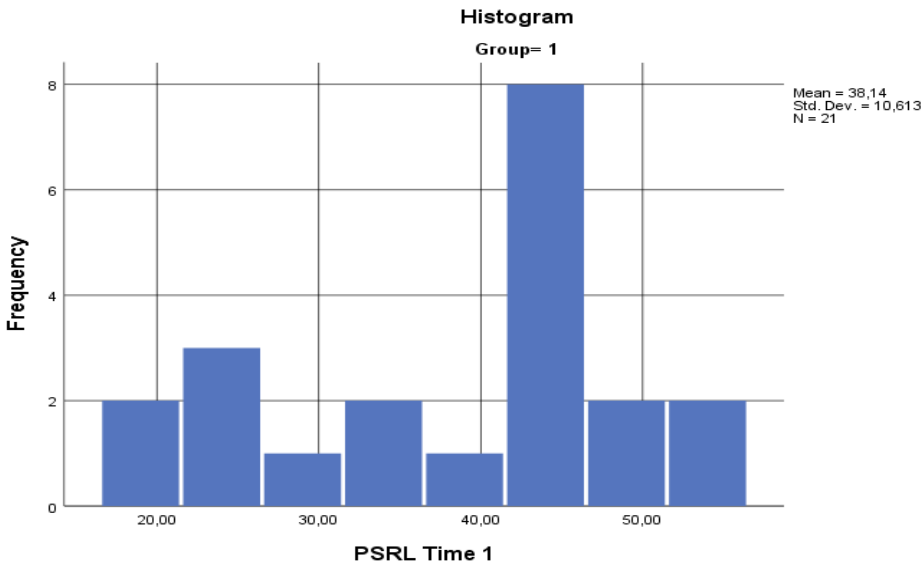

Figure 4.7. Histogram of PSRL time 1 measurement.

Skewness and kurtosis values of the graph of the PSRL scores in the experimentalgroup at Time 1 was examined to assess whether a parametric test could be used or not. The experimental group had SE-PSRL scores with - 0.61 skewness value and - 0.94 kurtosis value at Time 1. It was concluded PSRL Time 1 data were normally distrusted since the skewness and kurtosis values were not between -2 and + 2.

For the homogeneity of variances assumption, Levene's Test of Equality of Error Variances was examined and the signicance values for each time measurement were respectively, 0.27, 0.28, 0.08 and 0.50 and greater than 0.05. Therefore, the assumption was met. The Box's Test of Equality of Covariance Matrices was applied to test the homogeneity of covariances matricies and the significance value was 0.76. As this value was greater than 0.05, the assumption was met. For the sphericity assumption, Mauchly's Test of Sphericity was conducted and as the significance value was found as 0.06 which was greater than 0.05, therefore the assumption of sphericity was violated. If the sphericity assumption is not met, use of Greenhouse–Geisser correction is suggested (Field, 2019). The results of the Mauchly's test showed that $x^2(5) = 17.39$, $p = 0.004$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .76$).

The aim of this study focuses on examining the effects of two independent variable (time and group) on one dependent variable (PSRL score). Just looking at the results of main effects did not give the adequate findings. Therefore, firstly the interaction effect was examined and then the main effects were examined to interpret the changes on the dependent variable. Mixed ANOVA was conducted to assess the difference of PSRL scores of preservice mathematics teachers between four different time points. According to the results, there was not a significant interaction between time and group type on preservice mathematics teachers' PSRL scores ($F(3,126) = 0.91$, $p = 0.44$, $\eta^2 = 0.02$). This finding showed that PSRL measurements in time did not display differing progressions according to groups. The values for the experimental group and the control group did not show any pattern, however, the PSRL values of the control group were always higher than the PSRL values of the experimental group (see Figure 4.8). There was a significant main effect of group type on preservice mathematics teachers' PSRL scores ($F(1,42) = 10.35$, $p = 0.00$, $\eta^2 = 0.20$). The eta squared value indicated that the effect size of the group main effect on PSRL was large. There was not a significant main effect of time points on preservice mathematics teachers' PSRL scores ($F(3,126) = 0.20$, $p = 0.90$, $\eta^2 = 0.01$).

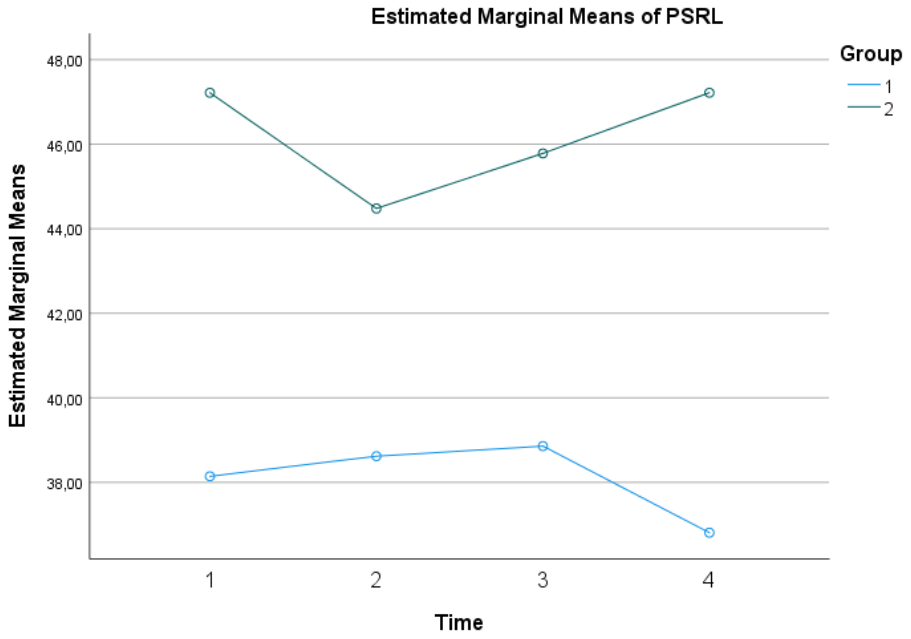

Figure 4.8. Estimated marginal means of PSRL in time by group.

4.1.3. Results of the Semi Structured Interviews

With the analysis of semi structured interviews, three main themes were found. These main themes were *Preservice Teachers Thoughts' on SRL*, *Preservice Teachers Thoughts on PSRL* and *Changes in Preservice Teachers Thoughts During Intervention Program*. These four themes were unravelled from different categories *Preservice Teachers SRL Definition, Preservice Teachers Positive Opinions on SRL, Factors for Developing PSRL, Method of Developing PSRL, Limitations on Applying PSRL, Effects of the Intervention Program* and various codes (see also Table 3.3). In this section, results from the qualitative data analysis will be explained.

4.1.3.1.Preservice Teachers Thoughts' on SRL. After the coding process of the qualitative data and the categories emerging from the initial codes, one main recurring theme was related to preservice teachers' thoughts on SRL. It was found that preservice teachers mainly expressed their definitions for SRL concepts and developed positive opinions towards SRL concepts during the program. When preservice teachers' SRL definitions were asked, almost all of them could mention various components of SRL. They defined SRL concept by referring to expressions such as "self", "metacognitive learning", "active learning",

"awareness", "regulation of learning", "control over learning". Only one participant managed to provide a definition for SRL similar to the ones in the literature and one of the participants expressed that she could not comprehend SRL concept exactly. These findings indicated that after the intervention, preservice teachers gained some theoretical knowledge toward SRL. However, participants could not properly learn SRL although this theoretical knowledge was conveyed during the intervention. The extract below shows how one of the participants, Participant 1, displayed her partial knowledge about the components of SRL without being able to provide a proper definition for this concept.

Researcher: If I asked you what SRL is or what self-regulation skills are; with your own thoughts, how would you like to define it?

Participant 1: In fact, when you say this, certain concepts come to mind, for example, like a control mechanism or regulation. And we are talking about a control, a regulation that takes place without intervention, that is, within its own mental process. In other words, making a certain assessment on what you have learned and giving necessary feedback on it, you know, something like self-feedback, actually comes to my mind.

In this extract, although Participant 1 could not give an exact definition of SRL, she gave a definition overlapping with some components (particularly monitoring and evaluation) within the commonly accepted definitions of SRL.

Another category under the overarching theme of preservice teachers' thoughts on SRL, was their general positive opinions regarding the usefulness and importance of SRL. When the preservice teachers' opinions on PSRL were investigated, all preservice teachers contended that they considered SRL as an important aspect of learning. There were not any negative opinions towards SRL. Their comments in the interviews showed that preservice mathematics teachers mainly highlighted SRL as something that would "*bring success in life*", "*support and increase success" and "be connected to real life*". These findings showed that preservice teachers gained a holistic view towards SRL concepts as they associated it with the real life and not just seeing SRL as an educational idea encapsulated within the classrooms.

Researcher: So why do you think SRL is an important issue? Why should students have it?

Participant 2: It is not about any subject, not just learning at school. I see it as a key for success, that is kind a self-evaluation, following himself in the process. And the student sets their own goals, here or in life. I have to study right now, I have to do sports right now, I have to devote that much time to sports. He sets his general goals and organizes himself accordingly. If he has this skill, he will lead a happier, better life.

In this dialog, it could be seen that Participant 2 did not consider SRL as just learning or any subject in schools but as a concept that was beyond the learning and related to life itself.

4.1.3.2. Preservice Teachers Thoughts on PSRL. The second main theme emerging through the coding of the interviews was preservice teachers' thoughts on PSRL. What preservice teachers mentioned during the interviews, was grouped into three categories: factors for developing PSRL, limitations of applying PSRL, methods of developing PSRL. Preservice teachers generally expressed that developing students' SRL depended on teachers rather than students. Some participants also indicated that teachers need to constitute a role model for students to develop their SRL. This view showed their perceptions about the importance of teachers' role on developing students' SRL and that they had beliefs about the necessity on PSRL strategies in classrooms.

Researcher: What do you think about the role of teachers in developing their students' self-regulation skills?

Participant 3: All in all, students don't know how to do it. In the first place, we as teachers should be an example in terms of how they give feedback to their classmates or how they evaluate themselves. We cannot expect them to do something from scratch in the first place. I think we need to set an example for them and direct them to do it and direct them to self-evaluation and regulation. Afterwards, they become to learn SRL as a certain habit, we can leave it to them.

This excerpt is an example of how participants indicated that teachers should be a role model for their students to acquire SRL skills and turn it into a habit. These findings showed how the intervention helped preservice teachers construct ideas towards the aim of the study. Yet, preservice teachers also touched upon practical limitations that the teachers had in integrating SRL into classroom aims for students. Preservice teachers too often indicated that developing students SRL via teachers' PSRL strategies were possible however, this required a long, cumbersome process and time. Preservice teachers often expressed their ideas on how difficult it would be to develop students' SRL in the limited time they had.

Researcher: When you think about these, do you think every PSRL item in the questionnaire can be applied by a teacher?

Participant 4: I think it's all applicable, but it's a process and it's a long process. There is no such thing as I did it immediately. let's say for a year. I am a teacher for a year and I attend the class, for example. I can apply these items and observe the process. I think these items can be applied easily and very well in that situation.

Some other factors that preservice teachers mentioned as influencing students' SRL skills via applying PSRL practices were "classroom sizes", "classroom culture", "lesson topic that are thought", "school type", "students' interest". However, these codes were not dominantly seen in the transcriptions. Two participants stated that applying PSRL strategies for developing students' SRL would depend on school type. They thought that such kinds of educational approaches were imposed to teachers and teachers had to apply SRL strategies and develop their students' SRL in private schools, however it would be a different story in public schools. Three different participants mentioned that classroom culture and lesson topic were considered as factors for developing PSRL. Classroom sizes were emphasized mostly among these factors and they asserted that teachers could enhance their students' interest and SRL in the small class sizes, when the number of students increased the efficiency of PSRL was decreasing. Some participants also believed that developing students' SRL depends on the students' interest and desire to learn. They indicated that if students were aware of the importance of SRL, they could learn and develop their own SRL themselves, teachers' role, at this point, should be creating SRL awareness for students rather than showing SRL strategies to students.

Apart from the factors for developing PSRL, preservice teachers also referred to limitations on applying PSRL. The limitations that preservice teachers mentioned had implications about preservice teachers' SE-PSRL and PSRL strategies. Almost all of the participants asserted that they could not take risks to implement PSRL in their practice teaching experiences linked with the course they were taking at the university.

Researcher: What were the most challenging parts of the PSRL implementation when you thought about your practice teachings?

Participant 3: The most challenging part...mmm.. Actually, there were a lot of things that prevented me from doing this such as time constraints. I had to show my best performance there so sometimes I could not take too much risk. I didn't know the students. I didn't want to take risk.

They stated that they focused on applying their lesson plans for the mathematical content, which was perceived as their priority and did not consider PSRL as part of their plan. They had the fear of not completing in time the lesson they had planned and not being able to apply PSRL as they learned PSRL skills recently. These issues were expressed clearly in the extracts below from two participants' interviews.

Researcher: Do you think that you applied PSRL in your classes?

Participant 2: I believed that I would do it in general, but since I did not know the students there, I focused on the lesson plan, let the time pass and sometimes I missed those items, I could not do what I wanted to do.

Researcher: What were the most challenging parts of the PSRL implementation in your lessons?

Participant 5: The large number of students in the class. At that moment, my ultimate goal was to manage the classroom in the best way and to give my lesson objectives that I could give. So, I couldn't do self-regulation.

Preservice teachers also discussed the methods of developing PSRL in different parts of the interview but mainly when they were asked about how they could apply PSRL in their teaching. Five of the participants specifically emphasized the significance of giving

initiatives to students while developing their SRL. While listing examples upon how students could be encouraged to take initiative, they mentioned “encouraging students to take responsibility in their learning process”, “providing opportunities to students for making decisions on their learning processes”, and “giving students independent time to make decisions about their learning”. One of the participants gave a teacher as an example who could use PSRL skills very well at her internship school.

Participant 6: She really gives students a certain responsibility over their own learning. But I don't think it's going to happen in a short time. It's really a hard thing to do. The teacher must first make an effort.

In addition to giving students initiatives, most commonly mentioned category was *giving feedback to students*. In the SRL Enriched intervention course, giving feedback and taking feedback issues related to SRLIT items were often discussed. Therefore, preservice teachers reflected this concept too much when they were mentioning their PSRL related actions. In addition to these, they tried to perform giving and taking feedback to students the most when they were applying PSRL in their practice teachings.

Researcher: Did you try to use practices to improve your students' SRL in your lectures? If so, what were they?

Participant 6: I couldn't do so many things, but I tried to help students how to give feedback to each other for each time. Then, for example, when I give a task asked about how long can you finish it? They said that we can finish in this time or in that time, then they finished the work sheet form at that time. I think students are inclined toward this.

In this extract, Participant 6 explained her PSRL strategies and especially mentioned “giving feedback” and “managing their time”. These practices overlapped with the items in the SRLIT scale. This also showed that participants started showing efforts to apply some of the PSRL strategies in their practice lessons.

4.1.3.3. Changes in Preservice Teachers’ Thoughts During Intervention Program. When the transcriptions of preservice teachers’ interviews were analyzed, various changes in preservice teachers’ thoughts were seen. This was one of the key themes for this study, since

it reflected insights into the perceived effects of the intervention program, and the quantitative analysis served as an opportunity to understand and interpret the quantitative research findings in a comprehensive way.

Firstly, all preservice teachers asserted that intervention process raised their SRL and PSRL awareness. They stated that even if they had some prior knowledge about SRL concepts, this knowledge was limited and inadequate. In addition to these, they did not know how to apply PSRL in their lessons. Participating in an intervention program such as the one in this study, increased their awareness for SRL and PSRL as a starting point for change. This result showed that some aspects of the research aim was being considered by the participants. Here is one of the explanations of a participant on intervention process and his PSRL plans for future.

Participant 2: I think I will definitely try to apply PSRL strategies in my lessons. My awareness has increased much more than at the beginning of the semester, maybe I can't have all of these skills, but at least I think that I will aim for my students to develop half of them.

On the other hand, even if preservice teachers mentioned their raising awareness towards SRL and PSRL, they did not find the intervention program sufficient. Four participants expressed that the time and SRL content for intervention process was not enough for them to exhibit PSRL strategies in their practice teachings. They thought that time needed to be longer than 13 weeks and the SRL content that were delivered should be focused on practical examples of PSRL.

Participant 1: Actually, I would rather learn PSRL spread over time. Because we are already in the senior year students and have a busy period, so I think we cannot give importance to this process. So, it can be an extra lesson, a fully focused term can be completely productive for us.

In these explanations of Participant 1, it could be said that some of the preservice teachers considered this intervention process as an extra burden on their seminar course.

Therefore, they may not have got adequate efficiency from it. Participant 1 emphasized that it could be beneficial to have separate time and focus for SRL and its promotion.

Another important aspect was changes in preservice teachers' thoughts in the intervention process. The coding of transcriptions revealed that preservice teachers had some beliefs before the intervention, however, as the intervention took placed, their beliefs and perspectives towards PSRL changed. Three participants asserted that they had low self-efficacy beliefs at the beginning and when they learned about SRL and PSRL concepts in the process, their efficacy beliefs towards being able to apply PSRL increased. Their quantitative results showed parallels with their expressions. However, four participants also stated that even if they had higher beliefs at the beginning of the research, after seeing the difficulty of applying PSRL in real classes, they tended to rate low score for SE-PSRL variable. This issue can shed light on why preservice teachers in the experimental group showed low scores rather than preservice teacher in the control group. After the coding process, preservice teachers mentioned the limitations and difficulties of applying PSRL. Five participants stated that at the beginning of the research that PSRL strategies seemed easy to implement, however, in their actual teaching, application of PSRL was very difficult and depended on other factors rather than having knowledge. Preservice teachers had some ideas to implement PSRL however, the real classroom includes various factors. For this reason, it was seen that interviewed preservice teachers generally tended to rate lower scores on PSRL scale. Only two of the participants expressed that they increased their scores as they learned PSRL practices, however preservice teachers mostly stated that raising awareness on PSRL practices, led to evaluate preservice teachers themselves in a more realist manner. Therefore, they were aware that some of their intended PSRL practices actually did not occur when they were doing their teaching practices.

Researcher: If you evaluated your PSRL scores, what did you say?

Participant 2: I think at first I didn't know what those were probably, I think so.

Researcher: You started to do it more consciously towards the end, didn't you?

Participant 2: I started to do it more consciously, maybe it was lower than the 12, I actually did the first time, maybe 10 points. I wasn't conscious, maybe I thought I was doing it.

One of the promising outcomes for the intervention process was preservice teachers' future agenda. Apart from raising awareness towards SRL and PSRL, preservice teachers also stated that they were aware of the importance of SRL in the educational settings and planned to apply PSRL to develop their students' SRL when they became a real teacher. All of the participants stated that they had the aim of transferring this awareness to their future agenda. In the extract below, one of the preservice teachers explained this issue clearly:

Participant 7: At first, I had no idea. Towards the end of the intervention, my PSRL awareness increased a little bit. I was wondering if it could be SRL when I did something. Interventions have had an impact on me in this respect. I became more and more aware of SRL concept. If I understand these PSRL items completely, I will definitely apply for my students.

The preservice teachers' future aims for PSRL was important because it showed that the intervention had an effect on their beliefs and perspectives, if not an immediate impact on their practice.

4.2. Results of Follow-Up Part of The Study

4.2.1. Comparison of Promotion of Self-Regulation (PSRL) in Groups

For the fourth research question whether there was a significant difference between promotion of self-regulated learning (PSRL) scores of senior inservice mathematics teachers participating in both groups (the experimental and the control groups) was investigated.

Inservice mathematics teachers made self-judgments about their promotion of self-regulation (PSRL) performances at once. Table 4.5 shows the number of participants (n), the mean (M), and standard deviation (SD) of inservice mathematics teachers' PSRL scores for one measurement for the experimental and the control groups.

Table 4.5. Descriptive statistics for promotion of self-regulation (PSRL) scores and the number of participants for each group in the follow-up study.

Measurement	Group	Mean	Std. Deviation	N
PSRL Follow-Up	Experimental Group	50.71	12.94	17
	Control Group	60.31	11.29	13
	Total	54.87	12.98	30

For the fourth research question, Mann-Whitney U Test was used. There was one dependent variable which was inservice mathematics teachers' PSRL scores and one independent variable which was group type (participation in the intervention or not). The independent variable consists of two separate groups (participation in the intervention or not), observations were done independently and samples were coming from previous study.

All of the assumptions of Mann-Whitney U Test were met for the study and was conducted to assess the difference between PSRL scores of the groups in one time point. According to the results, PSRL scores of the control group (Mdn = 60.00) were higher than PSRL scores of the experimental group (Mdn = 51.00). A Mann-Whitney test indicated that this difference was statistically significant, U = 62.50, z = -2,01, p = 0.04.

4.2.2. Comparison of Promotion of Self-Regulation (PSRL) of Groups in Time

For the fifth research question whether there was a significant difference between promotion of self-regulated learning (PSRL) scores of the inservice mathematics teachers who participated follow-up study and their time 4 PSRL measurement when they participated first phase of the study was investigated.

Inservice mathematics teachers made self-judgments about their promotion of self-regulation (PSRL) performances once for the follow-up study, and these results were compared to their Time 4 measurement to observe whether they could apply PSRL as they had planned. Table 4.6 shows the number of participants (n), the mean (M), and standard deviation (SD) of inservice mathematics teachers' PSRL scores for the follow-up measurement for the experimental and the control groups.

Table 4.6. Descriptive statistics for promotion of self-regulation (PSRL) scores and the number of participants for each group for time 4 and time follow-up measurements.

Measurement	Group	Mean	Std. Deviation	N
PSRL 4	Experimental Group	45.76	14.45	17
	Control Group	63.15	14.93	13
	Total	53.30	16.86	30
PSRL Follow-Up	Experimental Group	50.71	12.94	17
	Control Group	60.31	11.29	13
	Total	54.87	12.98	30

There were two independent variables which were within and between factors according to the design of the follow-up study. Within subjects factor was time (with two different time points - Time 4 and Time follow-up) and between subjects factor is group type (participation in the intervention or not). Promotion of Self-Regulation (PSRL) scores of the participants was the dependent variable.

Considering the mixed Anova assumptions, PSRL scores of the participants was a ratio measurement at a continuous level, first assumption was met. PSRL scores were measured in two different points in time, independence of observation assupmtions was also met. For normality assumptions, test of normality was conducted. The Shapiro-Wilk Test was used as the participants were considered as small sample sizes (< 50 samples). The Shapiro-Wilk test was analysing the normality of “PSRL” on the data of preservice mathematics teachers that were classified as both the experimental and the control groups with two different time points. As all of the significance value was greater than 0.05, we could conclude that “PSRL” for this particular subset of individuals was normally distributed (see Table 4.7).

Table 4.7. Normality of distribution of PSRL scores for groups.

Measurement	**Group**	**Significance Value in Shapiro-Wilk Test**
PSRL Time 4	Experimental Group	0.34
	Control Group	0.32
PSRL Time Follow-Up	Experimental Group	0.46
	Control Group	0.50

For the homogeneity of variances assumption, Levene's Test of Equality of Error Variances was examined and the signicance values for each time measurement were respectively, 0.87, 0.45 and greater than 0.05. Therefore, the assumption was met. The Box's Test of Equality of Covariance Matrices was applied to test the homogeneity of covariances matricies and the significance value was 0.60. As this value was greater than 0.05, the assumption was met. For the sphericity calculation, there should be three or more levels of repeated measure factor (Greenhouse & Geisser, 1959). As this analysis included two repeated measure factor, Mauchly's Test of Sphericity was not need to conduct.

Assumptions of mixed ANOVA were met for the study and mixed ANOVA was conducted to assess the difference between PSRL scores of the groups in two time points. According to the results, there was not a significant interaction between time and group type on inservice mathematics teachers' PSRL scores ($F(1,28) = 2.70$, $p = 0.11$, $\eta^2 = 0.09$). This finding showed that PSRL measurements in time did not display differing progressions according to groups. While the values for the experimental group seemed to show an increasing pattern and measurements for the control group showed that they decreased in time, the PSRL values of the control group were always higher than the PSRL scores of the experimental group (see Figure 4.9). However, these changes did not have a statistical significance. There was a not significant main effect of time points on inservice mathematics teachers' PSRL scores ($F(1,28) = 0.20$, $p = 0.66$, $\eta^2 = 0.01$). There was a significant main effect of group type on inservice mathematics teachers' PSRL scores ($F(1,28) = 9.50$, $p = 0.01$, $\eta^2 = 0.25$). The eta squared value indicated that the effect size of this main effect on PSRL was large.

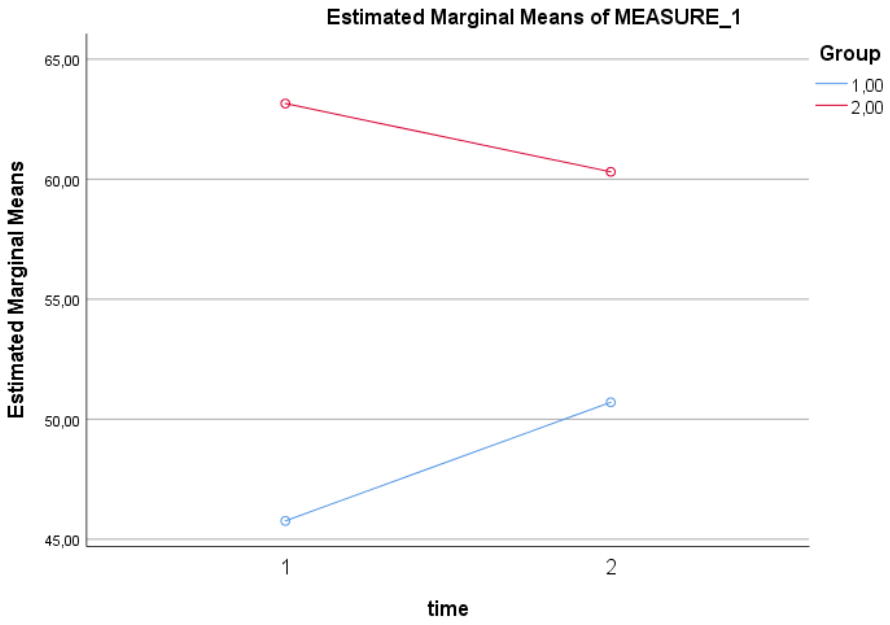

Figure 4.9. Estimated marginal means of PSRL in time by group (follow-up phase).

5. DISCUSSION AND CONCLUSIONS

5.1. Discussions of Findings

In this section, results of the study are discussed, followed by the implications and limitations of the study. The results of the first phase showed that the *group* and *time* variables had a significant interaction effect on pre-service teachers' SE-PSRL scores. These results were slightly different from the research hypotheses. Although time and group variables had an interaction effect on pre-service teachers' SE-PSRL scores, this interaction did not have the expected effect. The experimental group was expected to show higher SE-PSRL scores than the control group, as the experimental group received an intervention regarding SRL content. The results, however, showed the opposite and indicated that the SE-PSRL scores of the groups differed over time as scores of the control group increased and scores of the experimental group decreased.

Dignath-Van Ewijk (2016), and Dignath and Bütner (2018) revealed that self-efficacy beliefs towards PSRL could be considered as one of the most effective factors in promoting self-regulation. There were previous studies that investigated self-efficacy beliefs specific to promoting self-regulation (Chatzistamatiou *et al*., 2014; Tanrıseven, 2013). Research findings showed that teachers with high self-efficacy beliefs were more inclined to use PRSL in their lessons (Lombaerts *et al*., 2009; Tanrıseven, 2013; Venizt & Perels, 2019). Another study also revealed that teachers who had high self-efficacy beliefs about PSRL practice were more competent in promoting SRL strategies (De Smul, *et al*., 2018). SE-PSRL variable in this respect supported preservice teachers' PSRL skills positively as it could be seen in the literature findings. As well as taking into consideration self-efficacy as a key variable in teachers' PSRL, an important aspect of the current study was to examine the change in the SE-PRSL variable with multiple measures over time. Self-efficacy for PSRL was considered as the motivational variable affecting teachers' PSRL practices and it was stated that SRL was affected by small fluctuations over time due to its cyclical nature (Dignath & Büttner, 2018; Dignath-Van Ewijk, 2016; Zimmerman, 2000). Although an interaction effect of time and group variables on the SE-PSRL scores of the pre-service teachers was found in this study, it was surprising that the effect was opposite of what was

expected in light of literature findings. When the reasons were asked to participants, they mentioned some important factors during the semi-structured interviews. These factors were shortness of the intervention process and increased awareness for difficulty of applying PSRL. Preservice teachers said that as the intervention process was not enough, their SE-PSRL scores did not show the expected change. Additionally, they stated that their awareness toward PSRL increased, and they realized difficulty of applying PSRL during the intervention for this reason, they decrease their self-efficacy beliefs for PSRL. These factors are further discussed in the following parts of this section.

When the PSRL variable was examined, the results of the first phase of the study showed that *group* and *time* did not have a significant interaction effect on the PSRL scores of pre-service teachers. Since these variables did not have an interaction effect, the main effects were analyzed separately. As a result, it was determined that the group variable had a main effect on the pre-service teachers' PSRL scores, but time did not have a main effect on the pre-service teachers' PSRL scores. These findings showed that the PSRL scores of the pre-service teachers differed between the groups in each measurement without considering the time variable, however, the pre-service teachers did not differ in terms of time when the group variable was not considered. It was stated that the SRL process could be affected by time (Zimmerman, 2000), and in an intervention study which was conducted with Brazilian pre-service teachers, the self-efficacy belief scores and learning strategies of the pre-service teachers were examined separately. It was found that intervention had a more positive effect in the experimental group compared to the control group (Ganda & Boruchovitch, 2018). In this study, when the SE-PSRL and PSRL variables were examined separately, it was predicted that the participants in the intervention would have higher SE-PSRL and PSRL in time as reported by the previous studies in the literature, but the results were different from what was expected. While the experimental group was expected to have higher PSRL scores than the control group over time, group and time variables did not have a significant joint effect on the participants' PSRL scores. When the results of these findings were examined with the literature findings, some important interpretations could be made. Although current educational system emphasized the importance of the professional development opportunities for preservice teachers (National Council for Accreditation of Teacher Education, 2002), several researchers asserted that increasing preservice teachers' SRL abilities via intervention studies was not easy (Kramarski & Michalsky, 2010; Perry *et*

al., 2007; Randi, 2004). Preservice teachers generally did not have adequate knowledge and skills that they create new strategies and apply them in classrooms (Schön, 1995). Therefore, as the time interval was limited and participants were senior students of their university programs in this study, they might not give adequate time, attention and focus for the intervention. As preservice teachers might not have reached all the intervention objectives as intended, they might not have shown these skills in practice. Their self-efficacy beliefs were also affected from this process. In one study, it was suggested that developing teachers PSRL skills should be an educational issue instead of teachers' instincts or some knowledge and skills they learn in a limited time (Saraç & Tarhan, 2020). When participants were interviewed, they made explanations about the potential reasons of these findings. In what follows, these explanations are discussed in more detail.

As it is stated before, qualitative data can help to understand and interpret the above-mentioned results, by drawing some connections with the quantitative results. Participants mentioned various factors that might help explain why intervention did not produce the expected change. First of all, participants often mentioned the shortness of the intervention process. They stated that the concept of PSRL and its applications required both knowledge and practice as they were education related issues. Even if they received a certain training, it was not possible to show the effects of this in such a short time, the development of PSRL skills required a long process. They suggested that the intervention process should be spread over a year. Change in the SE-PSRL and PSRL scores of the pre-service teachers might not have taken place as expected due to the shortness of the process. Another interpretation of the results could be thought that since the preservice teachers in the experimental group started to learn PSRL concepts in more detail, they realized the complexity and difficulty of the PSRL implementation and scored their SE-PSRL and PSRL lower. Participants in the control group, on the other hand, might have answered the questionnaires without having as detailed information and evaluation as the participants in the experimental group, and therefore they may show higher scores. These comments were extracted from the interview data. In particular, experimental group participants stated that initially they had high self-efficacy beliefs, but their scores decreased as they became more aware of the concepts. In addition to these explanations, a participant from the control group also stated that he thought he had applied PSRL when he did any constructivist teaching practice, as he associated the concept of SRL with the constructivist teaching style. As pre-service teachers had such

uncertainties, their assessments may have been influenced by their personal perceptions, the intensity of their experience with PSRL and desirability for applying PSRL. Since PSRL measurement was based on pre-service teachers' self-reports in this study, the extent to which it reflects their actual performance rather than their perceptions can always be questioned. Indeed, in some studies, it has been suggested to measure PSRL variable with the observer data, systematic observation and think aloud protocols as well as just relying on participants' self-reports (Dignath, 2018; Veenmann, 2005). The measurement method of PSRL variable constituted a limitation for the findings of this study, which will be discussed in a following section.

Some of the findings in this study were also compatible with what was reported in the related literature. Firstly, Little (2002) argued as a result of her study that it was difficult to develop preservice teachers' SRL through an intervention program. Preservice teachers participating in the study also emphasized that it was not easy trying to develop SRL skills during the intervention process and trying to apply these skills in the classroom. There are also studies which have revealed that teachers tend to focus more on teaching subject knowledge rather than teaching and practicing self-regulation skills in the classroom (De Kock, Sleegers & Voeten, 2005). Similarly, pre-service teachers who participated in the study stated that they spent most of their time completing lesson plans rather than teaching SRL applications. One of the most mentioned codes from the transcriptions was "*not taking the risk for applying PSRL"*. Pre-service mathematics teachers in the experimental group often indicated that they could not take risks to apply PSRL in their internship teaching practice. This may be an explanation of why research findings differed from the hypotheses. Another code obtained from qualitative data, referring to what might have restricted PSRL application was "classroom sizes". In a study with preschool teachers, it was revealed that classroom sizes affected teachers' PSRL strategies. Teachers find it difficult to implement PSRL in their classrooms when the classroom is crowded, and they tend to use more teacher-centered strategies rather than constructivist teaching strategies (Almulla, 2015; Blatchford, 2005). As teachers' PSRL strategies were more dependent on using constructivist teaching strategies, crowded classrooms limited teachers' effective use of PSRL (Saraç & Tarhan, 2020).

The results of the second phase of the study showed that there was a significant difference between groups on the PSRL scores of inservice teachers for follow-up measurement. These results met the first hypothesis of the follow-up phase. However, PSRL scores of the control group were higher than those of the experimental group. In this respect, the results were similar to the scores in the first phase of the study and contradicted with the expectation that the experimental group would have higher PSRL scores than control group. When the PSRL scores of inservice teachers were analyzed between the groups at two different time points -Time 4 and Time follow-up-, it was seen that *"group"* and *"time"* did not have a significant interaction effect on the PSRL scores of inservice teachers. Thereupon, these variables were examined separately, and it was found that the group variable had a main effect on the PSRL scores of inservice teachers, but the time variable did not have a main effect on the PSRL scores of inservice teachers. These findings showed that the PSRL scores of inservice teachers differed in groups in each measurement without considering the time variable, but inservice teachers did not differ in terms of time without considering the group variable. It was also observed that the PSRL scores of the experimental group increased; the scores of the control group decreased gradually, but again, it was observed that the PSRL scores in the control group were always higher than the PSRL scores in the experimental group.

No such follow-up study has been conducted in the field regarding teachers' PSRL applications. However, since there was no change in PSRL assessments between the groups (Experimental group always had lower PSRL scores), it was observed that the effects of the intervention process continued after two years. For these evaluations, some explanations made for the first phase of the study could be made at this stage as well. In other words, inservice teachers in the experimental group participants might have filled the PSRL scale more consciously and with more knowledge compared to the participants in the control group because they were still under the influence of the intervention. As a result, this might have caused their lower PSRL scores compared to the scores of the control group.

5.2. Implications

The findings of the present study have important implications for the field of education. In recent years, researchers have especially emphasized the necessity of SRL

skills and their positive effects on one's life (Taranto & Buchanan, 2020). This study addressed a current and important research topic in the field of education as it examines SRL concepts and students' SRL development through teachers' classroom practices. While aiming to improve students' SRL, prospective and inservice mathematics teachers' beliefs about SRL and classroom practices of PSRL were also investigated.

As this study examined the promotion of SRL with real stakeholders -teachers, students, and preservice teachers- and in ecologically valid environments, the holistic nature of the study and the accompanying findings can inform researchers who are interested in investigating the development of this concept from all sides. This study was conducted under an intervention program and revealed some important effects of the intervention on the participants. There were previous intervention studies related to the concept of SRL in the literature. These studies mainly focused on preschool teachers' SE-PSRL and PSRL, secondary school students' knowledge of SRL strategies and their use of SRL strategies, and pre-service teachers' self-efficacy beliefs regarding SRL and learning styles (Ganda & Boruchovitch, 2018; González-Pienda *et al.*, 2014; Venitz & Perels, 2019). However, this study filled the gap by examining the preservice teachers' SE-PSRL and PSRL with its multiple measurement points, time span design and considering the dynamic nature of these variables. In addition to these, Ganda and Boruchovitch (2018) suggested that the intervention process should be analyzed qualitatively instead of focusing only on quantitative results in order to better understand the effects of the intervention program. This study is also important in terms of examining the intervention process with both quantitative and qualitative data analysis and the findings revealed that the qualitative data was key in making sense of the quantitative data more accurately. Although the research hypotheses were not fully met, the reasons for these results were discussed in more detail in light of the qualitative data. These results are valuable for the literature and can be a guide for researchers, teachers, and curriculum developers interested in supporting teachers' development in terms of particular dimensions of establishing SRL in mathematics classrooms.

This study also consisted of two different stages, and the effects of the intervention were also examined with a follow-up study whether the participants implemented classroom practices of PSRL plans as they stated in the interviews. This stage of the study is important

for the stability of its influence as it examines the long-term effects of the intervention process.

5.3. Limitations of the Study and Recommendations for Further Studies

Although the present study has some important educational implications, it also has some limitations. First of all, one of the main limitations of the study is the number of participants. There was a limited number of participants for both phases of the study (first phase 44; second phase 30 participants). Since the study included a quantitative research design, these participant numbers were not suitable for generalizing the results to the population of preservice math teachers. Therefore, the number of participants can be increased for supporting the generalizability of the findings in further studies. In addition to the number of participants, the sample is another limitation of the study. The sample consists of teacher candidates who graduated from a state university that chose their students with the highest score in the university entrance exam in this field. Sample selection was also considered as a limitation in some intervention studies in the literature as similar sample selection made generalizing research findings to the general population difficult. In a study whose sample was selected from typical top level students, it was stated that the findings were valid only for this type of students, and it was suggested to select participants from different backgrounds for the sample of the research (Almeida, 1992; Andrzejewski *et al*., 2016). It would be beneficial to conduct similar studies in this field with both larger numbers of participants and the participants with different characteristics in varying educational contexts.

Another limitation of the study is related to the measurement of promotion of self-regulated learning (PSRL) variable. Since this variable was not observed or directly measured in this study, the participants reported their scores themselves. This measurement can be considered as self-report and has various drawbacks. For example, participants may evaluate themselves as demonstrating PSRL strategy even if they actually do not. Therefore, the measurement results may not fully reflect the actual situation. There are some studies in the literature evaluating teachers' PSRL scores through participants' self-reports. One study suggested that think-aloud protocols and systematic observation could be an additional measurement tool to assess teachers' PSRL scores (Veenmann, 2005). Dignath (2018)

asserted that quantitative self-report measurements that deal with the PSRL variable should be supported with an observer data rather than just relying on participants' own reports. For further studies investigating the PSRL variable, appropriate measurement tools that PSRL variable can be observed or directly measured should be chosen. Mixed method studies with strong qualitative aspects should be given more place in the literature.

The last limitation of the study is related to the time factor. Time was one of the main focal points of the research design as this was an intervention study and examined a progression in time. Although the intervention process took 13 weeks, the participants stated that it was not sufficient for them. They stated that the intervention should last at least one year because it was related to education. Little (2002) mentioned the difficulty of implementing PSRL in the intervention studies. Researchers have suggested that teachers gave priority to using general teaching strategies (De Kock, Sleegers, & Voeten, 2005). Since the time is a compelling factor for teachers when applying the PSRL in real classrooms, it should be taken into consideration, and time interval can be extended in future studies.

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APPENDIX A: TEACHER SELF-EFFICACY SCALE TO IMPLEMENT SELF-REGULATED LEARNING (TSES-SRL)

Dear Participants,

The Teacher Self-Efficacy Scale to Implement Self-Regulated Learning (TSES-SRL) was developed by De Smul *et al.* (2018) for assessing teachers' perceptional views about their ability of implementing SRL. In this study, it is used for measuring preservice mathematics teachers' self-efficacy beliefs on promotion of self-regulation (SE-PSRL).

In this instrument, you are supposed to respond the 21 items on a five-point Likert-scale with 1 representing "cannot do at all", 2 representing "can do limitedly", 3 representing "can do moderately" 4 representing "can do certainly", 5 representing "highly certain can do".

Personal Information

Name / Surname:

Gender:

Age:

TSES-SRL

Please respond to each of the following items by placing a check mark (√) in the blank where indicated.

* TSES-SRL, is abbreviation of Teacher Self-Efficacy Scale To Implement Self-Regulated Learning

	Items of the TSES-SRL with instructions	Cannot do at all	Can do limitedly	Can do moderately	Can do certainly	Highly certain can do
1	How well can you demonstrate self-regulated learning strategies (i.e., without for example explicitly					

	explaining the how and the why of the strategy)?					
2	How well can you express your thought process aloud when demonstrating self-regulated learning strategies?					
3	How well can you encourage your students to use self-regulated learning strategies (for instance by asking open-ended questions)?					
4	How well can you teach your students which self-regulated learning strategies exist?					
5	How well can you inform your students about the importance and usefulness of self-regulated learning strategies?					
6	How well can you teach your students how to use and apply different self-regulated learning strategies?					
7	How well can you teach your students when and in what situations they can use and apply self-regulated learning strategies?					
8	How well can you make decisions with your students about what they learn?					
9	How well can you allow your students to make their own choices about the goals and expectations they set for themselves?					
10	How well can you make decisions with your students about with whom they learn?					
11	How well can you make decisions with your students about where they learn?					

12	How well can you make decisions with your students about when they learn?					
13	How well can you provide your students just enough support so they can work independently?					
14	How well can you challenge your students to achieve more than they initially thought (e.g., by determining with what additional help they can solve an exercise)?					
15	How well can you adapt tasks and learning content so that they are sufficiently challenging for individual students?					
16	How well can you present challenging exercises that can be solved in different ways?					
17	How well can you apply new learning content in a meaningful, authentic context?					
18	How well can you present new learning content in different contexts, so students can look at it from different angles?					
19	How well can you let your students evaluate their own tasks?					
20	How well can you let your students reflect on their own learning process?					
21	How well can you let your students give feedback on the work of others?					

APPENDIX B: SELF-REGULATED LEARNING INVENTORY FOR TEACHERS (SRLIT)

Dear Participants,

The Self-Regulated Learning Inventory for Teachers (SRLIT) was developed by Lombaerts *et al.* (2007) and is used for measuring preservice teachers' promotion of self-regulation (PSRL).

In this instrument, you are supposed to respond the 18 items on a five-point Likert-scale with 0 representing "never", 1 representing "rarely", 2 representing "sometimes" 3 representing "regularly", 4 representing "always".

Personal Information

Name / Surname:
Gender:
Age:

SRLIT

Please respond to each of the following items by placing a check mark (√) in the blank where indicated.

* SRLIT, is abbreviation of Self-Regulated Learning Inventory for Teachers

	Items of the SRLIT with instructions	Never 0	Rarely 1	Sometimes 2	Regularly 3	Always 4
1	I link what students want to learn to what is programmed in our learning plan.					

2	I tell my students to ask questions in order to find answers to task problems.					
3	Students introduce learning subjects during my lessons.					
4	Students come up with concrete examples or applications for specific sections of subjects.					
5	Students make decisions about which information to use during tasks.					
6	My students work on tasks that require them to plan their work themselves in a set time frame.					
7	Some tasks have to be carried out independently by my students.					
8	Students determine the order in which they complete their tasks.					
9	Students keep track of time when working on a task.					
10	Students decide themselves how long they work on an assignment.					
11	Students can consult a solution overview to evaluate their own work.					
12	I teach my students how to provide feedback to classmates.					
13	I teach my students how to deal with feedback.					
14	Students provide mutual feedback on how they each approached a learning task.					
15	When working in groups, we discuss the individual contribution of everyone.					
16	My students evaluate each others' learning results.					
17	When we review tasks in class, students have to say how they tackled a learning problem.					
18	My students evaluate their own learning performances.					

APPENDIX C: INFORMED CONSENT FORM

Dear participants,

This thesis is carried out by Meryem Cihangir who is a master student in the department of mathematics and science education at Boğaziçi University. The thesis is conducted under the supervision of Assist. Prof Engin Ader.

You are invited to take part in this thesis project entitled *"*An Examination of Preservice Mathematics Teachers' Promotion of Self-Regulation in time: An intervention study*."*

Your decision to take part in this study or not is completely voluntary. If you decide not to take part in this study, it will not affect the care you receive and will not result in any loss of benefits to which you are otherwise entitled.

The purpose of this study is:

- to investigate the difference between the promotion of self-regulation (PSRL) of preservice mathematics teacher who are participating SRL enriched intervention program and the promotion of self-regulation (PSRL) of preservice mathematics teacher who are not participating SRL enriched intervention program.

- to investigate the difference between the self-efficacy for promotion of self-regulation (SE-PSRL) of preservice mathematics teachers who are participating SRL enriched intervention program and the self-efficacy for promotion of self-regulation (SE-PSRL) of preservice mathematics teacher who are not participating SRL enriched intervention program.

- to investigate the interaction between promotion of self-regulation and self-efficacy for promotion of self-regulation for preservice mathematics teachers who are participating SRL enriched intervention program.

The benefits of the research will be:

- to better understand promotion of self-regulation (PSRL) and self-efficacy for promotion of self-regulation (SE-PSRL) concepts in the preservice teacher education context

- to gain better insight about the intervention studies in the SRL context contributed to preservice teachers' professional development.

In the context of this thesis, you are expected to respond to two measurement tools. First measurement tool is "*Teacher Self-Efficacy Scale to Implement Self-Regulated Learning (TSES-SRL)"* The other measurement tool is "*Self-Regulated Learning Inventory for Teachers (SRLIT)"*. Both scales take approximately 20 minutes to fill in. The participants are expected to respond the first scale in five and the second scale in four different time points.

Participating in this study is not expected to have any adverse effect on your physical or mental health. However, in the case of distressing or any emotional discomfort caused by the study, you may refuse to answer any question at any time and may withdraw from the study at any time without penalty.

The information or data which are obtained from this study will be used only for research purposes and your personal information will be kept confidential by the researcher. Approximately 44 people are anticipated to participate this study. Considering the goal of the study, participants are expected to respond all items in an honest and appropriate way and without being under any pressure of suggestion.

Please contact the researcher, *Meryem Cihangir*, if you have any questions about the study or for more information not included here before you consent.

If you sign this form, you do not give up your legal rights and do not release the researchers from their professional responsibilities.

Your signature:

I have read what this study is about and understood the risks and benefits. I have had adequate time to think about this and had the opportunity to ask questions and my questions have been answered.

☐ I agree to participate in the research project understanding the risks and contributions of my participation, that my participation is voluntary, and that I may end my participation at any time.

Signature of participant Date

Researcher's Signature:

I have explained this study to the best of my ability. I invited questions and gave answers. I believe that the participant fully understands what is involved in being in the study, any potential risks of the study and that he or she has freely chosen to be in the study.

Signature of researcher Date

APPENDIX D: INTERVIEW PROTOCOL (TURKISH)

GÖRÜŞME (MÜLAKAT SORULARI)

Görüşme sırasında ses kaydına en başta tarih-saat-yer-araştırma konusu kimle görüşüleceği belirtilerek başlanır.

Kısaltmalar ve Anlamları

SRL: *Self Regulated Learning:Öz Düzenlemeli Öğrenme*

PSRL: Öz Düzenlemeli Öğrenmeyi Destekleyici Sınıf İçi Uygulamalar

1) Kısaca SRL senin için ne ifade ediyor? Tanımlamak istesen nasıl tanımlardın?

2) Eğitimde SRL'nin öneminden bahsediliyor. Bu konuda senin düşüncelerin nelerdir?

3) SRL sence öğrencilerde geliştirilmesi gereken bir yön müdür? Neden? Bunun önemi nedir?

4) Öğrencilerin SRL'sinin geliştirilmesinde öğretmenlerin rolü hakkında ne düşünüyorsun? Bir öğretmen ne kadar ilerletebilir, yoksa daha çok kişisel çaba ile ilgili bir şey midir?

5) Kendi ders anlatımlarını düşündüğünde bunu SRL'yi uygulayacağına dair öz yeterlilik inançlarının sende etkisi olduğunu düşünüyor musun?

6) Anketteki maddeler düşünüldüğünde, her maddenin SRL açısından uygulanabilir olduğunu düşünüyor musun? Neden, varsa hatırladığın örnekleri sayabilir misin?

-SRLIT anketinde uygulanan maddelerin hiyerarşik bir yapıda olduğunu düşünüyor musun? Neden?

-Ders anlatımlarında PSRL'yi uygulamaya çalıştın mı? Evetse neler yaptın? Bu konuda zorlandığını düşünüyor musun? En çok zorlandığın yerler nelerdi? En güçlü olduğun yerler nelerdi?

7) Araştırma sürecinde aldığın intervention sonrasında öğretmenlerin SRL uygulamaları (PSRL) hakkındaki düşüncelerinde değişmeler oldu mu?

-Cevabın evetse ne tür farkındalıklar yarattı? Öncesinde, süreçte ve sonrasında inanışlarında neler değişti?

-Hayırsa neden yaratmadığını düşünüyorsun?

-SRL'yi uygulama konusundaki inançların genel olarak sabit miydi, yoksa daha değişken bir yapıda mıydı?

-İleride öğretmen olduğunu düşünelim. Sınıfındaki öğrencilerinin SRL ini geliştirmek için PSRL yi uygulayıp uygulamayacağına dair inancın ne yönde? Uygulayabileceğini düşünüyor musun? Neden?

Neler yapardın, örnekleyebilir misin?

8) Branşına yönelik özellikle Matematik olduğu için PSRL uygulamanın zor olduğunu düşündün mü? Neden?
9) Eklemek istediğin herhangi bir şey ya da önerin var mı?

APPENDIX E: INTERVIEW PROTOCOL (ENGLISH)

Common Questions Asked to the Participants	• In short, what does SRL mean for you? If needed, how would you define it? • The importance of SRL in education is emphasized. What are your thoughts about this? • Do you think SRL is an aspect that should be developed in students? Why? What is the significance of this? • What do you think about the role of teachers in developing students' SRL? How far can a teacher support their students about this, or is it a matter of individual effort? • Do you think that your self-efficacy beliefs have an impact on your PSRL when you think about your own teaching? • Considering the items in the questionnaire, do you think each item is applicable in terms of SRL? Why? Can you explain with examples? • Are there any changes in your thoughts on teachers' PSRL practices after the training you received during the study? • Do you think applying PSRL depends on the teachers' subject, e.g. yours being mathematics? Why?
Questions That Emerged During the Interviews	• Do you think that the items applied in the SRLIT questionnaire are in a hierarchical structure? Why? • Have you tried to implement PSRL in your teaching? If yes, what did you do? Do you think you had difficulties with this? Where did you have the most difficulty? Where were you strongest? • Is there any changes in your opinions about teachers' promotion of SRL practices (PSRL) after the training you received during the study? If yes, what kind of awareness did it create? What changed in your beliefs before, during and after? If not, why do you think you didn't? • Were your beliefs about applying the SRL generally stable or more varying? • Let's say you work as a teacher in the future. What is your belief about whether you will be able to apply PSRL to improve SRL of students in your class or not? Do you think you can apply it? Why? • What would you do for PSRL, can you give an example?

APPENDIX F: BOĞAZİÇİ UNIVERSITY SCIENCE AND ENGINEERING FIELDS HUMAN RESEARCH ETHICS COMMITTEE (FMINAREK) CONSENT FORM

Evrak Tarih ve Sayısı: 11.10.2021-33337

T.C.
BOĞAZİÇİ ÜNİVERSİTESİ REKTÖRLÜĞÜ
Fen Bilimleri ve Mühendislik Alanları İnsan Araştırmaları Etik Kurulu
(FMİNAREK)

Sayı : E-84391427-050.01.04-33337 11.10.2021
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Sayın Doç. Dr. Nizamettin Engin ADER
Matematik ve Fen Bilimleri Eğitimi Bölüm Başkanlığı - Öğretim Üyesi

"Preservice Mathematics Teachers' Promotion of Self-Regulation in Time" başlıklı projeniz ile Boğaziçi Üniversitesi Fen Bilimleri ve Mühendislik Alanları İnsan Araştırmaları Etik Kurulu (FMİNAREK)'e yaptığınız 2021/19 kayıt numaralı başvuru 04.10.2021 tarihli ve 2021/08 No.lu kurul toplantısında incelenerek etik onay verilmesi uygun bulunmuştur. Bu karar tüm üyelerin toplantıya on-line olarak katılımıyla ve oybirliği ile alınmıştır. COVID-19 önlemleri nedeniyle üyelerden ıslak imza alınamadığından bu onam mektubu tüm üyeler adına Komisyon Başkanı tarafından e-imzalanmıştır.

Saygılarımızla bilginize sunarız.

Prof. Dr. Tınaz EKİM AŞICI
Başkan

Bu belge, güvenli elektronik İmza ile imzalanmıştır.
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