www.ijres.net

Preservice Mathematics Teachers' Promotion of Self-Regulation (PSRL) in Time: A Mixed Methods Study

Meryem Cihangir
Ministry of National Education, Turkey

Engin Ader
Boğaziçi University, Turkey

To cite this article:

Cihangir, M. & Ader, E. (2024). Preservice mathematics teachers' Promotion of Self-Regulation (PSRL) in time: A mixed methods study. *International Journal of Research in Education and Science (IJRES), 10*(2), 354-376. https://doi.org/10.46328/ijres.3373

IJRES International Journal of Research in Education and Science
2024, Vol. 10, No. 2, 354-376 https://doi.org/10.46328/ijres.3373

Preservice Mathematics Teachers' Promotion of Self-Regulation (PSRL) in Time: A Mixed Methods Study

Meryem Cihangir, Engin Ader

Article Info

Article History

Received:
05 December 2023
Accepted:
28 March 2024

Keywords

Self-regulated learning
Promotion of self-regulated learning
Teacher training

Abstract

This mixed methods study was conducted to investigate mathematics preservice teachers' (PTs) promotion of self-regulated learning (PSRL) with respect to time through participation in a self-regulated learning (SRL) enriched seminar course. PTs' self-efficacy beliefs for promotion of self-regulation (SE-PSRL) over time was also investigated. Forty-four PTs participated in the study. They were divided into two sections and the SRL enriched seminar course was implemented with the experimental group for one academic term. The control group followed a parallel course without a particular focus on SRL. Participants were administered two different scales that measured their SE-PSRL and PSRL four times during the semester. Qualitative data were also gathered through semi-structured interviews with 9 participants. Mixed design analysis of variance (ANOVA) were conducted separately for SE-PSRL and PSRL scores to investigate the differences between the groups with respect to time. Results of the study indicated that while participants' SE-PSRL scores differed statistically ($F(3,126) = 9.13$, $p = .00$, $\eta^2 = 0.18$), PSRL scores did not differ according to time and group ($F(3,126) = 0.20$, $p = .90$, $\eta^2 = 0.01$). The results from the quantitative analyses did not exactly conform with the hypotheses and interview data pointed towards various reasons for such unanticipated findings.

Introduction

As the current educational reforms emphasized the importance of learning to learn, SRL has become one of the most studied topics in the field of education (Dignath et al., 2008; Winne, 2005). Due to the COVID pandemic, schools around the globe had to turn their face to face education system to online education (Zhang et al., 2020). Studies during the pandemic documented that the efficiency of online learning could be maximized by students' SRL processes (Cai et al., 2020). Consequently, the necessity for SRL especially arose during the global pandemic. SRL can be broadly described as one's planned thoughts, behaviors, and actions to accomplish a specific goal (Zimmerman, 2000). While SRL is concerned with one's learning process, it is also investigated within teaching and instruction (Chatzistamatiou et al., 2014; Zimmerman et al., 1996). Promotion of self-regulated learning (PSRL) refers to teachers' instructional strategies that develop their students' SRL skills (Capa-Aydin et al., 2009).

When the roles of teachers on helping students become self-regulated learners are discussed, researchers have mentioned the importance of designing appropriate learning environments. For creating these environments, quasi-experimental designs that evaluate the effectiveness of SRL interventions have been used. In such studies, teachers can use materials that develop their students' SRL skills and they can take professional trainings related to fostering their students' SRL skills (Vosniadou et al., 2024). Although teachers are aware of the importance of SRL and its efficiency in the learning processes, they often state that they do not have a chance to take training on, develop and practice their PSRL skills (Cleary, 2011; Schunk & Zimmerman, 2008). Intervention studies related to students' SRL capabilities showed that students can demonstrate and foster SRL skills, however they did not exactly reveal why teachers did not use SRL related strategies in their instruction and teaching. Studies have shown that professional development programs for teachers and preservice teachers are found to be effective on fostering students' development of SRL (Vosniadou et al., 2024). Therefore, there is a need for professional support for teachers to motivate and help their students to use SRL strategies. This study mainly investigates the effectiveness of a self-regulated learning enriched seminar course on preservice mathematics teachers' PSRL. Teachers' self-efficacy beliefs for promotion of SRL (SE-PSRL) was also investigated as a key determinant of such practice with its potential fluctuations during the course of an intervention (Dignath, 2021; Schunk & Zimmerman, 2008).

Literature Review

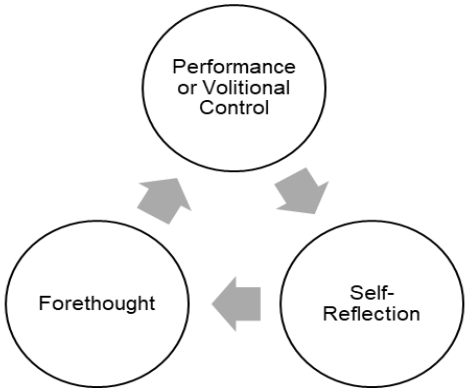
Self-regulation and SRL

Humans have the capacity to adapt and regulate their actions to survive in necessary situations. Each person develops a different sense of self and has different regulatory capacities. One's self-regulatory processes are affected by metacognitive, cognitive, and motivational factors. As these factors are continuously changing, in the self-regulation process, one needs to observe, monitor, and arrange one's own performance consistently. This process takes place in self-oriented feedback loops and therefore, the progression of self-regulation is assumed to be cyclical (Zimmerman, 2000).

While self-regulation is a broad term, SRL is mainly related to educational goals (Panadero, 2017). Similar to self-regulation, it is contended that the structure of SRL should be considered in a holistic yet multicomponent way. Researchers investigate its structure and the importance of SRL in educational settings. Although various SRL models have been developed over the years (see Panadero 2017 for a review), Zimmerman's Social Cognitive Model of SRL is widely used in educational studies due to its applicability in classroom settings. In this study, his Cyclical Phases Model of SRL was used. This model (See Fig. 1) shows all the components and subcomponents together and explains the interaction between each component (Zimmerman, 2000).

Cyclical Phases Model of SRL constitutes a useful lens for putting the construct into practice since the developed himself adapted these ideas to classroom practice (see Zimmerman et al., 1996 for a detailed discussion). His model conceptualized SRL in three phases in a cyclical structure. Forethought, first of the three phases, consists of task analysis and self-motivation beliefs that are mutually connected and inform one another. The second phase, performance/volitional control, has often been described as monitoring and control (Ader, 2019). The third phase,

self-reflection, is the final one but it is in a cyclical connection with the other phases and similar future tasks.



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

Figure 1. Cyclical Phases Model of SRL (Zimmerman, 2000)

Teachers' PSRL

Teachers can play a crucial role in enhancing their students' SRL (Karlen et al., 2023). They can enhance students' SRL by teaching self-regulation strategies to them and structuring the classroom environment by using constructivist educational strategies (Dignath-van Ewijk, 2016; Dignath & Veenman, 2021). Various studies discussed that teachers did not allocate enough time to promote their students' SRL and were more inclined to develop their students' content knowledge (e.g., De Kock et al., 2005), while others revealed that although teachers believe that they need to develop their students' SRL, they do not always know how to do it (e.g., Perry et al., 2008).

There have been various interventions in the past for supporting PSRL of teachers from varying disciplines and different stages in their careers (see Kramarski & Heaysman, 2021 for an extensive review). Butler et al. (2013) conducted a professional development program with secondary school teachers and through their instructional efforts on reading, they reported positive effects on teachers' PSRL and students' SRL. A key issue put forward by Butler et al. (2013) was the positive perceptions of the teachers about the program, which contributed to reaching some of their targets. Other researchers (e.g., Desimone 2009; Kramarski & Heaysman, 2021) also highlighted the importance of teachers' positive perceptions about the importance of the content and how the intervention program contributes to their development in a coherent way, as key precursors of success for professional development programs.

With a school-wide approach, Heirweg et al. (2022) documented that teachers had improvements in their PSRL but these improvements were found to be unrelated to student outcomes. Their study was generic, not connected to specific content, while targeting PSRL. Kramarski and Michalsky (2010) also conducted a study where they targeted developing in-service mathematics teachers' PSRL. Through document analysis and observations, they found that teachers in the experimental group had improvements in their PSRL compared to the control group. These studies highlighted that efforts to develop teachers' PSRL can yield positive results. While there are growing efforts for supporting teachers' PSRL, to our knowledge there is a lack of studies in the literature for supporting preservice teachers' PSRL. The current study is aiming to fill this gap.

There are also claims that teachers should be proficient in SRL themselves as well as learning how to teach self-regulation skills and practices effectively (Bolhuis & Voeten, 2001; Dignath & Büttner, 2018). This dual role of teachers, as performers and agents of SRL is attracting growing interest (Karlen et al., 2023; Kramarski & Heaysman, 2021). Indeed, teachers' own self-regulation and using different strategies to increase their SRL efficiency is found to accompany their PSRL (Andreassen & Braten, 2011; Dignath & Büttner, 2008). In the meantime, as well as teachers' own SRL, their knowledge about SRL, self-efficacy for SRL and value beliefs regarding SRL are being investigated as key competencies in relation with their PSRL (Karlen et al., 2023). Yet, there is still need for evidence about how these two roles are intertwined. Among various constructs, teachers' self-efficacy for PSRL is often found to be in a strong positive relationship with PSRL (De Smul et al., 2018; Dignath, 2021). While this study is aiming to investigate whether a training tailored towards developing PTs' PSRL can indeed reach that purpose, an exploration of the complex relationships between teacher competencies and PSRL is beyond its scope. The only related variable that is included is SE-PSRL since it has been reported to have the strongest relationship with PSRL and it is directly about PSRL rather than teachers' own SRL practice, knowledge or beliefs.

Self-Efficacy Beliefs as a Motivational Determinant of Teachers' PSRL

Self-efficacy beliefs refer to one's beliefs about his or her capacity to perform a specific goal. According to Bandura (1986), people with high self-efficacy beliefs can perform better in difficult tasks. Self-efficacy beliefs are also found to be an influencing factor in different SRL models. Several studies showed that teachers with high self-efficacy beliefs in teaching are more inclined to use effective teaching strategies to develop their students' learning (Bandura, 1993; Schunk & Ertmer, 2000; Zimmerman, 2000).

Researchers conceptualize and investigate people's self-efficacy regarding a particular construct (e.g. self-efficacy for PSRL) separately from their general self-efficacy. In the last decade this has also been the case for PSRL (Chatzistamatiou et al., 2014, De Smul et al., 2018). Self-efficacy beliefs for PSRL is found to be one of the important factors for teachers' PSRL (De Smul et al., 2019; Dignath-Van Ewijk, 2016). In this study, self-efficacy concept is conceptualised as preservice mathematics teachers' self-efficacy beliefs on supporting students' self-regulation skills. This is different from and should not be confused with the self-efficacy construct within the components of SRL targeted for development in students.

In the related literature, self-efficacy beliefs were often measured once and considered as a rather stable construct. However, self-efficacy beliefs can be considered as a key motivational aspect of SRL that operate in a dynamic fashion and recently suggestions have been made towards investigating self-efficacy as continuously evolving (Bernacki et al., 2015, p. 100). Bernacki et al. (2015) asserted that in SRL processes, one's motivation affects his or her behaviors and motivation can be informed by previous behaviors. Therefore, motivational factors, particularly self-efficacy beliefs can change during one's learning processes. In this respect, SE-PSRL was investigated as a dynamic variable in this study, measured at different time points due to its evolving nature.

Significance of the Study

As highlighted in previous studies, PTs should have the skills to support their students' SRL development. PTs need professional support for enhancing their actual practice and self-efficacy for PSRL in their teacher education curriculum. A review of related literature showed that even though there are various intervention studies conducted with teachers, there is a need for investigating whether efforts to support preservice teachers' development during their teacher training would yield the desired outcome. This study is significant as it examines the effectiveness of an SRL enriched seminar course with respect to time on preservice mathematics teachers' PSRL and SE-PSRL. Another key significance of the study is investigating SE-PSRL as a dynamic variable that has the potential to change as PTs progress in the program.

Research Questions

The research questions of the study are as follows:

1. Is there a significant difference between the mean scores of SE-PSRL of preservice mathematics teachers with respect to participation in an SRL enriched intervention program and time?
2. Is there a significant difference between the mean scores of PSRL of preservice mathematics teachers with respect to participation in an SRL enriched intervention program and time?

3.a What are the thoughts of preservice mathematics teachers participating in the study on SRL, PSRL and SE-PSRL?

3.b What are the participating preservice mathematics teachers' perceptions on how the program influenced their PSRL and SE-PSRL?

Method

Research Design

In this study, we adopted an explanatory sequential mixed methods design. Quantitative part of the study had a quasi-experimental design. Two different scales were used repeatedly to measure preservice mathematics teachers' PSRL and SE-PSRL at four different time points. Qualitative part was a case study and follow-up interviews were made with nine strategically selected participants for making sense of the findings from the quantitative part. Explanatory mixed methods design is often preferred when there are stronger leanings on the quantitative data collection but qualitative data is collected to interpret the findings from the quantitative data

especially the unexpected ones (Creswell, 2009, p. 211).

Participants

As participants of this study, preservice mathematics teachers who were final year undergraduate students in 2018-2019 academic year at a public university in İstanbul were selected. A majority of the participants graduated from their programs at the end of that semester. 44 PTs (36 female and 8 male; ages: M = 23.45 years and SD = 0.67 years) participated in the study and they were divided into two sections according to their choice for instructor of the course. The experimental group consisted of 21 PTs who were taking the SRL enriched seminar course offered by the second author and the control group consisted of 23 PTs who were enrolled in the seminar course without any particular focus on SRL content. An a priori power analysis was conducted using G*Power 3 (Faul et al., 2007) for sample size estimation. With a significance threshold of alpha = .05 and Power = .80, minimum sample size required for a medium effect size for the statistical analyses involved in this study was calculated as 24. Thus, the sample size obtained for our study was adequate.

As a potential compounding variable, GPA scores were investigated. GPA scores of the participants in the experimental group (M = 2.80, SD = 0.30) were compared with the GPA scores of the participants in the control group (M = 2.77, SD = 0.27) and there was not a significant difference, $t(42) = 0.32$, $p = .38$, enabling the ruling out of GPA acting as a confounding variable.

The Intervention: SRL Enriched Seminar Course

SRL Enrichment was integrated into the Seminar on Practice Teaching in Mathematics course. Two different instructors gave the two sections of the course based on a common schedule and similar instructional approach. The instructors had similar teaching approaches in general and their course evaluations by students in the previous years were very close to each other. The participants were given the option to choose their section, as a departmental policy of equal opportunities. However, this constituted a threat to validity in case there were confounding variables beyond those that were checked (no group differences in GPA) and discussed why they were not considered as major issues (instructors similar in teaching approach and past evaluations).

The second author as the instructor of one section prepared the course syllabus with complementary SRL content, which was the main difference between the two sections. The program lasted 13 weeks, 2 hours per week (See Table 1 for an overview of the weekly schedule). At the onset of the program, brief information about the study was shared with the participants and their consents were obtained. In the first 3 weeks, SRL theory and basic concepts were introduced, and selected cases from the book *Developing Self-Regulated Learners* (Zimmerman et al., 1996) were discussed. Strategies for PSRL were also introduced. The items from the instrument that was used in the study for measuring PSRL were also discussed so that they could be used as a context for discussing participants' classroom observations and their practice teaching experiences in their practicum schools. Participants were also asked to write learning log entries on PSRL so that they had opportunities to reflect on the development of their PSRL and SE-PSRL. From the third week until the end of the semester, microteaching was

done in class. Discussions about PSRL were conducted in the context of participants' practice teaching and microteaching experiences. Throughout the program participants were invited to discuss various components and strategies of PSRL in connection to their own experiences and with concrete contextual examples (see Cihangir, 2021 for a more detailed discussion of the activities in the course).

Table 1. Weekly Content of the SRL Enriched Seminar Course

Week	Course Activities
1st Week	General Information about the course and the research process
2nd Week	Completion of the informed consent forms
	Discussion of SRL through the reading assignment
3rd Week	Discussion of SRL through the reading assignment
	Discussion of PSRL through SRLIT items
	Microteaching
4th Week	Microteaching
	Analysis of microteaching sessions & teaching practices according to PSRL
5th - 12th Weeks	Microteaching
	Analysis of microteaching sessions & teaching practices according to PSRL
	Discussion of course assignments on PSRL
13th Week	Discussion of course assignments on PSRL

Instruments

Teacher Self-Efficacy Scale to Implement Self-Regulated Learning (TSES-SRL) which was developed by De Smul et al. (2018) was used for assessing PTs' SE-PSRL. It consisted of 21 items on a five-point Likert scale and had a four-factor structure. These factors were teacher self-efficacy for direct instruction, teacher self-efficacy for providing choices (indirect instruction), teacher self-efficacy for providing challenges and complex tasks (indirect instruction), and teacher self-efficacy for building in evaluation (indirect instruction). A sample item from the TSES-SRL scale is: *"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)?"* Participants were asked to respond to all items with 1-5 points according to their perceptions of their SE-PSRL. Possible scores for the scale ranged between a minimum score of 21 and a maximum score of 105. Evidence for validity and reliability for the instrument was previously reported (De Smul et al., 2018). The internal consistency of all factors, using Cronbach's α coefficients were calculated for the TSES-SRL scale for four measurement points. The four factors had average α values of .83, .83, .83 and .79 respectively. The whole scale had an average α internal consistency value of .74. These α values pointed to an acceptable internal consistency for the data collected for this study.

Self-Regulated Learning Inventory for Teachers (SRLIT), which was developed by Lombaerts et al. (2007), was used for assessing PTs' instructional strategies for developing SRL of their students. It consisted of 23 items on a five-point Likert scale and had three factors. These factors were forethought, performance and volitional control, and self-reflection (Lombaerts et al., 2007). A sample item from the SRLIT scale is *"Students provide mutual*

feedback on how they each approached a learning task." Participants were asked to respond to the items according to their perceptions about how often they conducted particular activities or worked towards creating a particular classroom environment supporting PSRL in their practice teaching. Their responses were on a five-point Likert-scale ranging between 0 corresponding to *never* and 4 corresponding to *always*.

For this study, 2 items from the forethought phase, 2 items from the performance and volitional control phase and 1 item from the self-reflection phase were removed from the SRLIT scale. These items were not suitable for evaluating PSRL in the context of this study as they related to statements which required teaching moves extending beyond single lessons and inappropriate for use with PTs conducting practice teaching only for 40-minute periods in classrooms (e.g., *"Pupils receive tasks they can work on for several lesson periods*").

In addition, some items were adapted to the context of the current study in middle schools by receiving expert opinion since the original scale was prepared for primary school contexts (e.g., changing the expressions *pupils* with *students*). In the version that was used in the study, there were 18 items. The scores PTs could get ranged between a possible minimum score 0 and a maximum score of 72. Evidence for validity and reliability were reported for the original SRLIT instrument (Lombaerts et at., 2009). The internal consistency of all factors, using Cronbach's α coefficients were calculated for the 18 item SRLIT scale for four measurement points. The three factors had average α values of .71, .79 and, .86 respectively. The whole scale had an average α internal consistency value of .90. These α values pointed to an acceptable internal consistency for the version of SRLIT used.

Apart from the measurement tools for the quantitative data collection, we also aimed to examine how PTs' SE-PSRL and PSRL changed over the intervention process, and what their feelings, thoughts, and actions were towards SE-PSRL and PSRL. For addressing this aim, semi-structured interviews were conducted with selected participants. 8 questions with some follow up questions were used (See Appendix A).

Procedure

Quantitative data were mostly collected during the intervention process. During the course, students had to perform four different practice teachings in their practicum schools. TSES-SRL scale was administered to each participant four times, just before their practice teachings. After the participants performed each of their practice teachings, they were asked to fill in SRLIT. Thus, all participants were administered these scales four times, with respect to the same sequential protocol but at different times according to the dates of their practice teaching.

Semi-structured interviews were conducted with nine participants after the TSES-SRL and SRLIT measurements. The selection of these nine participants was done according to their SE-PSRL and PSRL results. Participants with varying patterns of scores were selected in order to understand their experiences since their scores pointed to potentially different impact of the intervention program for these participants. The interviews lasted approximately 20-30 minutes and they were conducted face to face individually.

Data Analysis

While analyzing the quantitative data, statistical significance tests were conducted. Mixed ANOVA tests were conducted separately for analyzing the difference between SE-PSRL and PSRL scores of PTs in experimental and control groups over time. When analyzing the qualitative data of nine participants, firstly semi-structured interviews were transcribed. Then, these transcriptions were searched for meaningful parts which were labeled as *codes*. Codes were grouped into general titles which were named as *categories*. Lastly, categories were grouped into the most general titles which were named as *themes*. This was conducted as content analysis (Merriam & Grenier, 2019). All the codes, categories and themes provided a meaningful picture of the effects of the intervention program on preservice mathematics teachers' perceptions about SE-PSRL and PSRL.

Ethical Considerations

In this study, ethical approval was obtained from the Ethics Committee of the university with which the researchers are affiliated (Document No:2021/19) (See Appendix B). Participants were given informed consent forms about the research process, procedures, and their rights for withdrawal from the study at any time. 44 participants volunteered to take part in the study by giving their written consent. All names used while reporting the qualitative findings are pseudonyms.

Results

Comparison of SE-PSRL Scores of Groups in Time

The first aim of this study was to explore whether there was a significant difference between the experimental and control groups according to their SE-PSRL in time. Table 2 shows the descriptive statistics for preservice mathematics teachers' SE-PSRL scores. Before Mixed ANOVA was conducted to assess the difference in the SE-PSRL scores between groups in time, all assumptions for Mixed ANOVA were checked and confirmed (Cihangir, 2021).

Table 2. Descriptive Statistics for SE-PSRL Scores for Each Group

	Group	M	SD	N
SE-PSRL Time 1	Experimental Group	72.00	7.26	21
	Control Group	72.52	10.82	23
SE-PSRL Time 2	Experimental Group	69.71	8.02	21
	Control Group	76.13	10.60	23
SE-PSRL Time 3	Experimental Group	67.05	6.77	21
	Control Group	75.70	10.07	23
SE-PSRL Time 4	Experimental Group	64.19	10.31	21
	Control Group	79.39	11.85	23

The results showed that there was a significant interaction between time and group type on preservice mathematics

teachers' SE-PSRL scores ($F(3,126) = 9.13$, $p = .00$, $\eta^2 = 0.18$). This meant that SE-PSRL measurements in two different groups differed statistically. The eta squared value indicated that the effect size of this interaction on SE-PSRL was large. While SE-PSRL scores of the experimental group showed a decreasing pattern, SE-PSRL scores of the control group increased in time (see Fig. 2).

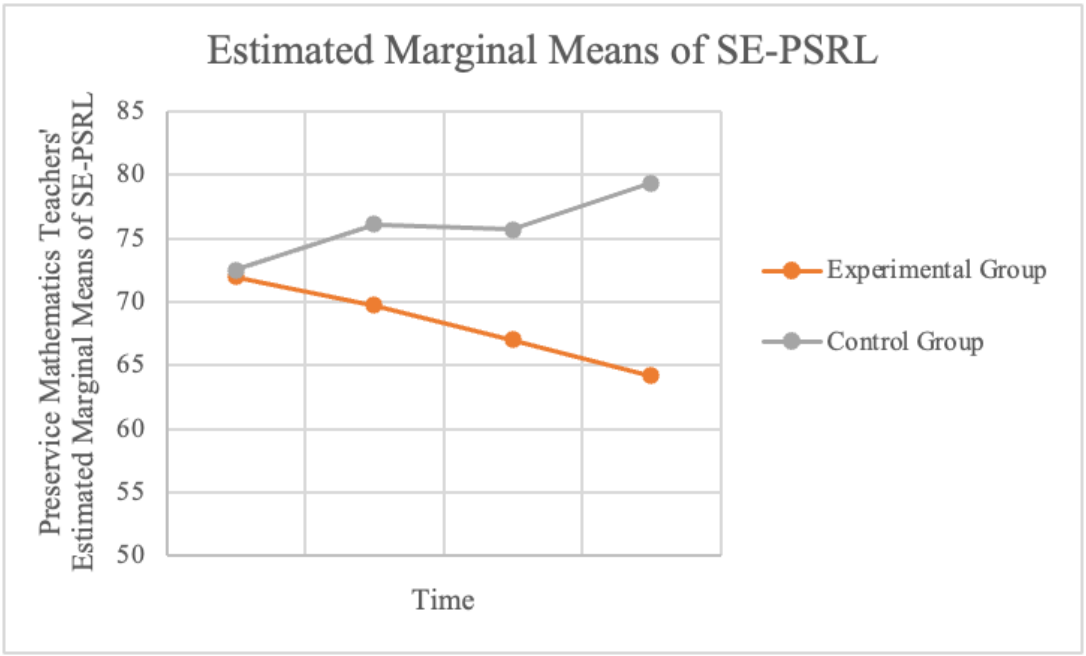


Figure 2. Estimated Marginal Means of SE-PSRL in Time by Groups

Apart from the interaction effect, main effects of each variable were also analyzed. There was a significant main effect of group type on preservice mathematics teachers' SE-PSRL scores ($F(1,42) = 10.73$, $p = .00$, $\eta^2 = 0.20$), with higher scores for the control group compared to the experimental group. The eta squared value for the main effects of group variable indicated that the effect size on SE-PSRL was also large. However, there was not a significant main effect of time points on preservice mathematics teachers' SE-PSRL scores ($F(3,126) = 0.44$, $p = .73$, $\eta^2 = 0.01$).

Comparison of Promotion of PSRL Scores of Groups in Time

Another aim of this study was to explore whether there was a significant difference between the experimental and control groups according to their PSRL in time. Table 3 shows the descriptive statistics for preservice mathematics teachers' PSRL scores. Before Mixed ANOVA was conducted to assess the difference in the PSRL scores between groups in time, all assumptions for Mixed ANOVA were checked and confirmed (Cihangir, 2021).

The results showed that there was not a significant interaction between time and group type on preservice mathematics teachers' PSRL scores ($F(3,126) = 0.91$, $p = .44$, $\eta^2 = 0.02$). This meant that PSRL measurements in the two groups did not differ statistically according to time. The PSRL scores for the control group were consistently greater than the scores for the experimental group and this difference did not change significantly along the intervention (see Fig. 3).

Table 3. Descriptive Statistics for PSRL Scores for Each Group

	Group	M	SD	N
PSRL Time 1	Experimental Group	38.14	10.61	21
	Control Group	47.22	9.28	23
PSRL Time 2	Experimental Group	38.62	9.97	21
	Control Group	44.48	10.28	23
PSRL Time 3	Experimental Group	38.86	8.87	21
	Control Group	45.78	12.34	23
PSRL Time 4	Experimental Group	36.81	10.98	21
	Control Group	47.22	10.01	23

Apart from the interaction effect, main effects of each variable were also analyzed. There was a significant main effect of group type on preservice mathematics teachers' PSRL scores ($F(1,42) = 10.35$, $p = .00$, $\eta^2 = 0.20$). The eta squared value for the main effects of group indicated that the effect size was large. However, there was not a significant main effect of time points on preservice mathematics teachers' PSRL scores ($F(3,126) = 0.20$, $p = .90$, $\eta^2 = 0.01$).

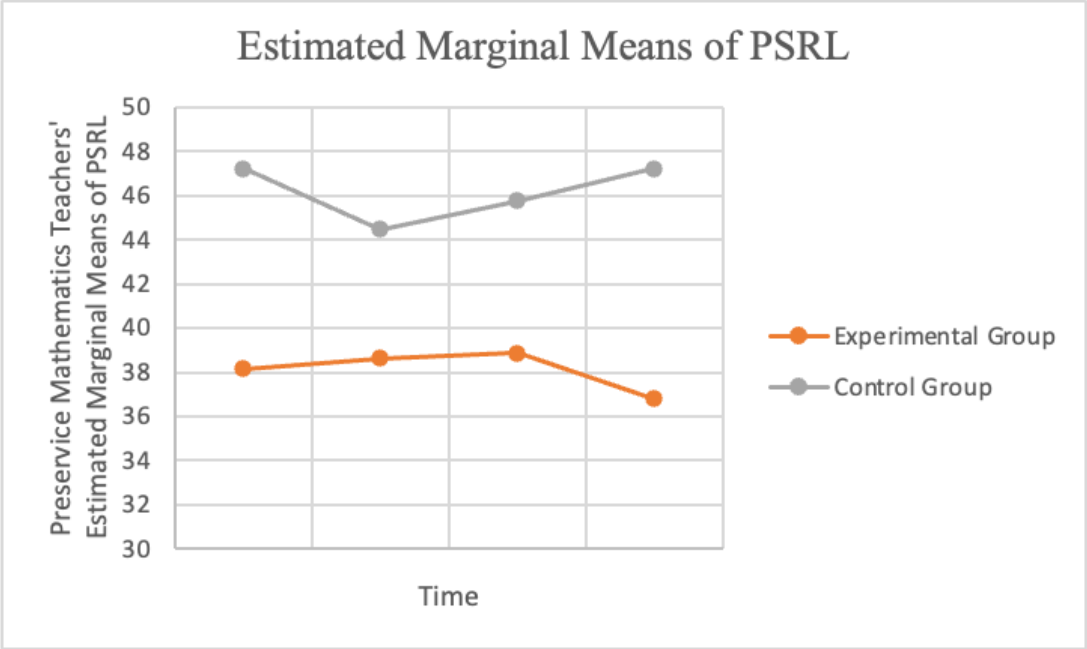


Figure 3. Estimated Marginal Means of PSRL in Time by Groups

Findings from the Semi Structured Interviews

In order to answer the third group of research questions, PTs' thoughts on SRL, PSRL and SE-PSRL and the effects of the intervention program on their perceptions about PSRL and SE-PSRL were analyzed. Upon coding the qualitative data from the interviews, codes and categories grouped under three main themes were obtained (see Table 4). In the following sections, PTs' views are presented with various extracts from the interviews.

Table 4. Codes, Categories and Themes Obtained from Qualitative Analysis

Codes	Categories	Themes
Referring to components of SRL definitions	Preservice teachers' idiosyncratic definitions of SRL	Preservice teachers' expanding thoughts on SRL
Comprehending the SRL concept		
Bringing success in life	Preservice teachers' positive opinions on SRL	
Supporting success		
SRL as a useful concept		
Connectedness with real life		
Teachers as a role model	Factors influencing development of SRL	Preservice teachers' thoughts on PSRL
Taking time in a process		
Dependence on the class related issues		
Dependence on the topic		
Dependence on the school		
Dependence on the students		
Need for taking risks	Limitations on PSRL	
Crowdedness of classrooms		
Time limitations		
Considerations for priorities in teaching		
Giving initiatives to students	Methods of developing teachers' PSRL	
Giving time for students to work independently		
Taking and giving feedback		
Plans for promoting SRL in the future	Effects of the intervention program	Changes in preservice teachers' thoughts during the program
Increasing awareness for promotion of SRL		
Changes in self-efficacy for promotion of SRL		
Changes in perspectives for promotion of SRL		

PTs' Expanding Thoughts on SRL

One of the themes that became evident in the qualitative data was PTs' expanding thoughts on SRL. When PTs were asked about the definition of SRL, they responded by using constructs such as metacognitive learning, active learning, awareness, regulation of learning, control over learning. Only one participant managed to give an inclusive definition of SRL consistent with all the components of Zimmerman's model and another expressed that she could not comprehend the SRL concept properly. Other participants managed to express one or more components of SRL. These findings indicated that PTs displayed some theoretical knowledge on SRL after the intervention process. But, as in the extract below, even when they referred to multiple components within SRL, they could not provide a coherent and connected explanation of various components and their knowledge was still in a process of being organized.

> *Ayşe: (after being asked about what self-regulation is) In fact, 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. Not so sure if this makes sense.*

The other important findings that occurred under this theme was PTs' positive opinions towards SRL concept. All nine PTs had developed some form of positive opinions about SRL and they expressed that SRL was an important process considered within aspects of learning in education. They used expressions such as bringing success in life, being connected to real life and supporting students' success when they mentioned SRL.

PTs' Thoughts on PSRL

Second theme was PTs' thoughts on PSRL and it was composed of three main categories—factors for developing PSRL, limitations on PSRL and methods of developing teachers' PSRL. When PTs were asked about their thoughts on PSRL, all but one expressed that teachers should be a role model for students to develop their SRL skills and emphasized a need for teachers' PSRL skills. The following extract constitutes an example of such a factor influencing students' development of SRL:

> *Elif: Students don't know how to do it….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.*

This was an example of how participants indicated that teachers needed to be a role model for their students to acquire SRL skills. This was also a sign that the intervention program initiated some connections to be drawn between development of SRL and how PTs could construct skills towards PSRL as targeted by the study. Yet, PTs also mentioned some practical issues that the teachers had in integrating SRL into the aims for students. They often indicated that developing students' SRL via teachers' PSRL strategies were possible. However, they also highlighted that it required a cumbersome process and a long time.

Some other factors that PTs mentioned as influencing students' SRL skills via PSRL were classroom sizes and culture (e.g., teachers could enhance students' SRL skills more easily in small-sized classrooms), type of topics that were taught, characteristics of the school (e.g., two participants claimed that private schools pressed for the development of such skills more than state schools in Turkey), and students' interest. However, these codes were not met frequently in participants' responses.

Apart from the factors for developing PSRL, PTs also referred to limitations on applying PSRL. The limitations that PTs mentioned had implications about their SE-PSRL and use of 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 and claimed that it would be a more suitable target when they started the profession in their own classrooms. Some also 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 a key part of their plan.

PTs also discussed the methods of developing PSRL. Five of the participants specifically emphasized the significance of giving initiatives to students while developing their SRL. In addition to giving students initiatives, most commonly mentioned method was giving feedback to students and students taking feedback from each other. In the SRL enriched seminar course, giving feedback and taking feedback issues related to SRLIT items were often discussed as strategies PTs endeavored to implement in their practice teaching. Therefore, PTs dwelled on this concept much when they mentioned their PSRL related actions. This was also taken as a sign that participants started showing efforts to apply some of the PSRL strategies in their practice teaching.

Changes in PTs' Thoughts during the Intervention Program

When PTs' responses in the interviews were analyzed, various changes in their thoughts were revealed. This was one of the key themes for this study, since it reflected insights into the perceived effects of the intervention program. Firstly, all PTs asserted that the intervention process raised their SRL and PSRL awareness. They stated that even if they had some prior knowledge about SRL concepts, this knowledge was inadequate. In addition, 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 catalyst for change. Below is the description of the intervention process and his PSRL plans for the future by a participant:

> *Deniz: I think I will definitely try to apply PSRL strategies in my lessons. My awareness has become 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 at least half of them.*

On the other hand, even if PTs mentioned their increasing awareness towards SRL and PSRL, they also highlighted various inadequacies of the intervention program. Four participants expressed that the time and SRL content in the intervention program was not enough for them to exhibit PSRL strategies in their practice teachings, lacking practical examples of PSRL.

The coding of transcriptions revealed that PTs had certain beliefs before the intervention, however, as the intervention took place, their beliefs and thoughts on PSRL started to change. Two 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 reported a change in an opposite direction. They 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 obtain lower scores for SE-PSRL. This issue, which is evident in the excerpt below, can shed light on why PTs in the experimental group got low scores in time compared with those of PTs' in the control group.

> *Deniz: I think at first I didn't know what those were probably. 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.

Those five participants stated that at the beginning of the research 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. Only two of the participants expressed that they increased their scores as they learned PSRL practices, however PTs mostly stated that with increasing awareness on PSRL practices, they started to evaluate themselves in a more informed manner, as expressed by Deniz

Discussion and Conclusion

The results for the first research question concerning self-efficacy indicated that the group and time variables had a significant interaction effect on PTs' SE-PSRL scores. But the nature of the effect was contrary to what was expected conceptually and in light of the corresponding literature. The experimental group was expected to show higher SE-PSRL scores than the control group in time. An important aspect of the current study was to examine the change in SE-PRSL with multiple measures over time. It has been previously stated that motivational and affective variables can have fluctuations over time due to the cyclical nature of SRL experiences (Zimmerman, 2000). Bernacki et al. (2015) have also stated that self-efficacy beliefs need to be examined as a dynamic variable and there is a scarcity in studies with such an approach. With the targeted training for PSRL and the accompanying practice and discussions, multiple measurements in time were expected to help report the gradual build up of positive self-efficacy beliefs in the experimental group.

There are various studies that investigated self-efficacy beliefs as a general construct and found them as one of the most effective factors in PSRL (Dignath-Van Ewijk, 2016; Dignath & Büttner, 2018; Lombaerts et al., 2009; Tanrıseven, 2013). There were also previous studies that investigated self-efficacy beliefs specific to promoting self-regulation (Chatzistamatiou et al., 2014; De Smul et al., 2019). Teachers with high self-efficacy beliefs about PSRL were more competent in PSRL strategy use (De Smul, et al., 2018). In light of the related literature, the intervention was expected to support participants' SE-PSRL which could in turn promote PTs' PSRL skills. 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.

Findings of the qualitative data analysis can help shedding light on how these unexpected results can be interpreted. A key issue emphasized by the participants was the increased awareness for difficulty of applying PSRL. Hence, they explained that their SE-PSRL decreased since their awareness toward PSRL increased and they realized how difficult it was for them to get proficient in PSRL. On the contrary, the control group might have experienced a perceived increase in their self-efficacy, displaying a potential Dunning-Kruger effect (McIntosh et al., 2019). As highlighted by some of the participants, such training for PSRL can be provided for PTs earlier in their teacher training program so that by the time they engage in practice teaching they can be better prepared and feel more efficacious to tackle the difficulties in bringing PSRL to life in the classrooms.

The findings for the second research question showed that the group and time variables did not have a significant interaction effect on PTs' PSRL. The main effects were analyzed separately to find that while the group variable had a main effect on PTs' PSRL scores, time did not have a main effect on their PSRL scores. The findings indicated that the PSRL scores of PTs differed between the groups in each measurement, with the scores of the control group being consistently higher. However, it should be noted that the PTs in the control group had higher levels of PSRL compared to those in the experimental group starting from the first measurement in the study and this was the main reason for this difference.

There are previous studies that document development of practicing teachers' PSRL through similar interventions (Butler et al., 2013; Dignath & Büttner, 2018; Heirweg et al., 2022; Kramarski & Michalsky, 2015). In this study, the target was investigating the development of PSRL with PTs through an intervention and it was also predicted that the participants in the intervention would have higher SE-PSRL and PSRL in time as reported in the literature, but the findings diverged from the expected outcomes.

Current educational systems emphasize the importance of the developmental opportunities for PTs (e.g., National Council for Accreditation of Teacher Education, 2002). However, it was also asserted that increasing PTs' SRL abilities via intervention studies was not easy (Kramarski & Michalsky, 2010). According to Schön (1995), PTs generally do not have adequate knowledge and skills in order for them to create new strategies and apply them in classrooms. Indeed, Karlen et al. (2023) recently highlighted potential links between teacher competencies as self-regulated learners—particularly their knowledge about SRL, their own SRL, their beliefs and value evaluations regarding SRL—and their PSRL. PTs' SE-PSRL did not evolve positively as expected in this study. Thus, potentially with other teacher competencies, this might have explained why PSRL of PTs in the experimental group did not change in a positive way. In a study by Vosniadou et al. (2024) a key finding was that many teachers did not know how to promote their students' SRL skills and did not give adequate importance to it. About half of the teachers did not use instructional tasks that would develop their students SRL. Some teachers rarely used SRL strategies explicitly or tried to develop their students' SRL skills. These findings showed that both teachers and preservice teachers need professional development programs about how they can promote their students' SRL. Universities should also give priorities to SRL concepts and open educational courses related to teaching of the different components of SRL and providing classroom examples of how teachers can promote SRL. The results of our study emphasized the need for exploring the intricate relationships among teacher competencies while exploring development of PSRL.

Saraç and Tarhan (2020) suggested that developing teachers' PSRL skills should be a key educational target rather than leaving it to teachers' instincts or expecting them to develop knowledge and skills in practice after limited learning opportunities. In this study, participants were senior students of their university and the seminar course was mainly targeted towards giving PTs opportunities for teaching practice and reflection on their practice. Besides, De Kock et al. (2005) contended that teachers tend to focus more on teaching subject knowledge rather than teaching and practicing self-regulation skills in the classroom. Similarly, some PTs in the experimental group stated that they spent most of their time completing lesson plans in their practice teaching rather than trying to develop students' SRL. This might have restricted the time, attention and focus for PSRL. Further studies can be

designed for earlier interventions in teacher training programs for development of PSRL so that PTs can have extended opportunities for practice and development.

Findings from the qualitative analysis help understanding and interpreting the quantitative results and explain why the intervention did not produce the expected results. Firstly, PTs often mentioned the shortness of the intervention process. They emphasized that the concept of PSRL and its application in classroom settings were critical and required both teacher knowledge and experience in practice. Although they participated in an intervention program in this study, the development of PSRL skills required a long process and it might not have been possible to see the effects of the program in such a short time. Therefore, they suggested that the intervention process should be spread over a year in order for the program to have the hypothesized outcome on PSRL and SE-PSRL. This needs to be investigated in future studies.

Some participants from the experimental group stated that they had high self-efficacy beliefs, but their scores decreased as they became more aware of the concepts and the difficulty of PSRL. A participant from the control group also stated that he associated the concept of PSRL with the teaching built on a constructivist theory of learning and he rated his teaching with high scores indicating that he applied PSRL when he adopted any teaching with a constructivist approach to learning. As PTs had such uncertainties, their assessments may have been influenced by their personal perceptions, the intensity of their experience or desirability issues (particularly for the responses in the interview). Since PSRL measurement was based on PTs' self-reports in this study, the extent to which it reflects their actual performance rather than their perceptions can be questioned. Findings of this study also pointed towards the need for measurement of PSRL with expert observations or its triangulation in order not to rely solely on participants' self-reports, which has been previously suggested (Dignath & Büttner, 2018; Veenmann, 2005).

Another finding of this study corroborating what had been previously reported, was the factors influencing teachers' PSRL. It was contended that preschool teachers found it difficult to implement PSRL in their classrooms when the classroom was crowded, and they tended to use more teacher centered strategies rather than constructivist teaching strategies (Saraç & Tarhan, 2020). Aligned with these findings, participants in the study mentioned that the classroom sizes affected their PRSL strategies negatively and they had difficulty in focusing on developing their students' SRL.

Limitations of the Study

Certain limitations of this study need to be acknowledged. First, even though the intervention was offered in the context of a university course and hence had ecological validity, the findings are confined by the features of the context–the highest ranked teacher training program and PTs in Turkey. Second, the constructs in the study were measured via self-report questionnaires. Self-report technique provides immense detail about teachers' perceptions and beliefs on how they use SRL promoting strategies in their teaching experiences. However, one possible drawback is that they might give biased reflections about their self-reports. They believe that they have developed their students' SRL however, they could not apply and use SRL promotion strategies as they have

thought (Dignath & Veenman, 2021; Veenman & van Cleef, 2019; Vosniadou et al., 2021). There are other methods suggested as being more reliable. One such technique to assess teachers' SRL promotion is classroom observations (e.g. Dignath & Büttner, 2018). When compared to self-reports, in this technique, researchers have a chance to observe teachers' instructional strategies and teaching quality in a context of promotion of SRL in real classroom environments (Vosniadou et al., 2024). In this study, it was not possible to use other measurement methods for PSRL due to practical reasons such as resources and in future research this needs to be taken into consideration. Third, teachers' dual roles and related competencies have been emphasized as key constructs for meaningful investigations on teachers' PSRL (Karlen et al., 2023). This study aimed at exploring only PSRL and only one strong motivational factor influencing it (SE-PSRL) within an intervention aiming at development of PSRL. In further research, exploring such developmental efforts with a broader framework involving teacher competencies such as teacher knowledge of SRL, their SRL practices and beliefs about SRL can help make sense of the interconnections among all these constructs potentially influencing the development of teachers' PSRL. A fourth and important limitation of the study corresponds to determination of the baseline levels for the constructs involved. The scales were administered for the first time after each participant's first practice teaching, which was either in the 4^{th} or 5^{th} week of the course. Since the experimental group had already received training for PSRL, the scores from the first administration of the instruments do not constitute a pretest in a traditional manner. However, since the items in the SRLIT scale required specific teaching experience it was impossible to administer the scale at the beginning of the course. In further studies involving intervention programs, earlier teaching opportunities could be provided for the participants so that their PSRL and SE-PSRL levels could be determined at the onset of any intervention to be investigated. The present study has focused on an analysis of preservice teachers' self-eficacy beliefs and practices about promoting SRL in real classrooms. In a study conducted by Vosniadou et al. (2024) teachers' practices about SRL were investigated and the researchers suggested that students' learning outcomes should also be considered. In future studies, in addition to investigating preservice teachers' beliefs and practices about promoting SRL, classroom observations of preservice teachers' teaching and their students' outcomes can also be measured. Results from such studies can provide a more detailed and accurate picture about the efficiency of SRL enriched intervention designs.

References

Ader, E. (2019). What would you demand beyond mathematics? Teachers' promotion of students' self-regulated learning and metacognition. *ZDM Mathematics Education. 51*(4), 613-624. https://doi.org/10.1007/s11858-019-01054-8

Andreassen, R., & Bråten, I. (2011). Implementation and effects of explicit reading comprehension instruction in fifth-grade classrooms. *Learning and Instruction, 21*(4), 520–537. https://doi.org/10.1016/j.learninstruc.2010.08.003

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*(2), 117–148. https://doi.org/10.1207/s15326985ep2802_3

Bernacki, M. L., Nokes-Malach, T. J., & Aleven, V. (2015). Examining self-efficacy during learning: Variability

and relations in behavior, performance, and learning. *Metacognition and Learning*, *10*, 99–117. https://doi.org/10.1007/s11409-014-9127-x

Bolhuis, S., & Voeten, M. J. (2001). Toward self-directed learning in secondary schools: What do teachers do?. *Teaching and Teacher Education*, *17*(7), 837–855. https://doi.org/10.1016/S0742-051X(01)00034-8

Butler, D. L., Schnellert, L., & Cartier, S. C. (2013). Layers of self- and co-regulation: teachers working collaboratively to support adolescents' self-regulated learning through reading. *Education Research International, 2013*, 1–19. https://doi.org/10.1155/2013/845694

Cai, R., Wang, Q., Xu, J., & Zhou, L. (2020). Effectiveness of students' self-regulated learning during the Covid-19 pandemic. *Sci Insigt, 34*(1), 175–182. https://doi.org/10.15354/si.20.ar011

Capa-Aydin, Y., Sungur, S., & Uzuntiryaki, E. (2009). Teacher self-regulation: Examining a multidimensional construct. *Educational Psychology, 29*, 345–356. https://doi.org/10.1080/01443410902927825

Chatzistamatiou, M., Dermitzaki, I., & Bagiatis, V. (2014). Self-regulatory teaching in mathematics: Relations to teachers' motivation, affect and professional commitment. *European Journal of Psychology of Education, 29*, 295–310. https://doi.org/10.1007/s10212-013-0199-9

Cihangir, M. (2021). *Preservice mathematics teachers' promotion of self-regulation (psrl) in time: a mixed-method study.* (Publication No. 729123) (Master's thesis, Boğaziçi University) Higher Education Council National Thesis Center.

Cleary, T. J. (2011). Emergence of self-regulated learning microanalysis: Historical overview, essential features and implications for research and practice. In B. J. Zimmerman, & D. H. Schunk (Eds.), *Handbook of self regulation of learning and performance* (pp. 329–345). New York: Routledge.

Creswell, J. W. (2009). Research design: Qualitative, quantitative and mixed methods approache. Sage.

De Kock, A., Sleegers, P., & Voeten, M. J. (2005). New learning and choices of secondary school teachers when arranging learning environments. *Teaching and Teacher Education*, *21*(7), 799–816. https://doi.org/10.1016/j.tate.2005.05.012

De Smul, M., Heirweg, S., Devos, G., & Van Keer, H. (2019). School and teacher determinants underlying teachers' implementation of self-regulated learning in primary education. *Research Papers in Education, 34*(6), 701–724. https:// doi.org/10.1080/02671522.2018.1536888

De Smul, M., Heirweg, S., Van Keer, H., Devos, G., & Vandevelde, S. (2018). How competent do teachers feel instructing self-regulated learning strategies? Development and validation of the teacher self-efficacy scale to implement self- regulated learning. *Teaching and Teacher Education, 71*, 214–225. https://doi.org/10.1016/j.tate.2018.01.001

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher, 38*(3), 181–199. https://doi.org/10.3102/0013189X08331140

Dignath, C. (2021). For unto every one that hath shall be given: Teachers' competence profiles regarding the promotion of self-regulated learning moderate the effectiveness of short-term teacher training. *Metacognition and Learning, 16*, 555–594. https://doi.org/10.1007/s11409-021-09271-x

Dignath, C., & Büttner, G. (2018). Teachers' direct and indirect promotion of self-regulated learning in primary and secondary school mathematics classes - Insights from video-based classroom observations and teacher interviews. *Metacognition and Learning, 13*, 127–157. https://doi.org/10.1007/s11409-018-

9181-x

Dignath, C., Büttner, G., & Langfeldt, H. P. (2008). How can primary school students acquire self-regulated learning most efficiently? A Meta-analysis on interventions that aim at fostering self-regulation. *Educational Research Review, 3*, 101–129. https://doi.org/10.1016/j.edurev.2008.02.003

Dignath, C., & Veenman, M. V. J. (2021). The role of direct strategy instruction and indirect activation of self-regulated learning—Evidence from classroom observation studies. *Educational Psychology Review, 33*, 489–533. https://doi.org/10.1007/s10648-020-09534-0

Dignath-van Ewijk, C. (2016). Which components of teacher competence determine whether teachers enhance self-regulated learning? Predicting teachers' self-reported promotion of self-regulated learning by means of teacher beliefs, knowledge, and self-efficacy. *Frontline Learning Research, 4*(5), 83–105.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191.

Heirweg, S., De Smul, M., Merchie, E., Devos, G., & Van Keer, H. (2022). The long road from teacher professional development to student improvement: A school-wide professionalization on self-regulated learning in primary education. *Research Papers in Education, 37*(6), 929–953. https://doi.org/10.1080/02671522.2021.1905703

Karlen, Y., Hirt, C. N., Jud, J., Rosenthal, A., & Eberli, T. D. (2023). Teachers as learners and agents of self-regulated learning: The importance of different teachers competence aspects for promoting metacognition. *Teaching and Teacher Education, 125*, Article 104049. https://doi.org/10.1016/j.tate.2023.104055

Kramarski, B., & Heaysman, O. (2021). A conceptual framework and a professional development model for supporting teachers' "triple SRL–SRT processes" and promoting students' academic outcomes. *Educational Psychologist*, 56(4), 298–311. https://doi.org/10.1080/00461520.2021.1985502

Kramarski, B., & Michalsky, T. (2010). Preparing preservice teachers for self-regulated learning in the context of technological pedagogical content knowledge. *Learning and Instruction, 20*(5), 434–447. https://doi.org/10.1016/j.learninstruc.2009.05.003

Lombaerts, K., De Backer, F., Engels, N., van Braak, J., & Athanasou, J. (2009). Development of the self-regulated learning teacher belief scale. *European Journal of Psychology of Education, 24*, 79–96.

Lombaerts, K., Engels, N., & Athanasou, J. A. (2007). Development and validation of the self-regulated learning inventory for teachers. *Perspectives in Education, 25*, 29–47.

McIntosh, R.D., Fowler, E.A., Lyu, T., & Della Sala, S. (2019). Wise up: Clarifying the role of metacognition in the Dunning-Kruger effect. *Journal of Experimental Psychology, 148*(11), 1882–1897. https://doi.org/10.1037/xge0000579

Merriam, S. B., & Grenier, R. S. (2019). *Qualitative research in practice: Examples for discussion and analysis*. San Francisco, CA: Jossey-Bass Publishers.

National Council for the Accreditation of Teacher Education. (2002). *Professional standards for the accreditation of schools, colleges and departments of education*. Washington, DC: Author.

Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for research. *Frontiers in Psychology, Vol. 8*. https://doi.org/10.3389/fpsyg.2017.00422

Perry, N. E., Hutchinson, L., & Thauberger, C. (2008). Talking about teaching self-regulated learning: Scaffolding student teachers' development and use of practices that promote self-regulated learning. *International Journal of Educational Research*, *47*(2), 97–108. https://doi.org/10.1016/j.ijer.2007.11.010

Saraç, S., & Tarhan, B. (2020). Preschool teachers' promotion of self-regulated learning in the classroom and role of contextual and teacher-level factors. *International Electronic Journal of Elementary Education*, *13*(2), 309–322.

Schön, D. A. (1995). Knowing-in-action: The new scholarship requires a new epistemology. *Change: The Magazine of Higher Learning*, *27*(6), 27–34. https://doi.org/10.1080/00091383.1995.10544673

Schunk, D. H., & Zimmerman, B. J. (2008). Motivation: An essential dimension of self-regulated learning. In D. H. Schunk, & B. J. Zimmerman (Eds.), *Motivation and self-regulated learning: Theory, research and applications* (pp. 1–30). New York: Routledge.

Schunk, D. H., & Ertmer, P. A. (2000). Self-regulatory and academic learning self-efficacy enhancing interventions. In M. Boekaerts, P. R. Pintrich, & M. H. Zeidner (Eds.), *Handbook of self-regulation*, (pp. 631–649). San Diego: Academic.

Tanrıseven, I. (2013). Primary school teachers' realization levels of self-regulated learning practices and sense of efficacy. *Educational Research and Reviews, 8*(7), 297–301. https://doi.org/10.5897/ERR2012.0493

Vosniadou, S., Darmawan, I., Lawson, M. J., Van Deur, P., Jeffries, D., & Wyra, M. (2021). Beliefs about the self-regulation of learning predict cognitive and metacognitive strategies and academic performance in pre-service teachers. *Metacognition and Learning, 16*, 523–554. https://doi.org/10.1007/s11409-020-09258-0

Vosniadou, S., Bodner, E., Stephenson, H., Jeffries, D., Lawson, M. J., Darmawan, I. G. N., Kang, S. H. K., Graham, L., & Dignath, C. (2024). The promotion of self-regulated learning in the classroom: A theoretical framework and an observation study. *Metacognition and Learning, 9*, 381–419. *https://doi.org/10.1007/s11409-024-09374-1*

Veenman, M. V. J. (2005). The assessment of metacognitive skills: What can be learned from multi-method designs. In C. Artelt, & B. Moschner (Eds.), *Lernstrategien und metakognition. Implikationen für forschung und praxis [Learning strategies and metacognition. Implications for research and practice]* (pp.77–99). Münster: Waxmann.

Veenman, M. V. J., & van Cleef, D. (2019). Measuring metacognitive skills for mathematics: Students' self-reports versus on-line assessment methods. *ZDM Mathematics Education, 51*(4), 691–701. https://doi.org/10.1007/s11858-018-1006-5

Winne, P. H. (2005). A perspective on state-of-the-art research on self-regulated learning. *Instructional Science, Vol. 33*, pp. 559–565.

Zimmerman, B. J. (1995) Self-efficacy and educational development. In A. Bandura (ed.), *Self-efficacy in changing societies* (pp. 202–231). New York: Cambridge University Press.

Zhang, W., Wang, Y., Yang, L., & Wang, C. (2020). Suspending classes without stopping learning: China's education emergency management policy in the COVID-19 outbreak. *Journal of Risk and Financial Management, 13*(3), 55. https://doi.org/10.3390/jrfm13030055

Zimmerman, B. J. (2000). Attaining self-regulation: a social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13–40). San Diego, CA: Academic Press.

https://doi.org/10.1016/b978-012109890-2/ 50031- 7

Zimmerman, B. J., Bonner, S., & Kovach, R. (1996). *Developing self-regulated learners: Beyond achievement to self-efficacy.* American Psychological Association. https://doi.org/10.1037/10213-000

Author Information

Meryem Cihangir

https://orcid.org/0000-0001-6854-8564

Mathematics Teacher

Ministry of National Education

Turkey

Engin Ader

https://orcid.org/0000-0002-4454-4216

Boğaziçi University

Department of Mathematics and Science Education and Learning Sciences Program

Turkey

Contact e-mail: *ader@bogazici.edu.tr*

Appendix

Appendix A. Semi Structured Interview Questions

1. What does SRL mean for you? If needed, how would you define it?
2. The importance of SRL in education is emphasized. What are your thoughts about this?
3. Do you think SRL is an aspect that should be developed in students? Why? What is the significance of this?
4. 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?
5. Do you think that your self-efficacy beliefs have an impact on your PSRL when you think about your own teaching?
6. Considering the items in the questionnaire, do you think each item is applicable in terms of SRL? Why? Can you explain with examples?
7. Are there any changes in your thoughts on teachers' PSRL practices after the training you received during the study?
8. Do you think applying PSRL depends on the teachers' subject, e.g. yours being mathematics? Why?

Appendix B. Boğaziçi 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
Konu : 2021/19 Kayıt no'lu başvurunuz hakkında

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