

# Promoting Self-Regulated Learning Skills of Pre-Service Chemistry Teachers: Motivation Component

## OPEN ACCESS

Volume: 11

Special Issue: 1

Month: January

Year: 2023

E-ISSN: 2582-1334

Received: 06.09.2022

Accepted: 12.12.2022

Published: 20.01.2023

### Citation:

Işık, B. & Atasoy, B. (2023). Promoting Self-Regulated Learning Skills of Preservice Chemistry Teachers: Motivation Component. *Shanlax International Journal of Education*, 11(S1), 26-40.

### DOI:

<https://doi.org/10.34293/education.v11iS1-Jan.5864>



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### Abstract

*This study tackles self-regulated learning from the motivation component, considering that not only the 'skills' but also the 'will' dimensions are essential for the development of self-regulated learning. The aim of the study is to promote pre-service chemistry teachers' motivation and to enhance their knowledge of motivational regulation strategies. The study was conducted in organic chemistry courses with 18 pre-service chemistry teachers. A semi-structured interview, a semi-structured diary, and an open-ended scale were employed as data collection tools to identify motivational components and motivational regulation strategies used by the pre-service teachers. The qualitative data collected were analyzed using descriptive and content analysis techniques. Results showed that the pre-service chemistry teachers had positive motivational beliefs and were more persistent about academic activities. Moreover, improvements occurred in pre-service teachers' motivational regulation strategies. It was further found that the positive change in the pre-service chemistry teachers' motivations diversified their learning strategies and that they began to use these strategies more frequently.*

**Keywords:** Self-Regulated Learning, Motivation, Motivational Beliefs, Motivational Regulation Strategies.

### Introduction

One of the most critical factors affecting learning in today's educational system is the teacher. Teacher training programs are often reformed for this reason (National Council for the Accreditation of Teacher Education, 2002). Along with providing subject matter and pedagogical knowledge to teachers, the development of self-regulated learning skills is aimed as well (Heaysman & Kramaski, 2022; Kramarski & Michalsky, 2009).

The development of self-regulated learning skills means that an individual becomes aware of his/her learning process and is thereby able to manage and regulate these processes. To achieve this, it is necessary for an individual to regulate his/her learning cognitively, motivationally, and behaviorally (Pintrich, 2000; Zimmerman, 2000). Although it is not easy to cultivate individuals with self-regulated learning skills, the acquisition and development of these skills are necessary (Zimmerman, 1990; 2000). Most teachers either do not possess these skills, or do not know how to equip students with them.

Further, teachers find the development of the skills and their inclusion in learning environments to be a complicated matter (Kramarski & Michalsky, 2010; Randi, 2004). Including the development of self-regulated learning skills in teacher training programs facilitates both the pre-service teachers' learning and the students' attainment of these skills. Many teacher training programs endeavor to improve pre-service teachers' self-regulated learning skills for this reason (Little, 2002). It is important that teacher training programs incorporate self-regulated learning practices, considering that only teachers who are aware of their own learning and who value self-regulated skills throughout the learning processes can improve their students' SRL skills, according to researchers (Kramarski & Michalsky, 2009, 2010; Putnam & Borko, 2000; Randi & Corno, 2000).

### Self-Regulated Learning

Self-regulated learning (SRL) holds an essential place in education research (Winne, 2005; Zimmerman, 2008). Studies in this field revealed that successful students were highly self-regulated, and intervention studies targeting the improvement of SRL showed that their improvements enhance students' academic achievement (Dignath & Büttner, 2008; Dignath et al., 2008; Fuchs et al., 2003; Masui & De Corte, 2005; Perels et al., 2005; Schunk & Ertmer, 2000).

SRL models assume that learners are individuals who act towards their academic goals and are active and reflective enough to undertake the responsibility of their learning process (Butler & Winne, 1995; Pintrich, 2000; Schraw, et al., 2006; Zimmerman, 2000, 2008). Self-regulated learners are individuals who can use their cognitive strategies when appropriate and who have metacognitive awareness and adaptive motivational beliefs oriented towards their learning goals (Zimmerman, 2000). Pintrich (2000) defined self-regulated learning as an active and constructive process through which learners set their learning goals and attempted to monitor, regulate and control their cognition, motivation and behavior.

Early definitions of the concept of self-regulation defined it through cognition and metacognition overlooking the effects of motivational and

emotional processes on self-regulation (Op'tEynde et al., 2007). Today, the relation between motivation and self-regulation is unambiguously manifested in theoretical models (Boekearts, 1995; Pintrich, 2000; Schraw et al., 2006; Zimmerman, 2000; Zimmerman & Schunk, 2004). According to Pintrich (2000), an individual can regulate his/her motivation as well as cognition. Regulation of motivation involves attempts to regulate of motivational components, such as goal orientation, self-efficacy, causal attributions, and task values, using various strategies (Wolters, 1998). Goal orientation includes the underlying purposes for the individual's achievement of an academic task (Pintrich, 2000). Task values encompass an individual's belief regarding the importance, utility, and relevance of a task, while self-efficacy refers to the individual's belief in their capacity to achieve a self-assigned task (Bandura, 1997). Causal attributions are related to how the individual perceives the reasons for achievement or failure when assessing their own performance (Weiner, 2010).

Regulation of motivation consists of planning, monitoring, control, and reflection phases (Pintrich, 2000). Motivational planning, the first phase, involves the activation of motivational beliefs, such as values and interests, and the self-efficacy beliefs. The individual builds an interest in and value-perception of the task at the end of their assessments. Motivational monitoring, the second phase, involves the individual's attempts to control and monitor his/her efficacy, values, interests, and anxiety. The monitoring of motivation is a significant start for the subsequent two phases, which are control and reflection. The motivational control phase involves the individual's attempts to control and monitor his/her motivation and their effects in the learning process. The individual, in this phase, uses multiple strategies, which are referred as motivational regulation strategies, to overcome any motivational problems they face (Wolters, 1998). Motivational reflection, the last phase, involves the individual's emotional reactions to outcomes after fulfilling the task (e.g. feeling happy for success, sad for failure) and causal attributions. The inferences made by the individual at the end of the four phases guide their motivation for future tasks (Pintrich, 2000). The

individual is deemed to have performed effective self-regulation, if he/she can thoroughly consider the learning process and reflect their views to the next learning process (Zimmerman, 2000).

According to the social cognition theory (Bandura, 1997), motivational components, as well as cognitive processes, should be taken into consideration for the improvement of self-regulated learning skills. Students should be motivated to give additional time and effort and use multiple strategies for self-regulated learning (Pintrich, 1999). It is crucial for students to employ various strategies in the learning process, change them when necessary, and demonstrate eagerness to be active metacognitively; in other words, be motivated in the learning process (Wolters, 1999, 2003). Previous research revealed that instruction in cognitive strategies alone was not enough for self-regulated learning, but rather, that the motivation component was of significance in terms of students acquiring the ability to use these strategies (Butler & Winne, 1995). According to Zimmerman (2000), students who had cognitive strategies to achieve an academic task but were unmotivated to use these strategies are not able to fulfil this task. Further, Schraw et al., (2006) emphasized that motivation affected the use and development of cognitive and metacognitive skills. According to Hofer et al., (1998) students should be able to use cognitive and metacognitive strategies in learning environments and be motivated to use those strategies. In brief, students should develop both 'skills' and 'will' during learning processes.

This study aimed to equip pre-service chemistry teachers with adaptive motivational components and to enable them to improve motivational regulation strategies. For this purpose, training individuals who were capable of setting learning goals, demonstrating adaptive self-efficacy beliefs during learning processes, making adaptive causal attributions in the face of success and failure, and using more motivational regulation strategies against academic difficulties was aimed. The following research questions were developed to achieve this aim:

- What are the pre-service chemistry teachers' motivational components before and after the study?
- What changes occurred in the pre-service

chemistry teachers' academic goals and goal orientation?

- What was the change in the pre-service chemistry teachers' self-efficacy beliefs?
- What was the change in the pre-service chemistry teachers' causal attributions regarding success and failure?
- What are the pre-service chemistry teachers' motivational regulation strategies before and after the study?

### **Methodology of Research Self-Regulated Learning Skills Development (SLSD) Plan**

The aim of the SLSD plan was to develop the self-regulated learning skills of the pre-service chemistry teachers. In the first part of this plan, the pre-service teachers were trained in basic learning strategies (planning and managing time, reading comprehension and summarizing, note taking in the classroom, preparation for exams, writing, problem-solving and posing questions) and in metacognitive awareness for the development of their self-regulated learning skills (See Ekici, 2015).

This study constitutes the second part of the SLSD plan. In this study aimed to develop the pre-service teachers' positive and adaptive motivation components and to expand the strategies they used to regulate their motivation. It tackled goal orientation, self-efficacy and causal attributions within this framework.

### **Participants**

This research was conducted in the education faculty of a well-established state university. The participants of the research are 18 junior students studying in the 3rd year of the chemistry department of an education faculty. The participants consisted of 16 female and 2 male students. Their ages ranged between 19 and 22. The research was conducted with the participants in the organic chemistry course. Participants received integrated cognitive and metacognitive strategy training for the development of self-regulated learning skills in general and inorganic chemistry courses in their first and second years (See Ekici, 2015). In line with the purpose of the research, the participants were selected using the convenience sampling technique.

## Ethical Considerations

The participants were informed at the beginning of the research that the research would be conducted in the organic chemistry and additional practice classes, and that they were free to withdraw from the study at any time. All participants voluntarily agreed to participate in the study. Pseudonyms were used to ensure the anonymity of the pre-service chemistry teachers' identities who participated in the research. Further, the name of the state university chosen for the research was kept anonymous, as well.

## Data Collection Tools

Various data collection tools were used to answer the problem statement and sub-problems defined for the research.

**Semi-Structured Interviews:** Semi-structured interview technique was used to monitor the pre-service chemistry teacher's motivational components (goal orientations, self-efficacy beliefs, and causal attributions) for the organic chemistry course. Interview questions were formed considering the items in the Pintrich and De Groot's (1990) 'Motivated Strategies for Learning Questionnaire' Scale. The questions were finalized upon discussion with two chemistry educators working in self-regulated learning and motivation fields to ensure content validity. The interviews were recorded using a recorder and the interviews lasted between 30 and 45 minutes. All the participants were interviewed twice, at the beginning and at the end of the research. The pre-service teachers were asked questions targeting intrinsic goal-orientation, such as "What does being successful in the organic chemistry course mean for you?", and questions targeting causal attributions, such as "Who or what do you blame when you fail?"

**Open-ended scale/ scenarios:** Open-ended scale/ scenarios were used as the data collection tool to identify the pre-service chemistry teachers' motivational regulation strategies they use when they face various academic situations in the organic chemistry course. The data collection tool was arranged according to an open-ended scale developed by Wolters (1998) and adapted to fit an organic chemistry course. With the open-ended scale, the pre-service teachers were asked to read scenarios created on the basis of four academic tasks (during lesson,

when reading about the course, when preparing an assignment, during preparation for exams) and three motivational problems (unnecessary/insignificant, challenging and boring/uninteresting) they might face, and then to write down what they would do to fulfil the academic tasks given in these scenarios and to sustain their efforts. For example, the pre-service teachers would be given a scenario such as, "You lost focus due to the difficulty of the questions when doing your assignment. In this case, what do you do to keep studying and to achieve your target of finishing the assignment?", and then asked to respond to it. The open-ended scale was applied in four sessions at different times for each academic situation. Each session lasted about 20 minutes.

**Semi-Structured Diaries:** The pre-service chemistry teachers were asked to make diary entries that reflected their academic goals, motivational components, and self-regulated strategies within the framework of the academic activities (solving practical problems posed in the organic chemistry course, studying organic chemistry midterm and final exam). The academic diaries were structured on the basis of the self-regulation model, which included the phases of forethought, performance, and self-reflection suggested by Zimmerman (2000). Forethought, the first phase, includes the motivational aspect, such as determination of academic goals, planning (what should be done to achieve the goal) and self-efficacy. Performance, the second phase, involves the types of self-regulated strategies employed to attain goals and how study time is planned. And finally, self-reflection, the third phase, covers whether the goal is achieved or not, and reasons, attributions, and inferences for the next task. The pre-service teachers were then asked to make diary entries after the academic activities and completion of the assignments given by the researcher. The diaries, which were collected following each activity, were reviewed and then returned to the pre-service chemistry teachers.

**Research Procedure:** This research was conducted through integrating it with the organic chemistry courses (I, II) in two academic semesters. The organic chemistry courses (I, II) are conducted six hours per week in the chemistry education program. Lectures for the theoretical organic

chemistry courses (I, II), which cover four hours per week, were performed by the third researcher, who has taught organic chemistry courses for 30 years and has been interested in chemistry education for 15 years. The other two researchers attended the four hours a week organic chemistry (I, II) theory classes in the teaching program as observers and contributed to the remaining two-hour practice classes (supporting students in solving practical problems assigned at the end of the subject) as instructors.

In class observations and interviews were conducted throughout the teaching of the organic chemistry-I course offered in the first semester to determine the pre-service chemistry teachers' overall situation regarding SRL (the motivational beliefs they had for organic chemistry course, strategies they used in organic chemistry class to regulate their motivation, learning strategies they used during academic activities). Thus, pre-service teachers were observed, the data regarding them were collected and they were assessed.

Teaching applications, which covered the second part of the SLSD plan, were performed in the second semester under organic chemistry-II course. These applications were performed as part of the eight hours per week the course was taught (four hours of theory, two hours of practice, and two hours of training). The course took twelve weeks. The four-hour theoretical organic chemistry-II class was performed to support the SLSD plan. Self-regulated strategies were supported with expert modelling through exemplification by the lecturer, and these strategies included cognitive strategies, such as taking notes, posing questions; metacognitive strategies, such as self-monitoring and self-assessment; resource management strategies, such as help seeking, collaboration, planning study time; and motivational strategies, such as setting achievable goals and making adaptive attributions. These classes were planned in accordance with the six

general instructional strategies suggested by Schraw et al. (2006) to develop SRL skills in science classes. Accordingly, the research focused particularly on (1) the use of the 'inquiry-based learning' teaching method, which aimed at helping students acquire high level thinking skills, (2) collaboration among students to support the sharing of cognitive and motivational strategies, (3) strategy instruction and performing expert modelling, (4) the development of mental models through classroom discussions, (5) the use of technological tools for teaching abstract concepts by utilizing three-dimensional models, and (6) the creation of favorable environments for the regulation of motivational components.

First and second researchers conducted the two-hour practice classes of the organic chemistry course. The organic chemistry practice questions were solved for each unit together with the pre-service chemistry teachers in the classroom. These practices aimed to support the use of SRL skills, which were discussed and developed with the pre-service teachers, in natural classroom environments by pre-service teachers and to reflect these skills to classroom practices.

The training activities conducted as part of the research were performed within the two extra hours added to the weekly lesson plan so as not to disrupt the advancement of the organic chemistry-II course. The aim of the SLSD plan is to train individuals to take responsibility for their own learning and be active and self-regulatory. In this part of the research, pre-service chemistry teachers would develop their adaptive motivational components, expand their knowledge of motivational regulation strategies, enhance the use of their learning strategies in academic activities, and plan, monitor, and evaluate by incorporating self-regulatory strategies in the triadic forms of self-regulation. Table 1 shows the four teaching applications along with a brief description of them.

**Table 1 SLSD Teaching Application**

<b>Application</b>	<b>Purpose of Application</b>	<b>Interventions Performed</b>
Awareness Raising	Development of understanding about self-regulated learning Development self-knowledge	Classroom discussions
Motivation Components	Development of motivation components, such as goal-setting, self-efficacy, causal attributions	Classroom discussions, peer and expert modelling, feedback, study groups

Motivational Regulation Strategies	Enhanced knowledge of motivational regulation strategies	Classroom discussions, peer and expert modelling, feedback, study groups
Planning, monitoring, and evaluation	Incorporation of self-regulatory strategies in the learning cycle	Assessment of diaries and feedback

- Awareness raising sessions were held in the first three weeks of the SLSD teaching applications to help the pre-service teachers develop an understanding of SRL and self-knowledge. Discussions were held to enable the pre-service teachers to have an idea of their own learning processes, know about their own weaknesses and strengths, and be aware of the self-regulatory strategies they have.
- The pre-service teachers were given assignments, including practice questions at the end of each organic chemistry unit. These assignments were defined as weekly academic task formed for the pre-service teachers. Pre-service teachers were demanded to set their goals and divide these goals into sub-categories to complete the task. In addition, during the goal-setting process, they were expected to indicate the reasons why they set a specific goal. In setting their respective goals regarding the practice questions corresponding to ten organic chemistry subjects taught in an academic year, the pre-service teachers were further asked to set their academic goals for the preparation process of the organic chemistry midterm and final exams.
- To attain their academic goals, the pre-service teachers were demanded to explain their own self-knowledge and the characteristics of the goal. This self-knowledge and these goal characteristics involve information on, 'what do I know and I do not know about the subject?', 'which subjects should I study?', 'who did I work with and where?', duration of study, and applied learning and motivational regulation strategies.
- The pre-service teachers were asked after the attainment of each academic goal to explain whether they achieved their goals and the underlying reasons. They were asked to think about 'what they did to fulfil the task', 'what they did not do', 'what they did right' and 'what they missed'.

Steps 2, 3 and 4 were reiterated for each academic task, and the pre-service teachers were requested to share this knowledge through classroom discussions. The purpose of the classroom discussions was to have the pre-service teachers learn from each other and to perform expert modelling, through examples provided by the researchers, from their respective learning. During the applications, the pre-service teachers were told to keep records to facilitate their performance of planning, monitoring and regulation in the self-regulated learning cycle. These records were kept through structured participant diaries, which included entries on the discussions held in the 2nd, 3rd and 4th steps. The participant diaries were collected from the pre-service teachers at the end of each academic task and then examined by the researchers and discussed with the pre-service teachers. Two of the invariable characteristics of these teaching applications were 'being a model and giving informative feedbacks. Each application step included peer and expert modelling, and informative feedback to help pre-service teachers to benefit from self-regulated learning skills in learning processes and develop adaptive motivational beliefs. At the same time, it was aimed to make pre-service teachers be aware of each other's learning strategies by facilitating of learning processes share through collaboration via the formation of study groups.

### Data Analysis

The study used descriptive and content analysis techniques together to organize the qualitative data collected. Data analysis involved (1) data coding, (2) establishing categories, (3) organizing data according to codes and categories, (4) reviewing codes and categories, and (5) interpreting results. Codes and categories were generated for the analysis of the qualitative data in line with the theoretical models used in self-regulated learning and motivation research. Table 2 shows these codes and categories. Semi-structured interviews and semi-structured

diaries were used as data sources to examine the change in the pre-service teachers’ motivational components. Motivation components were examined under three headings: goal orientations, self-efficacy beliefs, and causal attributions. Goal orientation was analyzed under intrinsic and extrinsic goal orientation sub-headings. Self-efficacy belief was analyzed under academic and self-regulatory self-efficacy belief while causal attributions were examined under adaptive and inadapative attribution categories (Table 2). Open-ended scale/scenarios

and semi-structured diaries were used as data sources to examine the change in the strategies used by the pre-service teachers to regulate their motivation. Motivational regulation strategies were investigated under intrinsic and extrinsic regulation, will, and information processing categories (Table 2). Semi-structured diaries were used as a data source to investigate the change in the pre-service teachers’ learning strategies. Learning strategies were examined under the categories of cognitive strategies and resource management strategies (Table 2).

**Table 2 Data Analysis: Emergent Categories and Codes**

Motivation Components	Motivational Regulation Strategies	Learning Strategies
<b>Goal Orientations</b> <b>Intrinsic Goal-Orientation</b> <ul style="list-style-type: none"> <li>Improving learning and learning processes</li> <li>Self-improvement</li> <li>Extrinsic Goal-orientation</li> <li>Being successful</li> <li>Doing better than others</li> </ul> <b>Self-Efficacy Beliefs</b> <b>Academic Self-Efficacy Belief</b> <ul style="list-style-type: none"> <li>Low</li> <li>High</li> </ul> <b>Self-Regulatory Self-Efficacy Belief</b> <ul style="list-style-type: none"> <li>Low</li> <li>High</li> </ul> <b>Causal Attributions</b> <b>Adaptive Attributions</b> <ul style="list-style-type: none"> <li>Effort</li> </ul> <b>Inadapative attributions</b> <ul style="list-style-type: none"> <li>Talent</li> <li>Teacher effect</li> <li>Difficulty</li> </ul>	<b>Extrinsic Regulation</b> <ul style="list-style-type: none"> <li>Achievement goal</li> <li>Reward</li> </ul> <b>Intrinsic Regulation</b> <ul style="list-style-type: none"> <li>Learning goals</li> <li>Goal valuing</li> <li>Interest</li> <li>Self-efficacy</li> </ul> <b>Will</b> <ul style="list-style-type: none"> <li>Environment</li> <li>Attention</li> </ul> <b>Information Processing</b> <ul style="list-style-type: none"> <li>Help-seeking</li> <li>Cognition</li> </ul>	<b>Cognitive Strategies</b> <ul style="list-style-type: none"> <li>Rehearsal</li> <li>Organization</li> <li>Elaboration</li> <li>Critical thinking</li> </ul> <b>Resource Management Strategies</b> <ul style="list-style-type: none"> <li>Management of time and Study environment</li> <li>Peer cooperation and help</li> </ul>

**Results**

Findings on the pre-service teachers’ motivation components, motivational regulation strategies, learning strategies, and teaching applications are presented below with direct references.

**Changes in Pre-Service Chemistry Teachers’ Motivation Components**

The change in the pre-service teachers’ motivation components (goal orientations, self-efficacy beliefs and causal attributions) as they related to the organic chemistry course was identified through the collection and analysis of the data on their beliefs

before and after the application. The findings on the pre-service teachers’ motivation components are presented below under the headings of (a) goal orientations, (b) self-efficacy beliefs, and (c) causal attributions.

(a) Goal orientations: The findings on the pre-service teachers’ goal-orientations are given below with participant numbers (Table 3). The number of pre-service teachers who set academic goals in line with their intrinsic goal-orientations increased while the number of pre-service teachers who set academic goals of doing better than the others decreased.

**Table 3 Comparison of Findings on Goal Orientations Before and After Applications**

Pre-service Teachers (N)		
Emergent Codes and Categories	Before	After
Intrinsic Goal-orientation		
• Improvement of learning and learning processes	4	12
• Self-improvement	3	8
Extrinsic Goal-orientation		
• Being successful	12	16
• Doing better than the others	6	3

Sophie was observed to set her academic goal for self-improvement after the applications, whereas she set her academic goal to be successful before the application.

Sophie: "... my goal in this course is to get a high score; I want to pass this course with A ...” (Interviews with the pre-service teacher, 2nd Week)

Sophie: "... I must be successful at all chemistry courses because I will become a chemistry teacher. I am trying to understand all subjects in the organic class. To be a better teacher ...” (Semi-structured diary entry, 12th Week)

**Self-Efficacy Beliefs:** The findings on the pre-service teachers’ self-efficacy beliefs’ are given below with participant numbers (Table 4). The pre-service teachers’ academic and regulatory self-efficacy beliefs increased after the applications. A higher number of pre-service teachers were found to strengthen their belief in their cognitive capacities and learning strategies and they applied during the

academic activities. For example, Claudia had a high self-regulatory self-efficacy belief after the applications, while she had a low self-regulatory self-efficacy belief before the applications.

**Table 4 Comparison of Findings on Self-Efficacy Beliefs Before and After Applications**

Pre-Service Teachers (N)			
Categories		Before	After
Academic self-efficacy belief	Low	12	3
	High	6	15
Self-regulatory self-efficacy belief	Low	13	5
	High	4	14

Claudia: "... I have studied via writing since high school. This causes an excessive loss of time ... but my study style is always the same. I don’t know if I can try a new strategies, nor can I think of anything new” (Interviews with the pre-service teacher, 2nd Week)

Claudia: "I have started to study differently ... ever since I started collaborating with Jasmin. I’m reviewing my notes, making more concise summaries, making study plans and I trust myself now” (Semi-structured diary entry, 11th Week)

(c) Causal attributions: Table 5 shows the findings regarding the pre-service teachers’ causal attributions along with participant numbers. A higher number of pre-service teachers made their causal attributions concerning academic outcome through their own efforts at the end of the applications. A decrease was also observed in inadapative attributions including talent, teacher effect, and difficulty (Table 5).

**Table 5 Comparison of Findings on Causal Attributions Before and After Applications**

Pre-service Teachers (N)		
Emergent Codes and Categories	Before	After
Adaptive Attributions		
• Effort	4	16
Inadapative Attributions		
• Talent	8	2
• Teacher effect	8	-
• Difficulty	10	4

Jasmin attributed her academic outcome to working hard and effort, after the application, whereas before, she had related them to the teacher effect and difficulty of the subjects.

Jasmin: "... I could not achieve my goal, the lecturer gave lecture very fast, the subjects were tough in all cases ...” (semi-structured diary entry, 4th Week).



Jasmin: "... I make more time for studying now. I ask my friends the points I don't understand. I can do it if I study more ..."

Changes in the strategies used by the pre-service chemistry teachers to regulate their motivation

The change in the strategies applied by the

pre-service teachers to regulate their motivation in the organic chemistry course was determined after collecting and analyzing the data on the strategies they used before and after the applications. The findings on the strategies employed by the pre-service teachers to regulate motivation are presented below with participant numbers (Table 6).

**Table 6 Comparison of Findings on Motivational Regulation Strategies Before and After Applications**

Pre-service Teachers (N)		
Emergent Codes and Categories	Before	After
<b>Extrinsic Regulation</b>		
• Achievement goal	8	15
• Reward	6	14
<b>Intrinsic Regulation</b>		
• Learning goal	3	10
• Goal valuing	-	8
• Interest	6	12
• Self-efficacy	5	10
<b>Will</b>		
• Environment	10	16
• Attention	5	8
<b>Information Processing</b>		
• Help-seeking	7	14
• Cognition	6	12

A higher number of pre-service teachers used motivational regulation strategies to orient themselves toward academic goals and to sustain their effort (Table 6). Moreover, the pre-service teachers began to use new motivational regulation strategies, such as achievement and learning-focused self-talk, making the subject enjoyable, and dividing the subject into small parts. Eight of the pre-service teachers developed new strategies to regulate their motivation after the applications. These strategies are grouped under the 'goal valuation' category.

In the post-application period, Vanessa was observed to have oriented herself to the academic goal and sustained her effort by developing strategies, such as relating a problem to daily life and other issues to enhance academic goal value.

Vanessa: "... if the subject is boring, I ask the lecturer why that subject is important, when would we come across it in daily life and how it relates to other subjects ... I try to understand its importance. I can keep listening to the lecturer in this way." (Open-ended Scale/Scenarios)

**Changes in the Pre-Service Chemistry Teachers' Learning Strategies**

The change in the learning strategies used by the pre-service chemistry teachers was determined by collecting and analyzing the data regarding the strategies they used to prepare the organic chemistry midterm and final exams. The findings on the pre-service teachers' learning strategies are given above (Table 7).

The pre-service teachers favored cognitive strategies and resource management strategies (Table 7). Further, it was found that the pre-service teachers started to use organisation strategies, such as drawing concept maps and diagrams, and elaboration strategies, such as forming questions and making interpretation. In addition, the pre-service teachers applied new resource management strategies, such as removing distractors, co-working with different study groups, utilizing different books, and going to the library.

Kate: "... The subjects multiplied while preparing for the final exam. I am drawing concept maps for the subjects. I am working with concept maps to

keep the reactions, mechanisms in mind ..." (Semi-structured diary entry, 13th Week).

**Table 7 Pre-service Teachers' Learning Strategies**

Emergent Codes and Categories	Before Midterm Exam (%)	Before Final Exam (%)
<b>Cognitive Strategies</b>		
• Rehearsal	40	65
• Organisation	35	55
• Elaboration	30	50
• Critical Thinking	10	35
<b>Resource Management Strategies</b>		
• Time and Study Environment	45	75
• Peer Learning and Help-seeking	35	65

### Discussion and Conclusion

This study aimed to help pre-service chemistry teachers have positive motivation components, improve their knowledge of motivational regulation strategy, and apply the learning strategies they adopted more often. It can be argued in view of the above-mentioned results that motivated learning environments help pre-service teachers improve self-regulation learning skills.

### Examination of Change in Motivation Components

The pre-service teachers determined their academic goals in accordance with their intrinsic goal-orientations (improvement of learning processes and self-improvement) after the applications (Table 3). At the same time, the goals determined by the pre-service teachers' desire for success increased while there was a decrease in those determined by the desire to do better than the others (Table 3). These results showed that the pre-service teachers were motivated intrinsically toward goals when setting their academic goals. It can be argued that the pre-service teachers who set their own academic goals and developed their own strategies to achieve these goals feel more independent by controlling their learning processes and set more goals that are learning-focused. Pintrich and Garcia (1991) revealed in their studies that the students who monitored and knew about their own learning processes set more learning-focused goals. Similarly, a study by Cleary and Zimmerman (2004) on training self-regulated learners found that students set higher academic

goals when they were aware of their learning processes, kept a record of these processes, and were provided with proper feedback. The use of semi-structured diaries in the present research provided the pre-service teachers the opportunity to monitor and evaluate learning processes. The findings showed that the researchers' assessment of the diaries and their subsequent feedback were effective for the pre-service teachers in terms of improving their goal-setting and orientation. It was also concluded that the pre-service teachers selected more adaptive motivation resources to achieve their goals, as keeping structured diaries provided them with the opportunity to keep records of learning processes, to recall previous processes easily, and hence, to monitor the learning processes. Similarly, in their five-week study with undergraduates, Schmitz and Wiese (2006) reported positive effects on the use of standardized student diaries on students' self-regulated behaviors, such as goal-setting.

The pre-service teachers' self-efficacy and self-regulatory efficacy beliefs for academic activities and goals increased as a result of the applications (Table 4). The pre-service teachers in this research were able to acquire tangible information of their learning processes and performance by keeping diaries that tracked the self-regulatory learning cycle (pre-thought, performance, and self-reflection). Thus, pre-service teachers' self-efficacy beliefs toward their respective cognitive capacity and their ability to change the learning strategies they used were more accurate and reliable. Likewise, a study by Soeger and Ziegler (2008) on encouraging students to use the self-

regulated learning cycle, reported that students' self-regulated skills were improved by the developments in their self-monitoring and self-efficacy beliefs. The results of the present research provided evidence that the evaluation of the structured diaries, subsequent feedback, in-class discussions, and, peer and expert modelling improved the pre-service teachers' self-efficacy beliefs. Zimmerman and Kitsantas (2005) similarly remarked that students developed more appropriate academic attitudes by knowing more about their respective learning processes through the use of structured diaries. A study by Güvenç (2010) on the effects of class diaries of pre-service teachers' self-regulated learning revealed that class diaries had a positive effect on the students' self-regulating skills and self-efficacy beliefs. The present study found that the provision of informative feedback and performing peer and expert modelling improved the pre-service teachers' belief towards both cognitive capacity and the use of self-regulatory strategy. According to Smith (2001), the study applications and proper informative feedback given to the students improved students' perception of self-efficacy and were useful regarding their motivations.

It was determined that the pre-service chemistry teachers made more adaptive causal attributions after the applications in regard to their performance and outputs during the academic activities (Table 5). Following the applications, the pre-service chemistry teachers made attributions concerning their performance and outcomes to intrinsic factors, such as learning strategies, studying more or eagerness to learn, instead of extrinsic factors, such as talent, teacher effect, and challenge. The formation of the study groups enabled the pre-service teachers to collaborate, leading them to work together and share self-regulatory learning strategies (cognitive, metacognitive, and motivational) with each other, which consequently had positive effects on their attributions in view of success and failure. In light of the evidence from the interviews and diaries, it can be argued that pre-service teachers who were cognizant of each other's learning and motivational regulation strategies were more motivated to correct situations in which their effort was lacking. They gained the skill to make adaptive attributions by better assessing their own success and failure.

### **Examination of Change in Motivational Regulation strategies**

The pre-service chemistry teachers applied a higher number of motivational regulation strategies to overcome a motivational problem they faced during the learning process (Table 6). An increase was also evidenced in the variety of the strategies used by the pre-service teachers who employed a higher number of strategies for regulating their motivation. The findings showed that the pre-service teachers used intrinsic regulations (learning goal, goal value, interest and self-efficacy) as well as extrinsic regulations (reward and performance goal) after the applications, whereas before the applications, they used more extrinsic regulations. The pre-service teachers' use of various strategies to regulate motivation regarding academic activities and their persistence and resoluteness for achieving goals showed that they were better motivated. The research applications provided the pre-service teachers the opportunity to regulate their motivation and they learned that they could regulate their motivation during academic activities. Peer modelling was performed using in-class discussions and through the subsequent sharing of the strategies applied by the pre-service teachers to regulate their motivation. Thus, the number of strategies that the pre-service teachers applied to regulate their motivation was considered to increase. The positive development in the pre-service teachers' motivational beliefs may attribute to the rise seen in the strategies they employed to regulate motivation. In their studies, Wolters (1998) and Wolters and Rosenthal (2000), disclosed a positive association between students' motivational beliefs and the motivational strategies they employed, and they reported that the more motivated the students were, the more they used multiple and various motivational regulation strategies, were persistent for academic goals, and sustained their effort.

### **Examination of the Change in Learning Strategies**

The findings showed that the frequency and variety of the pre-service teachers' cognitive strategies (rehearsal, organisation, elaboration and critical thinking) employed while studying the organic chemistry subjects and exams increased

after the application (Table 7). Thus, it is considered that the positive change in the pre-service teachers' motivations encouraged them to use cognitive strategies more often and motivated them to apply new strategies. The pre-service teachers who were motivated in the learning process seemed to work harder, endeavor, and try new things by undertaking the responsibility of their learning. The sharing of and discussion on cognitive strategies and peer and expert modelling in the classroom incentivized the use of new strategies by the pre-service teachers, as well.

The pre-service chemistry teachers' organisation of study time and environment, cooperation, and help-seeking attempts was found to increase when studying chemistry subjects and working exams after the application (Table 7). The favorable changes in the pre-service teachers' motivations are considered to stimulate them to adopt behaviors such as organizing their study environment and planning study time. The increase in the pre-service teachers' use of learning strategies may be explained by their acquisition of more accurate and tangible information regarding the study processes as a result of the diaries they kept as a recording tool. Similarly, a study by Bembenutty and White (2013) found that the use of self-monitoring forms improved student self-regulation skills, while a study conducted by Stoeger and Ziegler (2008), in which they provided students with the opportunity to evaluate learning processes, showed that self-regulation skills including time management, self-efficacy, self-monitoring, and learning skills were in fact able to be improved. Furthermore, Boekaerts and Corno (2005) reported that having students keep learning diaries contributed to the development of student self-regulation skills because it allowed them to keep records of their cognitive, metacognitive, and motivational behaviors and thoughts in the learning process. Shmitz and Wiese (2006) argued that student diaries including students' views regarding the course, what they learned, what they felt, what they did in the face of challenges and their comments, in brief, tangible, direct, and accurate information about learning processes, contributed to the expansion of student awareness of the learning process and to the betterment of their self-regulation skills.

It can be concluded that the formation of the study groups and the participation of the pre-service teachers in group studies explained the increase in their behaviors of help-seeking, collaboration, and learning from peers. Moreover, Jarvela and Jarvenoja (2011) found in their study that students' motivation increased by enabling them to collaborate via teaching applications that nurtured a cooperative environment, and that their strategies were able to be diversified through the sharing of strategies.

According to the results of the present study, the motivating learning environments improved the pre-service teachers' self-regulated learning skills. As a result of the applications the pre-service teachers became more self-directed learners through being aware of their learning processes. The use of semi-structured diaries in the applications made the pre-service teachers perform planning, monitoring and regulation by keeping records of the learning processes. Further, it can be argued that modelling and informative feedback, which are the elements of the teaching applications given in Table 1, helped the pre-service teachers to use SRL skills and to develop proper motivational beliefs in the learning processes. Through the creation of a favorable environment, wherein collaboration was facilitated through the study groups, the pre-service teachers were better motivated by learning about each other's strategies through the sharing of learning processes.

### Acknowledgement

This study is based on the doctoral thesis conducted by the first author under the supervision of the second author.

### References

- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.
- Bembenutty, H., & White, M. C. (2013). Academic performance and satisfaction with homework completion among college students. *Learning and Individual Differences, 24*, 83-88.
- Boekaerts, M. (1995). Self-regulated learning: Bridging the gap between metacognitive and metamotivation theories. *Educational Psychologist, 30*(4), 195-200.

- Boekaerts, M., & Corno, L. (2005). Self-regulation in the classroom: A perspective on assessment and intervention. *Applied psychology, 54*(2), 199-231.
- Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of educational research, 65*(3), 245-281.
- Cleary, T. J., & Zimmerman, B. J. (2004). Self-regulation empowerment program: A school-based program to enhance self-regulated and self-motivated cycles of student learning. *Psychology in the Schools, 41*(5), 537-550.
- Dignath, C., & Büttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. *Metacognition and learning, 3*(3), 231-264.
- Dignath, C., Büttner, G., & Langfeldt, H. P. (2008). How can primary school students learn self-regulated learning strategies most effectively?: A meta-analysis on self-regulation training programmes. *Educational Research Review, 3*(2), 101-129.
- Ekici F. (2015). Instruction of basic learning strategies to develop the self-regulated learning strategies of pre-service chemistry teachers, Doctoral dissertation, Ankara: Gazi University.
- Fraenkel, J. R. & Wallen N. E. (2006). *How to design and evaluate research in education*. (6th ed.), New York, NY: McGraw-Hill.
- Fuchs, L. S., Fuchs, D., Prentice, K., Burch, M., Hamlett, C. L., Owen, R., & Schroeter, K. (2003). Enhancing third-grade students' mathematical problem solving with self-regulated learning strategies. *Journal of educational psychology, 95*(2), 306.
- Guvenc, H. (2010). The Effects of Cooperative Learning and Learning Journals on Teacher Candidates' Self-Regulated Learning. *Educational Sciences: Theory and Practice, 10*(3), 1477-1487.
- Heaysman, O., & Kramarski, B. (2022). Promoting teachers' in-class SRL practices: effects of Authentic Interactive Dynamic Experiences (AIDE) based on simulations and video. *Instructional Science, 50*(6), 829-861.
- Hofer, B. K., Yu, S. L., & Pintrich P. R. (1998). Teaching college students to be self-regulated learners. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self-Regulated Learning: From Teaching to Self-Reflective Practice* (pp. 57-85). New York: Guilford.
- Järvelä, S., & Järvenoja, H. (2011). Socially constructed self-regulated learning and motivation regulation in collaborative learning groups. *Teachers College Record, 113*(2), 350-374.
- Kramarski, B., & Michalsky, T. (2009). Investigating preservice teachers' professional growth in self-regulated learning environments. *Journal of educational psychology, 101*(1), 161.
- 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.
- Little, J. W. (2002). Locating learning in teachers' communities of practice: Opening up problems of analysis in records of everyday work. *Teaching and teacher education, 18*(8), 917-946.
- Masui, C., & De Corte, E. (2005). Learning to reflect and to attribute constructively as basic components of self-regulated learning. *British Journal of Educational Psychology, 75*(3), 351-372.
- National Council for Accreditation of Teacher Education, (2002), Professional standards for the accreditation of schools, colleges, and departments of education. Washington, DC.
- Op't Eynde, P., De Corte, E., & Verschaffel, L. (2007). Students' emotions: A key component of self-regulated learning?. In *Emotion in education* (pp. 185-204). Academic Press.
- Perels, F., Gürtler, T., & Schmitz, B. (2005). Training of self-regulatory and problem-solving competence. *Learning and instruction, 15*(2), 123-139.
- Pintrich, P. R. (1999). The role of motivation in promoting and sustaining self-regulated learning. *International journal of educational research, 31*(6), 459-470.

- Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In *Handbook of self-regulation* (pp. 451-502). Academic Press.
- Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of educational psychology*, 82(1), 33-40.
- Pintrich, P. R., & Garcia, T. (1991). Student goal orientation and self-regulation in the college classroom. *Advances in motivation and achievement: Goals and self-regulatory processes*, 7(371-402).
- Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning?. *Educational researcher*, 29(1), 4-15.
- Randi, J. (2004). Teachers as self-regulated learners. *Teachers College Record*, 106(9), 1825-1853.
- Randi, J., & Corno, L. (2000). Teacher innovations in self-regulated learning. *Handbook of self-regulation*, 651-685.
- Schmitz, B., & Wiese, B. S. (2006). New perspectives for the evaluation of training sessions in self-regulated learning: Time-series analyses of diary data. *Contemporary educational psychology*, 31(1), 64-96.
- Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in science education*, 36(1), 111-139.
- Schunk, D. H., & Ertmer, P. A. (2000). Self-regulation and academic learning: Self-efficacy enhancing interventions. In *Handbook of self-regulation* (pp. 631-649). Academic Press.
- Smith, P. A. (2001). Understanding self-regulated learning and its implications for accounting educators and researchers. *Issues in Accounting Education*, 16(4), 663-700.
- Stoeger, H., & Ziegler, A. (2008). Evaluation of a classroom based training to improve self-regulation in time management tasks during homework activities with fourth graders. *Metacognition and Learning*, 3(3), 207-230.
- Uzuntiryaki-Kondakci, E., Demirdöğen, B., Akın, F. N., Tarkin, A., & Aydın-Günbatır, S. (2017). Exploring the complexity of teaching: the interaction between teacher self-regulation and pedagogical content knowledge. *Chemistry Education Research and Practice*, 18(1), 250-270.
- Weiner, B. (2010). The development of an attribution-based theory of motivation: A history of ideas. *Educational psychologist*, 45(1), 28-36.
- Winne P. H. (2001). Self-regulated learning viewed from models of information processing, Self-regulated learning and academic achievement: *Theoretical Perspectives*, 2, 153-189.
- Wolters, C. A. (1998). Self-regulated learning and college students' regulation of motivation. *Journal of educational psychology*, 90(2), 224.
- Wolters, C. A. (1999). The relation between high school students' motivational regulation and their use of learning strategies, effort, and classroom performance. *Learning and individual differences*, 11(3), 281-299.
- Wolters, C. A. (2003). Regulation of motivation: Evaluating an underemphasized aspect of self-regulated learning. *Educational psychologist*, 38(4), 189-205.
- Wolters, C. A., & Pintrich, P. R. (1998). Contextual differences in student motivation and self-regulated learning in mathematics, English, and social studies classrooms. *Instructional science*, 26(1), 27-47.
- Wolters, C. A., & Rosenthal, H. (2000). The relation between students' motivational beliefs and their use of motivational regulation strategies. *International journal of educational research*, 33(7-8), 801-820.
- Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational psychologist*, 25(1), 3-17.
- Zimmerman B. J., (2000). Attaining self-regulated learning: A social- cognitive perspective. In M. Boekaerts, P.R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13-39). San Diego: CA, Academic Press.
- Zimmerman, B. J. (2008). Investigating self-regulation and motivation: Historical background, methodological developments,

and future prospects. *American educational research journal*, 45(1), 166-183.

Zimmerman, B. J., & Kitsantas, A. (2005). Homework practices and academic achievement: The mediating role of self-efficacy and perceived responsibility beliefs. *Contemporary Educational Psychology*, 30(4), 397-417.

Zimmerman, B. J., & Schunk, D. H. (2004). Self-regulating intellectual processes and outcomes: A social cognitive perspective. In D. Y. Dai & R. J. Sternberg (Eds.), *Motivation, emotion, and cognition* (pp. 323-350). Routledge.

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