

Self-Regulated Learning Strategies Used by Students to Prepare Mathematics Exams

Belma Türker Biberⁱ
Aksaray University

Abstract

This study aims to determine self-regulated learning strategies used by students to prepare for mathematics lesson exams. The data were collected from high- and low-achievement students considering their general grade point averages and grade point averages in mathematics courses. The students were enrolled in the 7th grade of two different middle schools during the time of data collection. Case study method, which is a qualitative research approach, was used in this study. Data were collected with an interview form containing questions on potential sample events and situations that students may encounter while preparing for mathematics lesson exams. Descriptive analysis method was utilized for data analysis. Considering students' mathematics achievement and academic averages, it was concluded that the high-achievement students used all the strategies more or less, but the low-achievement students used only some of these strategies. According to the findings, these self-regulated learning strategies that used by low-achievers determined as self-assessment, seeking information and help, environmental regulation, and reviewing notes before maths exams.

Keywords: Self-Regulation Learning; Self-Regulation Learning Strategies; Mathematics Exams; Student Academic Achievement

DOI: 10.29329/ijpe.2022.459.16

ⁱ **Belma Türker Biber**, Assist. Prof. Dr., Department of Education, Aksaray University, ORCID: 0000-0002-0374-9493

Email: belmaturkerbiber@gmail.com

INTRODUCTION

It is significant for learners to organize their study methods, determine strategies, and gain awareness of the extent to which they have learned the subject under study. Acquiring such awareness at an early age enables learners to know how they learn new information, what they do to learn and understand, what they have to do, and at which level they can position themselves. Students' self-awareness and self-regulation regarding what and how they learn are significant skills emphasized in raising individuals, who are high-achievers, confident, and who have good time management both at school and in daily life.

“Self-regulated learning skills” are considered to be significant according to researchers due to its role in academic success (McCardle, Webster, Haffey, & Hadwin, 2017; Pintrich, 2004; Zimmerman, 1986). According to the social cognitive theory, which was influential in introducing the concept of self-regulation to the framework of education, self-regulated learning is a process in which learners set goals for their learning; monitor, evaluate and, if necessary, organize their knowledge, motivation, and behavior to achieve these goals (Zimmerman, 1989; Zimmerman & Schunk, 2001). In the self-regulated learning process, students should gain awareness on their learning behaviors and adjust their behaviors according to environmental conditions and employ different strategies. The self-regulation skill requires knowing various learning strategies that can be used in the learning process and using these strategies appropriately when necessary, and evaluating their effectiveness by monitoring the process (Sakız & Yetkin-Özdemir, 2014; Zimmerman & Schunk, 2001).

Zimmerman (1986) has revealed specific strategies employed in the learning process by the learners who possessed self-regulated learning skills. The majority of the other self-regulated learning models also include strategies used by students in the learning process and consider these strategies as significant. (Boekaerts, 1996; Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman, 2000). According to Zimmerman (1989; 1990), all the processes included in the learning process by students who have self-awareness, and the ability to evaluate themselves and adjust their behaviors to acquire knowledge, skills, and success are called “self-regulation strategies”. Zimmerman, Bandura, and Martinez-Pons (1992) analyzed these strategies in three dimensions by addressing them from a metacognitive, motivational, and behavioral perspective. According to their study, the students who have self-regulation skills and use the strategies (a) metacognitively; to set goals for themselves, organize studying plans to achieve these goals, determine the strategies to be used in the process, control, monitor, and evaluate the process; (b) motivationally; to cultivate intrinsic motivation taking into account the importance of achieving the goals and the returns (praise, success, awards, and so on.); (c) behaviorally; to create or choose the appropriate studying environment for learning to take place. Adding different dimensions to the self-regulated learning process, Zimmerman (1994, 1998), in his later studies, examined the concept in six dimensions and determined the strategies used in each dimension (Table 1).

Table 1. Dimensions of Self-Regulation and Strategies (Zimmerman, 1998)

Dimensions of Self-Regulation	Strategies
Motivational	Goal setting
	Self-Efficacy
	Self-judgement
	Task strategies
Methodological Time	Imagery
	Self-instruction
	Time management
Behavior	Self-monitoring
	Self-evaluation
	Behavior regulation
Environmental	Environmental structuring
	Noticing and removing distractions
Social	Selective help-seeking
	Choose partner, model or teacher

As Table 1 demonstrates, there are 14 strategies used by students in the self-regulated learning process, which consist of self-evaluation, organizing and transforming, goal-setting and planning, seeking information, keeping records and self-monitoring, environmental structuring, rewarding, rehearsing and memorizing, seeking social assistance, and reviewing notes and records (Sakız & Yetkin-Özdemir, 2014; Zimmerman and Pons, 1986; Zimmerman, 1998).

The success or failure of the students and the efficiency or inefficiency of the studying processes differ based on the self-regulation strategies used (Pape & Wang, 2003; Zimmerman & Martinez-Pons, 1986). Cognitive or metacognitive strategies used during studying play an essential role in the success of the learning process because it is much more important for students to study efficiently rather than studying for long hours (McCardle et al., 2017). Indeed, several studies show a positive correlation between the self-regulated learning strategies and students' success (Fuchs et al., 2003; Kaya, 2019; Turan, Demirel, & Sayek, 2009; Villavicencio & Bernardo, 2013; Zimmerman & Martinez-Pons, 1986). Fuchs et al. (2003) found that there is a significant relationship between the primary students' self-regulation strategies and their problem-solving performance. Villavicencio and Bernardo (2013) found a positive relationship between students' sense of achievement in trigonometry and the self-regulation strategies. Similarly, Turan et al. (2009) pointed out that using self-regulated learning skills created a positive change in students' academic success. Zimmerman and Pons (1986; 1988) found that the frequency of using self-regulated strategies was different for high-achieving and low-achieving high school students. Some of the recent studies conducted in Turkey examined the relationship between the use of self-regulated learning strategies and motivation, academic success, self-efficacy, cognitive and metacognitive skills (Demir & Budak, 2016; Kaya, 2019; Özçakir Sümen & Çalışıcı, 2017; Üredi & Üredi, 2005). Kaya (2019) reported that motivation, self-regulated learning strategies, and metacognitive awareness of 246 seventh graders were significantly correlated with mathematics achievement. These variables explained 46% of the variance of mathematics achievement. In a study carried out with 158 eighth graders, Özçakir Sümen & Çalışıcı (2017) found that motivation and self-regulation strategies predicted mathematics achievement. Demir and Budak (2016) examined the relationship between the fourth graders' academic success in the mathematics class and their self-regulation strategies, metacognitive skills, and motivation. They suggested that motivation created the biggest impact on success, followed by self-regulation strategies and metacognitive skills, respectively. As the overall result of the studies, the self-regulated learning strategies used by students were found to be a significant factor affecting students' academic success.

Mathematics is known to be a subject that students struggle with and employ many strategies to be successful. Although there are many quantitative studies in the literature that demonstrate the positive relationship between self-regulation strategies and success, there is not a qualitative study that examines the link between strategies and written mathematics exams. In this context, the study's starting point is to reveal the strategies used by high-achieving students in mathematics. By determining the strategies employed by the high-achieving students in mathematics during their learning process, strategies which the low-achieving students lack can also be ascertained. Therefore, this study plays an important role in determining the strategic factors affecting the students' success or failure regarding the mathematics class and exams. Accordingly, the aim of the study is to reveal which of the self-regulated learning strategies determined by Zimmerman and Pons (1986) are employed by the high-achieving and low-achieving seventh graders during the preparation for mathematics exams. In this context, the research questions have been determined as follows:

- Which self-regulated learning strategies are used by high- and low- achieving students while studying for the math exams?
- How do the self-regulated learning strategies used for studying for mathematics exams differ between high- and low-achieving students?

METHOD

Research Model

Case study method, which is a qualitative research approach, was used in this study. Case studies focus on in-depth research of individuals' experiences and opinions based on a case or event. (Creswell & Poth, 2016; Patton, 2002). Considering the use of strategies by the students as a case, the appropriate research design in terms of the research questions was determined as a singular case. In singular case studies, the researcher focuses on an event or a problem and then selects a situation to unveil this problem or event (Creswell & Poth, 2016; Yin, 1994).

Research Sample

The study group included six students selected from the 7th graders of two different middle schools. In qualitative research, the sample size can be determined by the richness and depth of the data (Stake, 2000; Yin, 1994). According to Yin (1994), if the most comprehensive data about the case can be obtained from a single person, the sample of the data may even be a single person. We determined that we reached data saturation as we received recurring and similar responses based on the data collected from 10 students included in the main (6) and pilot (4) interviews. Criterion sampling, one of the purposive sampling methods, was used to select participants. In this method, the event, case, or people to be examined are selected according to certain criteria (Patton, 2002). In selecting students, their overall academic success and success in math courses were determined as the criteria. According to these criteria, the students whose academic average and mathematics lesson grades were high and low, in other words, high-achieving and low-achieving students were included in the study group. Of the six students in the study group, three students (Ö1, Ö2, Ö3) were categorized as high-achievers, while the other 3 (Ö4, Ö5, Ö6) were categorized as low-achievers. Considering the first written math exam grades in the fall semester of the 2019-2020 academic year, all the high-achieving students got 100 while the low-achieving students' grades got 30, 45, and 55. It was found that the students' grade point average (GPA) and final math grades in previous years were similarly high for the high-achieving students and low for the low-achieving students.

Data Collection Tools and Procedure

Data were collected through semi-structured interviews. By taking into account the self-regulated learning strategies determined by Zimmerman and Pons (1986), an interview form with 25 questions was prepared to conduct the in-depth interviews with the participants. The interview form was first presented to 5 researchers who expert in mathematics education and took courses in self-regulation and qualitative research at the mathematics education PhD level. After getting their critical reviews on the form, it was assessed objectively. Then, the content and construct validity of the form was established by a researcher who is an expert in self-regulated learning and qualitative research and observed the entire research process. According to the field expert's opinion, some questions were combined, and the form was condensed to 21 questions. The necessary corrections to this interview form were made by asking the expert's opinion on language and semantics. The interview form was given its final form following the pilot interviews carried out with two high-achieving and two low-achieving students selected through the criterion sampling method from schools. Several sample questions from the interview form are as follows:

“How many days before the exam did your teacher tell you the date of the math exam?”

“What did you feel when you learned the date?”

“Let's say, you have five days before the math exam, and you haven't done any preparations yet... What would you do?”

“If you didn't understand a topic while studying for the exam, what would you do first?”

Each student was informed that they would talk about “how they study for math exams” before the interviews. Interviews took approximately 35-40 minutes with each student. They were recorded by a voice recorder with the students' permission. The interviews took place in the school counselling service office, which was a quiet environment.

Data Analysis

The results were obtained by the descriptive analysis method used in qualitative research. The interview data in the voice recorder were first translated to text. Then, texts were analyzed by considering self-regulated learning strategies given in Table 2 determined by Zimmerman and Pons (1986). In the analysis process, the converted data were coded twice with two weeks interval by the researcher. Researcher triangulation was used to increase the research's reliability (Merriam, 2009). Following the researchers' coding, the coding was simultaneously presented to 5 researchers who specialized in mathematics education and took courses in self-regulation and qualitative research at the PhD level. An objective examination of the coding was ensured. Lastly, a lecturer who specialized in self-regulated learning and qualitative research was asked to examine the coding for researcher triangulation. Regarding the coding, 95% consensus between the researcher and the expert was observed. Consensus was reached after reviewing transcripts and audio recordings in cases of disagreement. Thus, the categories of self-regulation strategies were clarified, and the data were interpreted.

Table 2. Self-regulated Learning Strategies (Zimmerman and Pons, 1986)

Self-regulated Learning Strategies	Definitions of Strategies and Examples
1. Self-evaluation	Statements that show students' evaluation about the quality or progress of their work, for example, "I check my work to make sure I've done it right.", "That's the number of questions I got right on the exam."
2. Organizing and transforming information	Statements that show the instructional materials have been rearranged to improve open and latent learning, for example, "I prepare an outline before I write the final version of my essay.", "I underline the important parts about the subject."
3. Goal-setting and planning	Statements that show students' educational goals or sub-goal setting and plans for sorting, scheduling, and completing the activities related to these goals, for example, "I start studying and reading two weeks before the exams, then, speed myself up."
4. Seeking information	Explanations that show students' efforts to research as much information as possible during their duties such as doing assignments and studying for the exams, for example, "Before I start writing my term paper, I go to the library to obtain as much information as possible about the subject".
5. Keeping records (notes) and monitoring	Explanations that show students' efforts to record activities that they've initiated or results, for example, "I noted down the class discussion." "I kept a list of the words I got wrong."
6. Environmental conditions structuring	Explanations that show student's efforts to choose or organize the physical environment to facilitate learning, for example, "I turned off the radio so that I can focus on what I'm doing."
7. Reward (punishment)	Statements that keep students motivated and show the students' expectation of a reward or punishment they will get when they achieve or fail to achieve their goals, for example, "If I succeed in this exam, I can go to the cinema with my friends."
8. Rehearsing and memorizing	Explanations that show student's efforts to memorize the material with an open or latent practice, for example, "While preparing for a math exam, I keep writing until I can remember the formula."
9-11. Seeking social assistance	Explanations that show students' efforts to seek assistance from their teachers (9), friends (10), or adults (11), for example, "If I have problems studying math, I ask a friend for her/his help."
12-14. Reviewing notes and records taken during the class	Preparatory work such as student's rereading (12) notes or textbooks (13) or (14) solving questions from test books for the exam preparation, for example, statements such as "While preparing for the exam, I review my notes in my notebook."

Ethical

Validity and reliability studies in qualitative research are achieved by credibility, consistency (reliability), confirmability (certifiability), and transferability criteria (Stake, 2000). According to Creswell (2003), accuracy can be proved by observation of certain credibility strategies. Reducing researcher bias, participant confirmation, and triangulation were used to increase the credibility of this research (Başkale, 2016). Although researchers were aware that the relevant literature findings revealed that high-achieving students' self-regulation skills were at a reasonable level, researchers aimed not to be affected by the previous results not to project these findings on the present study. Thus, they listened to both the high-achieving and low-achieving participants with an open mind, and unbiased attitude; and did not make any changes in the data. After the interviews, the students' views were collected and summarized for the students, thereby attaining participant confirmation to make sure that the data were understood correctly. Researcher triangulation was used by taking the opinions of the researchers specializing in mathematics education. In terms of transferability of the research, the collected data were supported by the students' quotes, and thus detailed descriptive method was used. In addition, the purposive sampling method was used to recruit students who can be classified as high-achievers and low-achievers based on their GPA and mathematics lesson grades. Researcher triangulation, methods for reducing researcher bias, and participant confirmation were used to increase the research data's consistency (reliability) and confirmability (certifiability).

FINDINGS

In this section, the findings are sequentially presented in line with the research questions.

What are the Self-Regulated Learning Strategies used by High and Low Achieving Students?

The research findings have revealed that the students who can be classified as either high-achievers or low-achievers considering their academic averages use almost all self-regulated learning strategies while studying. It was found that self-regulation strategies, used by all the high-achieving students, were not sufficiently used by the low-achieving students as demonstrated in Table 3. Findings indicate that the low-achieving students used strategies such as self-evaluation, seeking information, environmental structuring, seeking assistance from the social environment, and reviewing notebooks before the exams. According to the findings, the low-achieving students did not use the main strategies that support self-regulated learning, such as organizing and transforming information, goal-setting, planning, and so on.

Table 3. Use of Self-Regulated Learning Strategies

Self-Regulated Learning Strategies	High-achieving Students			Low-achieving Students		
	S1	S2	S3	S4	S5	S6
1. Self-evaluation	√	√	√	√	√	√
2. Organizing and transforming information	√	√	√	-	-	-
3. Goal-setting and planning	√	√	√	-	-	-
4. Seeking information	√	√	√	√	√	√
5. Keeping records (notes) and monitoring	√	√	√	-	√	-
6. Environmental conditions structuring	√	√	√	√	√	√
7. Reward (punishment)	√	√	√	-	-	√
8. Rehearsing and memorizing	√	√	√	-	√	√
9-11. Seeking social assistance	√	√	√	√	√	√
12-14. Reviewing notes and records taken during the class	√	√	√	√	√	√

How does the Use of Self-Regulated Learning Strategies Differ between High and Low Achieving Students?

The data on how the use of self-regulated strategies by the high-achieving and low-achieving students are presented under separate headings, as follows:

Goal-Setting and Planning

The participants were asked whether they made a study plan for math exams and what they did during the goal-setting and execution process to acquire knowledge and skills related to the exam topics. The situations and the questions presented to the participants in this regard were as follows:

“Your teacher set the date for an exam within the term. What would you do first?”

“Let’s say, you will start studying for the last math exam of this term... You have a week and seven days until the exam... What would you do? What would you do first?”

Based on the responses about this strategy, it was found that one high (S1) and one low-achieving student (S4) went to a private education center to prepare for the high school entrance exam, and a study program was prepared by the private education center. Despite the existence of such a plan for both students, they said that neither of them followed this program. However, it was concluded that the high-achieving student (S1) had their own program involving daily plans, instead of following the study program made by the education center. S1 made the following statement about the program she made for her goals:

“For example, you are expected to have dinner between 8:00 and 8:30 at the education center and study between x and y hours without giving any break. I’m not doing like that. I have dinner when I feel like it and I take a break as much as I want.”

S1 expressed that as soon as she learns about the exam date from the teacher, she creates a schedule in line with the dates of the other exams, both in her mind and in her planning notebook. She starts studying immediately, following this schedule. Besides, the student also goes over the topics and solves tests almost every day. Therefore, the student does not get worried about not being able to cover or finish the exam topics when the exam date is determined. The student just focuses more on studying for the exam. The other two high-achieving students who do not go to the education center (S2, S3) stated that they do not make a special preparation for the exams. They have a general study program and always solve a test for each subject daily. S3 said that he prepares a 100 problem test by tearing the tests out of books and stapling them together and he sets a goal to finish his tests in 2 hours after finishing daily homework. The student stated that he received help from his parents for the preparation of these tests and time monitoring. Thus, the student does not have many topics left to study until the exam and the student increases the number of math tests only during the last days before the exam. Below are the excerpts from S3’s statements that prove his situation:

S3: “Normally I solve 100 math problems (daily). My mother and I made the program. I finish them in 2 hours according to my plan. I used to solve 100 problems for each subject. I realized that I got bored. I was feeling like I wasn’t going to finish them as the book had too many pages. Now we’ve extracted the 20-question tests from the book and stapled them separately. I solve 100 math problems for 5 subjects, I’ve realized now it is better for me.”

The low-achieving student, S4, does not follow the program made by the education center, neither does he prepares a study plan. The student did not make a statement regarding his family’s support for this process. The student stated that he could not follow the education center’s program because he has difficulty in doing the homework given by the education center and school on time, so the only time the student is interested in studying is when he needs to take care of the homework and he does not do any daily review either. One of the findings observed in the interview is that the student, who does not do any periodic review, seemed to use the phrases such as “doing a test” and “solving problems”, which obviously result from the exam system and private education centers. S4

stated that he gets worried and anxiety when teacher announces the exam date. To the following questions:

R: *What do you do for your math exam anxiety?*

S4: *I solve math problems and I save the ones I can't solve.*

R: *Do you start studying immediately?*

S4: *No, I don't start studying right away because I've got other exams, too. So I start a week later.*

The other low-achieving students S5 and S6 do not prepare a study program, either. It was determined that neither of the students set a goal during the study process and they do not have a regular (daily) study plan either. The statements of S5 and S6 regarding the aforementioned questions are as follows:

S5: *I don't set a goal, but I do now and then... For example, I think maybe I'll finish rational numbers. Sometimes, guests come over or sometimes we visit them.*

R: *Did you make a plan while studying for the exam from which you got 45 in this term?*

S5: *No, I did not.*

R: *Do you set goals while studying for the math exams? Do you have a general study plan?*

S6: *I don't make plans. When I go home, I have some snacks and I have some rest. I watch TV, then we have dinner around 7 pm. I do some reviews for the lessons for an hour. Then, I watch TV a bit and go to bed.*

Based on the statements of S4, S5, and S6, these students' studying styles differed from those of S1, S2, and S3. While the high-achieving students talk about reaching their goals within a study program, the low-achieving students appear not to have a planned study process.

In the light of these statements, the high-achieving students, who are good at using the "goal-setting and planning" strategy as determined by Zimmerman and Pons (1986), can create a study plan by setting their own goals. They can monitor themselves in this regard. Compared to the low-achieving students, they study in a more systematic and planned manner.

Rehearsing and Memorizing

The high-achieving students review the lectures and solve tests almost every day apart from their preparation for the exams. It has been found that the students divide the topics into days while preparing for the exams, so they spend less time studying for the topic explanations. They focus more on solving tests since they usually review the topics every three-four days. The students also stated that they memorize math formulas by writing them down, reading them over and over again, and solving more problems on the topic. A statement from S2 is presented as follows:

S2: *I've divided the topics in my sourcebook into weeks. There are a certain number of math problems to be solved for each topic every week. I study until I reach the number that I set for a topic. That is, I study regularly learning the topics and in addition I prepare for the exams. I just read my notes in my notebook the last two days before the exam and, I solve more math problems. It is not something different. That's my usual way of studying.*

The low-achieving student S4 stated that since there are also other subjects that he has to study for, he studies by dividing the topics into days, and he tries to solve the problems that he has not been

able to solve before and he goes over the topics when he fails to solve these problems. Stating that he does not review periodically, he repeated the phrase “doing a test” in reference to his exam preparation. During the interviews about reviewing and memorizing, the following dialogue took place between the researcher and the low-achieving student S6:

R: Suppose a friend of yours told you that “I studied for the math exam yesterday” ... What do you think she/he did? What does “I studied for math” mean for you?

S6: I write down the explanations from the textbook in my notebook, and memorize. The teacher tells us the parts that can be asked in the exam and I study them. I study for about an hour, I go over my notebooks for 15 minutes for each subject every evening...

Examining S6’s statements, the student uses several strategies such as reviewing and memorizing, though, not effectively. Similarly, S5 also memorizes the parts that the teacher emphasizes. As for reviewing the lectures, the student stated that she resolves the problems in her notebook.

Thus, the findings of the study have revealed that all the high-achieving students use this self-regulated learning strategy and two of the low-achieving students also use it, but not effectively. One low-achieving student stated that he never used this strategy.

Seeking Information

The students were asked how they reached the knowledge for studying exams. According to their responses, the high-achieving students consider their notebooks as the primary source to understand their teacher’s question style. In addition to their notebooks, they stated that they also rely on books that include “good-quality questions” and they use sourcebooks supplied from the training center or some other places. In addition, one of the high-achievement students, S3, stated that he watches video lessons on some websites about the topics he has not understood in addition to his notebooks and sourcebooks. Similarly, the low-achieving students review their notebooks and test books as a primary source to reach information. One of the low-achieving students, S5, gave the following statements about this strategy:

S5: I got a test book. Sometimes I bring it to the class, but I usually review my notes for the exams since we write down the things the teacher says. However, I check out the book, too.

Based on the statement by S5, the student uses her notebook and test book as a primary source to reach information. However, considering the fact that the student checks out the book “sometimes”, it can be noted that the student does not effectively use the self-regulated strategy of selecting suitable sources in seeking information.

In conclusion, all the high and low achieving students use the “seeking sources for information” strategy; however, high-achieving students use this strategy more effectively.

Regulating and Organizing Information

The participants were asked about the self-regulation strategy of regulating and organizing information. They were occasionally asked supporting questions such as parallel form questions. From the point of expression of low-achieving students, it was observed that they were not able to evaluate what they knew, what they were required to know, and how they could organize what they had learned. Almost all of the students answered as ‘I try to solve the questions that I do not understand’.

When the students were asked what they had done to organize what they knew and did not know, while preparing for an upcoming exam, S4 answered: “I write down the questions that I don’t understand about that a particular topic, and I try to solve them at weekends.” When the student was

asked about how he proceeds when he thinks that he ran into something of importance, and answered that he did not take any notes. It seemed that the student was not sure about what he really knew and what he had to improve. Therefore, the student could not organize what he knew and what he needed to learn. It was observed that S4 constantly talked about the questions he could not solve and how he planned to solve them later on. Similarly, S5 and S6 said that ‘I would solve the questions on my notebook and sourcebook.

It was determined from the answers of the high-achieving students that they actually pay attention to this strategy during their studies. These students first determine their topics of emphasis, and then take a look at their notes. They also emphasized that the notes are essential for them since the questions are prepared by their teachers. While the study, they develop questions similar to what their teachers may ask on the exam and turn to other resources to find answers to them. They also take notes which remind them of the definitions used. Furthermore, they summarize the entire topic in all lessons and just create a shorter version of their notes in an attempt to make sense of the topic in all those notes. A statement from S1 is written as follows:

“I first collect all the topics together where I can visualize them...Then, I determine the topics that I might run into in the test. For example, ratio and proportion. I note down important information about the topic. I go ahead and add some similar questions as well as additional info. I basically write down tricks that will help me solve questions about that particular topic.”

To the question “Do you follow a specific method to get ready for your math exam?”, the low-achieving students answered “no”; while the high-achieving students indicated that they first revise the topics, see if they have anything missing or a mistake in their notebooks about the topic, and then practice by solving questions about the topic, later on. High-achieving students expressed that this strategy does not only apply to math, but also to all the other courses they take. They added that this strategy helped them understand better and take better notes.

Keeping Notes/Records and Monitoring

Due to its nature, math includes many formulas and statements that students may not always understand. How students retain math formulas and the complex information they need to remember is considered among the self-regulated learning strategies. It was found that when the low-achieving students do not understand some terms or formulas they are supposed to remember; they usually revise them, review their notes, and not use any additional other methods. It is understood from the following statement of student S4 that he could not proceed with this strategy effectively:

S4: *“When I find something challenging, I go back and revise the topic all over again, and then I take another look at the question I couldn’t solve”.*

S4: *“I do not take notes, I just gather all the questions I could not solve and I deal with them on Saturdays.”*

Some of the conflicting statements of low-achieving students on whether she/he can use the ‘taking notes and reviewing’ strategy include “I don’t take notes, I just gather the questions I can’t solve, and I try to solve them on Saturdays”. Determining these questions in the first place could be considered as ‘reviewing’ in terms of going over the questions she/he fails to solve. However, they do not mention using techniques such as determining topics that require extra studying, noting, marking or highlighting the parts that they do not understand. Student S6 did not mention taking notes or keeping a record of information. S5 said that she took notes whenever she thought the teacher was telling something important.

S5: *“When the teacher starts talking about something, she tells us not to start taking notes, but my friend and I still take notes just in case she may ask about them in an exam.”*

Although the statement indicates that S5 uses the note-taking strategy, she cannot conceptually express why she took these notes. The student simply justifies her need to take down notes by noting that the relevant information could be seen on an exam. Although the student uses the technique, it could not be stated as efficient.

It was understood that high-achieving students learn important information by writing them down on colorful papers or highlighting the information. High-achieving students S1 and S3 stated that they write down the definitions or formulas, which they could not learn right away, on small colored papers and stick them on the wall. Thus, they learn them since they keep them in sight all the time. Here are some examples of students' statements:

S1: *"I write down the summaries and notes on pieces of blue, green, pink paper, I write them especially bigger with colorful pens to make sure they are visible. I stick them to the places next to my bed, my desk, and everywhere."*

S2: *"There is also another way that our teacher suggests, I write down the information that I need to remember, especially formulas, on colorful post-it-notes and hang them on my wardrobe. When I wake up or come home, I read them over and over again while I get dressed."*

S3 stated that he takes notes of the important parts of what the teacher says during the class, underlines them with a red pen, and also underlines the important parts in the books. Thereby, the student makes them more visible to learn easily. The following dialogue took place between the high-achieving student, S1, and the researcher, as the student explained another way of note-keeping that she only uses at the private education center:

S1: *I have seen it from a friend of mine... It doesn't happen at school but the teacher at the education center makes us take notes... I take these notes in A4 papers, then copy them into my notebooks at home.*

R: *Why are you using such a technique?*

S1: *To review it one more time. Because I write them once, I learn by writing them down, polish my knowledge while copying them into my notebook, I go over them one more time and when I solve problems. This means I've already repeated them four times. So I understand them.*

Reviewing the Class Notes and Records

The strategy of reviewing the notes and records taken during the class is the common strategy used by both groups of students. Both of the groups go over the notes that the teacher makes them take in their notebooks. It was concluded that students always go over their notes and books to remember the information and review the sample questions. Some excerpts are presented below on reviewing notes.

S3: *While studying for the exams, I first check out the notes taken during the class, especially the parts with explanations, then, I go on to solving problems. I read the class notes until I understand.*

S5: *While studying, I check out the things that the teacher asked us to write in our notebooks because the exam questions are prepared by our teacher. I study from my notebook and answer the questions.*

Structuring Environmental Conditions

Students' arrangement of their study environment is also one of the strategies determined by Zimmerman and Pons (1986). This strategy can be considered as a commonly used strategy. All the students have a room and study desk. However, one of the low-achieving students, S4, shares his room with his other two siblings, while the high-achieving student, S1, is the only child at home since her

elder sisters are studying in another province. Despite having a large study space at home, S1 expressed that she still does not study at a desk and she prefers to study by lying on the carpet, instead. The high-achieving student, S3, stated that he studies next to his mother in the living room while his younger brother is sleeping. The student studies in her/his room when his brother wakes up. S3 stated that he needs his desk to be tidy and he can only study in a quiet environment. Some of the statements of the student are presented below:

S3: On my desk... I put all my sourcebooks in the furthest right corner. Next to them, I put my reading books and pencils. First I do the tests in my extras, after finishing and checking them, I read my storybooks. I also need silence. TV in our house is turned on only at night, not during the day, so there is no noise at home. I've never been interested in music; I can't study while listening to music."

The low-achieving students S5 and S6 prefer studying at a tidy desk. Both high-achieving and low-achieving students stated that they would not feel comfortable while studying in a noisy environment or the presence of music.

Seeking Assistance from Social Circle

It has been concluded that all the participants always get help when they have difficulty in understanding some topic or solving a problem. All of them first check out their notes for the exam questions or topics they have difficulty in understanding. If they still struggle, they consult the closest family member as the final solution. This family member is the elder sister or brother for both group of students. For example, the high-achieving student, S1, consults the topics she has difficulty with by calling her elder sister or taking a remedial class at the private education center and asking her/his teachers directly. S2 stated that he runs after the teachers, asking them these questions until he understands. On the other hand, S3 said that he first reads the problems that he cannot solve or the topics that he cannot understand over and over again, then watches videos online and tries to solve the problems again. If he still does not understand after these attempts, he gets help from his father:

S3: I read from the beginning till the end, for example, from page 50 to page 80, I read those 30 pages. It doesn't matter whether it is long or short. I solve problems afterwards. Then, I watch videos online. If I still don't understand, my father is a teacher and I ask him. But I'm already good at math and I usually understand. There are a few things that I don't understand.

The use of this strategy is similar for the low-achieving students. One of the low-achieving students, S4, receives support from his circle by attending remedial classes at the private education center or receives help from his elder sister about the problems he cannot solve. S5 stated that she consults to her elder sister in the 8th grade, who is studying for the high school entrance exam while S6 consults her sister in high school about the topics and math problems he was not able to understand. Low-achieving students did not express getting any assistance from their parents.

Reward/ Punishment

Another strategy that can be used to differentiate between the high- and low-achieving groups of students was found to be the reward and punishment strategy. As for this strategy, one of the high-achieving students, S1, stated that he rewards herself with fun activities, watching TV and taking a rest. After finishing with her homework and studying, she watches TV and meets her friends at weekends. The low-achieving students do not seem to reward themselves when they achieve their goals or punish themselves when they fail to show the performance since they do not study within a plan or program. S1 stated that she would study more for the following exam when she received a poor grade. However, when she was asked about the meaning of "studying more", it was understood that the student does not try to do anything to punish herself.

Self-Evaluation

The self-evaluation process was the common strategy for all the participants. Although differences in their studying styles of the high- and low-achieving students, they assess themselves according to their right answers on the tests depending on the exam system. It was concluded that performing self-evaluation means marking the right answers in the test. Therefore, they gave similar responses to the interview questions about this strategy.

S3: For example, having 4 mistakes out of 20 in a test means a lot for me because 4 out of 20 means 1 in 5. I check out where I did wrong, then I go over those topics.

S2: If I have a few mistakes, it means I'm successful.

S5: To succeed in the math exam, I need to solve problems and teacher's questions by myself. I should be solving the problems the teacher asked us. If I study more for the lessons and solve more math problems, it means I'm good at math.

S6: If my answer to the problem is correct, it means I've understood the topic.

CONCLUSION AND DISCUSSION

There are several factors affecting success. The methods that high-achieving students use to study for their courses is a matter of curiosity for most people. In the same token, the methods that low-achieving students fail to use while studying and factors that impede their success are a piece of critical knowledge for mathematics education. From this point of view, the study aimed to examine the use of the self-regulated learning strategies by high-achieving and low-achieving students as grouped based on their GPAs and math grades. This research concluded that the students considered within the high-achievers category used almost all the strategies while the low-achieving students used only some of the strategies. In addition, it was found that the high-achieving students used the self-regulated learning strategies effectively for the preparation of math exams while the low-achieving students did not use these strategies efficiently. Thus, it can be concluded that the low-achieving student's ability to use self-regulation strategies is low.

The findings of this research confirm previous studies that examined the relationship between self-regulated learning strategies, motivation, cognitive skills, and academic success, and found that the students who have low academic success do not use self-regulated strategies effectively (Kaya, 2019; Özçakir Sümen & Çalışıcı, 2017; Pintrich, 2000, 2004; Schunk, 2005; Zimmerman & Schunk, 2001). In the light of these studies, it can be concluded that one of the reasons for students' low academic achievement is their lack of use of the self-regulated learning strategies. Based on this conclusion, it can be suggested that positive interventions can be designed to increase the use of self-regulation strategies and to overcome the shortcomings in low-achieving students' study methods (Zimmerman & Martinez-Pons, 1988). Self-regulation strategies and various educational activities regarding their use should be included in the curriculum and teachers should include these activities in the classroom to promote student achievement. According to Kistner et al. (2010), teachers should try to teach or improve these strategies directly or indirectly by performing them in teaching activities, continuously telling students what they should do directly, or creating suitable learning environments. It can be suggested that teachers can be more mindful of teaching self-regulation skills especially to the low-achieving students (Veenman, 2005).

Pape and Wang (2003) suggested that self-regulated learning strategies used by primary school students with high and low academic success vary. High-achieving students display more strategic behaviors and do not use strategies different from the ones the low-achievement students use (Pape & Wang, 2003). This study concluded that high-achieving students use more self-regulated learning skills and they perform them effectively during their preparation for the math exams. The strategies frequently used by high-achieving students are self-evaluation, organizing and associating

knowledge with other information, goal-setting, and planning, seeking information, and reviewing and memorizing. These strategies seem to contribute to success in math exams. Pape and Wang (2003) have stated that during the problem-solving process, high-achieving students frequently use strategies such as seeking sources for information, seeking social assistance, goal-setting and planning, organizing information. Students' awareness about strategies they use for math enables them to decide what they should do and not do in order to become successful. Thus, students make some inferences about what they have done in the exam, where they have achieved success and which self-regulation behaviors they should perform more effectively to attain a much better performance in future exams. Since high-achieving students know what they know and what they should learn within their metacognitive skills, they set goals for themselves, plan the required strategies, find suitable learning materials by identifying the topics they have not understood, and ask for help when needed. Therefore, the high-achieving students have self-control during the exam preparation process and they monitor, evaluate and adjust their learning performance (Bland, 2005).

The results of this study show that low-achieving students do not use most of the strategies. However, they use self-evaluation, environmental structuring, asking for assistance from social environment, and reviewing the notes taken during class. It can be suggested that the students cannot tackle the problems on their own and need assistance from their social environment. They can perform self-evaluation through the correct test answers due to the examination system. It has been concluded that low-achieving students do not use the primary and main self-regulation strategies such as preparing a study plan, goal-setting, organizing information, which are specifically emphasized for high achievement in the exams.

According to the results of the study, the following suggestions can be made: Considering that one reason for low academic achievement is students' lack of strategy use, learning programs should be developed for students to improve their self-regulation skills and use these strategies effectively. In addition, classroom environments where the activities for their self-regulation skills are carried out should be created. Low-achieving and high-achieving students in the same classroom environment can be included in collaborative group works. Thereby, these strategies can be taught through peer learning or at least students can be encouraged to use them. In the research, the results were obtained through the students' academic status (high-achieving and low-achieving students) and their strategies. In future studies, examinations analysis regarding the use of strategy and other variables can be carried out by observing the students' academic success with high and low self-regulated learning skills, in terms of different factors.

REFERENCES

- Başkale, H. (2016). Nitel arařtırmalarda geerlik, gvenirlik ve rneklem byklğnn belirlenmesi. *Dokuz Eyllnn Hemřirelik Fakltesi Elektronik Dergisi*, 9(1).
- Boekaerts, M. (1996). Self-regulated learning at the junction of cognition and motivation. *European psychologist*, 1(2), 100.
- Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*: Sage publications.
- Demir, M. K., & Budak, H. (2016). İlkokul Drdnc Sınıf ğrencilerinn z Dzenleme, Motivasyon, Biliř st Becerileri ile Matematik Dersi Bařarilarinin Arasındaki İliřki. *Dokuz Eyllnn Buca Eđitim Fakltesi Dergisi*, 41, 30-41.
- Fuchs, L. S., Fuchs, D., Prentice, K., Burch, M., Hamlett, C. L., Owen, R., & Schroeter, K. (2003). Enhancing third-grade student's mathematical problem solving with self-regulated learning strategies. *Journal of Educational Psychology*, 95(2), 306.

- Kaya, D. (2019). Yedinci Sınıf Öğrencilerinin Matematik Başarılarının Yordanması: Motivasyon, Öz-Düzenleyici Öğrenme Stratejileri ve Üst Bilişsel Farkındalığın Rolü. *Ondokuz Mayıs Üniversitesi Eğitim Fakültesi Dergisi*, 38(1), 1-18.
- McCardle, L., Webster, E. A., Haffey, A., & Hadwin, A. F. (2017). Examining students' self-set goals for self-regulated learning: Goal properties and patterns. *Studies in Higher Education*, 42(11), 2153-2169.
- Merriam, S. B. (2009). *Qualitative Research*. San Francisco, CA: Jossey Bass.
- Özçakir Sümen, Ö., & Çalışıcı, H. (2017). Sekizinci Sınıf Öğrencilerinin Özdüzenleme Stratejileri ve Motivasyonlarının Matematik Başarıları Üzerindeki Yordayıcı Etkileri. *Dicle University Journal of Ziya Gokalp Education Faculty*(30).
- Pape, S. J., & Wang, C. (2003). Middle school children's strategic behavior: Classification and relation to academic achievement and mathematical problem solving. *Instructional Science*, 31(6), 419-449.
- Patton, M. Q. (2002). *Qualitative Research and Evaluation Methods*. Thousand Oaks, CA: Sage.
- Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In *Handbook of self-regulation* (pp. 451-502): Elsevier.
- Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. *Educational psychology review*, 16(4), 385-407.
- Sakız, G., & Yetkin-Özdemir, İ. E. (2014). *Özdüzenleme: öğrenmeden öğretime özdüzenleme davranışlarının gelişimi, stratejiler ve öneriler*: Nobel.
- Stake, R. E. (2000). Case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (2nd ed., pp. 435-454). Thousand Oaks, California: Sage Publications.
- Turan, S., Demirel, Ö., & Sayek, İ. (2009). Metacognitive awareness and self-regulated learning skills of medical students in different medical curricula. *Medical teacher*, 31(10), e477-e483.
- Üredi, I., & Üredi, L. (2005). İlköğretim 8. sınıf öğrencilerinin öz-düzenleme stratejileri ve motivasyonel inançlarının matematik başarısını yordama gücü. *Mersin Üniversitesi Eğitim Fakültesi Dergisi*, 1(2).
- Villavicencio, F. T., & Bernardo, A. B. (2013). Positive academic emotions moderate the relationship between self-regulation and academic achievement. *British Journal of Educational Psychology*, 83(2), 329-340.
- Winne, P. H., & Hadwin, A. F. (1998). *Studying as Self-regulated Learning* (D. J. Hacker, J. Dunlosky, & A. C. Graesser Eds. Metacognition in educational theory and practice ed.). Mahwah, NJ: Lawrence Erlbaum Associates.: Routledge.
- Yin, R. K. (1994). *Case study research: Design and methods* (2nd ed.). Thousand Oaks, California: Sage Publications.
- Zimmerman, B. J. (1986). Becoming a self-regulated learner: Which are the key subprocesses? *Contemporary educational psychology*, 11(4), 307-313.
- Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology*, 81(3), 329.

- Zimmerman, B. J. (1994). Dimensions of academic self-regulation: A conceptual framework for education. *Self-regulation of learning and performance: Issues and educational applications, 1*, 33-21.
- Zimmerman, B. J. (1998). Academic studing and the development of personal skill: A self-regulatory perspective. *Educational psychologist, 33*(2-3), 73-86.
- 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. 13-39). London: Elsevier Academic Press.
- Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal, 29*(3), 663-676.
- Zimmerman, B. J., & Martinez-Pons, M. (1986). Development of a structured interview for assessing student use of self-regulated learning strategies. *American educational research journal, 23*(4), 614-628.
- Zimmerman, B. J., & Schunk, D. H. (2001). *Self-regulated learning and academic achievement: Theoretical perspectives*: Routledge.