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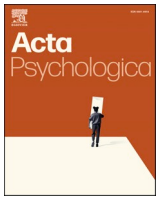

What makes them self-regulated? Self-regulation procedures of academically successful students and key influences

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ABSTRACT

Self-regulated learning (SRL) skills are strong predictors of positive learning outcomes, but the factors causing students to develop these skills are still not clearly defined. The purpose of this study was to explore the nature of the SRL process of high achievers and factors promoting the development of SRL. To serve this purpose, qualitative data were collected from science high school students and teachers. Criterion sampling was used to select students and maximum variation sampling was used for teachers. While choosing student participants ($n = 15$), three students from each school getting the highest scores from the questionnaire were chosen. While choosing teacher participants ($n = 15$), branch, gender, and teaching experience were considered. Individual interviews were conducted with students and teachers. The data were analyzed via content analysis method. The results of the study showed that SRL process is complex, and several phases of SRL take place concurrently. High achievers employ multiple SRL strategies and excel at these strategies by experimenting with them. Primary school teachers play a key role in SRL development, while other K12 teachers help students maintain SRL strategies. Teaching SRL skills, recording students' learning, building rapport and generating academic interest were the most effective practices for enhancing SRL. Student-related factors like having multiple motivational beliefs to attain goals, a co-regulating companion, positive self-efficacy beliefs, and advanced critical thinking skills were also found influential.

1. Introduction

Self-regulation is an essential part of what we choose to do and what we choose not to do. It also involves who we choose to be and who we avoid becoming. Vohs and Baumeister (2016) maintain that self-regulation subsumes many processes in which the human psyche controls our actions through inner processes which are regular rather than one shot. Considering self-regulation in education, research on self-regulated learning (SRL) deals with how meta-cognitive processes impact the learners' ability to shape their learning processes and arrange their learning environment in accordance with their goals (Schunk & Greene, 2018). SRL consists of various activities such as modifying, initiating and sustaining certain acts aimed at learning (Zimmerman, 2013). Examples of these activities include attending to instruction, processing information, rehearsing and linking new pieces of information to already existing ones, and having the belief that one is capable of learning (Schunk, 2005). SRL is particularly essential when the learners must manage complicated learning tasks or exams covering a great deal of content, both of which require students to study in a dedicated way (Broadbent & Poon, 2015; Schneider & Preckel, 2017). Enabling students to develop self-regulation not only leads to better achievement in content knowledge but also helps them to acquire both study and social skills and to develop intrinsic motivation that can inspire people to continue learning throughout their lives (Flook et al., 2015; Hertel et al., 2024; Kadioglu et al., 2011; Khiat & Vogel, 2022).

A great deal of research shows that a learner's ability to regulate attentional, behavioral, and emotional impulses leads to academic achievement in school (e.g., Dent & Koenka, 2016; Duckworth & Carlson, 2013; El-Adl & Alkharusi, 2020; Nota et al., 2004; Sitzmann & Ely, 2011). For this reason, the Organization for Economic Co-operation and Development (OECD) (2020) highlighted this skill as a fundamental and transdisciplinary aim of education. This signals the crucial importance of SRL-oriented instruction guided by research. The research on self-regulation could most effectively serve instruction if researchers and

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practitioners analyze students' self-regulation processes within the framework of their pertinent goals and how they perceive and interpret the positive and negative factors within their environment which affect their learning (Boekaerts & Corno, 2005). Also, research on SRL has been gathered mainly in European and North American settings (e.g., Dent & Koenka, 2016; Lombaerts et al., 2009; Schunk & Zimmerman, 2023) and has primarily focused on younger populations, such as at the preschool (e.g., Eberhart et al., 2024) or primary school level (e.g., Wigfield et al., 2011). While studies have also examined SRL at the secondary level (e.g., De Boer et al., 2018; Dignath & Büttner, 2008), much of the research has emphasized early SRL interventions and foundational strategy development. Thus, conducting more research with adolescent populations, particularly within diverse cultural and educational contexts, can help address these gaps in the literature (Pintrich & Zusho, 2002). Also, empirical studies in this field focus on self-regulation and self-assessment training interventions, as well as reflection. However, in addition to noting the results of a particular training, it is also crucial to view existing SRL strategies and their development process together with the factors affecting this process, such as motivation, methods of learning, use of time, physical environment, social environment and performance (Panadero, 2017; Zimmerman & Risemberg, 1997). As Dembo and Eaton (2000) set forth, amendments to curriculum and improved teacher education are essential elements in improving students' learning process. Still, the role of the student in facilitating their own learning should not be ignored. For this reason, how SRL is facilitated and how time is managed around a particular purpose throughout the phases of SRL needs to be comprehensively explored (Wolters & Brady, 2021). Panadero (2017) underlines that "although SRL models provide a quite specific picture of their processes, there is still much needed to understand SRL mechanisms more precisely (e.g., how self-reflection works, interactions that lead to attributions)" (p. 24). Thus, the current study aims for a deeper understanding of the SRL concept by using academically successful high school pupils as its sample and exploring the developmental process of already existing SRL strategies. While acknowledging the validity of established SRL models, this study also seeks to expand upon them by identifying potential novel factors that contribute to the self-regulated learning process. In doing so, it aims to offer new insights that refine and extend our understanding of how students develop and apply self-regulation strategies in academic contexts.

2. Method

This study has a qualitative instrumental case study design (Stake, 1995). According to Stake (1995), instrumental cases studies start with a selection of a case that is particularly informative about the phenomenon of interest. Unlike the other types of case studies, in instrumental case studies, the case itself is not the core concentration. Instead, the case is utilized to examine a broader phenomenon. In line with Stake (1995), in this study, the specific case of science high schools was chosen to examine SRL concept in depth and to gain insights into the development of SRL strategies.

2.1. Context of the study

The students are selected for these science high schools through a highly competitive national exam including questions on Math, Social Sciences, English, and Natural Sciences. This exam is called the High School Entrance Exam, and it is administered throughout the country by the Ministry of National Education (MoNE). The students taking this exam are placed into state high schools based on their exam scores. The students obtaining the highest scores can be placed into the science high schools in Türkiye if they choose to study in these high schools (Ministry of National Education, 2024). The students ranking in the top 1 % are placed in the top-ranking science high schools in Türkiye (Ministry of National Education, 2022).

Marshall and Rossman (2011) suggest that researchers justify their setting and provide a sound rationale for the setting they choose in line with their research questions. In this study, science high schools were chosen considering their student profile, as there is the extensive research showing the close link between achievement and self-regulated learning skills (e.g., Mega et al., 2014; Theobald, 2021; Zimmerman & Schunk, 2001). However, to see if these students are, in fact, self-regulated and what kinds of SRL strategies they use, the Self-regulatory Strategies Scale (SRSS) developed by Kadioglu et al. (2011) was administered to 857ninth and tenth-grade (65 % male, 35 % male) students in these five top-ranking science high schools.

2.2. Participants

Criterion sampling was employed for the student sample, whereas maximum variation sampling was utilized for the teacher data. Three students from each school with the highest score on the SRSS were selected to be interviewed. Table 1 summarizes the characteristics of the student participants:

For the teacher interviews, subject matter, gender, and years of experience were considered to ensure variation. Table 2 displays the characteristics of the teacher participants:

Fifteen teachers with 10 to 24 years of teaching experience were selected. All the selected participants agreed to take part in the study. Informed consent forms were provided for all the participants.

2.3. Data collection instruments

Two interview protocols were developed for students and teachers. The questions in the interview protocol for students were prepared based on the Self-Regulated Learning Interview Scale (SRLIS) (Zimmerman & Martinez-Pons, 1986), a detailed review of the literature, and feedback from three education experts with PhDs in the field. In SRLIS, students were asked to indicate the methods they used to participate in class, to study, or to complete their assignments in different learning environments such as home, classroom, or exams. To elicit more meaningful responses, the questions provided concrete examples within a relevant context. There were 14 categories of self-regulation behaviors. While adapting the SRLIS, some categories were modified, removed, or added to better align with the current study's focus on students' self-regulation. For example, while the original SRLIS focused extensively on self-monitoring in task performance, the present study prioritized the role of social interactions and motivational elements in SRL. This shift led to the inclusion of questions about peer collaboration and teacher support. Conversely, some categories related to metacognitive awareness were merged to avoid redundancy. Thus, the participants were prompted to discuss both their SRL skills and the

Table 1
Student participants of the study.

Student participants	Grade	Gender	Age	Science High School (SHS)
Student 1	10th	M	15	SHS1
Student 2	9th	F	14	SHS1
Student 3	10th	M	16	SHS1
Student 4	9th	F	15	SHS2
Student 5	10th	M	15	SHS2
Student 6	10th	F	16	SHS2
Student 7	9th	M	15	SHS3
Student 8	9th	M	15	SHS3
Student 9	10th	M	16	SHS3
Student 10	9th	F	14	SHS4
Student 11	9th	F	14	SHS4
Student 12	10th	F	16	SHS4
Student 13	10th	M	15	SHS5
Student 14	10th	M	15	SHS5
Student 15	9th	M	15	SHS5

Table 2
Teacher participants of the study.

Teacher participants	Branch	Years of experience	Gender
Teacher 1	Math	20	M
Teacher 2	Physics	17	M
Teacher 3	Chemistry	15	M
Teacher 4	Biology	22	F
Teacher 5	Turkish	19	M
Teacher 6	History	10	F
Teacher 7	German	14	F
Teacher 8	English	17	F
Teacher 9	Geography	14	M
Teacher 10	Religious Education	23	M
Teacher 11	Philosophy	24	F
Teacher 12	Math	22	M
Teacher 13	Biology	19	M
Teacher 14	Chemistry	16	M
Teacher 15	History	24	M

developmental trajectory of these skills, providing insights into how they have continued to regulate their learning over time. Moreover, interview questions were piloted and refined. In the final form of the protocol, there were 13 questions exploring key SRL processes. For instance, to explore goal-setting, students were asked, "What is your future academic goal? How are you planning to reach this goal?" To examine strategic planning and time management, they were posed scenarios such as "You have a very important exam in the coming days and you have a lot to cover, but limited time to study. How would you study for this exam?" Follow-up questions were also included to investigate the developmental aspects of these self-regulation skills, such as "How did you set this goal for yourself?" "Since when have you been using this strategy? How have you learned or developed this strategy?"

In the interview protocol of the teachers, there were 14 semi-structured questions designed to hold an inquiry of the research subject. Some examples were "*Do you provide guidance to your students on how to study after school? If so, what strategies do you suggest them*?". Thus, the data on what teachers do to foster SRL were collected to reveal the role of the teachers in SRL development.

2.4. Data analysis

Qualitative data were examined through content analysis with MAXQDA 2022 (VERBI Software, 2021). During the data analysis, both inductive and deductive coding methods were benefitted (Creswell, 2013). Deductive codes were derived from Zimmerman's (2000) SRL Model, while inductive codes emerged from participants' responses, allowing for the identification of novel aspects of the SRL process. Thus, the coding framework was developed iteratively, beginning with an initial set of predefined codes, such as "goal setting," "self-monitoring," "metacognitive strategies," and "motivational regulation." As data analysis progressed, additional codes surfaced, such as "peer influence on self-regulation" and "adaptive strategy shifts based on task difficulty," which were incorporated into the framework. To illustrate, when a participant provided several reasons for achieving a particular goal and how these reasons sustained their motivation to continue learning, this response was categorized under *multiple motivational beliefs*. Similarly, statements reflecting students' ability to adjust their study methods after receiving feedback were coded under *self-monitoring and reflection*. External influences, such as parental encouragement, were classified under *social aspect of SRL*.

During this process, certain validity issues were addressed: intercoder reliability, referential adequacy, internal homogeneity, and external heterogeneity. For intercoder reliability, the researchers conducted a blind coding process with three experts in the field of education for randomly selected three interviews. At the end of this process, the codes given by the experts and the researchers were observed to significantly match. Minor changes were made in the wording of some codes. Then for addressing internal homogeneity and external heterogeneity, the researchers created a coding table to make sure that the codes were consistent and the rationale behind placing certain codes under particular categories was clear. For referential adequacy, the codes were depicted with quotations, and extensive data were provided to create implications. Another issue addressed was trustworthiness involving credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985; Marshall & Rossman, 2011). To increase the credibility of the research, detailed feedback from field experts was received and interview questions were piloted prior to the data collection. Additionally, to meet the transferability criterion, a detailed description of each stage as well as participants was provided, and the context as well as the rationale behind choosing this context was clarified. Also, confirmability and dependability were provided via audit trail method (Lincoln & Guba, 1985). Additionally, researchers conducted the research together documenting every stage, which contributed to the consistency and objectivity of the results.

3. Results

The results of the interviews with the students and teachers revealed several insights related to the SRL process. Based on these insights seven assertions were generated.

Assertion 1: Setting goals and having multiple motivational beliefs to attain these goals are the starting point of the SRL process.

The interviews with the students indicated that goal setting is the first step that triggers the SRL process. However, these goals should not be simply perceived as end points for the students. Instead, these goals represent a detailed description of the aspirations to which they are committed and the SRL process might start with goal setting, but this strategy is only truly effective when the students possess more than one motivational belief to achieve those goals:

> I want to be an entrepreneur. I like creating codes and animations. I want to start a company in which I can combine entrepreneurship and software. In my company, I aim to connect my jobs together. Keeping this aim in mind, I need to study hard to study ata top-ranking university in Türkiye. Studying in a top-ranking university is crucial for me to broaden my horizons. Therefore, while I am studying or planning my day, I feel that I am pursuing my dreams.
>
> (Student 11)

As the quote demonstrates, *setting a goal* and staying connected to this goal paves the way for the SRL process. While all the student participants underlined that they have more than one reason to achieve their goals, the majority ($f = 12$) also stressed that they regularly remind themselves of these goals to motivate themselves to keep studying. The importance of goal-setting and multiple motivation were also stated by many teachers ($f = 11$).

There is a great difference between the students in my previous workplace and the students that I have now in science high school. Here all the students have goals. They study hard in order to achieve these goals. (Teacher 14).

> I can say that my students are self-regulated and they do it not just for academic success. They plan and organize their lives in order to multitask effectively…This is what makes these students successful. They, I mean 60 or 70 % of my students, have a variety of hobbies and in order to be successful in different areas of life, they control themselves…
>
> (Teacher 13)

Goal setting can be described as a driving force that starts the SRL process and motivates learners throughout that process to continue regulation.

Assertion 2: The SRL process is a complex process in which

several phases can take place concurrently.

The results of this study revealed that the SRL process is intricate, allowing many phases to occur simultaneously. Once the students set goals with multiple motivational beliefs, they start to create strategies and plans to achieve these goals. These plans include the learning sources, time to be allocated, and learning strategies to be used. Thus, the students create a route toward their destination. These strategies are facilitated by the other phases of SRL such as *self-control, task orientation, feeling accountable for learning, environmental organization, attention focusing,* employing *a variety of task strategies, help-seeking, and self-evaluation*. Thus, it is appropriate to underscore that cognitive SRL strategies mark the beginning of the process, and the process is continued with the exercise of self-control and the development of tactics to orient oneself to the task. During this process, the learners assume accountability for their own learning. The following quote shows how the student goes through several phases of SRL at the same time to attain their goal:

> I am well aware of the fact that I have to study so as to pursue my dreams. For this reason, I do not give myself any chance to procrastinate. I stay in my room for four or five hours and I do not go out without completing the tasks that I designated for that day.
>
> (Student 13)

As the quotation illustrates, the student has already set goals and they take accountability to attain this goal. With this purpose in mind, they exercise self-control, plan their learning, and follow the plan. Their words illustrate how several phases of SRL are intertwined. Some phases like creating an optimum learning environment by *organizing their sources, finding a proper place to study, wearing suitable clothes,* and *physically getting ready to study* and performing *attention-focusing* strategies seem to take place in a more linear order. However, these phases are also facilitated by feeling accountable for learning, self-control, help-seeking, and self-evaluation strategies. The results of this study also showed that while feeling accountable for learning and self-control processes are the main driving forces of the SRL process, help-seeking and self-evaluation strategies are the ones that feed the process at every step and help students maintain their SRL strategies. Seeking help from peers or online is reported by the students ($f = 14$) as well as teachers ($f = 13$) to function as the catalyst of the process making it flow smoothly. Similarly, self-evaluation has been reported to feed every phase of SRL, including goal setting. Students ($f = 15$) have reported that they constantly evaluate their performances through tests, comparing their results with their or peers' previous performances, asking themselves comprehension check questions, or color-coding the content to better help them determine their level of comprehension and reroute if needed. Thus, it is possible to conclude that SRL strategies such as taking accountability for learning, self-control, help-seeking, and self-evaluation strategies can occur simultaneously and/or follow each other. Furthermore, we can state that these phases are "roofing" the other ones, which ultimately makes SRL a complex or interwoven process.

Assertion 3: SRL does not automatically come about once students learn to be self-regulated. Learners deliberately choose to regulate their acts in the cases they encounter.

The best example of this assertion is *attention focusing.* Attention focusing seems like a process automatically achieved when wished for, yet the results showed that it is not. The students have tailor-made tactics to focus their attention, and they purposefully employ these tactics. This includes *starting with a more favorable subject* or *with an easier subject, revising previously taken notes*, or *focusing their minds on staying in the moment*.

> In order to focus better, I start studying with easy subjects and then continue with harder ones.
>
> (Student 10)

> Before I really start studying, I solve my Geometry problems. This makes me feel very smart and enriches my concentration.
>
> (Student 11)

Another example of this assertion is the process of *self-control.* Self-control seems to be a trait or capacity rather than an act and it is often believed that people either have or lack self-control (Baumeister et al., 2007). However, the results of the present study showed that self-control is not a trait; it is a process that is built. Self-regulated students employ strategies to perform self-control. They struggle to have self-control day by day and they employ a different strategy if they feel that they are losing their control. One of these strategies is focusing on the goals they set earlier, and the other one is exercising *emotional control.* During the interviews, students did not mention difficult feelings of boredom, fatigue, or helplessness while they were describing their SRL process. It was obvious that rather than getting caught up in negative feelings, they were focusing on strategies to manage the SRL process and also cooperating with their friends. They did not mention how exhausted they were because they needed to self-regulate all the time. Instead, their replies focused on their goals and sources of motivation to achieve these goals. These responses show that the students consciously choose to employ strategies to stay regulated. This was also observed by their teachers ($f = 8$) who noted similar patterns in students' behavior both in the classroom and during self-study activities. Teachers reported that students appeared focused and persistent in their efforts, often engaging in self-regulatory strategies even outside of structured learning environments.

Assertion 4: Academically successful students experiment with SRL strategies until they excel at them and resourcefully utilize these strategies.

This study showed that academically successful students benefit from several *task strategies* to regulate their behaviors and to complete the learning task at hand. Students ($f = 9$) reported that they *self-experimented with the methods* and kept utilizing the ones they think are handy. Then, by calibrating these task strategies, they gradually begin to excel at them. *Deciding on what to learn before starting to study* or *making a to-do list, predetermining the method of studying before they start*, *highlighting the important parts*, *using different sources of information*, *taking and revising notes,* and *self-teaching the subject* were among the task strategies underlined by the students.

> I have developed my own method of learning by trial and error method. For example, there is a topic called "projectile motion" in Physics. There are certain formulas to solve the problems related to this topic. I use various sources to master the topic and then when I start to solve problems, I tell myself "the question is asking this, you can utilize that method." And then I solve the problem step by step.
>
> (Student 15)

First of all, I make a complete list of what I am going to study. Then I organize the topics by selecting one new topic and one old topic respectively. Thus, I study a new topic and then revise an old topic. I always use multiple sources and underline the important parts with colorful pencils. I have my own way of organizing sources. I use sources with relatively easy questions first and then I continue with the sources with more difficult questions. When I use all the sources and complete my list then I feel really good about myself. (Student 9).

As seen in the quotation, academically successful students determine the most fitting strategy considering the nature of the field of study and their learning styles. Using the correct strategy at the correct time expedites the SRL process.

Assertion 5: Although self-regulation seems like an isolated or individual process, it can actually be promoted through collaboration.

The interviews with both students and teachers indicated that *parents, siblings, social circles,* and *peer collaboration* are principal contributors to the SRL development process. Parents can facilitate their

children's development of SRL by raising their awareness of the importance of regulating behavior, accompanying their kids' studying process, and teaching them task strategies, time management, and emotional regulation. The results of the present study also suggest that the practices of parents should be regular and sustained rather than one-shot or irregular. Developing SRL skills is a process that requires time and relentless effort. When parents set good examples of self-regulation and prioritize the learning process, children tend to follow them, too. Many students ($f = 12$) stated that their parents have a substantial impact on their SRL development. They stated that their parents are actually the ones who started the SRL process.

> I was feeling the strict discipline in our home. I had to complete my homework before dinner. I had to check the topics of the following day before I slept. Otherwise, they would not buy me the toys or the magazines that I liked.
>
> (Student 2)

Although the methods might vary, it is obvious that parents supervised the SRL process, and they supported the emotional regulation process by providing help if need be. They also worked to create positive self-efficacy beliefs. Similarly, siblings and social circles were reported to have a positive impact on the development of SRL skills. Some students ($f = 4$) indicated that their siblings set good role models for them, providing companionship or coaching the process. Similarly, the social circle was shown by some students to influence this process ($f = 5$). However, the pattern of effect diversified. In some cases, the students were from a competitive social background in which many people are academically successful, and they therefore want to fit in. In some other cases, the social background of the student did not have much to do with academic studies, and the student desired to be different.

Additionally, peers were reported to contribute and immensely facilitate this process. They could particularly feed the goal-setting, help-seeking, and self-evaluation phases of SRL. In fact, the majority of the students ($f = 13$) and all of the teachers ($f = 15$) underlined that peers are one of the main reasons these students stay self-regulated.

> I am terrible at memorizing things. My friends helped me to solve this problem. I was about to give up studying, but one of my friends told me that she was studying while walking and this helped her remember better. Then we started to walk together, and we revised the topics while walking. This has saved me. I have kept studying thanks to my friend.
>
> (Student 11)

Also, the students share task strategies or tactics and sources with each other which helps them succeed together. (Teacher 3).

> They motivate each other to study. Sometimes, I think they are like the parts of the same puzzle, and they complete each other.
>
> (Teacher 10)

Here we see that the students provide inspiration to each other to study, and they teach SRL strategies to one another. Moreover, students often do not feel the need to ask questions to their teachers as their peers are there to help them by simplifying complicated subject matters. This prevents the feeling of helplessness that might arise in students, and they keep studying or regulating themselves since they are able to find answers to their questions easily. These results indicate the social aspect of SRL and reveal the role of interaction in preserving SRL.

Assertion 6: Primary school teachers play the main role in the SRL development process while other K-12 level teachers are particularly effective in preserving SRL strategies.

The students emphasized that their teachers, particularly *primary school teachers* ($f = 13$), helped them to organize their lives around their academic studies. They clearly stated that their primary school teachers were the ones teaching them SRL skills. They also expressed that their middle school and high school teachers helped them maintain SRL skills and build on them by teaching them more strategies. The teachers ($f = 11$) also underlined that they placed special emphasis on teaching SRL strategies and motivating students to stay regulated. For example, Teacher 3 reported closely monitoring students and act when needed:

> Sometimes I observe that the students get lost among all the high achievers. At that point, I talk to those students during the breaks, and I try to understand what the problem is. Then I assign some tasks to them, and I always check those. With that special attention, that student starts to study regularly, too.
>
> (Teacher 3)

Teaching SRL skills, building rapport with students, arousing academic interest, keeping a record of students' learning, IT integration, linking the class content with daily life, and encouraging collaborative activities were cited by both teachers and students as teaching practices aiming to promote self-regulation.

To elaborate, *teaching SRL skills* has been reported as an influential factor in SRL development. Many students ($f = 8$) mentioned that their primary school teacher taught them important SRL skills like *managing time* via *to-do lists* and encouraged them to study regularly. Thus, they allocated a certain amount of time for each activity in their lives and started to manage their time to study regularly and efficiently. They maintained this habit in the phases of education that would follow, and their middle and high school teachers helped them build onto these skills by teaching them more skills, such as *taking effective notes, revising them,* and *breaking complicated content into more manageable units*. Similarly, *keeping a record of students' learning* has been pointed out as a significant practice. When teachers record their students' learning and provide feedback on their performance from time to time, learners tend to develop the skills of *self-evaluation*. They gradually internalize the operations of tracking the learning process, and they both manage and evaluate their progress. Also, *building rapport with students* was underlined as an important factor in promoting the development of SRL. C*reating good relationships with students* and *having a positive attitude toward teaching* make it easier to guide students through SRL. However, this factor is not enough to promote SRL among learners, and it was reported to be mainly effective when it is combined with other teaching practices such as *teaching SRL skills* or *generating academic interest in students*, which can be achieved through *stories, games,* or *images*. SRL promotion can also be possible through *IT integration*, *linking the class content with daily life*, and *encouraging collaborative activities*. More specifically, IT integration has been revealed to promote SRL development since it enables teachers to assign learning tasks to the students to be completed after school, and it helps learners continue the learning process on their own following the instruction. This is also true for linking the class content with daily life and encouraging collaborative activities because they pave the way for learning after school as students get the chance to make observations related to class content. Similarly, when collaborative activities are encouraged, students are more likely to regulate their behaviors to keep learning, for SRL can be a greatly collaborative process, as mentioned earlier.

Assertion 7: Individual factors like critical thinking skills and self-efficacy beliefs are highly effective in SRL development.

The results of the study denoted that some individual actors like *critical thinking skills* and *self-efficacy beliefs* are effective in SRL development. Teachers ($f = 6$) underscored that developing critical thinking skills is an essential factor in the SRL process because the students with better critical thinking skills can make better analyses, which leads to better decisions. This helps them manage the SRL process more efficiently than the others. For instance, a teacher said, “Some students have great critical thinking skills. They are much better than the others in terms of organizing their lives. They have high awareness of their responsibilities. They act accordingly” (Teacher 1). Also, teachers ($f = 8$) stated that self-efficacy is an area that they particularly worked on because it motivates their students to keep learning. Similarly, the students ($f = 9$) stated that when they see that they can succeed, they

gradually start to study more. That's why they are actively working on increasing their self-efficacy, which in turn facilitates learning.

4. Discussion

The results of this study revealed several assertions related to the nature of SRL process and how SRL strategies were developed. The first striking result of the study was the critical importance of setting goals along with multiple motivational beliefs. Although goal setting has been highlighted by several SRL studies and models (e.g., Bouffard et al., 1998; Teng, 2024; Winne & Hadwin, 1998; Zimmerman, 2013), the present study contributes to the literature by underlining the interplay between goal-setting processes and motivational beliefs as a driving force for SRL. It appeared that these two processes may better facilitate self-regulation when they occur concurrently.

Another striking result of this study was the demonstration of the complex nature of SRL in which a range of phases take place concurrently. Widely accepted models of SRL denote that SRL process is cyclical (e.g., Boekaerts, 2011; Winne & Hadwin, 1998; Zimmerman, 2000). The results of this study justify the cyclical nature of SRL, but also state that certain phases of SRL can overlap. Particularly self-control, self-evaluation and help-seeking extend throughout SRL process. As stated by Corno and Mandinach (2004), learning is believed to involve its own reward, and "studenting" includes the completion of many tasks which are ultimately proven to be beneficial, but the overall task of fulfilling the responsibilities of a learner is not always easy or as put forward by Li (2024) academic delay of gratification requires resilience. However, by activating self-control strategies, self-regulated learners take actions against their immediate desires and retain boredom control (De Ridder et al., 2012; Letzring et al., 2005; Li et al., 2024). Self-evaluation and help seeking strategies also feed SRL process. Self-evaluation creates feedback loops for the learners by helping them monitor their activities and compare them against certain standards (Schmitz & Perels, 2011), whereas help-seeking contributes to emotional regulation by preventing the feeling of helplessness (Villavicencio & Bernardo, 2013; Zimmerman, 2013). These findings correspond with Pintrich's (2004) self-regulation model, which highlights self-evaluation as a key metacognitive process in SRL. However, while Pintrich (2004) describes help-seeking as a reactive strategy, the current study suggests that students proactively integrate help-seeking as an ongoing regulatory mechanism, reinforcing its role in emotional and cognitive adaptation.

While strategies like self-control, help-seeking and self-evaluation are conducted throughout SRL process, some phases such as strategic planning, environmental organization, attention focusing and use of SRL task strategies ignite the start of each other in a chain-like manner. This interpretation builds upon Winne and Hadwin's (1998) model, which views self-regulation as a recursive process involving dynamic adjustments. Also, it is revealed that although certain SRL processes such as attention focusing seem look like automatic responses once the learner decides to learn, in fact, they all require purposeful effort by the learner—a finding which is substantiated by Callan and Cleary (2019). This result also aligns with one of the major implications of Winne and Hadwin (1998), underlining how SRL is innately self-directed and productive. Additionally, the finding that learners must actively sustain focus rather than rely on automaticity suggests that SRL is not only self-directed but also effortful and continuously managed, reinforcing the concept of "cognitive control" as discussed by Efklides (2011). Learners need to work on cognitive change by filling in the gaps in their knowledge; they must also perform response modulation by working on the feelings of boredom and fatigue and replacing them with the satisfaction of completing their agenda to achieve SRL (Duckworth et al., 2014). This is only possible if the learner feels accountable for their own learning (Cook-Sather & Luz, 2015; Fishman, 2014; Jiusto & DiBiasio, 2006; Kohns & Ponton, 2006).

It has also been revealed in this study that through experimentation, the students grew to excel at certain SRL task strategies. Once again, we see how SRL involves a collection of skills developed over time (Whittlesey & Steiner, 2021). This process has been described as metacognitive monitoring by Zimmerman (2013), and in this process, students can take an adaptive or defensive action toward a learning strategy. These results are in line with the findings presented by Zimmerman (2013) and Pintrich (2004). However, the findings of the present study brought forward two more important implications about the use of these task strategies. First, although these task strategies look simple, the students use them in complicated ways. That is, they have a very detailed way of using these strategies, which actually facilitates their SRL process. When they make a to-do list, this also includes the method of learning, which changes depending on the nature of the course. When they use multiple sources, they have a clear rationale for using that specific source; or when they underline certain parts, they do it systematically, rather than randomly. There is a specific explanation for each part they underline. In addition, they have a precise and orderly style of taking and revising notes. Thus, this tells us that it is not the strategies themselves but the way that the students tailored the strategies conscientiously, in consideration of their learning needs, that makes the difference in terms of facilitating the SRL process. Secondly, these students use multiple strategies effectively and simultaneously to attain their goals. They do not stick to one strategy but employ a different one depending on the requirements of particular courses. This is one of the essential factors that assist their SRL process (Banarjee & Kumar, 2014).

The present study also revealed findings on the social nature of SRL which matched with the socially shared regulated learning model of Hadwin and Oshige (2011).The findings of the study showed that self-regulated learners are able to maintain their self-regulation skills by getting help from their peers and teachers. This aligns with the statement of Hadwin et al. (2011) indicating that co-regulation fosters SRL by providing external scaffolds. However, the study further suggests that co-regulation is not only about external support but also serves as a motivational enhancer, particularly in maintaining effort and persistence which has been attributed to the fact that peers can provide valuable feedback and support to one another and can encourage each other to work harder and stay focused, which greatly contributes to the SRL process (Järvelä & Hadwin, 2013). Furthermore, peer learning activities can promote social and emotional skills such as cooperation, communication, and teamwork, which are critical for success in both academic and non-academic settings (Boud & Cohen, 2014; Hogan & Tudge, 1999). Thus, the role of co-regulation in the SRL process should be understood within the cultural context, where the form and extent of peer interaction may vary. In different cultural and educational settings, the way students seek and receive support can be influenced by social norms and educational traditions (Nolen, 2024). In addition to peers, social circle, siblings and parents can have an impact on SRL process though the pattern of their contribution is diverse (Henderson & Cunningham, 2023; Mata & Pauen, 2023; Perry, 2019). Thus, it is possible to suggest that the socio-cultural environment in which students develop can shape their self-regulation strategies and the extent to which they rely on others for support. This takes us to the conclusion that SRL has socio-historic and environmentally situated aspects and co-regulation and socially shared regulation are likely to lead to enrichment in the SRL process. Therefore, the learning journey of students can be described as interdependent (Panadero & Järvelä, 2015; Tinajero et al., 2024). In this regard, the ways in which learners regulate their learning are not only influenced by their individual abilities but also by the broader cultural and institutional frameworks in which they operate (Hadwin et al., 2011; Nolen, 2024). Recognizing SRL as an interdependent process highlights the importance of creating learning environments that balance individual agency with collaborative support, ensuring that students from diverse backgrounds have access to effective self-regulation strategies.

About the impact of instruction on SRL development, the results of the present study showed that different layers of K-12 education can

make different contributions to the SRL process. However, the student participants particularly emphasized the role of the primary school teacher in the SRL development process during the interviews. By actively working on promoting SRL by teaching SRL skills, building rapport with students, and generating academic interest in students, primary school teachers made a unique contribution in SRL development. This takes us to the conclusion that such methods are much more effective when they are applied to students at a younger age. Thus, students internalize SRL, and this leads to SRL development in the following years. Apart from this finding, the present study uncovered that teachers can promote SRL process directly and indirectly. To elaborate, the teachers can directly enhance SRL process by teaching SRL strategies as also suggested in research (e.g., Azevedo & Cromley, 2004; Bautista, 2012; Becker, 2013; Jivet et al., 2020; Perels et al., 2009). However, as stated earlier, SRL is not a talent that stays with students at all costs. It is a skill that students need to hone on a regular basis. At some point, they might be less regulated. At these points, practices of teachers to navigate students to SRL can be instrumental in being re-regulated. IT integration can contribute to this process through generating academic interest among students by using a variety of visual, audial and textual sources and motivating them to keep learning after school by arousing curiosity (Majitol & Yunus, 2023). In addition to these direct impacts, teachers can indirectly affect the process with practices such as linking class content with daily life to make it less intimidating for the learners which is also in line with what Boekaerts et al. (2006) stated earlier.

Finally, considering the results of the present study and the present literature, it is possible to conclude that self-efficacy and self-regulation have a reciprocal relationship in which they can positively or negatively affect one another (Schunk & Zimmerman, 2023; Teng, 2024). A learner with high self-efficacy beliefs is likelier to regulate their acts as they believe that they have the required capability to succeed. In turn, a person with lower self-efficacy beliefs is less likely to organize their life to learn further, as they believe that they stand a lower chance of achieving (Bezci & Sungur, 2023; Schnoll & Zimmerman, 2001). The results of the study reported so far including the key role of self-efficacy are in line with what Wang et al. (2024) stated. That is, metacognition, motivation, self-efficacy, and feedback loops form the basic elements of SRL process. Additionally, research indicates the positive effect of SRL on critical thinking (Schunk & Zimmerman, 2023). The findings of the present study add to the research by providing the insight that critical thinking skill is also a contributor to the self-regulation process as the learners who possess better critical thinking skills better regulate themselves by carrying out effective self-evaluation processes. Although this is in line with the critical thinking skills that Zimmerman (2008) accentuated as a part of self-evaluation process, the results of this study signaled the effect of critical thinking skills in a wider area of SRL. Because self-regulated learners can think critically by judging their sources, capabilities, and the feasibility of the tasks at hand, they can set effective goals and make strategic plans to attain them. Then they can critically evaluate each stage that they go through and take precautions or make changes in their plans or acts to boost their performance. Thus, critical thinking skills affect the entire SRL process.

All in all, it is essential to conclude that there are several factors impacting SRL development. Ultimately, however, SRL is a self-directed process which requires active effort by the learner. The major difference stems from the learners' choice to show perseverance, adapt to new learning opportunities, and take personal initiative to learn after being exposed to SRL strategies.

5. Implications for practice

This study has several implications for practice which can be particularly implemented to promote SRL skills at primary, middle and high school levels, and task strategies can be initiated at higher education level as well. Drawing from the results of this study, curricular activities to help students set goals and find sources of motivation to achieve these goals at the beginning of academic programs are recommended. Also, it is crucial in such trainings to provide information on the nature of SRL process to students, as they might then increase their awareness of how to exercise ostensibly automatic SRL processes like self-control or attention-focusing. Teaching students key SRL strategies like help-seeking, environmental organization or self-evaluation can also be enlightening as they can increase their awareness of how to employ strategies when needed. Additionally, teacher practices to promote SRL can be taught to both prospective and experienced teachers. The importance of collaboration in SRL should also be emphasized during these trainings. Finally, similar training can be provided to parents so that SRL development can be promoted at home.

6. Limitations and suggestions for future research

This study had certain limitations, which can be addressed in future studies. The study included a Turkish sample collecting data from teachers and students only. However, collecting data from other contexts and involving parents would be useful. Also, this study focused exclusively on the students studying at science high schools. Future research could incorporate a more diverse sample, including lower achievers, to examine potential differences in self-regulation strategies and the factors contributing and inhibiting SRL development Furthermore, longitudinal studies revealing the development process of SRL starting from primary school are recommended.

On a final note, it is essential to state that incorporating machine learning methods into SRL research could offer a more objective and large-scale analysis of self-regulation patterns, enhancing the qualitative findings particularly for validating self-reported SRL strategies (Alkattan et al., 2023). Additionally, the use of machine learning techniques can complement traditional self-report measures, leading to a more robust analysis of students' SRL strategies as also mentioned by Flayyih and Hassan (2023). Thus, utilizing the latest technology for SRL research can effectively further our understanding of the nature of SRL.

CRediT authorship contribution statement

Seda Aydan: Writing – review & editing, Writing – original draft, Validation, Resources, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Yesim Capa-Aydin:** Writing – review & editing, Supervision, Methodology, Formal analysis, Data curation, Conceptualization.

Ethics statement

The study was approved by the METU Human Research Ethics Committee.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

The data that support the findings of this study are available from the

corresponding author upon reasonable request.

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