INVESTIGATION OF SELF-REGULATED LEARNING (SRL) STRATEGIES USED BY GIFTED STUDENTS WHILE LEARNING SCIENCE

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1. INTRODUCTION

Along with the changing living conditions, educational standards have also changed. Today's world requires individuals to be life-long learners to regulate their learning not just during but also after schooling period (Stoeger, Fleischmann & Obergriesser, 2015; Eilam & Reiter, 2014). Therefore, the ultimate goal of education has changed to teach students how to become self-regulated learners. There are various benefits of being a self-regulated learner because many studies show that self-regulated learners display better learning performance (McInerney *et al.*, 2012; Stoeger, Fleischmann & Obergriesser, 2015), low level of anxiety (Pekrun *et al.*, 2002), high levels of self-efficacy and motivation (Stoeger, Fleischmann & Obergriesser, 2015), and high levels of engagement with the cognitive task when faced with distractions and difficulty (Pintrich & De Groot, 1990).

As there is a relationship between self-regulated learning (SRL) and better learning performance, gifted and talented students can be investigated in terms of their characteristics. Research about gifted and talented students and SRL showed that some other factors, other than intelligence, can be considered as important during the process of learning. These factors include cognitive and metacognitive strategy use, motivational and epistemological beliefs, and affective and behavioral conditions (Snyder, Nietfeld & Linnenbrink-Garcia, 2011; Neber & Schommer-Aikins, 2002). However, there are contrasting findings about SRL skills of gifted and talented students. For example, while some studies state no difference or scarcer use of self-regulatory skills in gifted-students (Sontag, Stoeger, & Harder, 2012; Snyder, Nietfeld and Garcia, 2011), there are other studies that show better display of SRL skills by gifted students (Geary &Brown, 1991; Zimmermann & Martinez-Pons, 1990; Greene, Moos, Azevedo, Winters, 2006).

There are multiple dimensions under the construct of self-regulated learning such as cognition, metacognition, motivation and behavior (Zimmermann, 2000; Pintrich, 2000; Boekaerts & Niemivirta, 2000). The cognitive component includes some learning strategies such as cognitive strategies, problem-solving strategies, and critical thinking skills which are used by students to improve learning (Schraw, Crippen & Hartley, 2006).

Cognitive learning strategies mainly consist of rehearsal, elaboration, and organizational strategies (Prins, Veenman, & Elshout, 2006; Pintrich, 2002; Weinstein & Mayer, 1986). Some examples of cognitive strategies can be listed as constructing graphs and tables, chunking, constructing concept maps, creating analogies and metaphors, frames, mnemonics, imagery, paraphrasing, summarising, generative note-taking, selecting the main idea, making an outline of the material to be learned, explaining ideas to someone else, question asking and answering, reading aloud, and highlighting text (Stott & Hobden, 2016, Pintrich& De Groot, 1990; Tan, Dawson, & Venville, 2008; Zimmermann& Martinez- Pons, 1990).

The metacognitive component of SRL requires individuals to have knowledge about cognitive processes and be aware of their cognitive states by monitoring and be able to regulate their cognitions to reach the expected standard (Zimmermann, 2000; Pintrich, 2000; Schraw& Moshman, 1995; Pintrich& De Groot, 1990; Flavell, 1979; Brown, Bransford, Ferrera, & Campione, 1982). Therefore, metacognition is a construct that helps learners become active participants in their performances by the processes of self-appraisal and self-management (Paris & Winograd, 1990). Thus, according to Paris and Winograd, metacognition is both an outcome and producer of cognitive processes as it helps learners to have knowledge about cognition and manage cognitive processes. These characteristics of metacognition make it an inevitable characteristic of self-regulated learners. Self-regulated learners apply some metacognitive strategies to improve their learning such as planning, monitoring, evaluating, goal-directed search, summarization, evaluate the content, processes for handling task difficulty and demands (Azevedo, Greene, & Moos, 2007; Pintrich & De Groot, 1990).

Although gifted students' academic achievement seems to be better than non-gifted students, there are a small number of studies that investigated cognitive strategy choices of gifted students that help them learn better (Geary& Brown, 1991; Davidson & Sternberg, 1986; Obergriesser & Stoeger, 2016). Also, there is limited information about the metacognitive skills of gifted students and comparison of these skills with that of non-gifted students (Obergriesser & Stoeger, 2016; Alexander, Carr, & Schwanenflugel, 1995).

Also, there are a scarce number of studies which investigated the processes of self-regulation in science learning (Schraw, Crippen, & Hartley, 2006; Rickey& Stacy, 2000; White & Mitchell, 1994) and it decreases more when it comes to investigating the gifted student profile (Tang& Neber, 2008; Neber& Schommer-Aikins, 2002; Yoon, 2009; Tan, Dawson & Venville, 2008). Moreover, previous literature includes contrasting results in terms of gifted students' use of self-regulated learning skills, especially, in terms of cognitive and metacognitive strategy use (Greene, Moos, Azevedo, Winters, 2006; Schneider & Bjorklund 1992; Sontag *et al.*, 2012; Obergriesser & Stoeger, 2016). Hence, this study aims to deeply investigate the cognitive strategy use and metacognitive awareness of gifted students in the context of studying a science concept.

Therefore, the current study will contribute to the literature about cognitive and metacognitive strategy use preferences of middle school gifted students while regulating their learning about two science concepts from biology and physics disciplines. The findings of this study may help us understand the underlying processes of self-regulated learning in terms of cognitive and metacognitive procedures in the group of gifted students. Educators and practitioners may make use of the obtained findings to manage educational processes, the teaching of science, as well as designing science classes for both regular and special education.

2. LITERATURE REVIEW

In this chapter, a review of previous studies relevant to the present study is provided. This chapter consists of two main sections including self-regulated learning and gifted students. In the first part, the definition and the components of self-regulated learning are explained. Especially, cognitive and metacognitive components of self-regulated learning are explained in detail. In the second part, research studies about gifted students and their self-regulated learning skills in terms of using cognitive and metacognitive strategies are provided in detail.

2.1. Self-Regulated Learning

2.1.1. Definition of Self-Regulated Learning

Previously, learning was considered as processing transmitted information which is determined by the components of sensory registers, short-term memory, long-term memory, and executive processes (Schunk, 2008). Today, learning is considered to involve more complex processes and components than previously thought, and is mostly dependent on the learner (Bandura, 1991; Pintrich, 2000; Zimmermann, 2000).

After Bandura extended his Social Cognitive Theory by incorporating the term self-regulation, the definition of learning has been converted into the statement that learning requires autonomous controlling by the learner (Bandura, 1991). According to the Social Cognitive Theory of Self- Regulation (Bandura, 1991), human behavior is mostly motivated and regulated by the practices of self-influence so learning can also be regulated by the practices of the learner himself/herself.

Zimmermann (2000) extended Bandura's Social Cognitive Theory of Self-Regulation and defined self-regulation as the self-generated thoughts, feelings, and actions that are helping to the attainment of personally-set goals by the triadic relations among person, behavior, and the environment. Hence, self-regulated learning (SRL) is viewed as self-regulation procedures that take place in educational settings (Pintrich, 2000) which, in turn, defines self-regulated learners as people who are metacognitively, motivationally, and behaviorally active participants in their own learning (Zimmermann, 1989).

Zimmerman (1989) explained learning by Self-Regulated Learning Theory with three components namely “students' self-regulated learning strategies, self-efficacy perceptions of performance skill, and commitment to academic goals”. As seen by the statement, in self-regulated learning, there is a motivational part that has an impact on learning. According to Zimmermann (2000), self- regulated students have “self-generated thoughts, feelings, and actions that are planned and cyclically adapted to attain their learning goals” (p.14).

Another researcher who defines SRL with the functioning of three domains namely cognition, metacognition and motivation/ affect is Boekaerts (1999). She considers the cognitive aspect of SRL as using cognitive strategies that help students learn and perform a task and are controlled and regulated by metacognitive strategies. According to her, motivation and affect component of SRL refer to all motivational beliefs such as self-efficacy beliefs about the task, affect related to the self and task, and interest in the task (Boekaerts, 1999).

According to Boekaerts’ and her colleague’s view, SRL is “a system concept that refers to the overall management of one's behavior through interactive processes between different control systems namely attention, metacognition, motivation, emotion, action, and volition control” (Boekaerts & Niemivirta, 2000). Boekaerts (1996) also stated that students’ appraisal of the learning situation affects their goal-setting, learning, and coping strategies. For example, the self-regulation process of goal-setting can be governed by an interpretation of self-focused beliefs such as self-efficacy judgment, attributions and, attitudes (Boekaerts & Niemivirta, 2000). When the goals have been set, volitional control, planning and monitoring stages are started by the learner, too (Winne & Perry, 2000). Volitional control is the ability to maintain goals when faced with distractions or disengagement (Boekaerts & Niemivirta, 2000). Thus, self-regulated learners can maintain their cognitive engagement in the task even if there are distractions (Pintrich & De Groot, 1990).

Pintrich (2000) is another researcher who works in the development of self-regulated learning model. According to his model of SRL, learners are active in learning processes and they construct their knowledge by themselves by the activities of monitoring, controlling, and regulating their own cognition, motivation, behavior, and conditions of the environment that they are living in. In all of these actions, goals are one of the main factors that give meaning to all of these stages.

In the model, there are four areas for regulation. These areas are *cognition, motivation/affect, behavior,* and *context* (Pintrich, 2000b; Pintrich, 2000). In the model, there are four phases and all of these phases have different roles in the regulation of these four areas. These four phases are *forethought, planning and activation*, *monitoring*, *control*, and *reaction and reflection* phases. Phase 1 involves planning, goal-setting, forethought, activation of prior-content knowledge and knowledge about the self in terms of the task at hand. Phase 2 involves monitoring skills related to metacognitive awareness of the self, task, and context. Phase 3 involves controlling behavior and selecting appropriate cognitive strategies for learning. Phase 4 involves reactions and reflections related to the self, task, and context.

In the overall process of self-regulated learning, there is a goal or standard that learner assesses his/her current state and compare it with the standards of the goal (Winne &Perry, 2000; Pintrich, 2000; Boekaerts& Niemivirta, 2000). Thus, goals are the gateway to the regulation of learning because it causes monitoring and, in turn, controlling mechanisms to reach that goal by controlling and regulating cognition, motivation, behavior, or environmental conditions. There are task-specific goals and goal-orientations. Task-specific goals are more specific goals related to specific content. Goal-orientations, on the other hand, describe more general goals related to achievement and motivation. Goal-orientations can be taken as mastery and performance goals. Mastery goals involve "developing skills, improve competence level, achieving a sense of mastery, etc.", whereas, performance goals aim to get better scores and perform better than others, etc. (Ames,1992).

Research showed a positive correlation between mastery goals, self-regulation, and achievement. Adopting a mastery-goal has positive implications for affective and motivational beliefs such as self-efficacy, task value, interest, pride, and satisfaction, etc. (Pintrich, 2000, Ames, 1992). Also, it was found that "students who endorse a mastery goal are more likely to report attempts to self-monitor their cognition and to seek ways to become aware of their understanding and learning (phase 2) such as checking for understanding and comprehension monitoring" (Pintrich, 2000, p.480). In terms of regulation of behavior and context, mastery goal-orientation was found to be positively related to time and effort management and help-seeking behavior (Pintrich, 2000). As seen in the literature, goal-orientation is one of the most important factors that correlates with the components of self-regulated learning.

2.1.2. Metacognitive Component of SRL

Many researchers claim that SRL contains metacognitive processes in it (Dinsmore, Alexander, & Loughlin, 2008; Zimmermann, 1989; Pintrich, 2004; Paris & Winograd, 1999). Metacognition was defined by Flavell (1985) "as any knowledge or cognitive activity that takes as its object, or regulates, any aspect of any cognitive enterprise…its core meaning is 'cognition about cognition'" (p. 104). Metacognition is one's awareness about his/her own cognitive skills which is constructed with the help of past experiences and one's ability to regulate his/her own cognition by monitoring and controlling it (Flavell, 1979; Brown, 1977; Schraw & Moshman, 1995).

Pintrich (2002) described three types of metacognitive knowledge. According to him, metacognitive knowledge consists of three types of knowledge which are *strategic knowledge*, *knowledge about cognitive tasks*, and *self-knowledge*.

First, strategic knowledge is the knowledge of general strategies for learning, thinking, and problem- solving and it includes general or domain-specific strategies. These strategies are important because when there is a lack of domain-specific knowledge, one can make use of metacognitive knowledge by considering general strategies to be able to solve the problem (Prins, Veenman, & Elshout, 2006). Strategic knowledge helps students memorize the material, extract meaning from the text, and comprehend the materials. These strategies can be grouped as rehearsal, elaboration, and organizational strategies (Weinstein & Mayer, 1986; Pintrich, 2002). Rehearsal strategies refer to repeating the material again and again to memorize them. Elaboration strategies, in contrast, include various tactics for memory tasks such as mnemonics, summarizing, paraphrasing, and selecting main ideas from the text. Organizational strategies include outlining, concept mapping, and note-taking. Organizational and elaboration strategies require students to make connections between the content elements so they result in better comprehension and learning than rehearsal strategies. Strategic knowledge includes tactics about planning, monitoring, and regulating learning and thinking. For example, strategies for planning include setting sub-goals; strategies for monitoring cognition include asking themselves questions to check understanding of a text or checking their answers in a math problem, and strategies for regulating cognition include re-reading or going back to the problem to correct their mistakes. Second, knowledge about cognitive tasks includes general knowledge about various strategies to accumulate knowledge but the student should also know “what” strategy to apply “when”, “why” and “how” to apply it. Third, self-knowledge refers to knowledge of one’s strengths and weaknesses. Individuals should be aware of themselves and different types of strategies that they are using in different situations to be able to adapt their strategy use according to the changing situations.

According to Pintrich (2002), these three types of metacognitive knowledge are responsible for students’ learning in a way that using appropriate strategies according to his/her own capabilities and can be used by the students to facilitate their own learning. Therefore, it can be said that in the self-regulated learning there is a metacognitive component which includes knowledge about general cognitive strategies, knowledge about the self in terms of cognitive aspects, monitoring of cognition, controlling of cognition by selecting and adapting cognitive strategies, and creating cognitive judgments by reflection and evaluation (Pintrich, 2004).

Some other metacognitive experiences that can take place in the regulation of learning can be counted as “a learner’s feelings of knowing, difficulty, confidence, satisfaction, and familiarity as well as learner’s judgments of learning, solution correctness, and cognitive demands including estimates of the time and effort required to complete a task" (Efklides, 2006). As seen, these are more motivational concepts that include judgments of learning (JOLs), and feelings of knowing (FOKs), difficulty and so on.

2.1.3. Origins and Development of Metacognition

Another issue that addresses the complex nature of metacognitive processes is about its origins and development. There are various findings about the time that metacognition starts to appear in children and how it develops. Many studies showed that metacognition shows a developmental trajectory. That's to say, younger children show awareness about cognitive knowledge (e.g. declarative, procedural, and conditional knowledge) and their knowledge gets more consistent and their metacognitive skills such as strategy use are getting better as they are getting older (Schraw & Moshman, 1995; Paris & Winograd, 1990; Sternberg, 1986; Brinck& Liljenfors, 2013).

Metacognition is related to the Theory-of-Mind which is a person's ideas about his/her own and others' mental states such as beliefs, intents, knowledge, etc. (Premack & Woodruff, 1978). There are various contrasting views about when metacognition appears in children and how it develops; this procedure is tried to be explained by how children develop and construct ideas about his/her cognitive processes as well as others' cognitive procedures. There are many studies which are dealing with these questions. For instance, a person develops Theory-of-Mind from the age of 3 to 5 years (Flavell & Hartman, 2004). Also, in the years after the ages of 3-5 years, metamemory and metacognitive knowledge develop and continue to develop at least throughout the adulthood (Reeve, Brown, 1984) or during the life span (Alexander, Carr & Schwanenflugel, 1995).

Younger students are more limited in knowledge about their cognition. Also, they are unable to monitor their cognitive activities so they can assume that they understand the topic or memorize the necessary information even though they do not understand or memorize (Flavell, 1979). Reeve and Brown (1984) linked the Social Cognitive Theory of Vygotsky (1978) to the development of thinking and articulating and regulation of cognitive processes in children. Social cognitive theory of Vygotsky (1978) states that learning can be learned from social interactions with others, especially those who know better the task at hand. Therefore, when the child was too young to take initiatives his/her parents take responsibility to execute metacognitive processes. With time, the child starts to take responsibility for his/ her own thinking procedures with the help of and interactions with parents (Reeve & Brown, 1984).

In the developmental research of Flavell and Hartman (2004) about children's awareness about mental experiences, it is found that children acquire some elementary knowledge about mental activities by the end of the preschool period. For example, they know thinking is an internal activity and people can think about things that are present or absent, real or imaginary. They have also found that only one-third of 13-year-olds and more than half of the adults were able to state the mind is spontaneously active and it is not possible to inhibit its activity for a long time (Flavell & Hartman, 2004) which is defined as a *stream of consciousness* by James (1890).

In another research (Flavell, Green, & Flavell, 1995b), it was asked to four-, six-, and eight- year-olds about thinking about two irrelevant things at the same time. Most of the six- and eight- year-olds demonstrated knowledge on task-oriented thought and selective focus but four-year-olds did not show such kind of knowledge.

However, according to some other researchers, metacognitive skills emerge at the age of 8 to 10 years and some higher order skills such as monitoring and evaluation even appear much later (Veenman & Spaans, 2005). Sternberg (1986) conducted a study with subjects of ages 8, 10, 12, 19 and found that there were differences in the analogical reasoning of younger and older children. Their characteristics differed from each other in the processes of problem defining, developing strategies, information processing, and information representation. Younger students showed less knowledge and awareness about the characteristics of problems and the use of cognitive skills such as encoding. Also, Siegler (1978) studied the differences in younger and older children's problem-solving skills and found that younger ones had premature encoding in information processing procedures which were found to be related to poor problem-solving skills by Sternberg (1977). Less knowledge about the characteristics of the problem is referred to less knowledge about the task as Flavell (1979) stated. Paying less attention to the encoding stage of problem-solving shows less knowledge about cognitive procedures and insufficient strategy use (Sternberg, 1986). Therefore, younger children showed poor performance in problem-solving and Sternberg relates this result to younger students' less developed metacognitive skills. These results and findings were consistent with the ideas of Reeve and Brown (1984) who stated that problem-solving steps were similar to metacognitive processes and being able to solve problems efficiently was related to improved metacognitive skills.

Some other studies investigate the development of Theory-of-Mind and metacognition in children. For example, a positive relationship between knowledge about when to use a strategy (conditional knowledge) and strategy use was found by Justice and Weaver-McDougall (1989). That's, a person's knowledge about his/her cognition is positively related to his/her regulation of cognition. Many researchers stated both of these skills developed throughout childhood and adolescence. For example, planning skills before starting to a task and skills to know how to do it especially develop more between the ages of 10 -14 in children. Also, when studetns get olders they engage more in global planning than local planning (Bereiter & Scardamalia, 1987).

Children begin to differentiate cognitive activities such as memory, inference, attention or thought from the ages of 8-10. However, they are not able to differentiate the difference between comprehension and attention or between different kinds of memory (Demetriou, 2000). Also, at the ages of 7-8, they create a general understanding of the mind and cognitive self-image about how they value various cognitive activities. However, differentiation between problem-solving and reasoning strategies start at the age of 13 years (Demetriou, 2000).

On the other hand, there are many more contrasting ideas which claim that metacognition starts to appear at an early age like the infancy period. According to Brinck and Liljenfors (2013), metacognitive abilities and skills start to develop between 2 and 4 months of age. According to them, "interactions with others allow infants to internalize and construct initial strategies for monitoring, and control of their own and others' cognitions by emotion and attention" (p.85) and these interactions develop metacognition in infants.

2.1.4. Cognitive Component of SRL

Other than metacognition and motivation, there is another component of SRL which is the use of cognitive strategies that involve strategies for learning and studying (Paris & Winograd, 1999). Some general cognitive learning strategies can be named as rehearsal, elaboration, and organizational strategies (Weinstein & Mayer, 1986), Some of these strategies are general strategies which can be applied to many disciplines whereas some of them are domain or task-specific (Wigfield, Klauda, & Cambria, 2011). Elaboration strategies to regulate cognition are linking and integrating knowledge with previous knowledge; organization which refers to summarizing and representing the information and problem-solving (Duncan, McKeachie, 2005).

When a learner is “strategic”, he/she can use strategies effectively by choosing the best fit strategy according to the situation and apply these strategies appropriately (Winne &Perry, 2000). Borkowski *et al.*(1990) found that students who use more reading strategies showed more increase in comprehension. Besides, students who use effective reading strategies have a higher reading achievement (Paris, Lipson, & Wixson, 1983).

Cognitive strategies are the cognitive and behavioral products (Winne& Perry, 2000) and can be explained by the metacognitive aspect which refers to declarative knowledge (knowing the strategy), procedural knowledge (how to operate strategies), and conditional knowledge (when and why to apply a specific strategy) (Paris & Winograd, 1999).

In the use of strategies, the cognitive state is monitored by the learner and as a result of the comparison of the current state of cognition and the goal, internal feedback is generated (Winne& Perry, 2000). Then, if there is a gap between the standard and the current state or if task demands change, learners modify their strategies until they reach that goal (Zimmerman, 2000; Butler & Winne, 1995).

Obviously, cognitive and metacognitive processes are interwoven to each other. In the self-regulation processes of learning, there are both cognitive activities and metacognitive processes that are used as a learning strategy by students. As it is difficult to assess the cognition and metacognition of individuals, metacognition can be inferred from the overt cognitive activities of individuals (Veenman, 2007) while investigating the SRL skills of students.

For example, there are some activities used by students while regulating their learning such as goal-setting, planning, and regulation (Zimmerman & Schunk, 2001; Stoeger & Ziegler, 2008b). Also, self-regulated learning was found to be positively correlated with students' goal-orientation, self-efficacy beliefs (Zimmerman & Martinez-Pons, 1990), and the ability to use cognitive and metacognitive strategies (Obergriesser & Stoeger, 2016).

Other various SRL strategies are applied by students while regulating learning. Some example strategies are rehearsing information to be learned, forming mental images, organizing information, monitoring level of understanding, and using retrieval strategies (Schunk, 2008). Similar activities are also stated by Schraw, Crippen, and Hartley (2006) as planning, goal setting, implementing and monitoring strategy use, and evaluating learning goals.

Note taking is one of the strategies that is used by many students in learning environments. There are studies which investigated note-taking skills and its relation to academic performance. There are studies which showed the impact of note-taking and reviewing notes on higher academic outcomes (Jiang *et al.*, 2018). For example, in a study about note-taking skills of middle school students, it was found that students who were trained about strategic-note taking performed better in recalling and comprehension than control group (Boyle, 2011).

In the study of Jiang *et al.*(2018), students' note-taking skills in science learning were investigated. Their notes were analyzed according to 3 categories namely 'type of note', 'source of note', and 'hypothesis/conclusion'. Type of note includes sub-catgories of content reproduction, content elaboration, metacognitive strategies. Content reproduction category includes strategies such as copying or close paraphrasing of the content that is provided. It doesn't include synthesizing of new ideas and information. Content elaborations category requires interpretation of semantic information such as making inferenses, linking past and new information or connecting ideas. Metacognitive category includes monitoring of one's own learning process, knowledge and experience in the learning environment. In the study, it was found that students who had content elaborative note-taking strategies performed better than students who had reproductive note-taking in science inquiry.

Also, there are studies which investigated the use of note-taking strategies by highly self-regulated learners. Some studies showed that students with high self-regulated lerning skills tended to take fewer notes whereas in other studies it was found that highly self-regulated learners took notes more effectively than regular students. Also, regular students were found to taking less relevant notes (Jiang *et al.*, 2018).

2.2. Self-Regulated Learning in Gifted and Talented Students

2.2.1. Theories about Intelligence and Giftedness

There are three main approaches towards intelligence which define intelligence from different perspectives and assess it with different methods. These three approaches can be stated as, cognitive, biological and psychometric approach (Helms-Lorenz & Jacobse, 2008). Cognitive approach is mostly influenced by the studies of Sternberg (1977) which deals with the problem-solving procedures and investigates it in terms information processing stages and reasoning skills. Biological approach investigates intelligence from the perspective of psychophysical functioning of brain activities (Helms-Lorenz & Jacobse, 2008).

Psychometric approaches assess cognitive functioning in terms of intelligence tests and defines intelligence by evaluating test responses statistically. Spearman (1927) defined "positive manifold" phenomenon which was a supporting finding for the attempt to define intelligence statistically. He found that all the valid tests that assessed intelligence correlated to one another and he called this common factor as 'general intelligence factor (g)' (as cited in Helms-Lorenz & Jacobse, 2008).

Then, the terms “fluid and crystallized intelligence” were defined by Cattell (1992). He defined crystallized intelligence as one’s general knowledge and ability to recall information from long-term memory. Fluid intelligence, on the other hand, is not determined by one’s knowledge but his/her ability to think, reason abstract concepts, elaborating different constructs and ability to solve problems that are newly encountered. Psychometric intelligence tests are being used to assess one’s both fluid and crystallized intelligences but it does not give information how much of these intelligence types contribute to one’s general intelligence score.

By many researchers, learning and academic performance are thought to be linked to one’s general intelligence (g score) which can be assessed with psychometric intelligence tests (Sternberg and Kaufman, 1998). Therefore, IQ test have been used widely for many areas to predict one’s future performance. The “g factor” that is obtained from these tests are used to interpret one’s intelligence level. For many years, g factor was thought to be the only variable that describe one’s behaviors and performance (Sternberg and Kaufman, 1998). However, today we see that one’s performance is not only determined by general intelligence but also by personality traits such as beliefs, attitutes, emotions, motivations, goals, metacognitive skills and contextual factors (Pintrich, 2000; Zimmermann, 1990; Boekaerts and Niemivirta, 2000).

Although today mostly psychometric tests are being used to identify gifted students before enrolling to gifted enrichment programs, researchers who study giftedness state that giftedness is not only dependent on general intellectual ability (g factor) but also it has various other components.

For example, according to Renzulli’s (1986) definition, giftedness has components of general and special talent, creativity and motivation. According to him, a gifted person should show “above average ability, high level of task commitment and high level of creativity”. In the Three Ring Theory, these three constructs interact with each other to define a gifted one’s behaviors. Similar to other theories of giftedness, this theory supposes that general intellectual ability is an important part of giftedness to some extent. Also, motivation is taken as an inevitable factor and important for task commitment which refers one’s willingness to complete and persistence on working and completing a specific task.

Besides these two characteristics, a gifted person is defined as who can come up with new and creative ideas and find creative solutions to problems.

Another model of giftedness is developed by Gagne (2005). Similar to Three Ring Theory of Renzulli (1986), motivation is accepted as one of the premises of putting some amount of effort to transform natural abilities (gifts) to outstanding knowledge and skills (talents).

In the Actiotope Model of Giftedness, intelligence is neither a multiplication of a psychological construct nor a group of various psychological constructs (Ziegler, 2005). It is an adaptive system trying to reach excellence by including dynamic interactions among some components namely person and environment by regulating goals, social relations and emotional states.

According to National Association for Gifted Children (2006), a gifted person shows an outstanding performance in one or more talent areas such as special academic ability, general intellectual ability, creativity, leadership, visual and applied arts. Gifted and talented children show advanced developmental trajectory especially in cognitive processes such as reasoning ability and problem-solving skills (Welsh *et al.*, 1991).

As stated above, almost all theories regarding giftedness, include talent or ability to some extent but some theories claim giftedness has various psychosocial and affective constructs inside and it requires controlling and regulating these constructs. Therefore, some researchers propose that there is a regulation aspect of giftedness which is controlled by higher-order cognitive skills (Veenman & Spaans, 2005). Higher-order cognitive skills include executive functions such as planning, cognitive monitoring, self controlling and self-regulation. However, there is still a controversy whether intelligence includes executive functions or executive functions are independent of intelligence (Leana-Taşçılar, 2016).

When executive functions are examined, it can be seen that these skills are similar to metacognitive component of self-regulation. Some researchers who study intelligence accept executive functioning of the cognitive processes as a component of intelligence.

Therefore, they state that metacognition is a dimension of intelligence (Sternberg, 2003). Therefore, there should be a positive correlation between inteligence and metacognition which can be concluded as gifted students should have higher metacognitive skills. These ideas are leading us to the questions of whether there is a relation between intelligence, metacognitive skills and, which in turn, self-regulated learning.

2.2.2. Research Studies about Gifted Student's Metacognition and Self-Regulated Learning

When the literature about relationship between intelligence and metacognition is reviewed it is seen that there are studies which support the idea of gifted students have higher-order metacognitive strategy use more frequently than regular students. For example, in a cross-cultural study which investigates relationships between metacognitive skilfulness, intelligence, and school performance in native and migrant groups of students. Results of the study showed that highly intelligent group in the native group showed higher metacognitive skilfulness (Helms-Lorenz & Jacobse, 2008). Results of another study which was conducted on elementary level students showed that students with higher IQ score, seemed to use exper-like strategies more often (Shore, 2000).

Also, there are contrasting results with the above mentioned studies. In some studies gifted and non-gifted students were investigated and results showed that gifted students were better in their metacognitive knowledge but they were not superior in using metacognitive strategies (Carr *et al.*, 1996; Zimmerman & Martinez-Ponz, 1990). Also, there are studies that showed intelligence and metacognition were not entirely dependent or independent to each other. That's to say, intelligence had impact on metacognition at the beginning to some extent but its impact was not directly proportional to metacognition(Veenman *et al.*, 2002). In another study Allon and colleagues (1994) investigated students' problem-solving metacognition skills and WISC-R scores and low correlation was obtained between the two variables.

There were also other studies which investigated the metacognitive procedures that were used by gifted students in educational settings. For example, in the study of Snyder, Nietfeld, and Linnenbrink-Garcia (2011), differences between gifted and non-gifted students' metacognition and its relation to exam performance were investigated. Results showed that there was no difference between measures of knowledge of cognition and regulation of cognition. Other results showed that gifted students consistently outperformed their typical peers, gifted students were consistently more accurate in their local monitoring judgments than typical students, neither group held an advantage in global predictive accuracy. Also, gifted students were statistically significantly more accurate than non-gifted students in their postdictive judgments throughout the semester.

To get a global perspective on gifted students' metacognition and self-regulation behaviors a cross-national study was conducted. In the study, Tang and Neber (2008) investigated gifted students in self-regulated science learning in terms of motivation, nation, gender, and grade level, it was found that their strategies do not really meet their intrinsic goals and their level of SRL and motivation are not advanced in higher grades.

In another study Greene and colleguages (2006) showed that while learning with hypermedia, gifted students more frequently used higher order SRL strategies (e.g. summarizing, selecting new informational sources, and coordinating informational sources) than grade-level students. In the same study, it has been found that gifted students who use more SRL strategies were more successful in self-regulate their learning of using hypermedia environment without any scaffolding.

Zimmerman and Martinez-Pons (1988) conducted a study to investigate self-regulated learners' strategies. Fourty academically advanced and 40 academically poor students were examined in terms of the self-regulated learning strategies they used. These strategies were determined as self-evaluation, organization and transformation, goal-setting and planning, information seeking, record keeping, self-monitoring, environmental structuring, giving self-consequences, rehearsing and memorizing, seeking social assistance (peers, teacher, or other adults), and reviewing (notes, books, or tests). Results showed that academically advanced students were different in their use of self-regulated learning strategies in variety and frequency. Low achieving students were found to be less expressed their strategies and they do not have self-regulatory initiatives.

As these results are counter-intuitive to the idea of gifted students are superior both in their cognitive and metacognitive skills which can be the explanation for their advanced performance and achievement, there is a need for further investigation of these concepts.

2.2.3 Research Studies about on Metacognition and Self-Regulated Learning of Gifted Students in Turkey

To be able to better interpret the sample of the present study, research studies which investigate Turkish gifted students in terms of their SRL skills and self-regulated learning stategies they use while learning were reviewed.

Gifted and non-gifted students were compared in terms of their self-regulated learning skills in science learning (Tortop, 2015). Study was completed on 264 students who are attending to 4-8th grade. Results showed that gifted students' self-regulation skills for science learning were significantly higher than non-gifted students but two groups did not differed to each other in the metacognitive component which is a sub-dimension of self-regulated learning. Also in the same study, Tortop (2015) investigated gender differences in both groups of gifted and non-gifted students in terms of their self-regulated science learning skills and no differences were found between female and male students.

Another study investigated 63 high achieving students to figure out their self-regulated learning strategies, motivations on mathematics learning and learning styles. Results showed that the student group mostly used cognitive regulation strategies and they were poor on planning and monitoring strategies for processes of doing homework (İspir *et al.*, 2011). The reason why these students do not show developed planning and monitoring skills can be explained with the view of Tortop (2015) which claims that these students have not been educated to develop these skills so they did not know about developing these strategies.

In the study of Tüysüz (2013), 85 gifted and talented students were investigated in terms of their metacognition level about problem solving skills. In this study group, their scores showed that they had high scores on metacognition and female students were found to be better than boys in terms of their metacognitive level about problem solving skills.

In another stud, Saraç et al(2014), 91 fifth grade students were investigated to identify if any correlations exist between metacognition and intelligence and their relevance to learning performance. Correlation between general intelligence and three factors of metacognition, namely metacognition knowledge, metacognitive monitoring and metacognitive regulation were investigated. Results showed that although there was no signitificant correlation between metacognitive knowledge and general intelligence and metacognitive regulation and general intelligence. However, there was a significant correlation between metacognitive monitoring and general intelligence. Also, although metacognitive knowledge was not a predictor of learning performance, besides general intelligence factor, metacognitive monitoring and regulation were found to be a significant positive predictor of learning performance.

In another study, students' learning strategies were investigated in 101 elementary school gifted students. Results showed that all gifted students frequently used affective strategies, female students mostly used elaboration, comprehension, monitoring and organizing strategies whereas male students used rehearsal strategies (Kontaş, 2010).

When the literature is reviewed it is seen that there are few studies which investigates gifted students in terms of their metacognitive and cognitive skills to regulate their learning processes. Also, when it comes to their learning strategies while science learning processes the number of studies are getting less. Therefore, there is a need to investigate all these concepts to be able to better understand gifted student profile and to be able to modify teaching strategies according to their behaviors, skills and abilities.

3. SIGNIFICANCE OF THE STUDY

Many instructional studies about SRL focus on students' learning outcomes, rather than mediating self-regulatory behavior but there is a need for investigating the self-regulatory behaviors that lead to better learning outcomes (Veenman, 2007) because many studies showed that self-regulated learning is associated with adaptive learning behavior and better academic performance (Moshman, 1995; Boekaerts, Pintrich, & Zeidner, 2000; Zimmerman & Schunk, 2011). Therefore, there is a need for a deeper understanding of students' use of SRL skills and strategies to create better learning environments.

There is a debate in terms of gifted students' metacognitive and cognitive strategy use to be a successful self-regulated learner. For example, some studies claim that especially metacognitive strategy use is applied when mostly there is a problematic situation so gifted and talented students mostly do not need to use these strategies (Boekaerts, Pintrich, & Zeidner, 2000; Zimmerman & Schunk, 2011). However, some studies showed that gifted and talented students were outperformed in all measures of self-regulated learning skills (Greene *et al.*, 2006). In order to create better learning environments and provide better opportunities for gifted and talented students there is a need to know about these students' skills and abilities (Stoeger *et al.*, 2015). Therefore, the current study will investigate SRL strategies used by gifted and talented studentswhile learning two science concepts. The first concept was selected from biology, which explains yellowing and pouring of leaves. The second concept was selected from physics, which explains how lightning and thunder happen. These concepts were selected specifically because these are the examples of scientific events in daily-life and observed by all students.

The study is a mixed method study including both qualitative and quantitative methods for data collection. Because of the complexity of the cognitive and metacognitive processes that are driven by the students, there were interviews conducted with the students which aim to reveal the underlying cognitive and metacognitive processes that help students regulate themselves while trying to get the information from the provided science videos.

Therefore, the current study is significant because of its design regarding science learning in both biology and physics disciplines. Also, the study provides multiple types of data were collected via multiple resources such as self-report inventories, questionnaires, and interviews.

4. THE PURPOSE OF THE STUDY

The main purpose of the current study is to investigate deeply the self-regulatory skills of middle school gifted students in terms of their cognitive and metacognitive strategy use while learning science concepts.

4.1. Research Questions

The research questions regarding the purpose of the current study are as follows:

1. Which skills do 7th - grade gifted students possess to carry out self-regulated learning?
    a. Which cognitive strategies are used by 7th - grade gifted students while learning science from a video?
    b. Which metacognitive strategies are used by 7th - grade gifted students while learning science from a video?

2. Is there any statistically significant correlation between students' metacognitive awareness and post-test scores for Video Content Questionnaire while controlling for their pre-test scores?

3. - Is there any statistically significant difference in terms of increase in students' pre and posttest video content knowledge scores for different groups of self-regulated learners?

4. Is there any statistically significant difference in students' metacognitive awareness level for different groups of self-regulated learners?

5. METHODOLOGY

In this chapter, detailed information about the methodology of the study is given. Information about the characteristics of the sample, design of the study, procedures, instruments for the data collection, and data analysis techniques will be discussed in detail.

5.1. Sample

Participants of the study were determined by convenient sampling. The sample consisted of 32 students who were diagnosed as *gifted*. All gifted students in the current study were attending an enrichment center which provides special education program only for gifted and talented students in Konya, Turkey.

The enrichment center was legally affiliated to the Ministry of National Education of Turkey. Students who are enrolled this center, attend various courses such as mathematics, science, history, language, geography, music, arts. Also, students can take elective courses such as creative writing, leadership, aviation and space, archeology, mechatronics, entrepreneurship. To be able to attend these gifted education centers, students should be identified by the special exams applied by the center and by Guidance and Research Center (Rehberlik Araştırma Merkezleri (RAM) which are also regulated by Ministry of National Education.

5.2. Research Design and Procedure

This study was a mixed-method research which was designed to have an in-depth understanding in self-regulated learning processes and skills in gifted and talented students. In this study, both qualitative and quantitative data collection methods were used to obtain data to explore gifted and talented students' self-regulatory skills by investigating their cognitive and metacognitive strategies.

5.2.1.Procedure

In this study, students were presented two videos about two science concepts which were chosen from physics and biology subjects to examine students in different science subject-matters. Videos were originally in English but translated dobbed to Turkish by the researcher. Expert opinions about the content-validity of the translated videos were obtained by two researchers from the Mathematics and Science Education Department.

While students were watching the video, their behaviors could give us data regarding their thinking ways and regulating strategies about their own learning processes. Video watching procedure provided flexibility to students on controlling their learning pathways which provides more information about their cognitive and metacognitive skills.

Science concepts were selected from daily life which can be observed by every child in his/her lifetime. The science behind lighting and thunder was chosen from the physics, scientific explanation for the color change in the leaves of trees was chosen from the biology topics.

During the data collection, the researcher met the participants twice. At the first meeting, participants completed the Metacognitive Awareness Inventory. Then, there was an interview about their SRL skills in general science learning. Then, before watching the science video, students' pre-knowledge about the selected content was measured by the questionnaire prepared by the researcher. Then, participants watched the video about yellowing and pouring of leaves two times. While watching the video the first time they took notes on the Student Worksheet. While they were watching it the second time, they took notes with different colors. They could use their time while managing watching time by stopping or rewinding the video. (For video link see Appendix E).

After watching videos, an interview was held with the student about the time that he/she watches the video and researcher trying to infer students' metacognitive monitoring and evaluation skills to regulate his/her learning. Also, students' understanding of the video content was investigated with questions. Finally, the students completed the post-test related to the content.

In the second meeting, the student watched the video about lightning and thunder. Before watching the video, again pre-knowledge test was applied. Then, the student watched the video about lightning two times in a way that is explained above. Then, the interview was conducted about the student's understanding of the video content and metacognitive awareness while watching the video. As a final step, the student completed the post-test about the video. The study was conducted in the 2017 spring-semester by the researcher in Konya. Table 5.1. shows the procedures that were followed during the research. (For video link see Appendix D).

Table 5. 1. Procedures of the research

Period	**Procedures**
Before Watching Video	Interview with the student about his/her General SRL Skills The student will complete the Metacognitive Awareness Inventory for Children The student will complete Pre-Test about the *yellowing and pouring of leaves*
While Watching Video	The student will watch the video about *yellowing and pouring of leaves* He/she will take notes on the Student Study Sheet with blue pencil The student will watch the video about *yellowing and pouring of leaves* once more He/she will take notes on the Student Study Sheet with red pencil
After Watching Video	The student will complete Post-Test about the *yellowing and pouring of leaves* Interview with the student about the content of the video and what he/she understood from the video Interview with the student about the metacognitive strategies that he/she used while watching the video

5.3. Instruments

In the current study, qualitative data were collected by interview questions, open-ended questionnaires and study worksheets. Open-ended questions and student worksheets were used to infer a deeper understanding of the metacognitive skills of the students in terms of cognitive knowledge and regulation of cognition. Also, students' self-regulatory skills in terms of strategy use and affective components were investigated with the qualitative data gathered from interviews and student worksheets.

Also, a Metacognitive Awareness Inventory for Children was used to have information about students' metacognitive awareness. This data were used to make inferences and be able to elaborate on the students' overall standing in terms of their metacognition.

5.3.1. Demographic Form

The demographic form was used to collect information about the participants' sex, grade, school name, school type, age, average point on Science courses, how many years do they participate enrichment center. As the present study involved watching a short video by the students on their own, their experience about watching documentaries were asked in the form.

5.3.2. Interview Protocols

To gather deeper information about students, researcher developed 4 semi-structured interviews which include questions regarding students' self-regulated learning skill, metacognitive skills and knowledge about science concepts. Detailed information about questions of the instruments and information regarding content-related validity of the protocols will be given in the following sections.

5.3.2.1.Interview Protocol for Self-Regulated Learning (Metacognitive Factor). The interview protocol was developed to examine the metacognitive processes in the self-regulated learning procedure. Metacognition involves both metacognitive knowledge, which describes a person’s knowledge about his/ her own cognitive capacity, characteristics of the task, and efficient strategies to employ to achieve the task (Flavell, 1979), and metacognitive regulation, which describes regulation of cognition with the help of three processes namely planning, monitoring, and evaluating (Brown *et al.*, 1982). The questions in the interview protocol were prepared to have a deeper understanding of students’ metacognitive skills. Table 5.2. shows the questions that were asked in Interview Protocol for Self-Regulated Learning which focuses on Metacognitive Factor.

Table 5. 2. Questions of Interview Protocol for Self-Regulated Learning on Metacognitive Factor

Interview Protocol for Self-Regulated Learning (Metacognitive Factor)	
Question 1	Did you stop the video? When did you stoop? Why you needed to stop?
Question 2	What did you do to retention information?
Question 3	Was it enouh to watch the video twice? Why, why not?
Question 4	What did you know before watching the video? Did you use or remember your previous knowledge?
Question 5	What could be done to better understand this video?
Question 6	Now do you think you have leanrt this topic completely?
Question 7	Would you like to prefer learning this topic any other way? Which method would you like to apply?

Question 1 was asked to examine students' awareness about themselves and apply strategies in return of the internal feedback. For a person to be a self-regulated learner, he/she should have metacognitive skills to take control of his own learning processes (Zimmermann, 1990; Pintrich, 2005; Butler & Winne, 1995). Cognitive monitoring and feedback are the cardinal processes in the regulation of learning because to be able to regulate one's learning, one should take control of his/her cognitive activities. Without monitoring cognition and comparing it to the standards of the desired outcome, there will not be anything to regulate (Winne & Perry, 2000). For example, during the application of strategies, while working on a task, monitoring activities should take place to evaluate the progress of the self and evaluate the effectiveness of these strategic actions (Brown *et al.*, 1982).

Question 2 was asked to understand participants' metacognitive awareness to use note-taking skills. Note-taking is one of the efficient learning strategies (Schraw *et al.*, 2006) and knowing why and when to use a particular strategy is a metacognitive skill which is called conditional knowledge (Schraw, *et al.*, 2006; Borkowski, Carr, and Pressley, 1987).

Questions 3 and 6 were prepared to examine participants' ability to evaluate his/her learning progress. If metacognition is thought as a set of self-instructions that a person uses to regulate his/her performance, another part of this circular process of regulation can be stated as evaluation (Veenman *et al.*, 2006). Also, according to Veenman and colleagues, monitoring and evaluation processes are higher-order metacognitive skills and they are generally working in the background. Therefore, these procedures rarely heard explicitly or seen during task performance. This makes them difficult to assess so they must be inferred from cognitive activities that take place during task performance.

Question 4 was prepared to examine the participants' awareness about his/ her pre-knowledge about the topic and his/her strategic planning about it. As mentioned earlier planning is another component of the cyclic process of regulation of learning. According to Zimmerman (2002), there is a forethought phase in self- regulation and one of its sub-processes involves goal-setting and strategic planning. In the strategic planning phase, prior knowledge related to the task is evaluated in students with self- regulatory skills and required links are constructed with the prior knowledge and task requirements.

Questions 5 and 7 were prepared to examine participants' metacognitive experiences and awareness about their own learning processes and strategies that are developed according to their metacognitive experiences.

When the interview protocol was developed, to investigate its appropriateness for the assessment of dimensions of self-regulated learning phases, it was compared with the Self-Regulated Learning Interview Schedule (SRLIS; Zimmermann & Martinez- Pons, 1986, 1988). The developed questions were related to some categories of SRLIS namely planning, self-monitoring, self-evaluation, environmental structuring, and seeking social assistance. Table 5.3. shows which factor of metacognition each question measures.

Table 5. 3. Interview Protocol for Self-Regulated Learning (Metacognitive Factor)

Factors	**Question Number**
1. Awareness about themselves and applied strategies in return of the internal feedback. • Cognitive monitoring and feedback are the cardinal processes in the regulation of learning (Winne & Perry, 2000)	Question 1
2. Metacognitive awareness, note-taking skills • Not-taking is one of the efficient learning strategies (Schraw *et al.*, 2006) and knowing why and when to use a particular strategy is a metacognitive skill which is called as conditional knowledge (Schraw, *et al.*, 2006; Borkowski, Carr, and Pressley, 1987).	Questions 2
3. Ability to evaluate his/her learning progress. • Monitoring and evaluation processes are higher order metacognitive skills and they are generally working in the background (Veenman *et al.*, 2006).	Questions 3 and 6
4. Awareness about his/ her pre-knowledge about the topic and his/her strategic planning about it. • Prior knowledge related to the task is evaluated in students with self- regulatory skills and required links are constructed with the prior knowledge and task requirements (Zimmerman, 2002).	Question 4
5. Metacognitive experiences and awareness about their own learning processes and strategies that are developed according to their metacognitive experiences.	Questions 5 and 7

Also, expert opinions were taken for the developed protocol from two researchers who were competent in the assessment of self-regulated learning to assess the content-related validity of the questionnaire.

5.3.2.2. Interview Protocol for Self-Regulated Learning. This protocol was developed to assess participants' self-regulated learning skills in general, in science learning and school science classes. Science and school science were separated because schools may not satisfy the needs of gifted students and their motivation for school science can be low and it may affect how they behave.

There is a motivational component in self-regulated learning which includes a lot of constructs such as self-efficacy, task interest (Schunk, 1989; Zimmermann, 1985), anxiety, motivation, attitude (Weinstein, 1987), epistemological beliefs (Yoon, 2009; Schommer, 1994; 1998), and goal-orientation (Pintrich & Schrauben, 1992). Thus, some questions were prepared to investigate participants in some motivational and affective dimensions. These dimensions were considered in terms of interest and task value, awareness and monitoring motivation and affect, and strategies for managing motivation and affect (Pintrich, 2005). Table 5.4 shows the questions that were asked in Interview Protocol for Self-Regulated Learning.

Table 5. 4. Questions of Interview Protocol for Self-Regulated Learning

Interview Protocol for Self-Regulated Learning	
Question 1	Which areas are you interested in? (If not science; so, are you interested in science classes?
Question 2	What kind of resources do you use to learn a topic you are wondering?
Question 3	Are there any better ways to learn science do you think? Which ways do you prefer in general? Do you think this way is the better? Why?
Question 4	Do you have targets in the fields of science? Do you think you can achieve your goals? In science classes at school, what are achieving the expected targets?
Question 5	Do you study science day by day? let's say you have a science lesson tomorrow, what do you do? So, how do you work?
Question 6	What do you do, when you have a science assignment? (if the answer does not come, for example, something like a research paper)
Question 7	How do you prepare for the science exam? let's say you have an exam tomorrow, what dou you do?
Question 8	What do you do if you get a low grade in your science exam?
Question 9	Do you make plans before starting to study science courses? How is your plan look like? Does it change according to the difficultness of the topic?
Question 10	When you failed while studying for a topic or realized that your way of studying is not efficient what would you do?
Question 11	What would you do when you are stuck with a specific topic?
Question 12	What do you do to see whether you learnt the topic or not?
Question 13	While studying a topic that you think is easy… a. What do you think? b. What do you do to learn this topic? c. How much time and effort do you spend to learn this topic?
Question 14	While studying a topic that you think is difficult… a. What do you think? b. What do you do to learn this topic? c. How much time and effort do you spend to learn this topic?

In questions 1, 10, and 11, participants' interest areas, interest towards science, and awareness about ideas when faced with a difficult and easy task, and strategies to manage motivation and affect in these two different conditions were asked. Also, in the "c" choice of questions 10 and 11, participants' help seeking and time and effort planning orientations were investigated in the situations when faces with easy and difficult tasks.

Questions 2 and 3 investigate students' preferred resources to learn something and science specifically and the rationale behind these preferences to see if the student is aware of his/her own metacognitive experiences. Also, questions 4, 5, and 6 were prepared to examine students' study habits for school science and school science examinations and school science assignments.

Questions 7, 8, 9 are focusing on the planning, monitoring and self-evaluation skills of the participants. Table 5.5. shows which factor of self-regulated learning each question measures.

Table 5. 5. Interview Protocol for Self-Regulated Learning

Factors	Question Number
• Interest areas • Differentiate students who interested in science and not interested	Question 1

• His/her awareness about
  ○ learning preferences,
  ○ learning strategies,
  ○ resource pereferences,
  ○ studying skills,
	Questions 2, 3, 5, 6, and 7

• Goal-setting • Goal-orientations (mastery, avoidance, performance)	Question 4
• Ability to realize deficiencies in his/her learning strategies • Ability to change, adapt or regulate his/her learning strategies • Ability to regulate emotions or motivation	Questions 8, 10
• Planning, strategic planning, forethought, integrating prior knowledge skills	Question 9
• Ability to monitor, evaluate their cognition • Internal feedback for regulation • Resource, effort, and time management skills	Questions 11 and 12
• Time and efort management • Motivation regulation • Volitional control • Resource and context management • Help-seeking behavior	Question 13 and 14

To assess content-related validity of the questionnaire, expert opinions were taken for the developed questionnaire from two researchers in the Primary Education Department and Special Education Department who were competent in the assessment of self-regulated learning.

5.3.2.3. Video Content Questionnaire (Pre-Test & Post-Test). Pre-Test and Post-Test were conducted to evaluate students' knowledge about the scientific explanation of the processes behind the color change in the leaves of trees, and lightning and thunder. In these instruments, there were questions related to the topics covered in the videos. Before the participants watched the videos, their existing knowledge about the topic was gathered with the Pre-Test. Then, the students watched the videos and they took the same instrument. The answer of the first question required both drawing and explaining the phenomenon with writing.

In the Question 2, students were asked about scientific terms and if a student chooses the option "I heard about it, I can explain it like…" he/she needs to give further explanation about the term.

Content validity of the instruments was obtained by expert opinions from researchers in Mathematics and Science Education Department.

5.3.2.4. Interview Protocol About Video Content. Two interview protocols were developed to assess student understanding about the topics that are covered in the videos. These interviews aimed to get deeper information about participants' knowledge and understanding of the video content after watching the videos. First, the participants were asked to draw and explain the content of the video. Then, there was a question which asked what they had learned new in the videos. The aim of this question was to assess participants' awareness about what they know previously and their ability to monitor themselves about what they have learned newly.

To gather information about their interests, questions 4 and 5 were asked. In the Question 6, a photograph was shown, and participants were asked to make inferences from the video and relate the picture to the video content. This question was expected to give more information about participant's understanding of the videos, make connections and inferences, and verbalize their ideas in an organized manner.

In each questionnaire, there was a higher-level question such as transfer questions or extension questions which assess participants' ability to transfer what they have already learned to a novel situation or their ability to make connections to make inferences. The final question asked participants to summarize what they have learned in a one full sentence. This question aimed to assess overall understanding of the students and their ability to organize their ideas. Content validity of the instruments was obtained by expert opinions from researchers in Mathematics and Science Education Department.

5.3.2.5. Student Worksheets. In the study, students watched two different videos explaining the science behind some natural events. These natural events were selected intentionally because they are very common events that every student has probably experienced once in his/her life time.

While watching the videos, students were given a study worksheet on which they can take notes, make drawings, schemas etc. while watching the videos. They watched each video twice and during each watching period they wrote with different color pencils. By that way, we could be able to observe their progress and their preferred learning strategies.

5.3.3. Inventories

5.3.3.1. Turkish version of the Metacognitive Awareness Inventory for Children (Jr. MAI). In this study, quantitative data were collected to examine the metacognitive abilities of the sample. Validity, reliability, and factor analysis studies of the A and B Forms of Metacognitive Awareness Inventory for Children (Jr. MAI; Sperling, Howard, Miller & Murphy, 2002) was done by Karakelle and Saraç in 2007 and the inventory was adapted to Turkish. The original inventory was developed to assess the metacognitive skills of students in grades from 3 to 9. There are A and B Forms of the instrument which are developed for grade 3-5 students and grade 6-9 students, respectively. Both forms of the inventory were adapted into Turkish and validity and reliability studies were done with the sample of 565 students for the A Form and 736 students for the B Form. As the sample of the present study consists of 7th grade gifted students, B Form of the Metacognitive Awareness Inventory for Children (Jr. MAI) was used.

Both forms were self-report measures including Likert-type questions. The adapted version of the A Form of the instrument included 12 three-point Likert scale questions and B Form included 18 five-point Likert scale questions. Jr. MAI- B Form was developed by adding 6 extra statements to Jr. MAI- A Form that examines more sophisticated or higher-level metacognitive skills. In the A Form, there were two categories under cognitive knowledge namely knowledge about the task and knowledge about the self and two categories under the regulation of cognition namely monitoring and evaluation. Table 5.6. shows the factors og metacognition construct that each question measures.

Table 5. 6. Item Numbers of Factors in the Jr. MAI- A Form (Karakelle and Saraç, 2007).

Factors	Number of Items
1. Regulation of Cognition- EVALUATION	3, 11, 6, 8
2. Knowledge about Cognition- TASK	2, 5, 12
3. Regulation of Cognition- MONITORING	10, 7, 9
4. Knowledge about Cognition- SELF	4, 1

In the adaptation study of the B Form of the scale, test-retest reliability of the inventory was calculated as 0.72 ($N = 373$, $p < .01$), and Cronbach alpha value was found as .80 (Karakelle & Saraç, 2007). These scores show that the instrument is reliable and valid to be used in the sample of respective age group students.

The factor analysis of the B Form showed that the instrument includes 4 factors regarding metacognitive knowledge and metacognitive regulation skills. However, unrotated component matrix values for all items were found to be focus on one value of 4.2 which means that factors were found to be correlated with each other and it is not appropriate to use it to measure sub-dimensions. Therefore, similar to original study (Sperling ve ark., 2002) the scale should be used as one factor scale which measures total score of metacognitive skills.

Permissions for the use of Metacognitive Awareness Inventory for Children (Jr. MAI) was gathered from the researcher who developed the inventory. Also, the required permission for conducting this research was obtained from the ethical committee of the Ministry of Education.

5.4. Data Analysis

In order to figure out self-regulated learning skills of gifted students, first it was decided to investigate which strategies they applied while managing their studies. Researcher used two methods to investigate Research Question 1.

First method was to hold interviews with the sample. Structured Interview Protocol for Self-Regulated Learning was used to ask students about their studying habits. Results were used to identify which cognitive, metacognitive and motivational strategies they use. 14 questions including concepts such as interests, studying methods, exam preparation methods, goals were asked to each student and their answers were open coded. Students were not asked directly about their strategy preferences but researcher tried to make inferences from their responses.

The second method included analyzing student behavior while they were trying to learn some scientific concepts while watching two videos which were about yellowing of leaves and lightning and thunder They watched the videos twice and they took some notes on the Student Worksheets. As shown in the Table 5.7., researcher constructed a coding list to analyze student behavior and strategy they used from their notes and drawings. Then, researcher used results of both methods to draw an overall picture of the student behavior in terms of learning strategy use.

Table 5. 7. Coding List for the Analysis of Student Worksheets

Categories	**Codes**
Abbreviations	Abbreviations of words Abbreviations of sentences
Using signs	
	Using signs for abbreviation. E.g. Using "+" for positive charge or using ("" "") for the places where there is a repetition. Using () sign to make a definition or give extra information. Using common signs.
	Using arrows/lines to link sentences or to express procedures. To make note taking easy and reflect easily what is in their minds.
	Creating icons and signs to express lightning and thunder
	Using chemical formulas while writing chemical compounds and matters.
	Putting question mark to places that do not understand
	Underline the words
	Putting exclamation mar to take attention
	Total
Organizing the writings	
	Using graphic organizers
	Writing item-by-item
	Writing the heading of the topic
	Total
Showing processes in a short way	
	Expressing chemical reactions in chemical reaction equality
	Expressing processes and conditions by drawings
	Showing sound effects by drawings to imply sound
	Total
Writing in the paragraph format	Not short way as a block

5.4.1. Quantitative Analysis

Quantitative data was obtained from the Metacognitive Awareness Inventory for Children. Quantitative data gathered from the inventory was only analyzed descriptively to better intepretation of the qualitative data.

5.4.2. Qualitative Analysis

As the study investigates a sample of gifted and talented students in terms of their metacognitive processes and self-regulated learning skills, there was a need to gather detailed information. Therefore, qualitative data collection methods were preferred in this study (Creswell, 2013).

160 semi-strucructered interviews which consist of questions that are prepared to gather information about students' self-regulated learning strategies, metacognitive and cognitive skills and knowledge about the video content were completed.

There were 4 interview protocols which were developed by the researcher to measure students' content knowledge about the related video content. One of the protocols were asked for two different video contents. Therefore, 5 interviews were done with 32 gifted and talented students which makes 160 interviews in total.

During interviews, researcher noted down the responses of the students. Also, researcher audio recorded the responses of the students to provent loss of information. However, these records were confidential that is only used by researcher.

Data of interviews was consisting of 547 minutes (approximately 9 hours) of dialogues which are all transcripted by the researcher. After reading, all of the transcripts, data were opencoded and then categorized by finding general themes. After the categorization of strategies, frequencies of categories were found and analyzed.

Besides the interviews, students were given Video Content Questionnaire-Lightning and Video Content Questionnaire-Leaves. Video Content Questionnaire-Lightning included 9 open-ended questions and analysis of 2 drawings (lightning and thunder). Video Content Questionnaire-Leaves included 8 open-ended questions and analysis of 1 drawing. These two questionnaires were applied two times as pre-test and post-test which makes analysis of 34 open-ended questions and analysis of 6 drawings.

As another data collection method, students were also given Student Worksheets to take notes during watching videos. Students were asked to watch each video two-times and took notes with two different color pencils for each watching. Researcher analyzed these worksheets in terms of drawings and notes by open coding and find strategies used by the students.

6. RESULTS

In this chapter, findings of the study will be presented. Findings are given in three main sections. In the first section, demographic data about students are presented. In the next section, descriptive statistics about gifted students' metacognitive awareness are presented. Finally, the themes that are obtained from the analysis of interview protocols, students' answers for open-ended questions and notes on their study worksheets are presented.

6.1. Descriptive Statistics regarding Demographic Data

The sample of the study consisted of 32 studentsincluding11 female students (%34) and 21 male students (%66). The students were enrolled at different schools all over Konya. Fourty-four percent of students were attending state schools and the rest of them were attending private schools (%56).

Also, the period of time for continuing the education in the enrichment center was changing among the sample. Almost half (47 %) of the students in the sample were attending the enrichment center for three years, 38% of students were attending for 5 years, 12% of students were attending for 4 years, and only 3% of students were attending for 2 years.

As the present study involves watching a short video by the students on their own, their experience about watching documentaries were asked in the form. Most of the students were accustomed to watching documentaries. 72% of the students stated that they have watched documentaries in their lives more than 10 times, 7-10 times (16%), and 3-6 times (12%). Nobody stated that they have watched documentaries in their lives about 0-2 times. Table 6.1. shows student numbers about how many times they have watched documentaries. Also, students stated their previous year Science Grades (M= 99.03, SD= 1.59).

Table 6. 1. Students' experience with watching documentaries

Experience about watching documentaries	**Number of Students**
0--2 times	0
3--6 times	4
7--10 times	5
More than 10 times	23
Total	**32**

6.2. Descriptive statistics regarding students' Metacognitive Awareness

The sample was given the Metacognitive Awareness Inventory to measure students' awareness about their cognitions and their ability to monitor and regulate their cognitions according to the needs of the task and their cognitive states. Students' scores on the inventory was found as (M= 72.4, SD= 8.64) on the total score of 90. Results related to the responses of students are shown in the Table 6.2.

Table 6. 2. Descriptive Statistics about Metacognitive Awareness of the Sample

	Sum (N)	Mean (M)	Standard Deviation (SD)
Metacognitive Awareness Scores of Students	32	72,4	8,64

6.3. Analysis of Qualitative Data

6.3.1. Analysis of Structured Interview Protocol for Self-Regulated Learning

To understand students' self-regulated learning behaviors and strategies commonly used by the sample, a Structured Interview Protocol for Self-Regulated Learning was applied. Students' responses to the questions were analyzed to draw an overall characteristic of the sample in terms of their interest areas, science studying habits, goals and motivations.

6.3.1.1. Analysis of Student's Subject Interest. In the protocol there were some questions which were asked to understand characteristics of the sample. In the first question, students' interest areas were asked. This question was important to know the student profile because the research was about science learning and here it is important to understand whether students were interested in science or not. The first question was not only focusing on lessons, but also their hobbies were investigated.

Respondents were allowed to state more than one answer to the question. Open coding results showed that students' interests were seen as mathematics, science, language (grammar and literature), foreign language, and social sciences.

All of the 32 students answered this question. As shown in the Table 6.3., twenty-six of the students indicated that they were interested in science (physics, chemistry, biology) which corresponds to 81 percent of all responses. Twenty-three of the students indicated that they were interested in mathematics which corresponds to 71 percent of all responses.

Three students indicated that they were interested in foreign language (English) which corresponds to 9 percent of all responses. Two students indicated that they were interested in language (grammar and literature) which corresponds to 6 percent of all responses. Two students indicated that they were interested in social sciences (history) which corresponds to 6 percent of all responses.

Table 6. 3 Analysis of students' subject interest

Subject interest	**Percentage (%)**
Science (physics, chemistry, biology)	81
mathematics	71
Language (foreign language, grammer, literature)	14
Social Sciences	6

Results showed that students in the sample were mostly interested in science and mathematics which was an expected result. These students were attending an enrichment center and they were enrolling there according to their test results which measures general aptitude which is similar to IQ tests. Also, these students know that in the enrichment center they will take extra science and mathematics courses so they were kind of willing to learn science and mathematics.

6.3.1.2. Analysis of Student's Interests: Hobbies. Open coding results showed that students interested in areas other than lesson subjects which are seen as sports, music, engineering/technological areas, reading books, art, science fiction, fashion design and knowledge games.

As shown in Table 6.4., thirteen students indicated that they were interested in sports (basketball, football, tennis, ping pong, taekwondo) which corresponds to 40 percent of all responses. 6 students indicated that they were interested in areas related to technology and engineering (robotics, computers, electronics) which corresponds to 18 percent of all responses. Five students indicated that they were interested in music which corresponds to 15 percent of all responses. Two students indicated that they were interested in art which corresponds to 6 percent of all responses. Two students indicated that they were interested in science-fiction which corresponds to 6 percent of all responses.

Table 6. 4. Analysis of students' interests: hobbies

Interest: Hobbies	Percentage (%)
Sports	40
Technology and engineering	18
Music	15
Arts	6
Science-fiction	6

6.3.1.3. Analysis of Students' Preferences of Research Resources: In the second question, students were asked about which type of resources they use when they want to make a research about a topic. Students were allowed to give more than one answer so Multiple Response Analysis was done to figure out percentage of each responses to overall responses. Open coding results showed that students commonly prefered internet, teacher, books and family members as a learning source to search for answers.

All of the 32 students answered this question. As shown in Table 6.5., twenty-nine students indicated that they preferred internet to make a research about what they want to learn about a topic which corresponds to 90 % of all students. Nine students stated that they preferred to ask their teachers which corresponds to 28% of all students. Eight of them stated they were looking for books related to the topic which corresponds to 25% of all students, 4 of them stated they look for popular science magazines and articles which corresponds to 12% of all students. Three of them which corresponds to 12% of all students stated that they asked to their family members and 3 of them stated that they asked to a knowledgeable person about the topic, 3 of them stated they were appling to online education platforms and one of them stated she watches scientific documentaries.As shown in Table 6.5. these responses were categorized into two as "asking to people" which corresponds to %25 of all answers and "searching from resources" which corresponds to %75 of all answers.

Table 6. 5. Analysis of students' research source preferences

Source Preference	Percentage (%)	Example responses
Searching from resources	75	"Lesson books" (Student 4)
Asking to people	25	"I would ask teachers if it is according to our ages." (Student 17)

There were some conspicuous answers in students' responses. For example, some students stated that their choice of source was changing if it was related to course or general life. If it was about a topic covered in the science course, they prefered to ask to the teacher otherwise they prefered to search it on the internet. Also, some of them said that they only asked questions when it was related to school science course.

6.3.1.4. Analysis of Student's Method of Learning Science Concepts. Question 3 was about students' awareness about their own way of learning science lessons or science concepts. This question assesses not only metacognitive awareness but also cognitive strategies that students use.

Open coding results showed that students mostly said that they learnt science best by practical ways such as experiments and observations. The second most stated way was to watch videos or documentaries. Students' third most preferred way of learning science was reading. Other responses were including social-interaction with others such as talking with people who knows the topic, asking to teacher, listen to the teacher during classes.

All of the 32 students answered this question. As shown in the Table 6.6., 13students which corresponds to 31 percent of all responses indicated that they learnt scientific topics better by doing experiments and observations which was in the category of real-life observations and Ten students which corresponds to 24 percent of all responses, indicated that they learnt scientific topics better by audio-visual resources such as watching videos and documentaries Ten of them stated that they learnt better by written resources such as by reading and note-taking, 4 of them which corresponds to 9 percent of all responses, stated that learnt better by social intereaction such as by talking to knowledgeable people.

Only 5 percent of the students stated that they were not aware of which ways they prefered for learning science.

Table 6. 6. Analysis of students' method of learning science concepts

Method of Learning Science	Percentage (%)	Example responses
Real-life observations	31	"By searching and doing experiments" (Student 28)
Audio-visual resources	24	"When I am curious about something I generally watch videos because I learn better that way." (Student 10)
Written resouces	24	"By reading". (Student 27)
Social interaction	9	"Asking to a knowledgeable person" (Student 15)
Others	5	"No, I don't have." (Student 19)

Three of the students stated that they learnt better if they summarized the topics or paraphrased what they learnt which can be taken as examples of elaboration strategies. Also, it was seen that three students were showing help seeking behavior and prefered to ask to a person who probably might have had knowledge about.

6.3.1.5. Analysis of Student's Schedule of Studying. In the 5th question, students were asked if they studied daily for their science courses. This question was asked to see whether they had a cognitive strategy to study science. All of the 32 students answered this question. Seventeen of the students indicated that they did not have a planned study schedule. Students who said "*I study sometimes, I study only before the exams, I do not study because I know the topics"* were put in this category. The number of students who statesd that they did not study daily corresponded to 53 percent of all the responses.

There were 15 students who stated "*I study almost every day, I study science on the specific days of a week (e.g. on Thursdays), I repeat when we have science classes"*. The number of students who stated they did not study daily correspond to 46 percent of all responses. Table 6.7. shows students' science studying frequency.

Table 6. 7. Analysis of students' frequency of studying science

Frequency of studying science	**Percentage (%)**	**Example responses**
Do not have a planned schedule	53	"I do not study because I already know" (Student 9)
Have a planned schedule	46	• "I study on Tuesdays and Thursdays" (Student 10) • "I study one day Social Sciences and other day science and mathematics." (Student 11)

Results showed that almost half of the students studied regularly (regularly means working at least one time or more in a week) for science classes. Although they were gifted and they seemd to learn faster compared to their peers, they still prefered to study regularly.

In the 5. b. question, students were asked about their study methods and strategies. Twenty-one students answered the question and 11 of them didn't reply the question because they said they did not study regularly. As shown in Table 6.8., 12 students which corresponds to 37% of all responses were systematic and their study methods consisted of three stages namely, repetition, exercise and evaluation 9 students which corresponds to 28% of all students were only repeating the topics but not exercising or evaluating.

Table 6. 8. Analysis of students' way of studying science regularly

Categories	Strategies	Percentage (%)
Systematic	- Repetition/Review - Test solving - Self- Evaluation	37
Half systematic	- Only repetition/review	28
No method	- Not study regularly	32

Students in the ststematic category, after reviewing notes generally applied to some strategies such as answering tests questions, exercising with different source books or solving the same problems that the teacher solved in classes or just changing the numbers and solve the examples again to reinforce their understanding.

In Question 5.b. students were asked about their science studying strategies. Regardless of these two categories there were some ways that students used when they were repeating topics covered in the classes. For example, 3 of them said they used *online education platforms*, *3* of them said they *watched lecture videos,* 3 students said they *reviewed notes from their notebooks,* and 2 of them said they *reviewed notes from various sources.*

In the students' responses to 5.b., it was found that almost every student had their own study strategies. These strategies were listed below in Table 6.9.:

Table 6. 9. Analysis of students' strategies while studying science

Categories	Strategies	Frequency
Elaboration Strategies	Summarization	2
	Write up / make a clean copy	1
	Total	**3**
Organizational strategies	Identify possible questions and parts that teacher would ask	2
	Focusing only the parts that he/she didn't understand	2
	Creating graphic organizers	1
	Total	**5**
Rehearsal Strategies	Try to remember the notes	1
	Studying by writing down	1
	Total	**2**
Planning	Put time limit before starting to study	**1**

6.3.1.6. Analysis of Student's Strategies While Doing Homework. In the 6th question, students' methods of doing homework were investigated. All 32 students answered the question. An interesting finding was that all of the students stated that they were submitting their homework on time. Before starting doing homework, students emphasized that they made research first to get information or repeat the lecture notes to remember the topic. As shown in the Table 6.10., for information gathering, 10 students which corresponds to %37 of all responses, stated they were using various sources to make a research such as internet 10 students stated that they were reviewing the lecture notes and the textbooks. Also, they stated that they were comparing information on different sources to get the correct information. Seven students which corresponds to % 26 of all responses stated that they were seeking help from others For example, they said they got help from their parents if the homework required to make a prototype or 3D model.

Table 6. 10. Analysis of students' strategies on doing science homework

Strategies	Perccentage (%)
Doing research on the internet	37
Reviewing lecture notes and textbooks	37
Help-seeking	26

The analysis of these responses showed that all of the students use some cognitive strategies such as information seeking behavior (research on the internet and reviewing notes), outlining the topics to study which was an example of organizational strategy, summarizing, repetition and using graphics organizers which were the examples of elaboration strategies. Also, it was seen that they apply help seeking behavior (e.g. asking help from parents).

There were some remarkable responses to mention. For example, one of the students stated that he benefited from professional presentations that were made by university academics. However, he highlighted that he adapted the presentation by considering his own level. Another strategy suggested by another student was to make an overall research and to note down the most important points then to sum up all of the information.

Another strategy stated by another student was to decide when to do the assignment. He said that "I first make a research about the topic, if I need to make a model or 3D prototype I prefer to finish it at the weekend." It was a good strategy to identify the homework doing days according to the needs of the task. Probably making a model required more time and shopping so it was a better to deal with the task at the weekends.

6.3.1.7. Analysis of Students' Strategies for Preparing Science Exams. In the 7th question, students were asked about their methods for preparing to a science exam. Result was similar to daily study methods of students. Three categorizations emerged from the open coding of data. As shown in Table 6.11., first category consists of 15 students who started with reviewing all of the notes on the internet, books or lecture notes. Then, they were solving problems and doing tests to evaluate themselves. Students in the first category corresponds to 46 percent of all responses. Second category consists of 10 students who chose to only review notes but didn't do any tests. This category corresponds to 31 percent of all responses. Third category consists of students who say they did not prepare for exams because they had already known the subjects. This category consists of 6 students which corresponds to 18 percent of all responses.

Table 6. 11.Analysis of students' method for preparing science exams

Method	**Strategies**	**Perccentage (%)**
Method 1	- Repetition/review notes - Test solving - Self-Evaluation	46
Method 2	- Repetition/review notes	31
Method 3	- Do not prepare for exams	18

The reults of the analysis showed that different strategies were used by the students. For example, some students mainly focused on the points that the teacher could possibly ask on the exam, they said this was a way for not wasting time.

Another group of students stated that they only focused on the points that they did not understand or remember which was a better strategy than the previous one. It was a useful way to save time while preparing for the exams which covered too many topics.

Another strategy was to prepare detailed notes. After reviewing all of the notes from books, internet or lecture notes, these students said they wrote down important points with their own words which were examples of elaboration strategies.

Another strategy that was used by one student was to create a coding system to memorize easily. He stated that he used this strategy when he needed to memorize something. For example, he said he wrote a poem to memorize elements in the periodic table. Another strategy that was used by one student is to review the graphic organizers that she has created while she is studying in her daily routine. Again, it was a good way to study fast because it was a summary of the topic and by this way she could save time. Table 6.12. shows the categories regarding the strategies that are used commonly by the sample while they are getting prepared to science exams.

Table 6. 12. Analysis of students' strategies for preparing science exams

Strategies	**Percentage (%)**
Focus more on the parts that they did not understand well	12
Focus more on the parts that teacher focuses	12
Prepare a detailed summary	9
Create odes for memorization	3
Prepare charts and study them	3

<u>6.3.1.8. Analysis of Students' Planning Skills.</u> In the 9th question, students were asked if they made any plans before starting to study science. All of the students responded to this question. As shown in Table. 6.13. Nineteen of them stated they were making plans and 13 of them which corresponds to 60 and 40 percent of all responses respectively stated they were not doing plans

Data were analyzed and categorized according to the Phases of SRL (Pintrich, 2004). Eight of them stated that they adapted their plans according to the difficulty level of the topic or the exam. To be able to decide the difficulty level of the topic student should activate his/her prior content knowledge to make an evaluation. For instance, one of the students said he didn't make any plans for multiple choice exams but he made while studying before written exams. Another student stated that he chose to do the activity parts in the book if he needed to memorize new information, and he chose to do a test if he needed to understand the topic better. Therefore, these students were put into the category of "prion content knowledge activation".

Six of them stated that they started studying with the most challenging part, or they gave more time for the parts that they were weak. In order to decide how much time to study, student should activate his/her prior content knowledge and make a judgement. Fourof the students planed their days and put a time limit to complete their studies which was in the category of "time planning". Four of them stated that they were not making plans, they were just studying with the order of the topics. Only 2 of them stated that they first decided which topics he/she would study, and put signs on the book to remind themselves. This strategy requires an organizational strategy and then goal-setting to plan. Table 6.13. shows categories regarding students' planning strategies by providing example responses for each category.

Table 6. 13. Analysis of students' planning skills

Categories		**Percentage (%)**	
Makes plans		**60**	
Do not make plans		**40**	
Sub-Categories	**Strategies**	**Percentage (%)**	**Example responses**
Prior content knowledge activation	Regulate their plans according to complexity of the task	25	"If I need to learn memorize information I do activity parts in lesson books, if I need to interpret information I solve tests." (Student 7)
	Start studying on the most difficult part or give more time to it	18	• "I study more the parts I am struggling." (Student 20) • "I focus the parts that I less understood". (Student 11)
	Total	**43**	
Time planning	Planning time, putting a time limit	**12**	• "I will study these until that time." (Student 16) • "I decide which parts I will study until when. I study all details and repeat few times so I won't forget." (Student 7)
Goal-setting	Determine the topics that he/she will study	**6**	"I decide parts that I will summarize and sign on the book tests that I will solve" (Student 2)

6.3.1.9. Analysis of Students' Metacognitive Strategies.

Research Question 1.b. Which metacognitive strategies are used by 7^{th} grade gifted students while learning science from a video?

To investigate which metacognitive strategies were being used by gifted students, Structured Interview Protocol for Self-Regulated Learning interview was conducted with the sample. Students' responses were open coded to find out students' ability to use metacognitive knowledge and metacognitive regulation in regulating their learning effectively.

Monitoring processes were found to be represented metacognitive awareness of a person in terms of the self, task and context (Greene *et al.,* 2006). Therefore, in the third question of the interview, students were asked about their preferred way of learning science to investigate if students were aware of their learning preferences which was an indicator of monitoring and a sub-factor of metacognitive awareness. While replying the question, some students also explained the reason behind why they chose these specific ways for learning which could be taken as an indicator of metacognitive knowledge.

Response of Student 7:

> "I think I learn better by doing experiments. If we think by inventing something we can understand easily what others think. If I want to learn some concept, I do it." (Student 7)

Student 7 stated that working on a model of the invention helped him to learn the subject easily because he could understand the way of thinking of the inventor of this invention by this way better. That's to say, a person can easily understand the science behind the concept if he/she starts to think same as the person who invents that model. This response showed that the student was aware of the cognitive processes of himself. Also, he found a way to understand the cognitive processes held by others, which was working on the real model of their inventions. Student 12 stated that his visual memory is stronger that is why he chooses to study with visual elements.

> "My visual memory is superior. Therefore, I memorize and learn easiliy with visual materials." (Student 12)

This example showed that this student was aware of his own cognitive processes thus he chose his learning strategy according to his ability. The same student also stated that learning by talking people who knew about the topic was more effective and permanent.

Response of Student 10:

"I learn better with videos therefore I chooses to watch videos when I want to learn a topic." (Student 10)

Student 20 stated that:

"I may forget what I heard on documentaries but I was remembering more when I was reading on books." (Student 20)

This again showed that, she was aware of her cognitive processes by evaluating her own level of understanding.

In the fifth question, students were asked about their study methods. 3 students stated that they are getting prepared for the following class. One of them stated that when he was getting prepared to following class he studied by looking at the images because his visual memory was superior.

Another student stated that her method was changing, if there was not an exam she only reviewed her notes from notebook, if there was an exam she prepared her own notes.

In the sixth question, students were asked about their way of doing an assignment (homework or project assignment). One of the students was using imitation strategy when he needed to prepare a presentation. He stated that he usually found similar presentations on the website of Ankara Observatory and benefited from them. However, he emphasized that when he was using a professional presentation, he adapted its level by considering his own level. It is important to note that student was aware that the professional presentation was at a higher level.

Another important example was that a student stated that “If I have received a project assignment, I have chosen a subject that I value. Therefore, I have been careful to use a lot of different things when doing the assignment.” Here, he made a differentiation between the assignments that the teacher assigned the subject and the assignment that he chose the subject on his own. He stated that if he caresd the subject he valued the assignment so he triedto do his best by adding various different information or materials.

In the seventh question, students were asked about their methods for preparing for a science exam. It has seen that they had metacognitive knowledge and they applied some metacognitive strategies while they were studying. Evaluation was one of the stages that should take place in learning. It has seen that students evaluated themselves and regulated their strategy use accordingly. For example, one of the students stated that she had problems when learning science. Thus, she paid attention to her study, she reviewed all the notes, used internet to study from course websites, drew a summary of what she has learnt, her mother prepared sample questions that were similar to the teacher’s questions, she solved tests. That’s to say, she knew that she was bad at science so she tried to apply various methods for studying. Other statements that showed students were evaluating themselves to regulate their behaviors are “I focus points that I am weak, listening to the class is enough for me to understand the subject so I do not prepare for the exams, if I read my notebook 3-5 times, it is enough for me to understand the subject, I do tests when I am preparing for exams”.

Some example responses:

“If I need to study a hard topic, I study in the same method for preparing a classic exam. I review lecture notes and learn all of them well, then I solve tests.” (Student 7, Int-SRL).

“I would feel happy. I would listen to teacher during class. If it is not enough, I would solve tests. If it still is not enough I would ask to teacher.” (Student, 13)

Table 6.14. shows analysis of students’ responses in terms of their self-evaluation skills in science learning.

Table 6. 14.Analysis of students' self-evaluation skills as a metacognitive strategy

Codes	Percentage (%)
Solving tests	50
Concentrating on parts that I struggle	12
I generally know topics covered at the courses	12
If I read 3-5 times, it is enogh for me to understand	3
I am struggling at science	3

Another indicator for metacognition is to be aware of others' ideas and thinking processes. There were some students who said they study the parts that the teacher probably will ask on the exam. Especially one student stated specifically that he tries to identify teacher's ideas to figure out how teacher will think and ask on the exam. This student is the same student with whom tries to understand thinking ways of inventors by working on their inventions.

Some students stated that 1-day study is not an appropriate way for learning. Learning is a longitudinal process so students should study regularly, it is not enough to study just for one night before the exam. These statements show that these students are aware that knowledge construction needs time so they study regularly. The same student also stated that "he learns what the school wants, not what he wants". Here, student compares his own thoughts and ideas to that of school administration which is another sign of metacognitive awareness.

In the ninth question, students were asked if they have done plans before starting studying. Self-regulated learns makes plans and making plans and following them requires metacognitive ability (Azevedo, Greene, & Moos, 2007). 19 of them stated that they make plans before studying and 8 of them stated that their plan is changing according to needs of the task.

One of the students was aware that he is not able to follow his plans even though he makes plans. Here, it is important to mention that some students who say they do not make plans may do plans but they may not aware of it. This is an indicator of low metacognitive ability.

Metacognitive regulation is being able to control one's own thinking procedures according to the needs of learning the task. A student with effective metacognitive regulation skills can understand the cognitive task, monitor his/her own cognition and compares the task itself and himself/herself and apply suitable strategies to reach the expected thinking position.

For example, student with effective metacognitive regulation skills changes his/her studying method after earning a poor grade on an exam (Stanton *et al.,* 2015). Therefore, in the 10th Question, students were asked about what they do when their study method is not working. All of the students answered the question. 12 of them stated that they will change their methods and look for other ways for studying until understand. These responses can be confirmed by the answers of the students to the previous questions. In the previous questions it is seen that students have different methods for different conditions and they interchange between the strategies. Some example statements are "if it is a project assignment I take help from my parents, if it is a project assignment I do it at the weekends, if it is a project homework I search it first on the internet, I review lecture notes if it doesn't help me to remember I search on the internet, if I am studying for the following course I review the previous week's notes, if I am preparing for an written exam I prepare my own notes, I prefer doing experiment while learning science, if it does not work I would prefer watching documentaries".

11 students stated that if their study method is not successful they ask for advice to their school counselor or they ask their science teacher to go over the class again, also 5 of them stated that they ask for help from their parents or siblings which correspond to 34 and 15 percent of all responses, respectively.

Three of them stated that they use internet to find a better way. 3 of them stated that their study method is successful and they have not been unsuccessful before. One of them stated that he takes a short break which is a good strategy to increase work engagement

(Kühnel *et al.*, 2016). Only one student stated he will go on studying by the same study method.

All these answers were categorized into two such as consulting to others which corresponds to 50 per cent, and searching for new ways which corresponds to 37 per cent of all responses.

In Question 12, students were asked about what they do to evaluate their learning. All of them answered the question. 19 students stated that they evaluate their learning by doing tests and control what they did wrong while solving the problems. 8 students stated that they repeat the information in their minds and compare them with the information on the books and lecture notes. Only 4 of them stated that they do not evaluate their learning but 2 of these students stated that they have been already understood that if they did learn or not. This is again is a sign of metacognitive ability but they do not know which strategies they apply to evaluate themselves.

3 of them stated that they prepare their own questions and try to solve them. This technique is a bit different from solving problems on test books. Here, the student constructs his/her own problem.

2 of them stated that they have written down what they know and compare them with the information on the books and lecture notes which is similar to the other 8 students' way but the difference only is that they do it in their minds but these students prefer to write down.

6.3.1.10. Analysis of Students' Goal-Orientations and Motivations.

One's ability to setting goals and regulating own behaviors according to this goal is an indicator of metacognition and self-regulation (Zimmerman, 1990). Therefore, in Question 4.a., students' goals related to science were investigated. However, most of the students didn't understand the question right when they heard it first time. Researcher needed to make an extra explanation about what the question wants to asks. This situation maybe shows that they do not aware of their goals or they already don't have any goals or the question was developed in an incorrect way. However, after researcher have given some examples of possible goals related to science, students were able to talk about their own goals.

All of the 32 students answered to the Question 4.a. Responses of students were open coded and students' responses were categorized. 9 students indicated that they do not have goals related to science and 2 of them stated that they have no idea about their goals which corresponds to 34 percent of all responses.

Seventen students indicated that they want be expert in some areas related to science which corresponds to 53 percent of all responses. Seven students indicated that they want to get high scores at science exams at school or at primary Passing from Education to Secondary Scool Exam (Temel Eğitimden Ortaöğretime Geçiş Sınavı, TEOG) which is a high stakes test for high school entrance which corresponds to 21 percent of all responses.

Moreover, in Question 4.a. question, students were asked about the things they do to reach that goal. Students who stated a goal stated that they study their courses to reach that goal. Actually, only studying is not a good plan. Students could have more sophisticated and effective strategies to reach their goals. However, it can be tolerated that these students are at 7^{th} grade so they do not have so much choices. Maybe, their plans get better when they attend to high school or university.

Table 6. 15. Analysis of students' goals related to science

Categories	Percentage (%)	Example responses
Getting expertise in science and mathematics areas	53	"having a Nobel Prize in Physics working nuclear physics area." (Student 22) "make an invention" (Student 16) "being a paleontologist" (Student 19) "being a physicist" (Student 28)
Getting high scores on exams	21	"Yes, I want to get high scores on exams." (Student 8)
Do not have any goals	34	"I don't have any." Yok (Student 21)

In Question 4.b., students were asked about the goals of school science courses on students. Similar to the Question 4.a. most students were not able to understand the meaning of the question and couldn't reply it when they first heard it. Thus, researcher needed to make an extra explanation and give some examples of possible school science goals. Still, there was 5 students who couldn't state goals of school science courses which corresponds to 15 per cent of all responses.

Responses of students were open coded and categorized. As shown in Table 6.16., fourteen students indicated that goal of school science is *to make students scientifically literate*. Surely, students didn't use the term "scientific literacy" in their responses but the researcher make sense out of their responses.

Some examples to scientific literacy can be given as:

- "Learning some scientific basics" (Student 1)
- "Having knowledge about nature and life" (Student 20)

- "To make every person know basic principles of science even if he/she isn't interested in science and mathematics." (Student 17)

These responses are very important because it is good to see that students are aware of school science goals.

On the other hand, the number of students who says school science goal is to *only make students get higher scores on exams* is not few. There are 9 students who say that the aim of science courses is to make students to get full score on exams which corresponds to 28 percent of all responses. Only 4 students stated that schools aim to raise expert people in science arease which corresponds to 12 per cent of all responses.

Table 6. 16. Analysis of students' awareness on goals of school science classes

Categories	**Percentage (%)**	**Example Responses**
Scientific literacy	43	"Knowing the principles that we need in the daily life to protect ourselves from danger." (Student 28)
High scores on exams	28	"Having a good science GPA and be the 1st in national exams." (Student 7)
Raising experts in science area	12	"To make everyone Einstein" (Student 29)
Do not know	15	"I don't know." (Student 4)

In the 8th question, students were asked what would they do if they took low grades in science courses. As shown in the Table6.17., 21 students (65%) stated that they would continue studying and focus to the next exam and try to get higher scores. This is a very achievement-oriented behavior. These students do not give up studying. Rather they do prefer prepare themselves to the next exam by studying more. 12 students (37%) stated that they would feel sad about their low grades. 5 of the students (%15) stated that they would find out their mistakes and focus these parts or examine which parts of the topics they didn't understand and study more on these topics. 5 of the students (%15) stated that they would take actions to find out immediate solutions to increase their grades. For example, they stated that they would ask for a project assignment or demand oral exam to increase their notes. Another interesting example was that one of them stated that he would ingratiate himself with teacher. 3 of them (%9) stated that they have never taken low grades on science courses. 2 of the students (%6) stated that they would ask to his/her teacher or a friend who knows the content better. Only 1 of the students stated that he didn't feel sad about his score and only 1 another student stated that he wouldn't take any actions if he would take low grades. Also, only 1 of them stated that his motivation to study would decrease. However, overall analysis of the responses shows that most of the students prefer to take actions to increase their low grades by motivating themselves and keep on studying and even increase their effort on the course.

Table 6. 17.Analysis of students' behaviors when got low grades in science

Categories	**Percentage (%)**	**Example Responses**
Aims to learn topic and get higher grades	59	• Asking to a teacher • Find out the falses and study them • Solve tests and review
Affective Reactions	50	• Feel sorry • Do not feel sorry • Demotivated • Motivated
Only aims to get higher grades	12	• Ask for a term-paper to get extra scores • Get along with teacher to get extra scores

In the 11th question, students were asked about what they do when they stick while they are learning science. As shown in Table 6.18., most of the students stated that they ask the teacher to repeat the course and explain the subject again. Then, it is followed by asking to parents and to the internet. They go over the lecture notes by reviewing all sources, solving tests, searching on the internet, and watching videos. One of them stated that he would study more, try to find logical ways, find cause-effect relationships.

Table 6. 18.Analysis of students' behaviors when they are stuck with a science topic

Categories	Percentage (%)	Example Responses
Help-seeking behavior from others	81	• Asking to a friend • Asking to teachers • Asking to family
Applying other resources	37	• Search in the internet • Solving tests • Review notes

In the thirteenth question, students were asked how they behave if they need to study relatively easier science topic. Students' answers were grouped into three categories. As shown in the Table 6.19., almost all students stated that they would spend less time and less effort for easy science topics which corresponds to % 84 of all responses. Students also talked about their way of studying. Students studying methods for easy concepts can be stated as skimming through the content, start with directly solving tests, just reading, skipping the parts that he knows, finish studying when he feels he has understood the topic or not studying at all.

9 of them talked about their feelings; (%12) stated they would feel happy, (%12) stated that they would feel relief, % 6 stated that they would probably bored with the content.

Responses of 5 students showed that they evaluated their learning or learning capacity for easy concepts which corresponds to %15 of all responses. These students stated they would easily and well understand easy topics and would get high grades at the exam.

Table 6. 19.Analysis of students' behaviors when they need to study an easy topic in science

Categories	Percentage (%)	Example Responses
Strategies about studying	84	"Spend less time only skimming." (Student 2)
Sub-categories	**Percentage (%)**	**Example Responses**
Affective responses	28	"Feel bored" (Student 13)
Self-evaluation	15	"Study for enough amount. When I understood I stop studying." (Student 10)

Contrary to thirteenth question, in the 14th Question student were asked how they would behave if they need to study a relatively hard topics in science. Students' responses were open coded and categorized were constructed according to responses. Same categories were found with the previous question. As shown in the Table 6.20., first category consists of responses related to the method of studying science. In this category, 27 students stated that they would spend more time and effort to understand difficult science topics. For example, some students stated that they would prefer studying Some of them stated they would consult to their parents or science teachers. Some of them stated they would listen to teacher carefully during class hour. Some of them stated that they would try to inquire the content first and then solves tests to reinforce their understanding. Also, some of them stated they would various different ways of learning. Some of them stated that they would focus more to the points that they did not understand well. And some of them stated that they would prepare some post-it notes and stick them to their study tables.

Students in the second category includes students who expresses their emotions and attitudes related to difficult science concepts. Student responses include positive and negative feelings. Examples of positive emotions are happiness and joy, do not feel hopeless. Some examples of negative feelings are anxiety, fear, stress, demoralized.

Third category was related to the evaluation of understanding of the content. Some students stated that they generally learn the content fast so they would probably learn the difficult topics easily, too. Some of them stated that they would pay attention until they learn the content. Some of them stated that they think they will understand it anyway, and some of them stated they will be never able to learn the topic. All of these responses cover evaluating understanding level of the content.

Table 6. 20.Analysis of students' behaviors when they need to study a hard topic in science

Goals of school science courses	Percentage (%)	Example Responses
Method of studying science	84	"Study slowly by understanding step-by-step." (Student 3)
Affective	28	• Fear • Anxiety • Demoralized • Happy
Self-evaluation	9	"Think need to study more focused and much." (Student 11)

6.3.2. Analysis of Interview Questions About Video Content

Students were asked questions related to the video content after watching the two videos. Firstly, students were asked to explain by drawing what is explained in the videos. However, almost all of the students were failed to both draw and explain video content at the same time. Most of them firstly drew their pictures without explaining. They started to explain their ideas after finishing their drawing.

6.3.2.1. Results of Interview About Video Content-Lightning.

In the first question, students were asked about the content of the lightning video. As shown in Table 6.21, most of the responses were showing that video was about the "definition of static electricity" (57%). Thirty-nine per cent of students stated video is about "different types of lightning including bolt of lightning". 27 per cent of students stated that the video content is related to "static electricity and its relation to formation of lightning". 23 per cent of students stated that video is about "formation and definition of thunder" and only 2 per cent of students stated that video content is about "definition of meteorologist".

Table 6. 21.Students' interpretation about the lightning video content

Categories	**Percentage (%)**	**Example responses**
definition of static electricity	57	"There are positive and negative both in our hands and at the door, when they touch there happens static electricity." (Student 20)
different types of lightning	39	"There are many types of lightning such as from cloud to cloud or cloud to ground-which we call lightning bolt." (Student 13)
relation between formation of lightning and static electricity	27	There is a relation between them. Statics electricityis kind of a small lightning." (Student 32)
Formation of thunder	23	"Here, all of them is cold air. When there is lightning they turn into hot air. When they move, they push these ones and they move so fast and creates sound." (Student 31)
definition of a meteorologist	2	"It was explaining lightning, formation of thunder and job that is dealing with them" (Student 16)

In the 3rd question, students were asked what they have learned from the video. Mostly the same categories were found with the 1st question. As shown in Table 6.22, 62 per cent of the students stated that they have learned "static electricity and its relation to formation of lightning", % 37 of students stated that they have learned "formation and definition of thunder", % 12 of the students stated that they have learned "different types of lightning including bolt of lightning" and 6 per cent of the students stated that they have learned "definition of meteorologist" from the video. Only 6 per cent of the students stated that they are keeping up with the content. That's to say, they stated that they already know most of the things in the video. Only one student stated that they did not know almost anything in the video.

Table 6. 22.Students' responses regarding evaluating themselves about what they have learned from the lightning video

Categories	**Percentage (%)**	**Example responses**
relation between formation of lightning and static electricity	62	"+ and – charges attract each other and form light bolt." (Student 4)
formation of thunder	37	"I kew that thunder forms with crashing air particles but video stated that it forms with vibrating air particles." (Student 27)
different types of lightning	12	"Ligt bolt is a type of lightning. There are types of lightning." (Student 1)
definition of meteorologist	6	"Meteorologist. Made a definition of it. I have learned it." (Student 11)
Keep up with the content	6	"Not much, I have already known most of them." (Student 5)

In the 4th question, students were asked at which parts of the video they are most interested in. For this question, overall observation of the researcher was that almost every student only interested in the parts that they did not know. Students' responses verified this claim of the researcher. For each student the answers for what they have learned from the video and interesting parts of the video were matching. Also, some of the students directly expressed that they are most interested in parts that they have not known and learn new from the video. 15 per cent of the students were interested in different things other than video content such as talking mouse, woman in the animation.

Some example responses:

"(thinking…) I was not interested with any part of the video. Only, the parts that have already learnt so the parts which explains different types of lightning." (Student 1, Int-Video Content-Lightning)

"Thunder because I did not know it" (Student 14, Int-Video Content-Lightning)

Students were also asked about what would they like to learn more related to this video content. Twenty-one per cent of the students would like to learn the answers of "how" question. They want to learn more about physical explanation about some physical concepts. Some important example responses are "how + and – electrical charges attract each other", "how ice particles form inside the clouds", "how + electrical charge forms inside the earth surface". As shown in Table 6.23, 21 per cent of students were curious about different types of lightning and different static electricity patterns. Six per cent of the students stated that they want to learn some numerical information such as speed and temperature of different types of lightning. Six per cent of students were curious about how our knowledge about lightning can be transferred into applied knowledge that's how we can produce projects by using lightning. 31 per cent of the students stated that they do not wonder anything more some of them think that everything was covered inside the video.

Table 6. 23.Concepts that students want to acquire deeper knowledge

Categories	**Percentage (%)**	**Example responses**
Curious about "how" question	21	• "How + and – electrical charges attract each other? How it happens?" (Student20) • "I would like to learn how ice particles form and stay inside the clouds?" (Student 7) • "Wasn't ground notr? How + electrical charge forms inside earth surface?" (Student1)
Curious about different types and patterns	21	"It was said that there are various types of lightning. I would like to learn them."(Student 23)
Curious about numerical information	6	"Are there different color lightning? If there is, what is the speed and temperature of different colors of lightning?"(Student 29)
Curious about project development	6	"Can we produce electricity from lightning?" (Student 4)
Not curious about deeper knowledge	31	"No, I don't want to." (Student 30)

After watching the video, students were shown a picture (Appendix D) of a lightning and asked to describe what they see on the picture. Students' responses were open coded and categorized. Responses were grouped into 4 categories. Most of the students only said they see a lightning on the picture (65%). 34 per cent of students expresses that they see different types of lightning and can differentiate a lightning and a bolt of a lightning. 28 per cent of the students consider the science behind a lightning when they see a picture of a lightning. For example, some students see formation of static electricity inside the clouds just before lightning happens, some of them imagine moving electrical charges between surface of the earth and clouds, some of them see hot air heated by the lightning. 18 per cent of the students link the picture with various different topics. For example, one of them connected lightning to the electricity to be cut soon after, one of them connected the photograph to a news that he saw before, one of them considered the things that will happen if it hits a living creature, some of them connected lightning to a sound that will be heard soon.

Table 6. 24.Students' interpretation of a lightning picture

Categories	**Percentage (%)**	**Example responses**
Just a lightning	65	"A lightning" (Student 4)
different types of lightning	34	"Because it is between cloud-ground, it is a liht bolt." (Student 3)
science behind a lightning	28	"Transfer of charges between ground and cloud" (Student 7)
Linking with different topics	18	I saw a news, a light bolt hits to a man, but doesn't die" (Student 5)

In the 6th question, students were asked to explain why it is not suggested to wait under the trees when it is raining. In this question, students' ability to explain a phenomenon with the information that they have already learned from the video was investigated. Seventy-one percent of the students were able to explain this phenomenon with a scientific explanation. As shown in Table 6.25., most of the explanations were "trees are high and it is likely to a light bolt occurs higher places". Some students stated that "electrical charges concentrate on the sharp edges of materials and trees have sharp tips". These students probably confused electrical charge distribution of conductors with insulators. However, considering electrical charge distribution to explain light bolt is a good way of thinking. The rest of the students couldn't explain the phenomenon by stating they do not know the reason or they made irrelevant explanations.

Table 6. 25.Interpretation of the video content

Categories	Percentage (%)	Example responses
Scientific explanation	71	"Trees are linked to earth ground and ground is positively charged so the tree is positive which attracts lightning." (Student 12)
Couldn't explain scientifically	29	"I couldn't remember." (Student 10)

In the 7th question, students were asked to summarize in one sentence what they have learned from the video. The same categories were found with the previous questions. As shown in Table 6.26, responses were grouped into 4 categories namely "different types of lightning including bolt of lightning (59%)", "formation and definition of thunder (50%)", "static electricity and its relation to formation of lightning (34%)" and "definition of meteorologist (1 student only)".

Table 6. 26.Summarization of the video content

Categories	Percentage (%)	Example responses
different types of lightning	59	"Types of lightning and how thunder is formed." (Student 13)
formation of thunder	50	"Thunder forms because of warm air produced by lightning." (Student 3)
relation to between static electricity and formation of lightning	34	"lightning forms because of electrical charges among clouds" (Student 3)

6.3.2.2. Results of Interview About Video Content- Leaves. Firstly, students were asked to summarize the video content to find out which parts do they mostly focus onin the 1st question. Their responses were open coded and categorized. 5 categories were obtained namely "why do leaves change color", "characteristics of trees", "processes of yellowing", "factors that affect yellowing process" and "features of coniferales".

Table 6. 27.Summarization of the video content

Categories	Percentage (%)	Example responses
why do leaves change color	50	"The reasons why do leaves change color and pour." (Student 26)
characteristics of trees	37	"Trees produce food and oxygen with chlorophyll, sunlight and carbondioxide." (Student 27)
processes of yellowing	21	"In the autumn, leaves loose their chlorophyll because of thinner channels so other pigments mostly show up. Also, a hormon is activated which causes foliage" (Student 8)
factors that affect yellowing process	21	"When sunlight is less, leaves starts to yellow slowly." (Student 2)
features of coniferales	3	"coniferales have chemicals to prevent freezing and so save color and water." (Student 9)

In the 3rd question, students were asked about what they have learned new from the video. Their responses were open coded and categorized. As shown in the Table 6.28., three categories were obtained. Most of the students (%65) stated they have learned "processes of yellowing and pouring of leaves", some of them stated that they have learned "characteristics of trees" and 3 students stated that almost every part of the video was new to them.

Table 6. 28.Students' responses regarding evaluating themselves about what they have learned from the leaves video

Categories	Percentage (%)	Example responses
processes of yellowing and pouring of leaves	65	"Sunlight, cold is important in color change of leaves but the most effective is sunlight." (Student 29)
characteristics of trees	40	"ıf there isn't enough sunlight, cannals going to roots and branches close and leaves fall." (Student 13)
Almost the whole video content	9	"…I did not know anything..." (Student 9)

In the 4th question, students were asked about which part of the video took their attention most. As shown in Table 6.29, 59 per cent of the students stated they most interested in the parts that chemical and biological processes occur. 37 per cent of the students stated that the most interesting part of the video was when it mentions about different species of trees and what color they take during autumn. Only 1 student stated she was interested the parts that she did not know before and 1 student stated that face of the man in the video took his attention most.

Table 6. 29.Parts that students interested most in the video

Categories	Percentage (%)	Example responses
Chemical and biological processes	59	"Trees produce food and oxygen with chlorophyll, sunlight and carbondioxide." (Student 27)
Colors of tree species	37	"Color change and pouring of leaves" (Student 32)

In the 5th question, students were asked about what they want to learn more related to yellowing of leaves. Students' responses were coded and categorized. As shown in the Table6.30., 37% of the students stated that they did not want to learn more about this topic. % 15 of the students stated that they would like to learn about chemical and biological processes to get deeper understanding such as how do leaves feed, how a chlorophyll form or die, how and why do different colors occur in the plants. % 12 of the students stated that they would like to learn other tree species and what color do they have in the autumn. % 9 of the students stated that they would like to search the terms such as ATP and coniferous plants. % 12 of the students stated that they do not know what they want to learn more about this topic.

Table 6. 30.Topics that students want to make a deeper research

Categories	Percentage (%)	Example responses
Do not want to make a research	37	"I do not think that I will use them so I don't want to." (Student 9)
chemical and biological processes related to leaves and plants	15	"Why do leaves do not turn blue color?" (Student 19)
Colors of tree species	12	"I would like to be able to state different species of trees considering heir colors" (Student 12)
Biological terms	9	"It was mentioned ATP in the video, I wonder, what was that?" (Student 22)
Do not know	12	"I want to but I do not know which part." (Student 6)

A "fall photograph" was shown to students and they were asked to describe what they see in the picture. Students' responses were open coded and 3 categories were obtained namely "structure in macro scale", "weather condition and climate" and "state of cell". Structure in macro scale category includes responses related to descriptions related to structure of leaves and trees in observable scale. Climate and weather condition category include responses related to interpretation of how is temperature, level of day light or climate at the place in the picture. State of cell category include responses which interpret the pigments, chlorophyll or sugar level inside the cell according to the color of the leaves. Table 6.31. shows student' interpretations when they have seen a photograph of a fall season

Table 6. 31.Students' interpretation of the fall picture

Categories	Percentage (%)	Example responses
structure in macro scale	75	"Trees have changed colors and fallen but pine tree hasn't." (Student 13)
climate and weather conditions	46	"All of them should be same color because they took same amount of sunlight." (Student 18)
state of cell	31	" It's all about pigments…The red one store more sugar in it." (Studen 31)

In the 7th question, students were asked to discuss similarities between cacti and coniferous plants. All of the students make a connection between cacti and coniferous plants in terms of their structures in macro scale. Twenty-one per cent of the students stated that their biological characteristics are similar for example both of them do not have fruits, both of them save water to stay alive. Table 6.32. shows students' responses regarding comparison of cacti and coniferous plants.

Table 6. 32.Similarities between cacti and coniferous plants

Categories	Percentage (%)	Example responses
structure in macro scale	100	"Needles of cacti and leaves of pine tree are similar." (Student 1)
biological characteristics	21	"Either cacti and coniferous plants do not change color." (Student 1)

In the 8th question, students were asked to summarize what they learned from the video in one sentence. Students' responses consist of categories namely "processes", "structure in macro scale", "factors that affect leaves" and "general". Responses in the "processes" category consist of processes that explain how leaves change color in fall, responses in the "structure in macro scale" consist of responses describing observable structure of plants. Responses in the "factors that affect leaves" category consist of factors and their impact on the color of leaves. Responses in the "general" category consist of general comments other than specific interpretations. Table 6.33. shows categories obtained from students' responses regarding summarizing the video content in one sentence.

Table 6. 33.Summary of the video in one sentence

Categories	Percentage (%)	Example responses
processes	46	"Trees block access to leaves when they can't produce enough food." (Student 14)
structure in macro scale	34	"Leaves are pouring and changing color in fall but coniferous don't" (Student 8)
factors that affect leaves	28	"Less sunlight causes color change" (Student 3)
general	9	"…Trees are beautiful…" (Student 9)

6.3.3. Analysis of Structured Interview Protocol for Self-Regulated Learning (Metacognitive Factor)

Interviews were done to investigate the which metacognitive strategies were applied by the students while watching videos. Responses to some questions were evaluated separately and some of them evaluated together for both lightning and leaves videos.

Students' responses to Question 1 were open coded and analyzed. Results showed that % 93 of students stated that they paused the video. The time when they decided to pause the video was also analyzed and categories were obtained from both data and literature about note-taking. As stated in the note-taking literature, type of notes is categorized into 3 namely content reproduction, content elaboration and metacognitive (Jiang *et al.*, 2018).

As shown in the Table 6.34. results showed that students paused the video when they need to take notes and draw some images. They stated that they paused video to not to miss information and they generally took notes when there is a definition, they did not understand what is told, when there is a new information and when the content is interesting. There was no example in content elaboration category.

Table 6. 34.Students' responses regarding their note-taking

Categories	Frequency	Example responses
Content reproduction	12	• Definitions • İnteresting information • Draw scene in the video
Metacognitive	14	• They they don't understand • There is new information • Not to miss information • Important points for me

In the Question 2, students were asked what strategies they applied to increase the retention of the video content. Students' responses for both of the videos were analyzed. Most of the students stated that they took notes. Then, the second most common answer was focusing on and careful listening to the video content.

Results showed that students' responses can be categorized into three namely rehearsal, elaboration and imagery strategies (Obergriesser & Stoeger, 2016) and metacognitive (Jiang et al, 2018)). Some examples for rehearsal strategies can be stated as constructing a coding system to help memorization, watching the video repeatedly, trying to bear the content in mind or repeat inside what is said in the video.

Some examples for elaboration strategies can be stated as linking new information with the past knowledge and trying to figure out how these processes happen. Students also used imagery strategies to increase the retention of the information. For example, some of them stated that they constructed images which they can recall for a long time and tried to envision what is stated in the video content. Only 9 % of students stated that they did apply any strategies to increase recall and retention of the information provided in the video. Table 6.35. shows students' regarding strategies for the retention of ideo content by providing example responses.

Table 6. 35.Students' responses regarding retention of video content

Categories	Frequency	Example responses
Content Elaboration	3	• linking new information with the past knowledge • figure out how these processes happen
Rehearsal strategies	16	• constructing a coding system to help memorization • bear the content in mind • repeat inside what is said in the video.
Imagery strategies	3	• constructed images to create long-term memorization • envision what is stated in the video content
Metacognitive	13	• Listening to video by focusing more

Students were also asked to evaluate their understanding level of the information provided in the video. This question was asked to analyze students' self-monitoring and self-evaluation skills. Responses for both of the videos were analyzed separately. Results showed that students' responses were categorized under 3 themes stating watching 2 times is enough, watching once is enough and watching two times is not enough. Results were similar for both videos.

As shown in table 6.36., results of the video about lightning showed that 50 % of the students stated that watching two times enough, 37 % of the students stated that watching only once is enough, 6 % of students stated that watching two times is not enough.

Results of the video about yellowing of the leaves showed that 51% of students stated that watching two times enough, 31 % of the students stated that watching only once is enough, 12 % of students stated that watching two times is not enough.

Table 6. 36.Students' evaluation regarding their understanding of the video content

Categories	**Percentage (%)**	
	Evaluation of video about lightning and thunder	**Evaluation of video about leaves**
• Watching twice was enough	50	51
• Watching once was enough	37	31
• Watching twice was not enough	6	12

Students, who stated watching two times is enough, explained their reasoning. Some of them stated that "I think, I learnt what is in the video, I constructed a general understanding of the video, we can stop the video anytime we needed so it is enough to watch two times". Students, who stated watching two times is not enough, explained their reasoning. Some of them stated that "a huge amount of information was presented in two minutes, I did not understand some parts so it won't be permanent for me, I forgot the process of how leaves pour".

In question 6, students were also specifically asked about their understanding of the topic that is provided in the video. Here, the difference between the previous question and this question is that, one focuses only on the video content but this question focuses on the whole topic. Students' responses categorized under 3 groups. The first group consists of students who stated that "I understood the topic". The second group consists of students who think they understood moderately not completely. Some example statements are "I understood some parts, I need to learn more".

There were also another group of students who stated that watching two times is not enough. Some example statements are "there can be more details, I need to do more research, it is a huge phenomenon there could be more information, not expert level but for now it's enough, I do not know if there is anything else".

Results of these two questions showed that some students do not aware of there is much more information about this topic. They think video covers all of the information about these two concepts. However, some of them emphasized that they have evaluated their understanding according to what is shown on the video but they know that there can be probably much more details. Table 6.37. shows analysis of students' responses regarding evaluation of their understanding of the whole topic.

Table 6. 37. Students' responses regarding evaluation of their understanding of the whole topic

Categories	Percentage (%)	Example responses
Yes, I understood topic	40	• I understood the topic
I understood moderately	28	• I understood some parts, I need to learn more
Not enough, there must be more information	23	• There can be more details, • I need to do more research, • It is a huge phenomenon there could be more information, • Not expert level but for now it's enough, • I do not know if there is anything else

In the Question 5, students also asked what could be done to better understand the video. Students' responses were categorized under 3 groups according to data. As shown in Tale 6.38., the first category consists of strategies suggested to improve cognitive processes. According to the results of the codes obtained from students' responses, most of the students suggested watching the video repetitively as a rehearsal strategy. Some of the students suggested watching the video by concentrating and analyzing provided information deeply. Some students suggested taking detailed and proper notes for example writing with different color pencils to take attention which is an example of effective note-taking strategies. Only one student stated that developing codes relating to the video content, especially for the part that examples of different tree stocks.

The second category consists of different learning methods. Students suggested to try different types of learning styles. For example, some of them stated they may study from a text by reading it themselves, some of them offered working with real samples by observing and doing experiments. Some of them stated they may make extra research related to the video content by using various sources. Only 1 student proposed asking to teacher, learning with images, and by solving tests.

The third category consists of strategies to change environmental conditions. Some proposed strategies are listening louder, working at a quiet place, flow of the video can be slower, the language of the video can be simpler and easier to understand and a Turkish person should act in the video because a foreigner disturbs concentration.

Table 6. 38.Students' responses regarding what can be done for create better understanding

Categories	Codes	Frequency
Strategies to improve cognitive processes	• Repetition • Concetrating • Analyzing information deeply • Strategic note-taking • Creating codes	6
Different learning methods	• By reading • Real-samples • Doing experiment • Doing research • Using various resources	23
Adapting environmental conditions	• Listening louder • Working in a quiet place • Language can be simpler • Flow of the video can be slower	32

In the 7th question, students were asked about their prefer way of learning this video to analyze their awareness about own learning preferences. Responses analyzed for both videos and a common result is derived. As shown in Table 6.39., results showed that all students have metacognitive knowledge about themselves because they explained why they prefer this way of learning.

Most of the students stated that they would prefer reading on a written material by themselves. Students stated they learn better by reading on their own because it helps to create permanent knowledge. Then second group of students stated that they would prefer these videos because it is more explanatory and illustrative. According to most of these students, video includes text, images and animations so it is more useful. Then, the third group consists of students who prefer experiments and working with real samples. Touching and observing how these processes happen in the real world. Other less stated preferred ways of learning are teacher lecturing, doing research on their own and by using simulations.

Table 6. 39. Students' responses regarding their preferred way of learning the video content

Categories	Frequency	Example responses
Reading of written materials	19	• Reading and writing is better because it creates permenant knowledge
Video was better	15	• It is more explanatory • Better illustrative • It has animation, text and images • More useful
Learning with real-life samples	9	• Touching • Observing • Having fun
Others	9	• Simulations • Teacher lecturing • Doing research

6.3.4. Analysis of Pre- Test Responses on Questionnaire about Lightning and Thunder

Questionnaire about Lightning and Thunder was given to students prior to watching the video about the formation processes of lightning and thunder (see App. F) Then, the same questionnaire was given the same students after watching the video.

6.3.4.1.Pre-test Analysis of Question 1.a.

Question 1.a.: What do you know about lightning? Please write and draw.

Students' responses were open coded and similar responses were grouped to form categories. There were 6 categories namely "formation process in micro scale", "formation process in macro scale", "condition of formation" , "emotion", "daily-life", and "energy".

Category of "formation process in micro scale" includes responses which describe the processes of formation of lightning in terms of the motion of positive and negative electrical charges. Category of "formation process in macro scale" includes responses which describe the processes of formation of lightning in the observable scale. For example, expressions such as 'lightning happens as clouds bump into each other', 'lightning is a light', 'lightning is a sound', 'lightning occurs between cloud and ground' were included into "formation process in macro scale" category. These expressions do not explain lightning in terms of atomic or sub-atomic particles.

Category of "formation process in micro scale" includes responses which describe the processes of formation of lightning in terms of the motion of positive and negative electrical charges. Category of "formation process in macro scale" includes responses which describe the processes of formation of lightning in the observable scale. For example, expressions such as 'lightning happens as clouds bump into each other', 'lightning is a light', 'lightning is a sound', 'lightning occurs between cloud and ground' were included into "formation process in macro scale" category. These expressions do not explain lightning in terms of atomic or sub-atomic particles.

Category of “formation condition time” includes responses which expresses at which conditions lightning happens. For example, expressions such as ‘lightning happens mostly when it is raining’, ‘lightning occurs when there are clouds in the sky’, and ‘lightning comes before thunder’ were included into this category.

There were some students who define lightning as energy such as ‘static energy’ and ‘electrical energy’ or ‘light energy’. One of the answers was including expressions related to emotions. One student stated that “Lightning can be found frightening by some people”. The other category was “daily-life” which includes a statement which relates lightning to daily- life. One student stated that “People put lightning-rod on top of the houses to prevent damage of lightning”. Table 6.40. shows students’ explanations about lightning before watching the video about lightning.

Table 6. 40. Students' descriptions of lightning in Pre-Test

Categories	Codes	Frequency		Example Responses
		Pre	Post	
Formation process in macro scale	• lightning happens as clouds bump into each other • lightning is a light • lightning is a sound • lightning occurs between cloud and ground • it's a light bolt	26	20	"It is a light that happens when clouds bump into each other while it's raining." (Student 25)
Formation process in micro scale	• interaction between positive and negative charges • transfer of electrical charges • electrical current • motion of positive and negative charges	18	16	"Transfer of positive charges in the ground to the cloud" (Student 24)
Condition of formation	• lightning happens mostly when it is raining • lightning occurs when there are clouds in the sky • lightning comes before thunder	8	1	"Instantanenous energy that is seen in the air on rainy days" (Student 15)
Energy	• static energy • light energy • electrical energy	7	12	"it is sound and light that happens when the energy inside the clouds discharge" (Student 11)

Table 6. 41. Students' descriptions of lightning in Pre-Test (cont.)

Categories	Codes	Frequency		Example Responses
		Pre	Post	
Daily-life	• use of lightning-rod in daily-life	1	0	"… People put a thing on the roof to avoid it" (Student 28)
Emotion	• frightening	1	0	"…some people may find it as frightning …" (Student 12)
Types of lightning	• Cloud to cloud	0	1	"…it is a natural phenomenon which can occur between clouds or from clouds ground…" (Student 12)
My knowledge has not changed		0	3	"My knowledge has not changed" (Student 32)

6.3.4.2. Pre-test Analysis of Question 1.b.

Question 1.b.: What do you know about thunder? Please write and draw.

In the second part of the first question, students were asked about thunder. Students' responses were open coded and categorized. It was found that the categories emerged were similar to the ones emerged in Question 1.a. The four categories constructed in this part are "formation process in macro scale", "formation process in micro scale", "condition of formation", and "sound".

In the category of “formation process in macro scale”, students explained the formation of thunder in terms of what they see by naked eye. For example, this category includes responses such as ‘it happens when clouds bump into each other’. Another category is “formation process in micro scale” which includes explaining formation of thunder in terms of atomic and sub-atomic particles. For example, this category includes expressions such as ‘thunder happens if electrical charges in the clouds bump into each other’ or ‘air particles start vibrate so fast which creates a huge sound’.

Similar to previous question, again students gave details about the formation conditions of thunder. For example, this category consists of statements such as ‘thunder happens after lightning’ or ‘thunder happens when it is raining’. Finally, most of the students described thunder as “sound”. Table 6.41. shows students’ explanations about lightning before watching the video about lightning.

Table 6. 42.Students’ descriptions of thunder in Pre-Test

Categories	**Frequency**	**Example response**
Sound	27	• It’s a sound
Formation condition	18	• thunder happens after lightning • thunder happens when it is raining
Formation process in macro scale	5	• it happens when clouds bump into each other
Formation process in micro scale	3	• thunder happens if electrical charges in the clouds bump into each other • air particles start vibrate so fast which creates a huge sound

After students expressed what they know about these two scientific terms, they were asked where they learned this information. The aim of this question was to investigate whether they are aware of how and when they learned these concepts or not.

6.3.4.3. Analysis of Question 2

Question 2: Where did you learn what you have written for lightning and thunder for Question 1?

Students' responses were open coded and categorized. As shown in Table 6.42., most of the students stated that they learned thunder at school, from their teachers or relatives. All of these responses were categorized as learning by "social interaction". Some students stated that they have learned these from a book or Bilim Çocuk Science Magazine which are called as "written resources". Also, some students stated that they have learned from some documentaries or videos which are called as "audio-visual resources". There were some students who stated that they had observed these phenomena in daily-life. Also, there were students who were not aware of where they learned from and there were 2 students who did not answer the question.

Table 6. 43. Analysis of resouces that students have learned about lightning and thunder

Categories	Frequency	Example response
Social interaction	16	• school • teachers • relatives
Written resources	6	• Bilim Çocuk Science Magazine
Audio-visual resources	6	• Documentaries
Rea-life observations	5	• Observed in real life
Do not know	5	
Null	2	

6.3.5. Analysis of Post- Test Responses on Questionnaire about Lightning and Thunder

6.3.5.1. Post-test Analysis of Question 1.a.

Question 1.a.: What do you know about lightning? Please write and draw.

After watching the video about the formation of lightning and thunder same questions were asked to students. Student responses were open coded and categorized.

For the first question, students wrote what they knew about lightning one more time. Results showed that most of the students expressed formation of lightning in macro scale. That's to say, they expressed it only in terms of observable events by naked eyes. For example, students who stated that lightning is a light or it happens between clouds and ground are counted in "formation process in macro scale" category.

Second category includes descriptions of lightning in terms of the processes at atomic or sub-atomic scale. Responses in this category expresses lighting in terms of positive and negative charges and interaction between these charges which was non-observable with eyes.

Third category includes students who defined lightning as energy or static electricity. Less stated responses include "condition of formation" and "types of lightning". Also, there were some students who stated that their knowledge about lightning has not changed. Table 6.43. shows students' explanations about lightning after watching the video about lightning.

Table 6. 44.Students' descriptions of lightning in the Post-Test

Categories	Frequency	Example Response
Formation process in macro scale	20	• lightning is a light • It happens between clouds and ground
Formation process in micro scale	16	• + charges on the ground and – charges inside the cloud replace by each other
Energy	12	• İt's elecrtical energy
Condition of formation	1	• İt occurs when there are clouds
Types of lightning	1	• İts type is cloud to cloud
My knowledge has not changed	3	

6.3.5.2.Post-test Analysis of Question 1.b.

Question 1.b.: What do you know about thunder? Please write and draw.

Students were asked again about their knowledge of thunder after watching the video. Students' responses were open coded and categorized. Similar to the previous question, there were students described thunder in micro scale, macro scale and made a definition. Also, there was one student who mentioned about the condition needed for thunder. Also, 3 students who gave similar answers to the previous question stated that their knowledge about thunders had not changed after watching the video. Table 6.44. shows students' explanations about thunder after watching the video about lightning.

Table 6. 45.Students' descriptions of thunder in the Post-Test

Categories	Frequency
Defined as sound or static electric	22
Formation process in macro scale	19
Formation process in micro scale	16
Formation condition	1
My knowledge has not changed	3

6.3.5.3.Comparison of Pre-Test and Post-Test Analysis of Question 3

Question 3: What do you know about the terms below? Please choose the best-fitting option for your experience with that term.

In Question 3, students were asked some terms that were related to the physical concept that was explained in the video. Some of these terms were explicitly mentioned in the video and they are defined or explained in the videos. However, some of them are not mentioned in the video explicitly. Thus, students should have been interpreting the meaning of these terms by constructing relations.

An example of terms asked in the Question 3:

Ex.

Electrical charge

- ☐ I have never heard that term.
- ☐ I heard about it but I can't explain it.
- ☐ I heard about it, I can explain it like …

There were 6 scientific terms related to lightning and thunder concepts namely 'electrical charge', 'positive charge', 'negative charge', 'static electricity', 'electrical attraction, and 'light bolt'. Students stated what they know about these terms before and after watching the video. Students' responses were open coded and categorized. First and second choices were counted as a category. For the third option, students' expressions about the term were also coded and categories were obtained.

For each term, first pre-test analysis will be shown. Then, their post-test responses will be shown. Finally, comparison of pre- and post- test results will be discussed to make an overall analysis.

6.3.5.4.Pre- Test Analysis of Term 1: Electrical Charge

Results showed that most of the students stated that they have heard about the term but they can't explain it by their own words. Eleven of the students stated that they have heard about the term and they made an explanation of it by their own words. Only 2 students stated that they have never heard about the term.

When students' explanations related to the terms were analyzed, it was seen that there are 5 categories which cover students' responses. As shown in Table 6.45., in the first category, there are students who explained electrical charge as "type of electrical charges: positive and negative". In this category, students gave examples of electrical charges as positive and negative electrical charge. Second category relates electrical charge with "atomic and sub-atomic particles". Third category include responses which relates electrical charge to "electricity and electric current". There are two students who correlated electrical charge to the formation of lightning. Only one student mentioned about pull and push of electrical charges.

Table 6. 46.Analysis of Pre-Test responses for Electrical Charge

Categories	**Frequency**
I have never heard that term.	2
I heard about it but I can't explain it.	19
I heard about it, I can explain it like … -Types of electrical charges: + and - -Relation to atomic and sub-atomic particles -Relation to electricity -Relation to formation of lightning -Pull and push of + and - charges	11

6.3.5.5.Post- Test Analysis of Term 1: Electrical Charge

As shown in Table 6.46., results showed that 8 students stated that they have heard about the term but they wouldn't be able to explain it. 1 of the students stated that he hasn't heard about the term. 5 of them stated that their knowledge about the term haven't changed so the pre-test response is still valid.

Table 6. 47.Analysis of Post-Test responses for Electrical Charge

Categories	Frequency
I have never heard that term.	1
I heard about it but I can't explain it.	8
I heard about it, I can explain it like … -Types of electrical charges: + and - -Relation to electricity -Relation to formation of lightning -Pull and push of + and - charges	16
My knowledge has not changed	5

16 students stated that they have heard about the term and explained 'electrical charge'. Their explanations were open coded. Results showed that 10 students explained it by stating two types of electrical charges as positive and negative. 5 students explained the term by relating it to electricity and electric current. Only 1 student related the term to formation of lightning. Also, only 1 student explained electrical charge by stating electrical attraction.

As compared to pre-test results, almost the same categories were obtained for Term 1. In the post-test, no students explained electrical charge in terms of atomic and sub-atomic particles. Students mostly explained the term as it is stated in the video, they did not add their interpretations to explain the term which was not a desired result.

6.3.5.6. Pre-Test Analysis of Term 2: Positive Charge

As shown in Table 6.47., results showed that 13 students stated that they 'have heard the term but they are not able to explain it'. Only 1 student stated she 'has not heard about it'. Also, 18 students stated that they 'have heard about it' and they wrote what they knew about the term. Their explanations were open coded and categorized.

Table 6. 48.Analysis of Pre-Test responses for Positive Charge

Categories	**Frequency**
I have never heard that term.	1
I heard about it but I can't explain it.	13
I heard about it, I can explain it like … -Relation to atomic and sub-atomic parti -Relation to electricity and electric curre	18

Students' explanations about 'positive charge' consist of responses explaining it with atomic and sub-atomic particles and by relating positive charge with electricity and electric current. Some students explained how current happened and direction of current flow in an electric circuit.

Table 6. 49.Analysis of Pre-Test responses for Positive Charge

Categories	**Frequency**
Relation to atomic and sub-atomic particles	8
Relation to electricity and electric current	7

6.3.5.7. Post- Test Analysis of Term 2: Positive Charge

As shown in Table 6.49., results showed that 6 students stated that they have heard the term but they can't explain it. 4 students stated that their knowledge about positive charge has not changed. Also, none of the students stated that they have not heard positive charge.

Table 6. 50.Analysis of Post-Test responses for Positive Charge

Categories	Frequency
I have never heard that term.	0
I heard about it but I can't explain it.	6
I heard about it, I can explain it like … -A type of electrical charges -Charge of earth ground -Electrical charge attraction -Relating with atomic and sub-atomic particles	18
My knowledge has not changed	4

Eighteen students stated that they have heard the term and explained what they know. Their responses were open coded and categorized. 7 of them stated that it is a type of ‘electrical charge’, 6 of them stated that positive charge is the ‘type of charge that is found in the ground’. This is an information which is expressed in the video. Therefore, described positive charge by stating it is the charge of earth ground. Two of them explained by stating electrical attraction. Only 1 of them explained it by ‘atomic and sub-atomic particles’.

6.3.5.8. Pre- Test Analysis of Term 3: Negative Charge

In the 3rd question, students were asked about negative electrical charge. AS shown in Table 6.50., results showed that 14 students stated that they have heard about it but they can’t explain. 1 student stated that she has not heard about negative charge.

Table 6. 51.Analysis of Pre-Test responses for Term 3

Categories	Frequency
I have never heard that term.	1
I heard about it but I can’t explain it.	14
I heard about it, I can explain it like … Relating with atomic and sub-atomic particles Relating with electricity and electric current	17

17 students stated that they have heard the term and explained it. Results showed that 12 students explained it by relating it with atomic and sub-atomic particles. 6 of them correlate it with electricity and electric current. Similar to previous question, students explained it with direction of current.

6.3.5.9. Post- Test Analysis of Term 3: Negative Charge

As shown in Table 6.51., results showed that 6 students stated that they have heard the term but they couldn’t explain it. 4 students stated that their knowledge about negative charge has not changed. Also, none of the students stated they have not heard the term which is an expected result because it is used in the video.

Table 6. 52.Analysis of Post-Test responses for Negative Charge

Categories	Frequency
I have never heard that term.	0
I heard about it but I can’t explain it.	6
I heard about it, I can explain it like … -A type of electrical charges -Charge of clouds -Electrical charge attraction -Relating with atomic and sub-atomic particles	19
My knowledge has not changed	4

Nineteen students stated that they heard the term before and they explained it. Their explanations were analyzed and 4 categories were obtained. 5 students stated that negative charge is found in clouds. Students heard this information again from the video and only focused that information. 4 students related it to atomic and sub-atomic particles. 3 students stated negative charge is a type of electrical charge. Only 2 students mentioned about the attraction of electrical charges.

6.3.5.10. Pre- Test Analysis of Term 4: Static Electricity

In the 4th question, students were asked about static electricity. As shown in Table 6.52., twelve students stated that they heard the term but they couldn't explain it. Five students stated that she has never heard the term.

Table 6. 53.Analysis of Pre-Test responses for Static Electricity

Categories	Frequency
I have never heard that term.	5
I heard about it but I can't explain it.	12
I heard about it, I can explain it like … -Electricity caused by rubbing -Explaining by giving examples	14

Fourteen students stated that they heard the term and explained the term. Results showed that their responses were grouped into 2 categories. Thirteen students stated that static electric is a type of electricity which is caused by rubbing matters. Seven students explained static electricity by giving examples such as rubbing a balloon to our hair and our hair raise up or rubbing plastic to wool sweater and pulling pieces of paper with it.

6.3.5.11. Post- Test Analysis of Term 4: Static Electricity

After watching the video, students were again asked to write what they know about static electric. AS shown in Table 6.53., 6 students stated that they have heard the term but couldn't explain it. 2 of them stated that they haven't heard it. 3 students stated that their knowledge is same with before watching the video.

Table 6. 54.Analysis of Post-Test responses for Static Electricity

Categories	Frequency
I have never heard that term.	2
I heard about it but I can’t explain it.	6
I heard about it, I can explain it like … -Electricity caused by rubbing -Explaining by giving examples	19
My knowledge has not changed	3

Nineteen students explained what they know about electricityafter watching the video about lightning. Electricityis explained in the video to describe formation of lightning. 15 students stated that electricityis formed by rubbing materials. 4 students used almost the same expressions that is used in the video by the narrator. They used almost the same words and sentences to explain static electric.

6.3.5.12. Pre- Test Analysis of Term 5: Electrical Attraction

In the 5th question, electrical attraction is asked to investigate whether students make interpretations from the video. The term is not used explicitly in the video but one can make interpretation from the content. As shown in Table 6.54., seventeen students stated that they heard the term but can’t explain it. 9 of them stated that they haven’t heard the term.

Table 6. 55.Analysis of Post-Test responses for Electrical Attraction

Categories	**Frequency**
I have never heard that term.	9
I heard about it but I can't explain it.	17
I heard about it, I can explain it like … -Electrified materials pull each other -Positive and negative charges pull each other -Definition of electromagnetic force -Definition of induction current	6

Six students stated they heard the term and explained what they know about it. Three students stated that electrical attraction is that when materials are electrified they pull each other. 1 student stated that positive and negative electrical charges pull each other. These two categories are kind of similar the only difference is that first category explains in macro scale and the other one in micro scale. There were 2 students who made an explanation. One of them made a definition of electromagnetic force and one of the students made a definition of induction current.

6.3.5.13. Post- Test Analysis of Term 5: Electrical Attraction

As shown in table 6.55., results showed that 12 students stated that they heard the term but can't explain it. 2 students stated that they haven't heard the term. 4 students stated that their knowledge is same.

Table 6. 56.Analysis of Post-Test responses for Electrical Attraction

Categories	Frequency
I have never heard that term.	2
I heard about it but I can't explain it.	12
I heard about it, I can explain it like … -Electrified materials pull each other -Positive and negative charges pull each other -Definition of induction current	13
My knowledge has not changed	4

Thirteen students stated that they heard the term and described it, their responses were open coded. Twelve of them expressed it again by positive and negative charges pull each other. Two of them again explained it electrified materials pull each other. Here, there is an increase in the category of explanation in micro scale by including positive and negative electric charges. 1 student still expressed electrical charge by induction current.

6.3.5.14. Pre- Test Analysis of Term 6: Lightning Bolt

On the last question, a light bolt is asked to students. As shown in Table 6.56., 14 students stated that they heard the term but can’t explain it. None of the students stated that they have not heard the term.

Table 6. 57.Analysis of Pre-Test responses for Lightning Bolt

Categories	Frequency
I have never heard that term.	0
I heard about it but I can’t explain it.	14
I heard about it, I can explain it like … -A type of lightning -Forms between cloud-ground -Convection of electricity -Convection of electrical charges	18

Categories	Frequency
I have never heard that term.	0
I heard about it but I can’t explain it.	14
I heard about it, I can explain it like … -A type of lightning -Forms between cloud-ground -Convection of electricity -Convection of electrical charges	18

Eighteen students stated that they heard the term and can explain it. Their responses were open coded. Nine students stated that it is a type of lightning. 8 of them differentiated that it forms between cloud and earth ground. Seven students stated that it is an electrical convection. Three of them explained it by positive and negative electrical charges and their convection.

6.3.5.15. Post- Test Analysis of Term 6: Light Bolt

After watching the video, students were again asked to write what they know about lightning. As shown in Table 6.57., 2 students stated that they have heard the term but can’t explain it. 1 student stated that her knowledge has not changed.

Table 6. 58.Analysis of Pre-Test responses for Lightning Bolt

Categories	Frequency
I have never heard that term.	0
I heard about it but I can’t explain it.	2
I heard about it, I can explain it like … -Forms between cloud-ground -A type of lightning -Convection of electrical charges -Convection of electricity	27
My knowledge has not changed	1

Twenty-seven students stated that they heard it and explained the term. There is an increase in students who tried to explained the term which is an expected result because in the video definition of light bolt is emphasized. Same categories were obtained with the pre-test results. Twenty-three students stated that it is formed between cloud and ground. Thirteen students expressed that it is a type of lightning. 6 students stated that it is a convection of electricity / electric current. 7 students stated that it is a convection between positive and negative electric charges. It is again seen that there is an increase in responses which includes micro scale explanations.

6.3.6. Analysis of Pre- Test of Post-Test Responses on Questionnaire about Yellowing and Pouring of Leaves

Questionnaire about Leaves was given to students prior to watching the video about color change procedures of the leaves (see App. G). Then, the same questionnaire was given the same students after watching the video. To investigate the impact of the video to students' answers, general themes of their answers were compared. The number of different categories and sub-categories that are written by each student were counted for pre- and post- test responses, respectively.

6.3.6.1. Pre-test and Post- Test Analysis of Question 1.a.

Question 1.a.: What do you know about leaves? Please write and draw.

Students' responses were analyzed by open- coding and general themes were put into categories and sub-categories. Analysis of the pre-test data showed that students' answers were including categories of "processes undergone by a leaf", "structural features of a leaf", "benefits of leaves", "conditions that affect leaves", "making analogies" and "features of coniferous plants". Also, analysis of the post-test data showed that students' answers were including categories of "processes undergone by a leaf", "structural features of a leave", "behind reasons for the foliage of leaves", "conditions that affect leaves", "color change processes", "foliage processes" and "features of coniferous plants". Table 6.58. shows categories and sub-categories of student responses in the pre- and post- tests with respective number of students.

Table 6. 59.Categories of Student Responses and Number of Students for Each Category and Sub-Category

Categories	Sub-Categories	Number of students	
		Pre-Test	Post-Test
processes undergone by a leaf	Season-cycle/ life-cycle	8	0
	Photosynthesis	18	13
	Respiration	2	0
	Transpiration	4	0
	Excretory ejection/ Waste storage	6	0
	Secrete hormone for foliage	0	3
	Total	**38**	**16**
structural features of a leaf	Form	3	5
	Color/Pigment	10	24
	Nervate	2	0
	Total	**15**	**29**
benefits of leaves	Food for humans and animals	3	0
	Looks good	2	0
	Create healthy life by producing O_2	1	0
	Fertilizer for trees	1	0
	Total	**7**	**0**
conditions that affect leaves	Sunlight	2	17
	Heat/ Temperature change	1	2
	Geographical characteristics/ climate conditions	2	0
	Seasonal change	1	1
	Total	**6**	**20**
making analogies	Born, grow up, die (like humans)	1	0
	Leaves are similar to respiratory organs of humans	2	0
	Total	**3**	**0**
features of coniferous plants	No color change and foliage in winter	2	4
	Leaf surface covered with waxy material	0	1

Table 6. 60.Categories of Student Responses and Number of Students for Each Category and Sub-Category (cont.)

Categories	Sub-Categories	Number of students	
		Pre-Test	Post-Test
	Secrete enzymes to prevent freezing	0	1
	Total	**2**	**6**
behind reasons for the foliage of leaves	To lower use of food and water	0	5
	To make tree alive in winter	0	1
	Total	**0**	**6**
Color change processes	Death of chlorophyll	0	12
	Producing less food	0	4
	Emergence of other pigments	0	13
	Storing sugar and chemical reactions with sugar	0	6
	Total	**0**	**35**
Foliage processes	Canals going to leaves are blocked	0	6
	Activating secreting hormone for foliage	0	3
	Total	**0**	**9**

6.3.6.2. Analysis of Question 2

Question 2: Where did you learn what you have written for leaves in Question 1?

This question was asked to see if students are aware of when they have learned their explanation. Also, by this question it will be possible to see how many different kinds of resources student use.

As shown in Table 6.59., findings showed that students gathered their knowledge about leaves mostly via social interaction (%43). Social interaction category consists of responses such as learning from teachers, school, family members, friends and neighbors.

Other responses include learning by audio-visual resources (15%) such as documentaries and internet, written sources (% 14) such as books and science magazines, and real-life observations (% 10) such as observing leaves in the gardens. The remaining students stated that they do not know where they have learned (%8) and some students did not answer the question (%10).

Table 6. 61.Analysis of resources that students learned about leaves

Categories	Frequency
Social interaction	22
Written resources	7
Audio-visual resources	8
Rea-life observations	5
Do not know	4
Null	5

6.3.6.3. Comparison of Pre-Test and Post-Test Analysis of Question 3

Question 3: What do you know about the terms below? Please choose the best-fit option.

In Question 3, students were asked some terms that is related to the biological concepts that are explained in the video. Some of these terms are explicitly mentioned in the video and they are defined or explained in the videos. However, some of them are not mentioned in the video explicitly. Thus, students should have been interpreting the meaning of these terms by constructing relations.

An example of terms asked in the Question 3:

Ex.

Chlorophyll

- I have never heard that term.
- I heard about it but I can’t explain it.
- I heard about it, I can explain it like …

There were 6 scientific terms related to yellowing and pouring of leaves namely ‘foliage, ‘color change’, ‘photosynthesis’, ‘chlorophyll, ‘pigment’, and ‘coniferous’. Students stated what they know about these terms before and after watching the video. Students’ responses were open coded and categorized. First and second choices were counted as a category. For the third option, students’ expressions about the term were also coded and categories were obtained.

For each term, first pre-test analysis will be shown. Then, their post-test responses will be shown. Finally, comparison of pre- and post- test results will be discussed to make an overall analysis.

6.3.6.4. Comparison of Pre- Test and Post-Test Analysis of Term 1: Foliage

Fall foliage is a very common phenomenon that is observable for everyone. This question is asked to investigate how this familiar biological phenomenon known to everyone is interpreted by our sample.

As shown in table 6.60., results showed that most of the students stated that they have heard about the term but they can’t explain it by their own words. Eleven of the students stated that they have heard about the term and they made an explanation of it by their own words. Only 2 students stated that they have never heard about the term.

Table 6. 62.Analysis of Pre-Test and Post-Test responses for Term 1: Foliage

Categories	Pre-Test Frequency	Post-Test Frequency
I have never heard that term.	1	0
I heard about it but I can't explain it.	9	4
I heard about it, I can explain it like … -Only macro level -Causes of foliage of leaves -Process of foliage	11	20
My knowledge has not changed	0	5

Students' responses were analyzed and 3 categories were obtained. Students' responses include information in terms of 'only macro scale', 'causes of foliage' and 'foliage processes'. In the first category, students described foliage in terms of their daily-life observations and their explanations were not detailed. It only includes responses that can be observed by anyone. For example, most students only stated that leaves fall in autumn.

In the second category, students explained this phenomenon by stating the causes of why it happens. For example, some students stated that trees have foliage for excretion. These responses are more detailed and is a sign that these students question what they see in their daily-lives. Finally, the third category includes descriptions about processes of foliage. Before watching the video, none of the students stated processes happening in the foliage.

6.3.6.5. Comparison of Pre- Test and Post-Test Analysis of Term 2: Color Change

In the second question, students were asked about the term color change. Color change is a common phenomenon that is observed by everyone every year. In this question, which points the students paid attention were investigated. As shown in Table 6.61., results showed that only 1 student has never heard that term and 13 students stated that they have heard but can't explain the term.

Table 6. 63.Analysis of Pre-Test and Post-Test responses for color Change

Categories	**Pre-Test Frequency**	**Post-Test Frequency**
I have never heard that term.	1	0
I heard about it but I can't explain it.	13	1
I heard about it, I can explain it like … -Only macro level -Micro with macro level -Causes of foliage of leaves -Process of foliage	18	27
My knowledge has not changed	0	2

Eighteen students stated that they have heard the term and explained it. Their explanations were analyzed and it was found that almost same categories with the Term1 were obtained. In this question, student responses in pre- test were grouped into 2 categories namely 'only macro level' and 'micro with macro level'. In the post-test 2 more categories were emerged namely ''color change processes' and 'causes of color change'.

6.3.6.6. Comparison of Pre- Test and Post-Test Analysis of Term 3: Photosynthesis

In the third term, students were asked about the term photosynthesis. Photosynthesis is again a common scientific concept which is covered in school science courses. As shown in Table 6.62., results showed that only 1 student has never heard that term and 1 student stated that he had heard but can't explain the term.

Table 6. 64.Analysis of Pre-Test and Post-Test responses for Photosynthesis

Categories	Pre-Test Frequency	Post-Test Frequency
I have never heard that term.	1	0
I heard about it but I can't explain it.	1	0
I heard about it, I can explain it like … Process Micro scale with macro scale Making analogy	29	26
My knowledge has not changed	0	5

Almost every student stated that he/she has heard the term and explained it according to his/her knowledge about it. 29 students' explanations about photosynthesis were analyzed and it's found that their responses were grouped into 3 categories. In the pre-test, most of the students explained the process of photosynthesis and only 2 of them focused processes and concepts in micro scale. Only 1 student, created an analogy to explain photosynthesis after watching the video.

6.3.6.7. Comparison of Pre- Test and Post-Test Analysis of Term 4: Chlorophyll

Students were asked about a pigment which is important and required for plants to make photosynthesis. It has seen that almost every student has heard about this pigment. As shown in Table 6.63., eleven students stated they can't explain it and only 1 one of them stated he has not heard that chlorophyll before.

Table 6. 65.Analysis of Pre-Test and Post-Test responses for Chlorophyll

Categories	Pre-Test Frequency	**Post-Test Frequency**
I have never heard that term.	1	0
I heard about it but I can't explain it.	11	6
I heard about it, I can explain it like … -Definition -Location -Task	19	18
My knowledge has not changed	0	6

Nineteen students stated that they have heard chlorophyll and explained what they know. Results showed that both of their pre- and post- test responses were grouped into 3 categories namely 'definition', 'location', and 'task'. In the definition category, students expressed it is a microscopic matter found in plants. Some students expressed its location in the plant such as inside cell or more specifically inside chloroplast. Some students mentioned about its task in the plant such as feeding the plant and carrying out photosynthesis processes.

6.3.6.8. Comparison of Pre- Test and Post-Test Analysis of Term 5: Pigment

Students were asked about the term 'pigment'. As shown in Table 6.64., results showed that all of the students have heard about the term before watching the video. Also, 22 of them stated that they can explain what pigment is.

Table 6. 66.Analysis of Pre-Test and Post-Test responses for Pigment

Categories	Pre-Test Frequency	Post-Test Frequency
I have never heard that term.	0	0
I heard about it but I can't explain it.	9	8
I heard about it, I can explain it like … -Definition -Location -Task	22	15
My knowledge has not changed	0	6

Students' responses about definition of the term 'pigment' were analyzed and same categories with the previous question were obtained. Their responses were grouped into 3 categories namely 'definition', 'location', and 'task'. As stated above, students in definition category, explained pigment as a matter or particle found in plants. In location category, students explained pigments are found inside cells. In task category, students explain task of a pigment. Most of them stated that they give color to a tissue.

6.3.6.9. Comparison of Pre- Test and Post-Test Analysis of Term 1: Coniferous plants

Students were asked about coniferous plants which is a term that is less common than other terms. In pre-test, results showed that 10 students have never heard that term before. 5 of them stated that they heard but can't explain it. In the post-test, every student stated that they heard it which is an expected result. Student number who can explain the term has increased after watching the video. Table 6.65. shows analysis of students' responses regarding coniferous plants in pre- and post-test by providing frequencies of responses.

Table 6. 67.Analysis of Pre-Test and Post-Test responses for Coniferous plants

Categories	Pre-Test Frequency	**Post-Test Frequency**
I have never heard that term.	10	0
I heard about it but I can’t explain it.	5	3
I heard about it, I can explain it like … -Giving example -Classification -Structural features -Functional features -Relating structural and functional features	17	24
My knowledge has not changed	0	2

Students’ explanations for coniferous plants were analyzed. Five categories were obtained for pre- and post-test analysis. In the first category, students gave examples for coniferous plants, most of them gave pine tree as an example. Some students were aware of biological classification and used expressions of pine tree and pinaceae separately. Both in pre- and post-test, students mentioned structural features of them.

After watching the video, students’ responses have increased in terms of functional features of coniferous plants. Also, these students correlated structural and functional features of these plants to describe their characteristics more accurately. For example, most students explained that their leaves have less surface area and waxy tissue on their leaves that’s why they are resistant in winter conditions. Also, some students stated they secrete some chemicals to prevent foliage and pouring.

6.3.7.Analysis of Drawings for Pre-Test and Post-Test

Both in the Questionnaire for Lightning and Thunder and in the Questionnaire for Leaves, students were asked open-ended questions to investigate how they represent their knowledge and how they organize their knowledge. These were investigated to make an interpretation about their cognitive and metacognitive abilities. In these questionnaires, students were asked both to describe what they know in written format and by drawings. The reason why they were asked to draw is that students' drawings could give some particular information about their cognitive and metacognitive processes.

6.3.7.1. Analysis of drawings about lightning

In the Questionnaire for Lightning and Thunder students were asked to describe their knowledge about lightning by drawing.

Both before and after watching the video students were asked the question below.

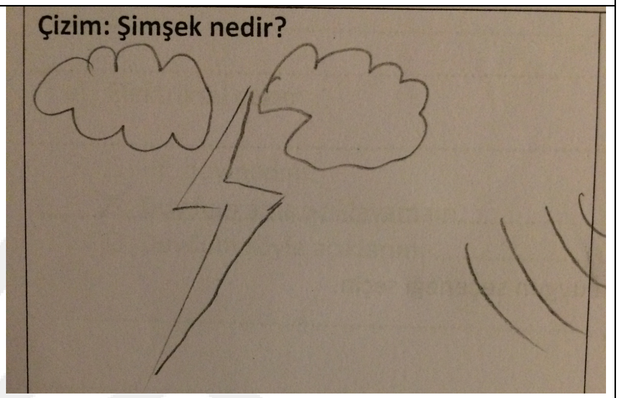
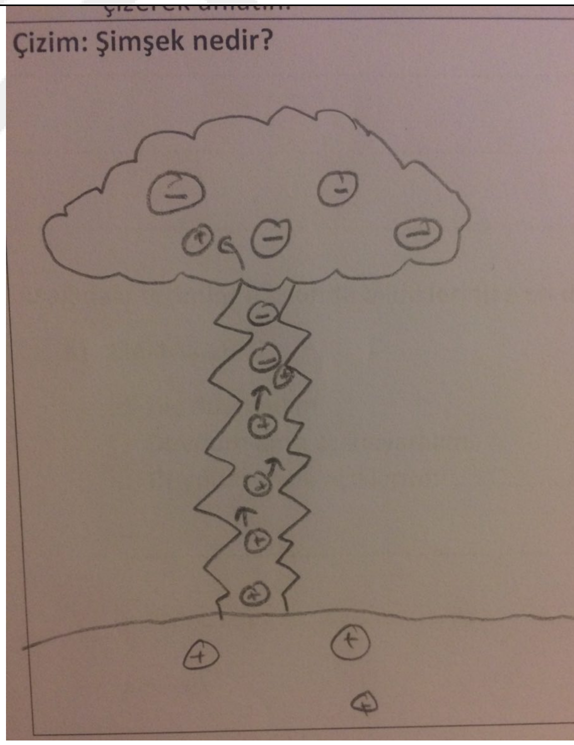
Question: Please draw the things that you know about lightning.

Students' drawings were open coded. The answers were mostly categorized into 'type of information (only structure or structure and process)', 'type of representation (only macro, macro and sub-micro together)' and 'use of details or legend (or not using)'.

1. Type of information

It was seen that while students drew what they knew about lightning they preferred to represent it either by focusing on its *structure* or *formation processes*. Therefore, their answers were subcategorized as "*structure*" or "*structure and formation processes*" under the category of type of information. This categorization was suitable for both pre-test answers and post-test answers. The Table 6.66. shows the number of students according to their pre- and post-test answers in terms of their preference about the type of information either by focusing *structure* or *formation processes*.

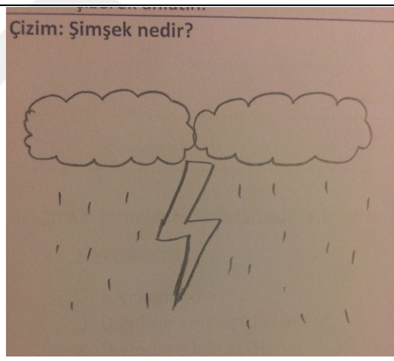
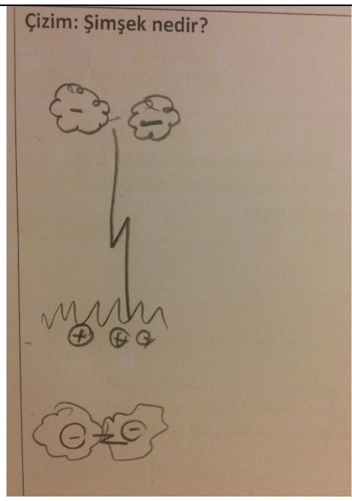
Table 6. 68. Analysis of Type of Information for Pre- and Post- Test

Type of information	**Frequency**		**Example response**
Sub-Categories	**Pre-Test**	**Post-Test**	
Structure	20	8	
Formation process	3	10	

2. Type of representation

It was also seen that some of the students drew what they knew about lightning *at the macro level only* whereas other students represented it at the *sub-micro level besides to the macro level.* Therefore, their answers were sub-categorized as *macro* or *macro and sub-micro* under the category of "type of representation". The Table 6.67. shows the number of students according to their pre- and post-test answers in terms of their preference about representation of information such as *macro* or *macro and sub-micro*.

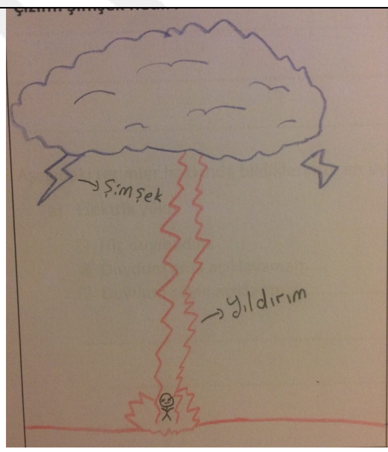
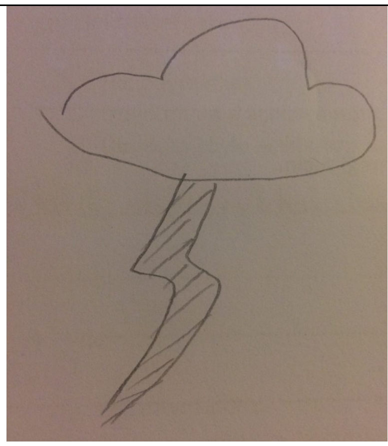
Table 6. 69.Analysis of Type of Representation for Pre- and Post- Test

Type of Representation	**Frequency**		**Example response**
Sub-Categories	**Pre-Test**	**Post-Test**	
Only macro level	4	4	
Macro and sub-micro level	12	12	

3. Use of details or legend

As a final result, it was seen that some of the students were giving more details in their drawings, they did not only draw information about the terms which was asked they also draw the things that are correctly related to the concept. For example, a lightning can be harmful for houses or humans, or the effect of lightning can be eliminated by using a lightning rod at the top of a house. Or, some of the students drew arrows to show and write the meanings of the things in his/her drawing. The Table 6.68. shows the comparison of number of students according to their pre- and post-test answers in terms of their preference about use of details and legend.

Table 6. 70.Analysis of Use of Details and Legend for Pre- and Post- Test

Use of Details and Legend	**Frequency**		**Example Response**
Sub-Categories	**Pre-Test**	**Post-Test**	
Use of details and legend	6	9	
No details and legend	17	9	

6.3.7.2. Analysis of Drawings about "thunder"

Both before and after watching the video students were asked the question below.

Question 2: Please draw the things that you know about thunder.

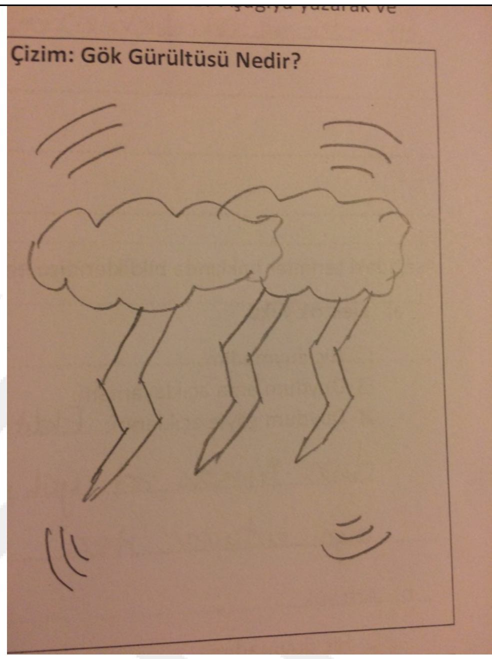
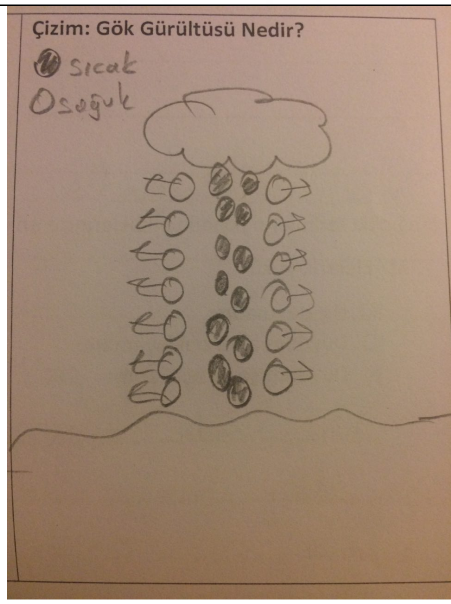
When the second question was analyzed, the same categories with the first question were obtained. Similar to the first question, in the second question students' answers were categorized into three main categories which are named as 'type of information (only structure or structure and process)', 'type of representation (only macro, macro and sub-micro together)' and 'use of details or legend (or not using)'. Detailed information about the analysis of these categories are mentioned below.

1. Type of information

When students' drawings about thunder were being analyzed the same categories with analysis of lightning data have been derived, too. That's to say, when students drew what they knew about thunder they preferred to represent it either by focusing on its *structure* or *formation processes*. Therefore, their answers were sub-categorized as *structure* or *structure and formation processes* under the category of "type of information". For example, some of the students stated thunder only as a sound or soundwave which depicts its structural features only whereas other students try to explain the processes of how a thunder occurs.

The Table 6.69. shows the number of students according to their pre- and post- test answers in terms of their preference about type of information either by focusing *structure* or *formation processes.*

Table 6. 71.Analysis of Type of Information for Pre- and Post- Test

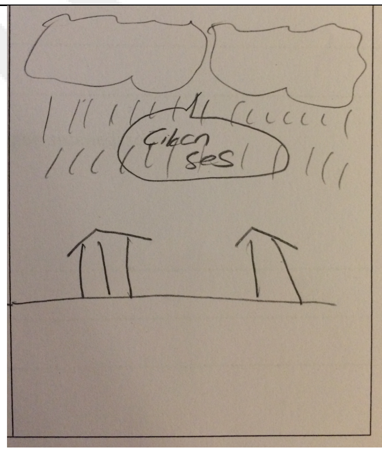
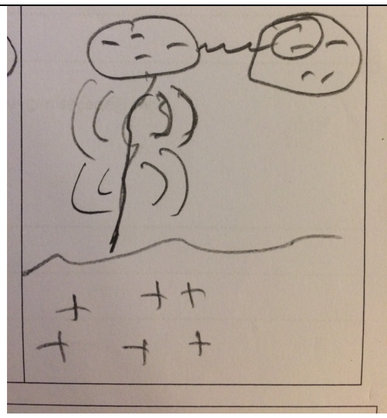
Type of information	**Frequency**		**Examle Response**
Sub-Categories	**Pre-Test**	**Post-Test**	
Structure	16	16	
Formation process	1	11	

2. Type of Representation

It is also seen that some of the students drew their knowledge about thunder *at the macro level only* whereas other students prefer to represent it at the *sub-micro level besides to the macro level.* Therefore, their answers were subcategorized as *macro* or *macro and sub-micro* under the category of representation type of information.

The Table 6.70. shows the number of students according to their pre- and post-test answers in terms of their preference about representation of information such as *macro* or *macro and sub-micro*.

Table 6. 72.Analysis of Type of Representation for Pre- and Post- Test

Type of Representation	**Frequency**		**Example Response**
Sub-Categories	**Pre-Test**	**Post-Test**	
Only macro level	16	4	
Macro and sub-micro level	1	12	

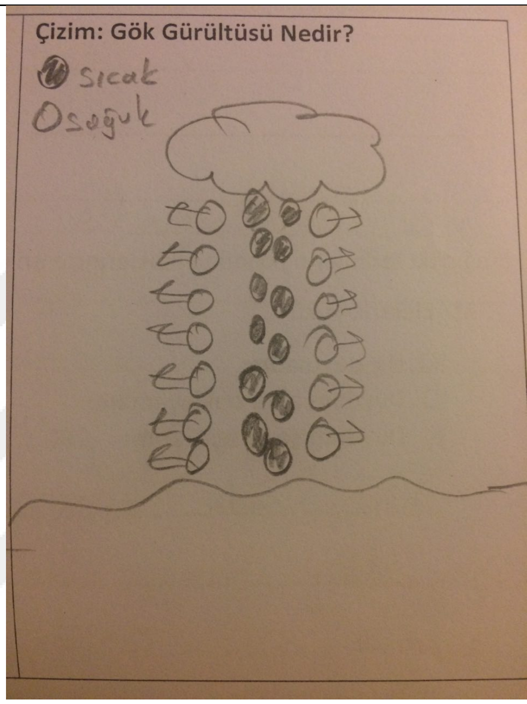
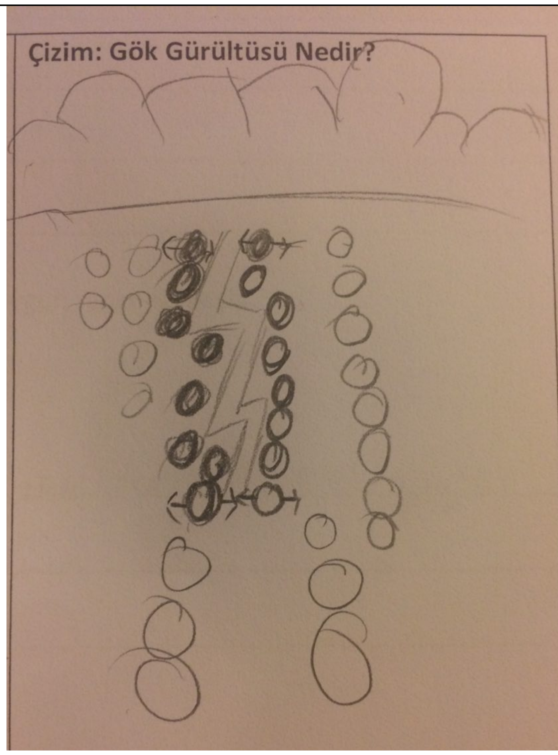
3. Use of details or legend

As a third category for the analysis of students' answers for thunder, it was seen that some of the students gave more details in their drawings, they do not only draw information about the terms which is asked they also draw the things that are correctly related to the concept.

For example, some students draw thunder as coming to ears of a human or to a house or the sound comes after the lightning. In these drawings these students gave further and detailed information about thunder and its relation to other things. Besides giving detailed information, some of the students draw legend to give information about the signs that they have used while trying to explain their ideas about the concept.

For example, if student used red pencil to show hotter air molecules and blue pencil to show colder molecules, he/she make a legend below and state the meanings of red and blue color. The Table 6.71. show the comparison of number of students according to their pre- and post-test answers in terms of their preference about use of details and legend.

Table 6. 73.Analysis of Use of Details and Legend for Pre- and Post- Test

Use of Details and Legend	**Frequency**		**Example Response**
Sub-Categories	**Pre-Test**	**Post-Test**	
Use of details and legend	6	11	
No details and legend	11	5	

6.3.7.3. Analysis of drawings about leaves

In the Questionnaire for Leaves students were asked to describe their knowledge about leaves by drawings.

Both before and after watching the video students were asked the question below.

Question: Please draw the things that you know about leaves.

Students' drawings were open coded. The answers were categorized into 'type of information', 'use of details or legend' and 'thinking as a whole system'.

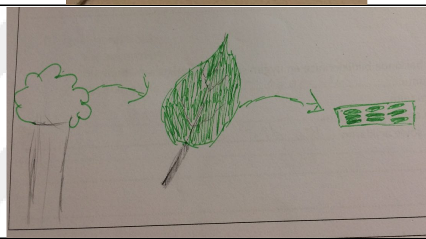
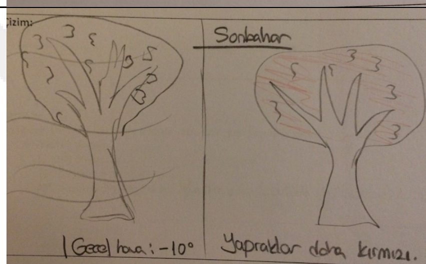
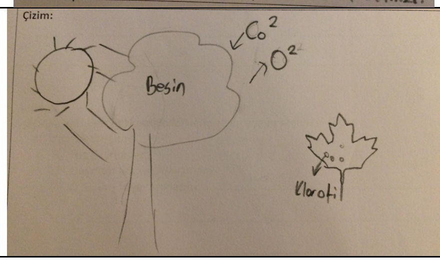
1. Type of Representation

It has seen that while students draw what they know about leaves they prefer represent it either by focusing on its *structure* or *formation processes*. Therefore, their answers were subcategorized as "*structure*" or "*structure and formation processes*" under the category of type of information.

Similar to categories found in lightning and thunder drawings, another relation was obtained in their responses. Regardless of students' preference on "structure" or "formation process", students drew in macro scale or in sub-micro scale. They made drawings in only macro scale or they included sub-micro scale to explain their knowledge about for both 'structure' and 'process' that are related to leaves.

The Table 6.72. show the number of students according to their pre- and post-test answers in terms of their preference about type of information either by focusing *structure* or *formation processes* and represent it whether in macro scale or in sub-micro scale.

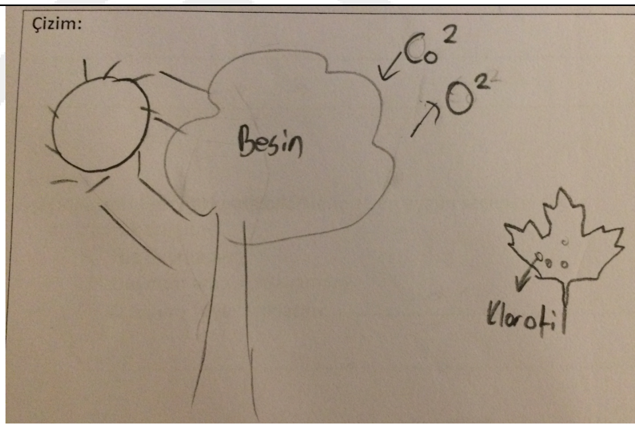
Table 6. 74.Analysis of Type of Representation for Pre- and Post- Test

Categories	**Sub-Categories**	**Open-Coding**	**Frequency**		**Example Response**
			Pre-Test	**Post-Test**	
structure	Macro-structure	leafstalk leaf nerves shape coniferous plants	17	3	
	sub-micro structure	cells pigments organic, inorganic matters	4	4	
process	macro process	defoliation color change photosynthesis	6	2	
	sub-micro process	defoliation color change photosynthesis	4	3	

2. Use of Details and Legend

Similar to previous findings, some students added some details to their drawings other than only giving information that is covered in the video. To be able to explain their ideas more clearly, some students used extra symbols and labels. Also, they prepared a legend to make it clear what they have drawn for other people. The Table 6.73. shows the comparison of number of students according to their pre- and post-test answers in terms of their preference about use of details and legend.

Table 6. 75.Analysis of Use of Details and Legend for Pre- and Post- Test

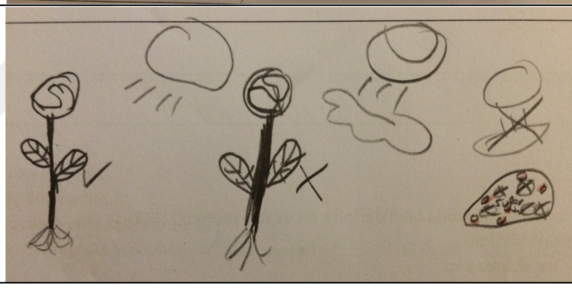
Category	**Frequency**		**Example Responses**
	Pre-Test	**Post-Test**	
Use of details and legend	12	4	

3. Thinking as a Whole System

In students' drawings, it was seen that some students think trees inside a whole system and made inference about its role in its own habitat. Thus, their drawings reflected these students' point of view for trees and leaves.

Some students discussed leaves and their roles in their own habitat. For example, they are food for other living creatures, they are a part of tree and there is a relation between other parts of the tree and the leaf. Also, when we look at a leaf it was seen that it has a cycle throughout its life. For example, it has a life-cycle and a seasonal cycle and what is going to be happen to a leaf is determined by other conditions such as climate and weather. The Table 6.74. shows the comparison of number of students according to their pre- and post-test answers in terms of their preference about thinking as a whole system.

Table 6. 76.Analysis of Use of Details and Legend for Pre- and Post- Test

Categories	Sub-Categories	Open-Coding	Frequency Pre-Test	Frequency Post-Test	Example Response
thinking as a whole system	its role in habitat	on the branches of trees food for other living creatures	9	3	
	life-cycle	life cycle seasonal cycle climate	2	2	

6.3.8. Analysis of Student Worksheets

In students' responses, it was seen that some students in the sample choose watching documentaries when they want to learn a science concept. Therefore, Study Worksheets were given to analyze which cognitive strategies students are using while they are watching a video clip about a science concept. Students were led to take notes and make some drawings while they are watching videos provided by the researcher. Then, students' notes and drawings were coded and categorized according to their themes.

Students were given two worksheets for two different videos. The first video was about lightning and thunder. Students were given the first Study Worksheet for lightning and thunder. They could write and draw while they were watching the video. If they want to take notes, they could pause or rewind the video and take their notes on the worksheet.

Also, students were encouraged to watch the video 2 times, and write with different color pencils to see the difference between first and second watching. The same procedure was applied for the second video which is about a biological process in plants- yellowing and pouring of the leaves.

Each student's first and second watch responses for both of the videos were coded. For each student, applied cognitive strategies were identified. Then, the total frequencies for each strategy were calculated. While calculating the total frequency of the strategy, *the total number of times that strategy is used* is summed.

Results showed that students' strategies were grouped under four categories that are derived from the data according to Cornell's Note-taking strategies (Pauk & Owens, 2010). The first category is the use of signs and symbols, which is the most common strategy used by students in the sample. It was seen that students use signs and symbols while they are taking notes on the worksheet. The use of signs and symbols is an effective way of taking notes because it fastens the writing process. Also, it makes it easier to review quickly the notes afterward. For example, students mostly used + and – signs while they are taking notes about the formation of lightning. They have used these signs to refer to positive and negative electrical charges.

Also, students mostly make use of arrows or lines to make extra explanations about a concept or to demonstrate the relationship between two different sentences. For example, a student used a line to show the relationship between two electrical charges and the result of this attraction.

Also, students used symbols such as exclamation mark (!) or underlining when they wanted to take attention to a piece of specific information. Putting some marks or underlining takes attention to the important points and helps students to study afterward. Some of them put question marks (?) to places where they didn't understand or not sure about. In these examples, students were not writing openly that they do not understand that part instead they only put a question mark to express the situation. For example, using an ampersand (&) instead of writing "and" is a good way to fasten the writing process.

Also, some students preferred to write chemical formulas of chemical compounds rather than writing their chemical names which are a faster way of writing. Another example was from a student who created two icons to represent lightning and thunder. Instead of writing lightning and thunder, he chooses to create an icon that will represent the concept. Another example is using parenthesis to make a further explanation about a word or a sentence. When students wanted to give extra information or explain a word or sentence, they preferred to write it in the parenthetical form. In all of these examples, students are using some representative symbols or signs to produce clear and understandable notes in the shortest possible time.

The second category consists of strategies that are used to describe long processes in simpler forms. For example, some students preferred to show a photosynthesis reaction in the form of a chemical reaction equation. In this way, they would be able to show all factors that affect the chemical reaction in one equation. Some of the students preferred to draw stages of a scientific process stage by stage. Sometimes drawings can be the simplest way of expressing ideas. Some students drew the formation processes of lightning, some of them drew the conditions that affect the color of leaves. Some of them put some drawings to represent dynamic processes such as the motion of molecules, electrical charges or sound waves. In the Cornell's System, students who learn better with doodling and drawings were encouraged to draw images while they are taking notes. Also, tactile learners were encouraged to benefit from these characteristics while taking notes. In the present study, for example, some students preferred to write the sound effects of thunder, static electricityor friction sound that happens while walking on the carpets.

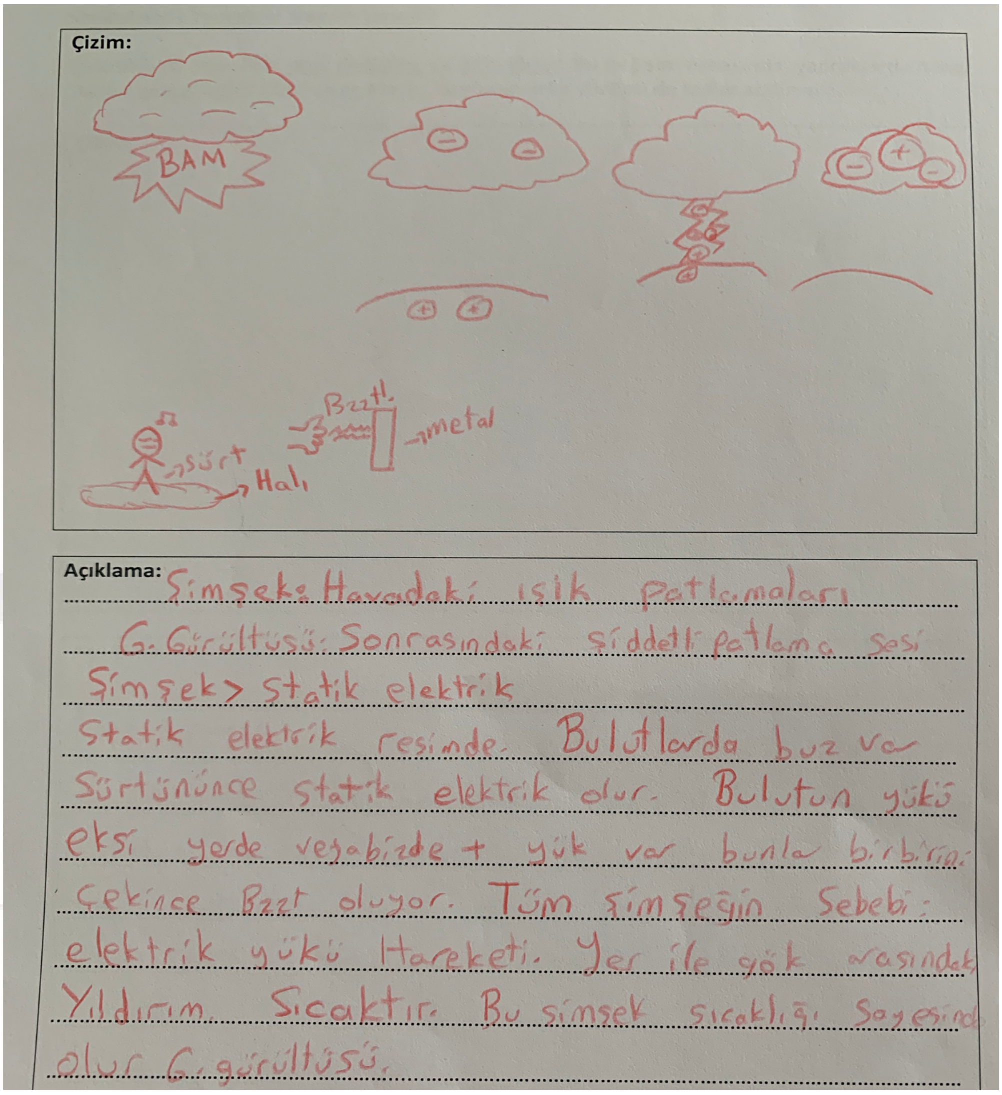


Figure 6. 1. An example of students notes while watching video about lightning for the first time

The third category is to use abbreviations as a note-taking strategy. Students use abbreviations to write faster. They sometimes used general abbreviations or sometimes they have created new abbreviations that can only be understood by themselves. They sometimes abbreviated words and sometimes shortened the sentences by eliminating some words.

The fourth category consists of strategies for organizing writing. A well-organized written content requires students to link ideas and show relations between concepts in the written format. A well-organized written content helps students to understand better when they need to review their notes afterward. Some strategies are used by students for organizing writing. For example, two students wrote the title of the topic at the top of the page. Writing heading is one of the first steps in Cornell Note-taking System. Some of the students preferred to take notes in the bullet point format. This format helps to take notes fast by reducing extra word usage. Also, it makes easier to read the notes afterward. Similar to the bullet point format, some students took notes item by item. However, they did not put any identifier mark at the beginning of the sentences. This may be because they probably do not yet know how to use this strategy. If these students were taught strategic note-taking methods, they could have taken their notes in the proper bullet point format.

Another way to organize writing is to use graphic organizers. Graphic organizers are beneficial for encoding information. However, in the present study, there were only two students who prefer to show information into graphic organizers format.

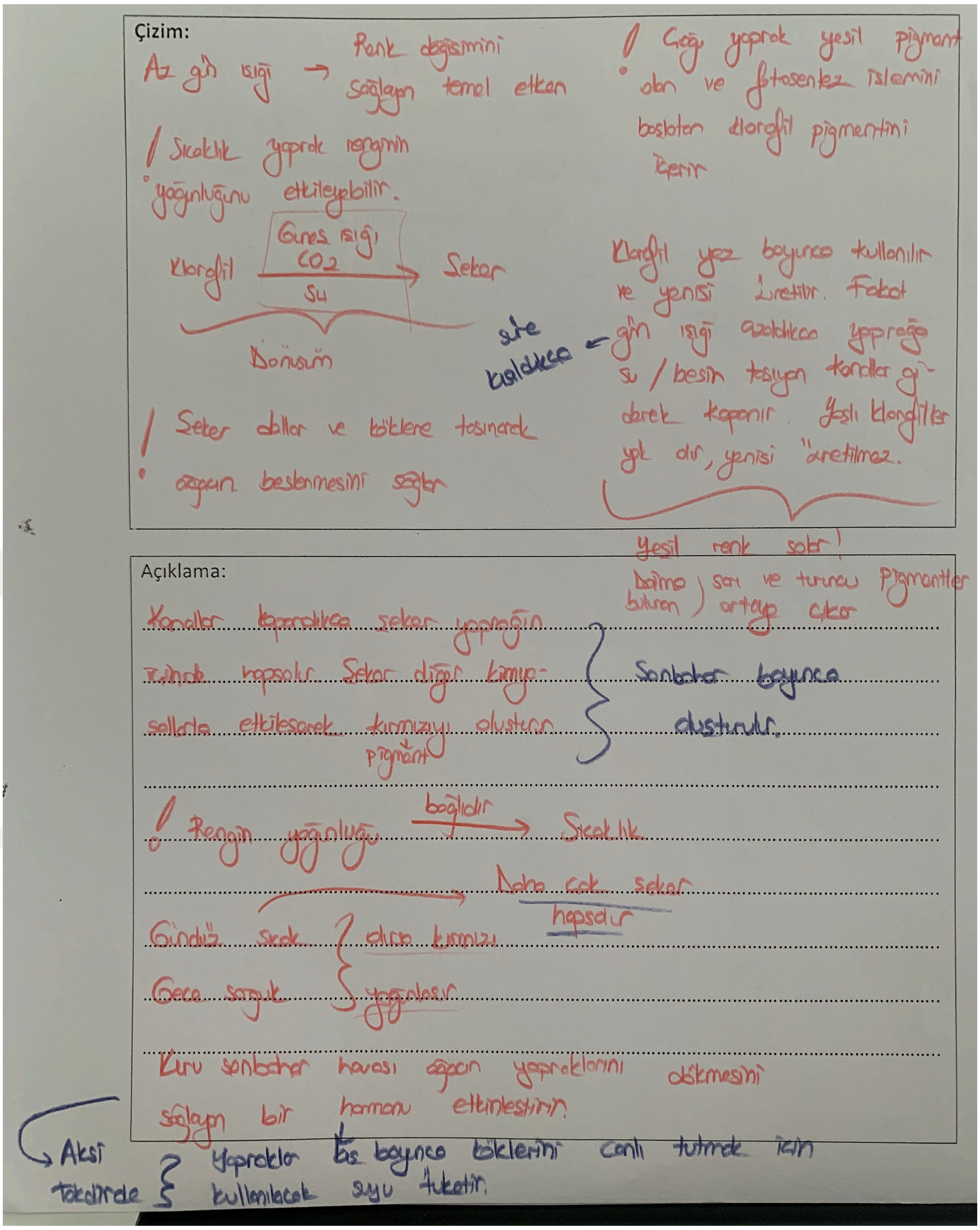


Figure 6. 2. An example note that is taken while watching video about leaves

Even though there are many different note-taking strategies used by students in our sample, still most of the students were unsuccessful in note-taking. In Cornell's Note-taking System, using complete sentences are not suggested. Students should leave a space between the lines because it enables them to add extra information when needed. However, most of the students (45%) in our sample took notes in the paragraph format. Paragraph format has other drawbacks such as it makes difficult to read the notes afterward. Also, writing a meaningful paragraph requires using so many conjunction words which increases time-spent.

Finally, observed in almost every student is they take notes with their own words. That's to say, they do not just copy what they have heard on the video. They write what they have inferred from what they have listened.

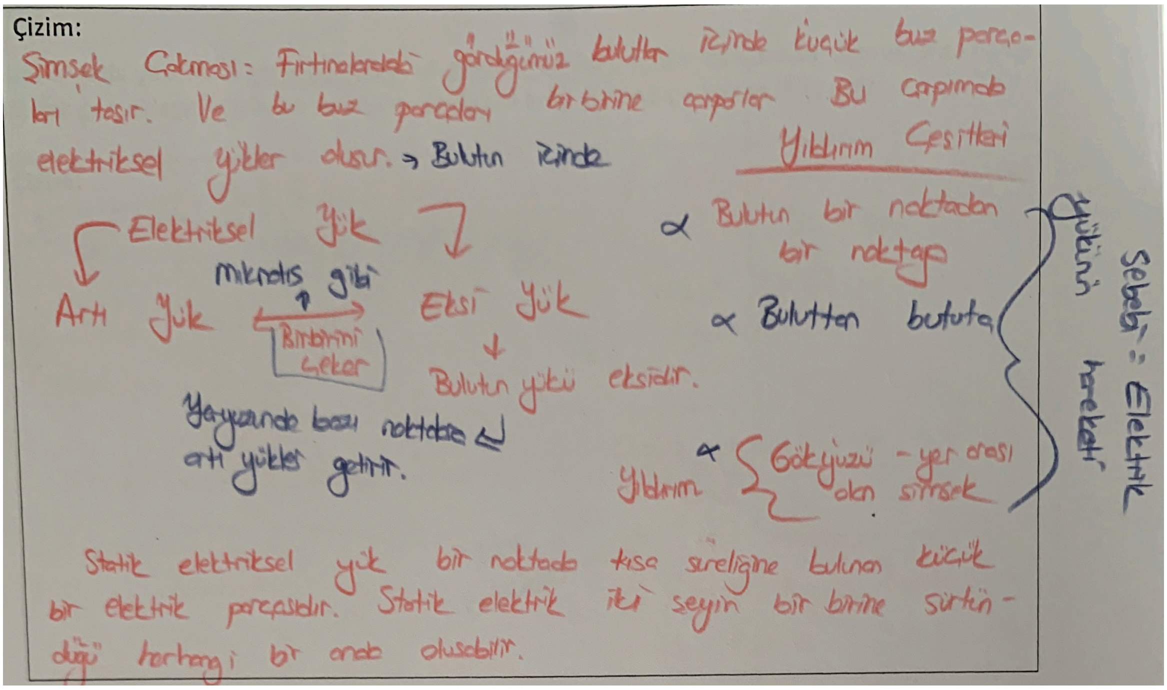


Figure 6. 3. An example of notes that are taken while watching video about lightning for the first and second times

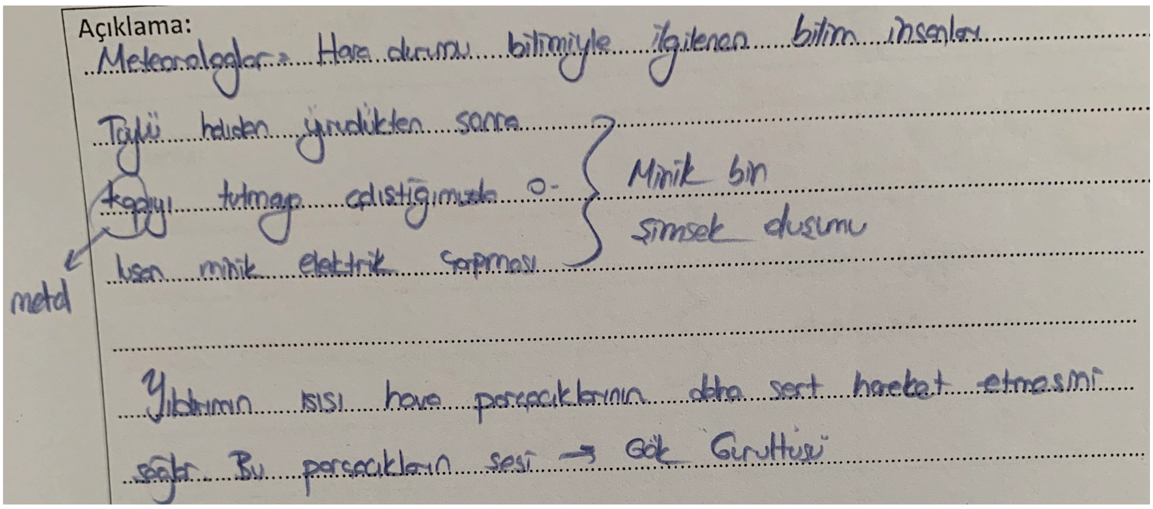


Figure 6. 4. An example of notes that are taken while watching video about lightning for the second time

Table 6. 77. Cognitive strategies used by students while taking notes about a science video

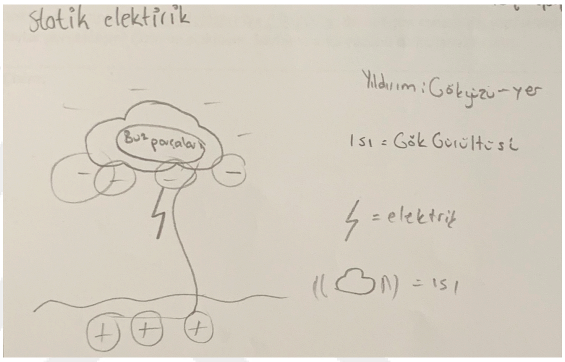
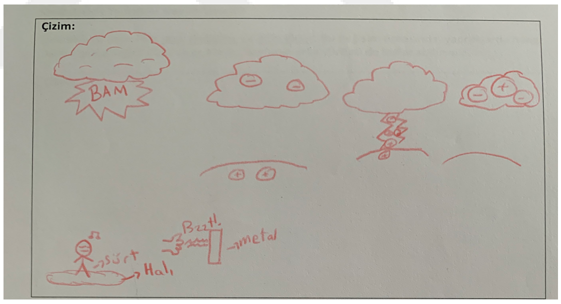
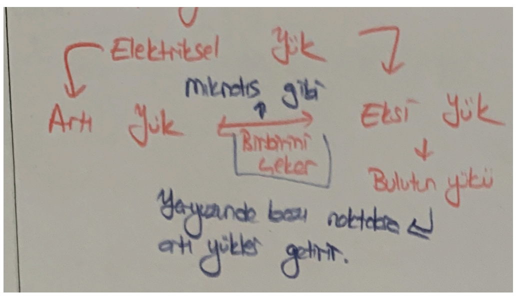
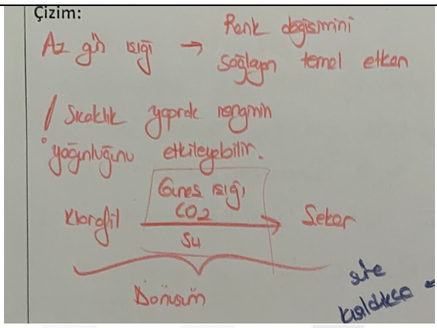
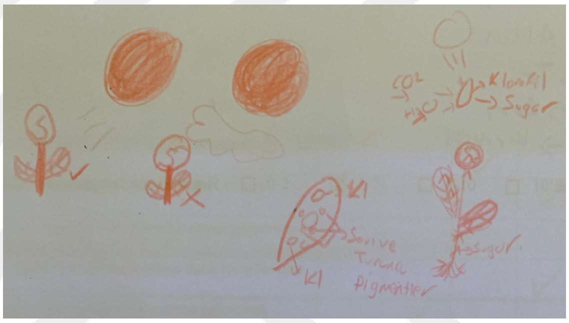
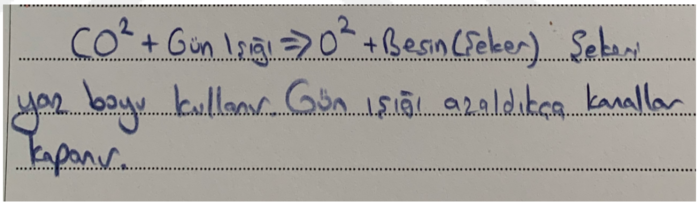
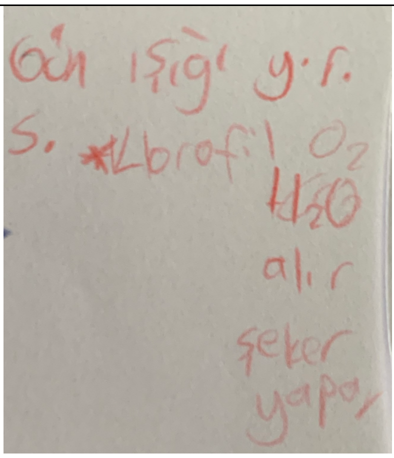
Categories	Percentage (%)	Example Response
Using signs and symbols	93	• Charge of Cloud - Charge of Ground +  When they come together, thunderbolt is formed.  
Organizing writing	18	

Table 6. 78. Cognitive strategies used by students while taking notes about a science video (cont.)

Categories	Percentage (%)	Example Response
Showing longer processes in simpler forms	14	  
Using abbreviations	10	

6.4 Analysis of Quantitative Data

6.4.1. Analysis of Correlations between Students' Metacognitive Awareness and Knowledge about Video Content

As stated in the literature, metacognitive skills have impact on student's learning processes. In the present study, correlation between metacognition and learning was tested by analyzing change in students' knowledge about a specific topic. Research Question regarding the above analysis is stated below.

Research Question 2: Is there any statistically significant correlation between students' metacognitive awareness and post-test scores for Video Content Questionnaire while controlling for their pre-test scores?

To test the correlation, following procedure is applied. Students have watched two videos about two different scientific phenomena and while they were watching the videos, they took notes or just watch to understand the video content. Before, watching the video they were given a questionnaire which includes questions to assess their knowledge about the present video content. After watching the videos, they were given the same the same questionnaire as a post-test. Then, students' responses were open coded and their responses were scored according to Rubrics which were developed by the researcher (see Appx. K and Appx. L). By that way, all students had pre-test and post-test scores regarding each video content. All students were applied Metacognitive Awareness Inventory and their total score is obtained regarding their metacognitive awareness. Then, a correlation test has been applied to test if there is a correlation between their metacognitive awareness levels and post-test scores by controlling their pre-test scores.

6.4.1.1. Analysis of Correlation between Metacognitive Awareness and Post-Test Scores about Leaves

To investigate the correlation between students' metacognitive awareness and scores for questionnaire about leaves video content, first the assumptions of the parametric Pearson-correlation test is checked. The assumptions of the Pearson-correlation test are normality, homoscedasticity, linearity, paired observations and no outliers (REF). The results indicated that the post-test data for the 'leaves' questionnaire value is not normally distributed since the kurtosis value is not within the range of +2/-2. Since the normality assumption of the Pearson-correlation test is violated, the nonparametric Spearman partial correlation test was used. By using this analysis, the relationship between post-test scores for Video Content Questionnaire and metacognitive awareness is investigated while controlling for pre-test scores. As shown in Table 6.76. According to results, students' metacognitive awareness and their post test scores about leaves are not significantly correlated whilst controlling for their pre-test scores (r(29) = .26, p = .14).

Table 6. 79.Correlation analysis between metacognitive awareness and post-test scores on leaves video content knowledge

Correlations			
Controlled Variable		Metacognitive Awareness Score	Post-Test Score
Pre-Test Score	Correlation Post-Test Score	.26	1
	Sig. (2 tailed)	.14	
	Metacognitive Awareness Score	1	.26
	Sig. (2 tailed)		.14

Results showed that there is no statistically significant relationship between students' metacognitive awareness and their post test scores about leaves video content whilst controlling for their pre-test scores. (r(29) = .26, p = .14).

6.4.1.2. Analysis of Correlation between Metacognitive Awareness and Post-Test Scores about Lightning

To investigate the correlation between students' metacognitive awareness and scores from that they have got on Video Content Questionnaire about 'lightning', first the assumptions of the parametric partial correlation test is checked. The results indicate that the linearity assumption of the Pearson-correlation test is violated since post-test scores and metacognitive awareness are not linearly correlated. Thus, the nonparametric Spearman partial correlation test was used to investigate the relationship between post-test scores for lightning and metacognitive awareness while controlling pre-test scores for lightning. As shown in Table 6. 77. According to results, there were no significant correlation between metacognitive awareness and post-test scores for lightning ((r(29) = .22, p = .23).

Table 6. 80.Correlation analysis between metacognitive awareness and post-test scores on lightning video content knowledge

Correlations			
Controlled Variable		Metacognitive Awareness Score	Post-Test Score
Pre-Test Score	Correlation Post-Test Score	.22	1
	Sig. (2 tailed)	.23	
	Metacognitive Awareness Score	1	.22
	Sig. (2 tailed)		.23

6.4.2. Analysis of Difference between Self-Regulated Learning Behaviors and Increase in Content Knowledge

Research Question 3: Is there any statistically significant difference in terms of increase in students' pre and posttest video content knowledge scores for different groups of self-regulated learners?

To investigate the third research question, firstly different student groups were formed in terms of their responses they gave to each question in Self-Regulated Learning

Interview Protocol. Then, statistical analysis was performed to analyze whether these groups were significantly different from each other in terms of the increase in their content knowledge scores. Specifically, the non-parametric Kruskal-Wallis test is used since this test investigates whether there is a statistically significant difference between groups. ANOVA, the parametric version of this test, is not used because the sample size of this study is below the required sample size. Students' content knowledge score was calculated by using pre- and post- test data which is collected by Video Content Questionnaire about 'leaves' and Video Content Questionnaire about 'lightning & thunder'. To map the increase from pre-test scores to post-test scores, the difference between these tests are calculated. The analysis was made separately for each question in the two questionnaires.

6.4.2.1. Analysis for Video Content Questionnaire about Leaves

A Kruskal-Wallis test was performed to examine increase in content knowledge scores of different student groups in terms of their research resource preference. The results of the analysis indicated that there was no significant difference between students who prefer different research sources $\chi 2(6) = 2.17$, $p = 0.90$. When other questions were analyzed separately, it was seen that there was no significant difference for students' science goals ($\chi 2(3) = 4.42$, $p = 0.21$), students' ideas about school science goals ($\chi 2(3) = 1.45$, $p = 0.69$), studying science method ($\chi 2(2) = 1.42$, $p = 0.49$), strategies for doing homework ($\chi 2(4) = 1{,}90$, $p = 0.75$), strategies for exam preparation ($\chi 2(2) = 0{,}15$, $p = 0.92$), reactions to earning low grades on science exams ($\chi 2(3) = 1.03$, $p = 0.79$), strategies while struggling to understand a science concept ($\chi 2(2) = 2.23$, $p = 0.32$), strategies for evaluation of learning ($\chi 2(4) = 1.97$, $p = 0.74$), actions while learning a relatively easy concept in science ($\chi 2(6) = 4.34$, $p = 0.63$), and actions while learning a relatively difficult concept in science ($\chi 2(4) = 4.29$, $p = 0.36$).

Since, a significant difference was found in the Kruskall Wallis test for Question 5.a., Question 9, and Question 10 which are asking for students' studying schedule, planning skills before studying and behaviors when become unsuccessful on a specific topic. As there were two categories in students' responses Mann Whitney U tests were performed to examine whether there was a significant difference among students in self-regulated learning skills groups in terms of increase in their content knowledge scores.

Results showed that there was not a significant difference for different groups regarding students' science studying schedule (U=123.50, p=0.86), planning strategies before studying science (U=79,000, p=0,085) and reaction for unsuccessful studying method (U=56.00, p=0.34).

6.4.2.2. Analysis for Video Content Questionnaire about Lightning

A Kruskal-Wallis test was performed to examine the difference between student groups in terms of their research resource preference and increase in content knowledge scores. The results of the analysis indicated that there was no significant difference between students who prefer different research sources while studying, $\chi 2(6) = 5.03$, $p = 0.53$. When other questions were analyzed separately, it was seen that there was no significant difference for students' science goals ($\chi 2(3) = 1.87$, $p = 0.60$), students' ideas about school science goals ($\chi 2(3) = 3.10$, $p = 0.37$), studying science method ($\chi 2(2) = 5.94$, $p = 0.05$), strategies for doing homework ($\chi 2(4) = 1.22$, $p = 0.08$), strategies for exam preparation ($\chi 2(2) = 0.95$, $p = 0.62$), reactions to earning low grades on science exams ($\chi 2(3) = 3.73$, $p = 0.29$), strategies while struggling to understand a science concept ($\chi 2(2) = 2.04$, $p = 0.35$), strategies for evaluation of learning ($\chi 2(4) = 2.49$, $p = 0.64$), actions while learning a relatively easy concept in science ($\chi 2(6) = 6.95$, $p = 0.32$), and actions while learning a relatively difficult concept in science ($\chi 2(4) = 0.97$, $p = 0.91$).

Since, a significant difference was found in the Kruskall Wallis test for Question 5.a., Question 9, and Question 10 which are asking for students' studying schedule, planning skills before studying and behaviors when become unsuccessful on a specific topic. As there were two categories in students' responses Mann Whitney U tests were performed. to examine whether there was a significant difference among students in self-regulated learning skills groups in terms of an increase in their content knowledge scores. Results showed that there was not a significant difference for different groups regarding science studying schedule (U=108.50, p=0.45), planning strategies before studying science (U=122.50, p=0.96) and reaction for unsuccessful studying method (U=49.50, p=0.19).

6.4.3. Analysis of Difference between Self-Regulated Learning Behaviors and Metacognitive Awareness

Research Question 4: Is there any statistically significant difference in students' metacognitive awareness level for different groups of self-regulated learners?

A Kruskal-Wallis test was performed to examine the relation between metacognitive awareness and self-regulated learning skills. According to the results there was a statistically significant relationship between metacognitive awareness and students' science goals $\chi2(3) = 10.25$, $p = 0.01$), studying science method ($\chi2(2) = 11.37$, $p = 0.00$), and strategies while struggling to understand a science concept ($\chi2(2) = 9.47$, $p = 0.00$).

To further analyze the Kruskal-Wallis test for the above-mentioned variables, Post hoc comparison using Tamhane's T2 test was performed. By using this test, the groups that are significantly different in their metacognitive awareness level and the direction of the difference is calculated. The results indicate that students whose science goal is to get high scores on science exams (M=80.25, SD=2.50) were higher in their metacognitive awareness level than student who don't have a science goals (M=67.60, SD=9.22).

Similarly, results of the analysis showed that students who had a systematic way of studying, (e.g. starting with reviewing lectures then taking tests for self-evaluation and regulating study accordingly) got higher scores in metacognitive awareness scale (M=76.50, SD= 6.11), than no method group, (e.g students who do not have a systematic way of studying method) (M=65.27, SD=9.83). Also, students who were in half systematic group, (e.g. students who were not very systematically studying but only review notes) got higher scores in metacognitive awareness scale (M=75.77, SD=2.94) than no method group (M=65.27, SD=9.83).

Similarly, a post hoc comparison using Tamhane's T2 test was performed to examine difference between groups. Results showed that students who seek help from others when they are struggling to learn a science concept scored lower (M=71.31, SD=8.62) than students who make a research on various resources (M=80.60, SD=1.51).

The results of the analysis suggested that metacognitive awareness was not related to research methods preference ($\chi2(6) = 7.45$, $p = 0.28$), students' ideas about school science goals ($\chi2(3) = 4.51$, $p = 0.21$), strategies for doing homework ($\chi2(4) = 8.35$, $p = 0.07$), strategies for exam preparation ($\chi2(2) = 3.34$, $p = 0.18$), reactions to earning low grades on science exams ($\chi2(3) = 0.43$, $p = 0.93$), strategies for evaluation of learning ($\chi2(4) = 0.70$, $p = 0.95$), actions while learning a relatively easy concept in science ($\chi2(6) = 3.82$, $p = 0.70$), and actions while learning a relatively difficult concept in science ($\chi2(4) = 8.17$, $p = 0.08$).

Since, a significant difference was found in the Kruskall Wallis test for Question 5.a., Question 9, and Question 10 which are asking for students' studying schedule, planning skills before studying and behaviors when become unsuccessful on a specific topic. As there were two categories in students' responses Mann Whitney U tests were performed. According to results, students' metacognitive awareness is significantly related to students' science studying schedule (U=74.50, p=0.04) which is higher for students who regularly scheduled studying plan (Mdn=76.0) than not-regularly scheduled group (Mdn=72.0). However, there was not a significant difference for planning strategies before studying science (U=107.00, p=0.52) and reaction for unsuccessful studying method (U=63.50, p=0.62).

7. DISCUSSION AND CONCLUSION

7.1. Discussion

In this chapter, some remarkable findings of the study will be discussed by leaning on literature. In the present study, some findings are found to be consistent with previous studies in some aspects. On the other hand, it was observed that there are contrasting findings with the past studies.

7.1.1. Self-Regulated Learning Skills: Cognitive and Metacognitive Strategy Use

In this study, gifted and talented student' self-regulated learning skills were investigated. To figure out which skills they have, we invesitagted them in terms of their cognitive strategy use and metacognitive strategy use.

Research Question 1: Which skills do 7th - grade gifted students possess to carry out self-regulated learning?

a. Which cognitive strategies are used by 7th - grade gifted students while learning science from a video?
b. Which metacognitive strategies are used by 7th - grade gifted students while learning science from a video?

To assess students' cognitive and metacognitive strategy use, an interview which included 14 questions asking about their studying strategies and behaviors for science classes and in general was conducted. Questions in the interview questionnaire were not explicitly asking about students' strategies but the researcher should interpret from students' explanations.

Students' behaviors were investigated through interviews which is a self-report measure and also students' behaviors were investigated during the research procedure.

Students' real-life behaviors were taken into consideration while analyzing the responses of students to interview questions. Also, we held another interview which included questions regarding students' metacognitive knowledge and metacognitive regulation strategies. It was found that there was a consistency among these responses. That's to say, some students gave similar responses to different questions without knowing the aim of that questions which increases the validity of findings. For example, students were asked to explain their behaviors when they realized that their studying method did not work and they were unsuccessful to learn a topic (Structured Interview Questionnaire for Self-Regulated Learning, Question 10). This question assessed a student's ability to monitor and evaluate student's own learning and ability regulate his/her own learning process by regulating his/her learning strategies to reach the expected results which require metacognitive skills. The most given response to this question was that they were changing the method of studying (%33) which required an evaluation of learning and evaluation of task demands and changing the way of studying. Similar responses were obtained from different questions. For example, students were asked about their feelings and behaviors when they were faced with a difficult topic in science (Structured Interview Questionnaire for Self-Regulated Learning, Question 14). According to Flavell (1979), metacognitive strategies and skills mostly show up when the task was challenging and requires careful and highly conscious thinking. Also, in the literature it was found that motivation was essential for the use of higher level of cognitive and metacognitive strategies (Pintrich & De Groot, 1990). Responses to Question 14 were analyzed and it was found that there were some responses which shows that they change their way of studying until they are successful to learn it (e.g. "if I am faced with difficult topics, I would focus more, if not enough I would solve tests, if still not enough would ask to a teacher") when they were faced with difficult topics (see Example Responce 1).

Students were asked to evaluate their understanding regarding the videos that they already watched (Interview Questionnaire for Self-Regulated Learning- Metacognitive Factor, Question 6). This question was asked to investigate students' ability to evaluate their learning process which was accepted as higher order metacognitive skills working in the background (Veenman *et al.*, 2006). Students' responses to this question regarding both lightning and leaves videos were consisted of statements of "yes, no, not completely, there must be more information about this topic". When this question was asked by the researcher, only one student go through all over the video and repeat aloud what has been covered throughout the video content. This can be a sign for that monitoring and evaluation of cognitive processes working in the background (Flavell, 1979; Baker, 1989; Veenman, 2011; Metcalfe, 2009).

When applied strategies of our sample were analyzed, it was seen that while they were studying they were using some cognitive strategies such as rehearsal, elaboration and organizational strategies (Weinstein & Mayer, 1986). For example, some students make repetition of what was written in their notebooks which was a rehearsal strategy. Some of them stated that they were learning better when they were summarizing and paraphrasing which could be taken as elaboration strategies. Also, their responses to Interview Questionnaire for Self-Regulated Learning- Metacognitive Factor and Questionnaire for Video Content were analyzed and it was found that they were linking new information with the past knowledge, constructed images to understand video content, watching the video several times and repeat what was said in the video or repeated inside what was said in the video. All of these are examples of rehearsal and elaboration strategies. In the literature, there studies which show that using cognitive strategies increase success (Yumuşak *et al.,* 2007). Therefore, it can be concluded that our sample is successful in school science (average grade point, M=99.3) because of using elaboration and rehearsal strategies effectively.

Metacognitive skills develop throughout from infancy to adolescence to adulthood (Brown, 1987; Meijer *et al.,* 2006). Some higher order metacognitive skills such as monitoring and regulating cognition develops at higher ages. To asses students' ability to monitor and regulate cognition, they were asked to draw and explain what has been covered in the video as if they were explaining it to another person who did not know (Video Content Questionnaire, Question 1). To explain something to someone else by drawing, requires first monitoring own thinking and ideas and organize them according to cognition of that person. Therefore, explaining what you know to someone else requires higher-order metacognitive skills such as monitoring and regulating cognition (Meijer *et al.*, 2006). In Question 1, almost all of the students drew their pictures without explaining it until they are finishing drawing. Reason for why students couldn't explain the content at the same time can be their metacognitive skills develop at higher ages.

After watching the videos about both lightning and leaves, students were asked about what would like to learn more related to these videos (Video Content Questionnaire, Question 6). For the lightning video, 21% of the students were thinking like a scientist and were curious about "how" question. They want to learn more about physical explanation about some physical concepts. Similarly, for the video about yellowing process of a leaf, 15 % of students they would like to learn more about "how and why" these biological processes happen in leaves and plants.

According to Weinstein and Mayer (1986), cognitive strategies can be divided into three major categories named as rehearsal strategies, elaboration strategies and organizational strategies. As shown by the results, student responses were including some cognitive strategies. For example, one of the students stated that she wrote again what was written in the notebook. This is a rehearsal strategy which can be taken as a repetition of the information or copying of the information (Weinstein and Mayer, 1986). Also, one student stated that he doodled when he tried to learn something as an learning stratgy for science classes . There are some studies which shows doodling increase attention and so it helps to recall information (Tayadon and Afhami, 2017) and it increases creativity and imagination (Aquino, 2013).

Students were asked about their behaviors and strategies while doing homework for their science classes (Questionnaire for SRL, Question 6). The analysis of these responses showed that students were using some cognitive strategies such as information seeking behavior (research on the internet and reviewing notes), outlining the topics to study which is an example of organizational strategy (Weinstein and Mayer, 1986), summarizing, repetition and using graphics organizers which are examples of elaboration strategies (Weinstein and Mayer, 1986). Also, it was seen that they said they applied help seeking behavior (e.g. asking help from parents, teachers or friends) which is used by self-regulated learners (Pintrich, 2000; Zimmerman and Martinez-Pons, 1988).

Students were also asked about their strategies while were being prepared for a science exam. (Questionnaire for SRL, Question 7). There were some responses including creating a coding system such as a poem or mnemonics. Another remarkable response was reviewing the graphic organizer that she created before while her daily studying activities. Using mnemonic devices (or here a poem) and using graphic organizers are efficient cognitive strategies found to be strongly related to academic performance (Hattie *et al.,* 1996). In our study, performance was not measured but student in our sample Science GPA was very high (M=99.3), which could be an evidence to higher performance.

There was another remarkable answer to the Question 6 in Questionnaire for SRL. He stated that he had been benefitting from professional presentations that were made by university academics and adapting it according to the needs of his homework (Student 7). This example is important because people use imitation of behaviors for learning and imitation can greatly hasten the process of independent learning (Miller & Dollard, 1941). Thus, his technique might have been useful to prepare an effective homework. Also, he emphasized that, he was adapted the professional presentations by considering his own level which was a sign of self-evaluation which in turn indicates metacognition (Schunk, 1996).

For Question 6, another important finding was that students' responses showed that they were aware of their own interests and motivations which is a sign of metacognitive knowledge (Crescenzi, 2016). Students expressed their strategies on doing homework by emphasizing that their strategies and motivations were changing if they the assignment was important for them.

To assess students' planning skills, they were asked about the strategies they used before starting to study science (Questionnaire for SRL, Question 9). Responses showed that some students were making time- planning before starting to study. Also, students' responses to Question 5 were confirming these responses regarding time-planning. Some students expressed that they had their science study days were in routine (e.g. every Tuesday), some students stated they put time limit so that they finished their studies until that time which is an important strategy to regulate study behavior (Pintrich, 2000).

Metacognitive knowledge requires knowing cognitive strategies that could be used to facilitate learning. Metacognitive knowledge requires not only knowing about the strategies but also knowing where and how to apply these strategies correctly. Also, metacognitive knowledge refers to one's ability to identify himself/herself in terms of cognitive processes. Thus, students with effective metacognitive knowledge skills are aware of their strengths and weaknesses. For example, they can identify the topics they have mastered or the ones that they need to improve themselves on (Stanton *et al.,* 2015) which requires monitoring and evaluating of the self.

Metacognition consists of two components namely metacognitive knowledge and metacognitive regulation. Metacognitive knowledge refers to one's knowledge about characteristics of human cognition and being aware of his/her own thinking (Stanton *et al.,* 2015). Therefore, students were asked to describe their preferred way of learning science to investigate their awareness about their own learning styles and strategies. One of the most interesting answers was that working on the invention model of a famous scientist to understand the topic by understanding his/her way of thinking (Student 7). Metacognitive regulation refers to how one controls his/her own thinking to facilitate learning (Stanton *et al.,* 2015). In this example, it was that he regulated his own behavior to increase learning outcome. He evaluatedhimself and concluded that he better learnt with modelling because he could better understand their way of thinking. Thus, he chose working on the models when he wanted to learn a scientific topic.

There was another student who stated that his preferred way of learning was talking with people who knew the topic (Int-SRL, Student 12). His responses were including social interactions such as asking to a science teacher, talking with a school counselor, asking to parents or relatives for questions about his preferred resources (Int-SRL, Question 2), strategies when he failed learning (Int-SRL, Question 10), strategies when he was stuck with a topic (Int-SRL, Question 11), and strategies while he faced with difficult topics (Int-SRL, Question 14). According to researcher's observations during the data collection procedures, he lookedlike a sociable person so interaction with others maybe more suitable for extravert students.

Students were asked about how they study science in their daily-routine (Int-SRL, Question 5). Responses showed that some students expressed their methods of studying by explaining the reason why he/she has chosen that specific method. For example, one of them stated that he was working by images because his visual memory was superior

(Student 12). This response showed that this person was aware of his capabilities and chose his study strategy according to his cognitive capability which was an indicator of metacognitive awareness (Paris and Winograd, 1999).

Also, one of them stated that her way of studying changes if there was an exam or not (Student 11) like while she was not preparing to exam she only was reading lecture notes, but if she was preparing to exam she summarized and paraphrased all topic and repeated them. This response is another indicator of metacognitive awareness because she alters her way of studying according to the needs of the task and her abilities (Paris and Winograd, 1999). Preparing to exam requires deep processing of information and reqires deep processing strategies and her strategies are appropriate for her goal (Yumuşak *et al.*, 2007).

In Question 7, students' ability to evaluate their learning was asked because if a person is metacognitively aware of his/her own learning, he/she should evaluate his/her cognitive processes (Pintrich, 2004; Zimmermann & Martinez- Pons, 1986). In the present study, studies in the literature (Pintrich, 2004; Zimmermann & Martinez- Pons, 1986) were supported with students' responses regarding evaluation of their learning by using strategies such as solving tests and control their false responses, self-evaluation for a specific discipline and the topics that they struggle etc.

A student with effective metacognitive regulation skills changes his/her studying method after earning a poor grade on an exam (Stanton *et al.,* 2015). Therefore, in Question 9 and 10 students' behaviors were investigated when they failed or had trouble in learning some topics. Responses showed that they took an initiative to change their studying habits to perform better until they succeeded. For example, students preferred to consult people and seek help from them if they failed to succeed in science which is a behavior used to regulate learning by self-regulated learners. Help-seeking behavior (teachers, parents and so on) is one of the learning strategies that self-regulated learners use (Zimmermann & Martinez- Pons, 1986).

7.1.2. SRL Skills: Goal-Orientation and Motivation

One's ability to setting goals and regulating own behaviors according to this goal is an indicator of metacognition and self-regulation (Zimmerman, 1990). Therefore, we asked questions in the interview to investigate if students in our sample set goals for themselves especially in science area. Also, their awareness about goals of school science classes were investigated by asking questions (Int-SRL, Question 4 and 4.a.).

Results of the present study showed that students' goals related to science consisted of responses regarding mastery goal-orientation (e.g. to be an expert in a science related area to have a job related to science) and performance goal orientation (e.g. getting high scores). Also, there were many students who stated that they did not have any goals or they did not know if they have any goals in science related areas.

Also, students' responses regarding school science courses homogeneous grouped into three categories such as learning the topic, getting high scores on exams and making everyone scientifically literate. Actually, there is not a consistency between school science classes. That's to say, it is not obvious that whether school science courses are designed to raise scientifically literate citizens or to teach with understanding or to make students memorize some concepts and get high scores on the exams. Therefore, we can conclude that the sample was quite successful on identifying the goals of school science courses.

Another remarkable finding was that almost half of the students gave the same answer to the questions of which part of the video took their attention most and what they would like to learn more about the topic that is covered in the video (Interview Questions About Video Content, Question 4 and Question 5). Thus, the findings showed and confirmed that students who think the task was interesting were motivated and exerted more effort on learning and mastering the task at hand as previously reported by (Yumuşak *et al.,* 2007).

Also, it was found that students in our sample mostly gave the same answer to the questions of which part of the video took their attention most and what new information they learnt from the video (Interview Questions About Video Content, Question 4 and

Question 3). The correlation between students' responses to Question 3 and Question 4 was realized by the researcher and also confirmed with the students' own statements. This finding is consistent with the ideas of Ames (1990), which proposes that there should be novelty and variety in task to create a science learning environment that facilitates self-regulated learning (see Example Responce 1).

When all the responses for students' strategies when they needed to learn easy topics and when they needed to study difficult topics (Interview Questionnaire for SRL-Question 13 and 14) considered these responses were kind of an evidence to Vygotsky' Zone of Proximal Development Theory. In the 13th question, almost all students stated that they would spend less time and effort for easy topics. Same as regular students, students in our sample felt boredom and they did not want to spend time for easy topics which was a block for learning.

Moreover, when it comes to difficult topics, almost all students stated that they would spent more time and effort until they understand. Also, when all answers were considered it was seen that students were aware of they might feel negative emotions if the topic was so hard, but they still could apply some different strategies to cope with this problem. This showed that they were willing to be successful on learning of difficult concepts and they could adapt themselves and environmental conditions according to the needs of the task which was a sign of self-regulated learning. These three categories are the examples of subcategories for self-regulated learning. All of these answers examples of applying cognitive, metacognitive and motivational strategies to regulate learning (Pintrich, 2000).

7.1.3. Note-Taking Strategies

Students' note-taking strategies were investigated and it was found that they were applying some strategies similar to suggested strategies by Cornell's Note-taking System, too (Pauk & Owens, 2010). For example, using some abbreviations, underlining or putting question marks for the parts that need to take attention are suggested ways of taking-notes.

Some studies show graphic organizers increase students' understanding and performance (Robinson & Kiewra, 1995; Robinson *et al.*, 2006). However, in students' Study Worksheets, there were only few students who created a graphic-organizers and they were not so detailed. One reason could be because the content may not be suitable for this format. The second reason could be that students did not have enough time to review their notes and construct a summary of what they have learned in total or they may not know how to do it because they did not have experience on how to do it. Third reason could be that taking-notes while learning from a multimedia source imposes high cognitive load which hardens encoding information and generate information (Jiang *et al.*, 2018). For all these reasons, there could be still more students benefitting from organizing information in the form of graphic organizers such as flowcharts or concept maps. Or, these students just didn't need it because they are gifted and they do some cognitive processes very automatically so that they did not need any strategies.

7.2. Limitations

During the data collection, students were given two questionnaires as pre- and post- tests which required them to focus and write all of their ideas. However, some students might have got bored with the procedure and did not want to answer all of 18 questions, a total of 36 questions in the Pre-Test and Post-Test. Thus, some of them might have given inattentive responses to questionnaires which might have led to loss of some of the important data.

In some questions, students had to write all of what they knew about the content. However, they did not want to spend so much time to this study so they weren't given all the details that about the topics that were asked to them. Thus, this made it difficult to compare their knowledge before and after watching the video and caused loss of information regarding our sample.

Cognitive and metacognitive processes are difficult to assess and measure because some of these processes happen automatically and people mostly are not aware of what they are thinking all the time. Therefore, researcher should make some interpretations by observing and analyzing the behaviors of students which probably lead to misinterpretations or suspicious information.

Students' study skills and study habits were investigated by interview questions which is a type of self-report measure. Therefore, we can't be sure that if the student acted as he/she stated during interview in real-life and under special circumstances. Also, questions about metacogntition creates cognitive load on students which may lead to loss of information.

Students in the sample were attending various schools and had different teachers. Therefore, there might have an impact of the culture of the school and behaviors of teachers on the students. This effect couldn't be measured by the researcher.

7.3. Suggestions

7.3.1. Suggestions for educators

As our findings supported that gifted students are more interested in the topics that they did not have knowledge and wanted to make search on the topics that were new to them. Teachers working with gifted and talented students should provide novelty and variety in tasks. Moreover, tasks should provide students "with an optimal level of challenge, to help students set short-term goals and focus on the meaningful aspects of activities" (Ames, 1992).

Also, findings showed that these students prefered to ask to their teachers when they had trouble with learning science or in general. Therefore, teachers should educate themselves and be ready for different questions that the students could ask.

Most students stated that they used internet to make a search about a topic that they want to learn. Therefore, teachers should provide them various useful resources so that they could make search on reliable sources. Also, students should definitely be warned to compare and contrast different sources to reach reliable information. In the study, some students emphasized that they checked information from different sources which is the right way of doing a search.

Literature shows that metacognitive strategies are not completely task-specific so transfer of use of metacognitive strategies to different tasks and disciplines can be possible (Meijer *et al.,* 2006). Therefore, teachers can inform both gifted and non-gifted students about different studying strategies and techniques. For example, one student (Student 7) stated that he made use of professional presentations while preparing project assignments which could be very helpful for many students to synthesize their ideas easily. Teachers couldmention these types of techniques when they assign a project for the first time. Also, the same student stated that he benefited from the website of Ankara University Kreiken Observatory to find presentations. Most students at that age are not be able to find these kinds of resources so teachers should lead them to find these types of useful websites.

Since gifted students' academic achievement is high and they do cognitive processes very automatically, teachers should be careful on teaching gifted students about metacognitive processes and skills to improve their metacognitive knowledge. It may cause a drawback for students by increasing cognitive load.

7.3.2. Suggestions for Researchers

In the present study, gifted students were investigated very deeply in terms of their cognitive and metacogntive strategies they apply while they are learning a science concept from video clips. Also, interviews have been made with these students to get information about their stated strategies. However, to be able to speak abput exact results, the researcher should confirm that these students are really gifted. Otherwise, our results won't cover the investigation of gifted students.

Also, to understand gifted students better same study can be replicated with regular students. Since then, we can make a comparison between non-gifted and gifted students and understand which strategies are specific to only gifted students.

Same study can be replicated by asking students to choose the videos that they are interested in and results can be compared to see the effect of task-interest. A more complicated task could be chosen to increase use of metacognitive strategies by students (Flavell, 1979).

Since, self-report data can be inaccurate, a longitudinal study can be done by investigating students’ study habits in their actual environments such as in the classes or by using and Learning Management System.

Also, as we know SRL strategies can be learned from social environment. Therefore, SRL strategies of their teachers can be investigated to figure out to find out if there is a correlation between behaviors of students and their teachers.

REFERENCES

Alexander, J. M., Carr, M., and Schwanenflugel, P. J., “Development of metacognition in gifted children: Directions for future research”, Developmental Review, 15, 1-37, 1995.

Alexander, J. M., and Schwanenflugel, P. J., “Strategy regulation: The role of intelligence, metacognitive attributions, and knowledge base”, Developmental Psychology, 30, 709-723, 1994.

Ames, C., “Classrooms: Goals, structures, and student motivation”, Journal of Educational Psychology, 84, 261-271, 1992.

Alemdar A., Bilişüstü beceri eğitiminin fen bilgisi öğrencilerinin başarılarına, kavram kazanımlarına, kavramlarının sürekliliğine ve transferine etkisi, Unpublished Ph. D., Marmara University, İstanbul, 2009.

Alexander, J., Carr, M., & Schwanenflugel, M., “Development of metacognition in gifted children: Directions for future research”, Developmental Review, 15, 1–37, 1995.

Allon, M., Gutkin, T., & Bruning, B. “The relation between metacognition and intelligence in normal adolescents: Some tentative but surprising findings”, Psychology in the Schools, 31, 93–97, 1994.

Azevedo, R., Greene, J., and Moos, D., "The effect of a human agent’s external regulation upon college students’ hypermedia learning", Metacognition and learning, 2, 67-87, 2007.

Bandura, A., "Social cognitive theory of self-regulation", Organizational Behavior and Human Decision Process, 50, 248-287, 1991.

Bereiter, C., and Scardamalia, M., "An attainable version of high literacy: Approaches to teaching higher-order skills in reading and writing", Curriculum Inquiry, 17(1), 9-30 1987.

Boekaerts, M., "Self-regulated learning at the junction of cognition and motivation", European psychologist, 1(2), 100-112, 1996.

Boekaerts, M., "Self-regulated learning: Where we are today", International Journal of Educational Research, 31(6), 445-457, 1999.

Boekaerts, M., and Niemivirta, M., "Self-regulated learning: Finding a balance between learning goals and ego-protective goals", In M. Boekaerts, P. R. Pintrich, and M.

Zeidner (Eds.), Handbook of self-regulation (Chap. 13), San Diego, CA: Academic Press, 2000.

Borkowski, J. G., Carr, M., and Pressley, M., "'Spontaneous' strategy use: perspectives from metacognitive theory", Intelligence, 11, 61-75, 1987.

Brinck, I., and Liljenfors, R., "The Developmental Origin of Metacognition", Infant and Child Development, 22, 85–101, 2013.

Brown, A. L., "Theories of memory and the problems of development: Activity, growth, and knowledge", Center for the Study of Reading Technical Report; no. 051, 1977.

Brown, A. L., Bransford, J. D., Ferrara, R. A., and Campione, J. C., "Learning, Remembering, and Understanding", Center for the Study of Reading. Washington D.C.: The National Institute of Education, 1982.

Butler, D. L., and Winne, P. H., "Feedback and self-regulated learning: A theoretical synthesis", Review of Educational Research, 65(3), 245-281, 1995.

18. Cattell, R., B Mankind, " The Relevance of Fluid and Crystallized Intelligence Concepts to Nature – Nurture Investigation", Mankind Quarterly, Periodicals Archive Online, 32(4), 359, 1992.

Davidson, J. E., and Sternberg, R. J., "What is insight?", Educational Horizons, 64(4), 177-179, 1986.

Demetriou, A., "Organization and development of self-understanding and self-regulation: Toward a general theory", 2000.

Dinsmore, D. L., Alexander, P. A., and Loughlin, S. M., "Focusing the conceptual lens on metacognition, self-regulation, and self-regulated learning", Educ Psychol Rev, 20, 391–409, 2008.

Duncan, T. G., and McKeachie, W. J., "The making of the motivated strategies for learning questionnaire", Educational psychologist, 40(2), 117-128, 2005.

Efklides, A.,"Metacognition and affect: What can metacognitive experiences tell us about the learning process?”, Educational Research Review, 1 (1), 3–14, 2006.

Eilam, B., and Reiter, S., "Long-Term Self-Regulation of Biology Learning Using Standard Junior High School Science Curriculum", Science Education, 98(4), 705–737, 2014.

Flavell, J. H., "Metacognition and cognitive Monitoring: A new area of cognitive-developmental inquiry", American Psychologist, 34(10), 906-911, October 1979.

Flavell, J. H., "Cognitive development", Prentice-Hall, 1985.

Flavell, J. H., "Cognitive monitoring", In P. Dickson (ed.) Children's Oral Communication Skills, New York: Academic Press, 1981a.

Flavell, J. H., and Hartman, B. M., "What children know about mental experiences", YC Young Children, 59(2), 102, March 2004.

Flavell, J. H., Green, F. L., and Flavell, E. R., "The development of children's knowledge about attentional focus", Developmental Psychology, 31, 706-12, 1995b.

Geary, D. C., and Brown, S. C., "Cognitive addition: Strategy choice and speed-of-processing differences in gifted, normal, and mathematically disabled children", Developmental Psychology, 27(3), 398-406, 1991.

Greene, J. A., Moos, D. C., Azevedo, R., and Winters, F. I., "Exploring differences between gifted and grade-level students' use of self-regulatory learning processes with hypermedia", Computer & Education, 50, 1069–1083, 2008.

Hattie, J. A., Biggs, J., and Purdie, N., "Effects of Learning Skills Interventions on Student Learning: A Meta-analysis", Review of Educational Research. 66(2), pp.99-136,1996.

Helms-Lorenz M., Jacobse, A.E., In: Meta-Cognition: A Recent Review of Research, Metacognitive skills of the gifted from a cross-cultural perspective, Nova Science Publishers, Inc., chapter 2, 3-43, 2008

İspis, O.A., Ay, Z.S.P., SAygı E., " Üstün Başarılı Öğrencilerin Öz-Düzenleyici Öğrenme Stratejileri, Matematiğe Karşı Motivasyonları ve Düşünme Stratejileri", Eğitim ve Bilim, 36 (162), 235-246, 2011.

Jansen, R., S., Lakens, D., IJsselsteijn, W., A. "An Integrative Review Of The Cognitive Costs And Benefits Of Note-Taking", Educational Research Review,22, pp 223-233, 2017.

James, W., "The principles of psychology", New York: Henry Holt, 1890.

Jiang, Y., Clarke-Midurab, J., Kellera, B., Bakerc, R., S., Paquetta, L., Ocumpaughc, J. "Note-Taking and Science Inquiry in An Open-Ended Learning Environment", Contemporary Educational Psychology, 55, pp.12-29, 2018.

Justice, E. M., and Weaver-McDougall, R. G., "Adults' knowledge about memory: Awareness and use of memory strategies across tasks", Journal of Educational Psychology, 81(2), 214, 1989.

Karakelle, S., and Saraç, S., "Çocuklar için üst bilişsel farkındalık ölçeği (ÜBFÖ-Ç) A ve B formları: Geçerlik ve güvenirlik çalışması", Türk Psikoloji Yazıları, 10(20), 87-103, 2007.

Kontaş, H., " Learning Strategies of Gifted Elementary Students", İlköğretim Online, 9(3), 1148-1158, 2010.

Leana Taşçılar, M., " Üstün Yetenekli ve Normal Öğrencilerin Planlama Becerileriyle İlgili Deneysel Bir Araştırma", Turkish Journal of Giftedness and Education, 6 (2), 55-70, 2016.

McInerney, D. M., Cheng, R. W., Mok, M. M. C., and Lam, A. K. H., "Academic self-concept and learning strategies: Direction of effect on student academic achievement", Journal of Advanced Academics, 23, 248–269, 2012.

Miller, N E., & Dollard, J., Social Learning and Imitation, US: Yale University Press, New Haven CT, 1941.

Neber, H., and Schommer-Aikins, M., "Self-regulated Science Learning with Highly Gifted Students: The role of cognitive, motivational, epistemological, and environmental variables", High Ability Studies, 13(1), 59-74, 2002.

Obergriesser, S., and Stoeger, H., "The influence of emotions and learning preferences on learning strategy use before transition into high-achiever track secondary school", High Ability Studies, 27(1), 5-38, 2016.

Paris, S. G., Lipson, M. Y., and Wixson, K. K., "Becoming a strategic reader", Contemporary Educational PSychology, 8, 293-316, 1983.

Paris, S. G., and Winograd, P., "Promoting metacognition and motivation of exceptional children", Remedial and Special Education, 11(6), 7-15, 1990.

Paris, S. G., and Winograd, P., "The role of self-regulated learning in contextual teaching: Principals and practices for teacher preparation", U.S. Department of Education. Washington, DC.: Office of Educational Research and Improvement (ED), 2003.

Paris, S. G., and Winograd, P., "The role of self-regulated learning in contextual teaching: Principles and practices for teacher preparation", Contextual teaching and learning: Preparing teachers to enhance student success in the workplace and beyond, Information Series No. 376, 1999.

Pekrun, R., Goetz, T., Titz, W., and Perry, R. P., "Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research", Educational Psychologist, 37, 91–105, 2002.

Pintrich, P. R., "The role of goal orientation in self-regulated learning", In Boekaerts, 2000.
M., Pintrich, P. R., and Zeidner, M., Handbook of self-regulation, San Diego, CA: Academic Press, pp. 451–502, 2000.

Pintrich, P. R., "Multiple goals, multiple pathways: The role of goal orientation in learning and achievement", Journal of educational psychology, 92(3), 544, 2000b.

Pintrich, P. R., "The role of metacognitive knowledge in learning, teaching, and assessing", Theory into Practice, 41(4), 219-225, 2002.

Pintrich, P. R., and de Groot, E. V., "Motivational and self-regulated learning components of classroom academic performance", Journal of Educational Psychology, 82, 33–40, 1990.

Pintrich, P. R., and Schrauben, B., "Students' motivational beliefs and their cognitive engagement in classroom academic tasks", Student perceptions in the classroom, 7, 149-183, 1992.

Pintrich, P. R., and Zeidner, M. (eds.), Handbook of self-regulation, San Diego, CA: Academic Press, pp. 451–502.

Pintrich, P. R., "A conceptual framework for assessing motivation and self-regulated learning in college students", Educational psychology review, 16(4), 385-407, 2004.

Premack, D., and Woodruff, G., "Does a chimpanzee have a theory of mind", Behavioral and Brain Sciences, 1(4), 515 - 526, 1978.

Prins, F. J., Veenman, M. V. J., and Elshout, J. J., "The impact of intellectual ability and metacognition on learning: New support for the threshold of problematicity theory", Learning and Instruction, 16, 374–387, 2006.

Reeve, R. A., and Brown, A. L., "Metacognition Reconsidered: Implications for Intervention Research", 1984.

Rickey, D., and Stacy, A. M., "The role of metacognition in learning chemistry", Journal of Chemical Education, 77(7), 915–919, 2000.

Robinson, D. H., and Kiewra, K. A. (1995). "Visual Argument: Graphic Organizers Are Superior to Outlines in Improving Learning from Text", Journal of Educational Psychology, 87, pp. 455-467.

Robinson, D. H., Beth, A., Odom, S., Hsieh, Y., Vanderveen, A., and Katayama, A.D."Increasing Text Comprehension and Graphic Note Taking Using A Partial Graphic Organizer", Journal of Educational Research, 100, 2006.

Saraç, S., Önder A., Karakelle S., " Üstbiliş, Zeka ve Metinden Öğrenme Performansı Arasındaki İlişkiler ", Eğitim ve Bilim, 39 (173), 2014.

Schneider, W., and Bjorklund, D. F., "Expertise, aptitude, and strategic remembering", Child Development, 63(2), 461-473, 1992.

Schommer, M., "An emerging conceptualization of epistemological beliefs and their role in learning", Beliefs about text and instruction with text, 25, 40, 1994.

Schommer, M., "The influence of age and education on epistemological beliefs", British Journal of Educational Psychology, 68(4), 551-562, 1998.

Schraw, G., Crippen, K. J., and Hartley, K., "Promoting self-regulation in science education: metacognition as part of a broader perspective on learning", Research in Science Education, 36, 111–139, 2006.

Schraw, G., and Moshman, D., "Metacognitive theories", Educational Psychology Review, 7(4), 351–371, 1995.

Schunk, D. H., "Social cognitive theory and self-regulated learning", In Self-regulated learning and academic achievement, Springer New York, pp. 83-110, 1989.

Schunk, D. H., Self-evaluation and Self -Regulated Learning, City University of New York and Graduate School, New York, 1996.

Schunk, D. H., "Metacognition, self-regulation, and self-regulated learning: Research recommendations", Educational psychology review, 20(4), 463-467, 2008.

Shaughnessy, M. F., Veenman, M. V. J. and Kleyn-Kennedy, C. Meta-Cognition: A Recent Review of Research, Theory and Perspectives, edited by Michael F. Shaughnessy, et al., Nova Science Publishers, Inc., 2008.

Siegler, R. S., "The origins of scientific reasoning", In R. S. Siegler (Ed.), In Children's Thinking: What Develops? Erlbaum, pp. 109-49, 1978.

Snyder, K. E., Nietfeld, J. L., and Linnenbrink-Garcia, L., "Giftedness and metacognition: A short-term longitudinal investigation of metacognitive monitoring in the classroom", Gifted Child Quarterly, 55(3), 181– 193, 2011.

Sontag, C., Stoeger, H., and Harder, B., "The relationship between intelligence and the preference for self-regulated learning: A longitudinal study with fourth-graders", Talent Development & Excellence, 4(1), 1-22, 2012.

Stanton, J. D., Neider, X., N., Gallegos, I., J., and Clark, N., C., “Differences in Metacognitive Regulation in Introductory Biology Student: When Prompts Are Not Enough”, CBE-Life Sciences Education, 14, pp. 1-12, 2015.

Sternberg, R. J., "Component processes in analogical reasoning", Psychological Review, 84(4), 353, 1977.

Sternberg, R. J. Wisdom, Intelligence and Creativity Synthesized. Cambrideg: UK. Cambridge University Press, 2003).

Sternberg, R. J., "Inside Intelligence: Cognitive science enables us to go beyond intelligence tests andunderstand how the human mind solves problems", American Scientist, 74(2), 137-143, March-April 1984.

Stoeger, H., Fleischmann, S., and Obergriesser, S., "Self-regulated learning (SRL) and the gifted learner in primary school: the theoretical basis and empirical findings on a research program dedicated to ensuring that all students learn to regulate their own learning", Asia Pacific Educ. Rev., 16, 257–267, 2015.

Stoeger, H., and Sontag, C., "How gifted students learn: A literature review", Gifted Education as a lifelong challenge, Essays in honour of Franz J. Mönks, 315-336, 2012.

Stoeger, H., and Ziegler, A., "Evaluation of a classroom-based training to improve self-regulation in time management tasks during homework activities with fourth graders", Metacognition and Learning, 3, 207–230, 2008b.

Stott, A., and Hobden, P. A., "Effective learning: A case study of the learning strategies used by a gifted high achiever in learning science", Gifted Child Quarterly, 60(1), 63– 74, 2016.

Swanson, H. L., " The relationship between metacognition and problem solving in gifted children", Roeper Review, 15(1), 43-48, 1992.

Tan, K., Dawson, V., and Venville, G., "Use of cognitive organizers as a self- regulated learning strategy", Issues in Educational Research, 18(2), 183-207, 2008.

Tang, M., and Neber, H., "Motivation and self-regulated science learning in high-achieving students: differences related to nation, gender, and grade-level", High Ability Studies, 19(2), 103-116, 2008.

Tüysüz, C., " üstün yetenekli öğrencilerin problem çözme becerisine yönelik üstbiliş düzeylerinin belirlenmesi", Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 10 (21), 157-166, 2013

Veenman, M. V., "The assessment and instruction of self-regulation in computer-based environments: a discussion", Metacognition Learning, 2, 177–183, 2007.

Veenman, M. V. J., Prins, F. J., & Elshout, J. J. "Initial learning in a complex computer simulated environment: The role of metacognitive skills and intellectual ability" Computers in Human Behavior, 18, 327–342, 2002.

Veenman, M. V., and Spaans, M. A., "Relation between intellectual and metacognitive skills: Age and task differences", Learning and individual differences, 15(2), 159-176, 2005.

Veenman, M. V., Van Hout-Wolters, B. H., and Afflerbach, P., "Metacognition and learning: conceptual and methodological considerations", Metacognition Learning, 1, 3–14, 2006.

Walter, P., Owens, R., J., How to Study in Collage, 10, Wadsworth, Boston, 2010.

Weinstein, C.E., and Mayer, R.E., "The teaching of learning strategies", In M.C. Wittrock (Ed.), Handbook of research on teaching, New York: Macmillan, 3rd Ed., pp. 315-327 1986.

Welsh, M. C., Pennington, B. F., & Groisser, D. B., " A normative developmental study of executive function: A window on prefrontal function in children. Developmental Neuropsychology", 7(2), 131-149, 1991.

White, R. T., and Mitchell, I. J., "Metacognition and the quality of learning", Studies in Science Education, 23 (1), 21–37, 1994.

Wigfield, A., Klauda, S. L., and Cambria, J., "Influences on the development of academic self-regulatory processes", Handbook of self-regulation of learning and performance, 33-48, 2011.

Winne, P. H., Perry, N. E., "Measuring self-regulated learning", 2000.

Yoon, C.H., "Self-regulated learning and instructional factors in the scientific inquiry of scientifically gifted Korean middle school students", The Gifted Child Quarterly, 53(3), 203-216, 2009.

Zigler A., The actiotope model of giftedness. In R. Sternberg & J. Davidson (Eds.),

Conceptions of giftedness, Cambridge, UK: Cambridge University Press, 411-434, 2005.

Zimmerman, B. J., "A social cognitive view of self-regulated academic learning", Journal of educational psychology, 81(3), 329-339, 1989.

Zimmerman, B., "Attaining self-regulated learning: A social-cognitive perspective", In M. Boekaerts, P. Pintrich, & M. Zeidner (Eds.), Handbook of self-regulation, San Diego, CA: Academic Press, pp. 13–39, 2000.

Zimmermann, B. J., and Martinez-Pons, M., "Construct validation of a strategy model of student self-regulated learning", Journal of Educational Psychology, 80, 284-290, 1988.

Zimmerman, B. J., and Martinez-Pons, M., "Student differences in self-regulated learning: relating grade, sex, and giftedness to self-efficacy and strategy use", Journal of Educational Psychology, 82(1), 51-59, 1990.

Zimmerman, B., J., “Self-Regulated Learning and Academic Achievement: An Overview”, Journal of Educational Psychologist, 25, pp. 3-17, 1990.

Zimmerman, B. J., and Schunk, D. H., "Reflections on theories of self-regulated learning and academic achievement", Self-regulated learning and academic achievement: Theoretical perspectives, 2, 289-307, 2001.

APPENDIX A: DEMOGRAPHIC FORM

Ad-Soyad:

Yaşınız:

Cinsiyetiniz: ☐ Kız ☐ Erkek

Sınıfınız:

Okulunuz:

Geçen dönem Fen Bilgisi ders notunuz:

Kaç senedir BİLSEM'e gidiyorsunuz?

Daha önce belgesel izlediniz mi? ☐ 0-2 kez ☐ 3-7kez ☐ 8-10kez ☐ 10'dan fazla

APPENDIX B: INTERVIEW PROTOCOL FOR SELF-REGULATED LEARNING

Merhaba ......, nasılsın? Ben öğrencilerin nasıl ders çalıştıklarını araştırıyorum. Şimdi sana bu konuda birkaç soru soracağım, tamam mı?

1. Hangi alanlara ilgi duyarsın? (Eğer fen dememişse, peki fen dersleri ilgini çekiyor mu?)
2. Merak ettiğin bir konuyu öğrenmek için hangi kaynaklardan yararlanırsın?
3. Fen (bilim) konularını öğrenirken daha iyi öğrendiğini düşündüğün yollar var mı? (Hangi yolları genel olarak tercih ediyorsun? Bu şekilde daha iyi öğrendiğini düşünüyor musun? Neden?)
4. Fen alanında, ulaşmayı hedeflediğin amaçların var mı? (Sence hedeflerine ulaşabiliyor musun?)

a) Okuldaki fen derslerinde ulaşman beklenen hedefler nelerdir?

5. Fen Bilgisi dersine günü gününe çalışır mısın? Yarın fen dersin var diyelim, ne yaparsın? Nasıl çalışırsın?
6. Fen dersinden ödev verildiğinde ne yaparsın? (Cevap gelmezse, mesela araştırma ödevi gibi bir şey…)
7. Fen Bilgisi sınavına nasıl hazırlanırsın? Diyelim ki yarın sınavın var, bu gece ne yaparsın?
8. Fen sınavında düşük not alırsan ne yaparsın?
9. Fen konularını çalışmaya başlamadan önce plan yapar mısın? Nasıl bir plan yaparsın? Bu plan çalışman gereken dersin zorluk derecesine göre değişir mi?
10. Bir konuyu öğrenirken başarısız olduğunda ya da çalışma yönteminin konuyu öğrenmene yardımcı olmadığını fark ettiğinde ne yaparsın?
11. Fen konularını öğrenirken takıldığın (anlamadığın) bir şey olursa ne yaparsın?
12. Çalışmanı tamamladığın zaman öğrenip öğrenmediğini görmek için ne yaparsın
13. Fen derslerini çalışırken kolay olduğunu düşündüğün bir konuya çalışırken

    a) Ne düşünürsün?

    b) Bu konuyu öğrenmek için ne yaparsın? (Eğer cevap gelmezse: Daha az çalışırım, yine aynı şekilde çalışırım vb.)

c) Bu konu üzerinde çalışmaya ne kadar çaba harcarsın? Bu konuya ne kadar zaman harcarsın?

14. Fen derslerini çalışırken zor bir konuyla karşılaştığında

a) Ne düşünürsün? Bunu çözmek için nasıl bir yol izlersin?

b) Bu konuyu öğrenmek için ne yaparsın? (Eğer cevap gelmezse öner: Daha çok çalışırım, o konuyu atlarım ve bir daha çalışmam, yardım isterim vb.)

c) Bu konu üzerinde çalışmaya ne kadar çaba harcarsın? Bu konuya ne kadar zaman harcarsın?

APPENDIX C: INTERVIEW PROTOCOL FOR SELF-REGULATED LEARNING (METACOGNITIVE FACTOR)

1. Peki, şimdi videoyu izlerken neler yaptın onla ilgili şeyler soracağım…
2. Videoyu izlerken hiç durdurdun mu? Ne zaman durdurdun? Neden durdurmaya ihtiyaç duydun? (şu kelimeyi bilmiyordum, bu olayı bilmiyordum vs.)
3. Videoyu izlerken bilgilerin kalıcı olması için ne yaptın?
4. Videoyu 2 kere izlemek yeterli geldi mi? Neden?
5. Bu konuyla ilgili önceden ne biliyordun? Videoyu izlerken geçmiş bilgilerini kullandın mı, hatırladın mı?
6. Bu videoyu daha iyi / kolayca anlamak için ne yapmak gerekir? (3 kere dinlerim, vs)
7. Şimdi bu konuyu yeterince öğrendiğini düşünüyor musun? Neden?
8. Video yerine başka bir yöntemle bu konuyu öğrenmek ister miydin? Nasıl bir yöntemi tercih ederdin? Neden? (cevap gelmezse: kitap ya da öğretmenin anlatması, deney, oyun)

APPENDIX D: INTERVIEW PROTOCOL FOR VIDEO CONTENT - LIGHTNING

Röportaj Soruları

Video Link: https://www.youtube.com/watch?v=pEjswGZzp1Y&t=10s

1) Videoda ne anlatılıyor, çizerek anlatır mısın?

2) Anlatmadıysa;
   a. Bazen kapının kolunu tutarken hissettiğimiz acının sebebi ne olabilir?
   b. Bu durumun şimşek çakması ilişkisi nedir?

3) İzlediğin videodan daha önce bilmediğin bir şey öğrendin mi? Ne öğrendin? Açıklar mısın?
4) Videoda en çok ilgini çeken yer neresiydi?
5) Bu konuyla ilgili başka (daha fazla) ne öğrenmek istersin?
6) Aşağıdaki resimde neler görüyorsun? Öğrendiklerinle bağlantılı olarak açıklar mısın?

7) Yağmur yağarken ağaçların altına sığınılmaması önerilmektedir. Bunun sebebi ne olabilir? Yıldırım düşerse peki neden düşer? Ağacın altına özellikle neden düşer?
8) Bu etkinlikte ne öğrendiğini bir cümleyle özetler misin?

APPENDIX E: INTERVIEW PROTOCOL FOR VIDEO CONTENT - LEAVES

Röportaj Soruları

Video Link: https://www.youtube.com/watch?v=B0a6c1aiFgI&t=17s

Video izlemeden önce:

1. Ağaçların yaprakları hakkında neler biliyorsun?
2. Sonbaharda yaprakların renkleri neden değişir?

Video izledikten sonra:

1) Videoda ne anlatılıyor, çizerek anlatır mısın?
2) Anlatmadıysa;

   a. videoda bahsi geçen pigmentler hangileri, hatırlıyor musun? Bu pigmentler yaprakların renklerini nasıl değiştiriyor?

(Hatırlamazsa ipucu ver: sebze-meyvelerde yeşil kırmızı sarı gibi renkler neden var mesela, bu renkleri veren maddeler nelerdir? Hatırlarsan daha sonra söylersin, şimdilik geçelim..)

   b. Güneş ışığı yaprakları nasıl etkiler?

3) İzlediğin videodan daha önce bilmediğin bir şey öğrendin mi? Ne öğrendin? Açıklar mısın?
4) Videoda en çok ilgini çeken yer neresiydi?
5) Bu konuyla ilgili başka (daha fazla) ne öğrenmek istersin?
6) Aşağıdaki resimde neler görüyorsun? Öğrendiklerinle bağlantılı olarak açıklar mısın?

7) Sence bütün ağaçların yapraklarında renk değişimi görülür mü? Renk değişiminin görülmediği ağaç türü var mıdır?
8) Bu etkinlikte ne öğrendiğini bir cümleyle özetler misin?

APPENDIX F: QUESTIONNAIRE FOR VIDEO CONTENT – LIGHTNING AND THUNDER

Şimşek ve Gök Gürültüsü Nedir?

1. Bir doğa olayı olan şimşek çakması hakkında ne biliyorsunuz? Aşağıya yazarak ve çizerek anlatın.

Çizim: Şimşek nedir?	**Çizim: Gök Gürültüsü Nedir?**

Açıklama:
Şimşek: ………………………..…………......…………………………………….
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Gökgürültüsü: ………………………..…………......…………………………….
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2. Şimşek ve gökgürültüsü hakkında verdiğiniz bilgileri nereden öğrendiniz?

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Aşağıdaki terimler hakkında bildiklerinize en uygun seçeneği seçin.

a) Elektrik yükü

- Hiç duymadım.
- Duydum ama açıklayamam.
- Duydum şöyle açıklarım: ………………………………………………………………………………

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b) Artı yük

- Hiç duymadım.
- Duydum ama açıklayamam.
- Duydum şöyle açıklarım: ………………………………………………………………………………

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c) Eksi yük

- Hiç duymadım.
- Duydum ama açıklayamam.
- Duydum şöyle açıklarım: ………………………………………………………………………………

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d) Durgun elektrik

- ☐ Hiç duymadım.
- ☐ Duydum ama açıklayamam.

Duydum şöyle açıklarım:

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e) Elektriksel çekim

- ☐ Hiç duymadım.
- ☐ Duydum ama açıklayamam.
- ☐ Duydum şöyle açıklarım: ....

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f) Yıldırım

- ☐ Hiç duymadım.
- ☐ Duydum ama açıklayamam.
- ☐ Duydum şöyle açıklarım: ....

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APPENDIX G: QUESTIONNAIRE FOR VIDEO CONTENT – LEAVES

Sonbaharda Yapraklar Neden Sararır?

Video izlemeden önce:

1. Yapraklar hakkında ne biliyorsunuz? Aşağıya çizin ve açıklayın.

Çizim:

Açıklama:

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2. Yapraklar hakkında bildiklerinizi nereden öğrendiniz?

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Terimler
Aşağıdaki terimler hakkında bildiklerinize en uygun seçeneği seçin.

a) Yaprak dökümü
- ☐ Hiç duymadım.
- ☐ Duydum ama açıklayamam.
- ☐ Duydum şöyle açıklarım: ……………………………………………………………………………………

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b) Yaprakların renk değiştirmesi
- ☐ Hiç duymadım.
- ☐ Duydum ama açıklayamam.
- ☐ Duydum şöyle açıklarım: ……………………………………………………………………………………

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c) Fotosentez
- ☐ Hiç duymadım.
- ☐ Duydum ama açıklayamam.
- ☐ Duydum şöyle açıklarım: ……………………………………………………………………………………

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d) Klorofil
- Hiç duymadım.
- Duydum ama açıklayamam.
- Duydum şöyle açıklarım: ……………………………………………………………………………………

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e) Pigment
- Hiç duymadım.
- Duydum ama açıklayamam.
- Duydum şöyle açıklarım: ……………………………………………………………………………………

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f) İğne yapraklı bitki
- Hiç duymadım.
- Duydum ama açıklayamam.
- Duydum şöyle açıklarım: ……………………………………………………………………………………

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APPENDIX H: STUDENT WORKSHEET – LIGHTNING AND THUNDER

ŞİMŞEK VE GÖK GÜRÜLTÜSÜ ÇALIŞMA KÂĞIDI

Bir doğa olayı olan şimşek çakması ve gök gürlemesi hakkında bir video izleyeceksiniz. Aşağıya yazarak ve çizerek not almalısınız. Kâğıdın arka yüzünü kullanabilirsiniz.

Çizim:

Açıklama:

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APPENDIX I: STUDENT WORKSHEET – LEAVES

Yaprakların Sararması Çalışma Kâğıdı

Sonbaharda Yapraklar Neden Sararır?

Sonbaharda yapraklar renk değiştirir ve dökülürler. Bu değişim esnasında, yapraklarda hangi olaylar gerçekleşir? Çizin ve açıklayın. Sayfanın arka yüzünü de kullanabilirsiniz.

Çizim:

Açıklama:

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APPENDIX J: METACOGNITIVE AWARENESS SCALE FOR KIDS – B FORM

Çocuklar için Üst Bilişsel Farkındalık Ölçeği (ÜBFÖ-Ç)
B Formu

Ad- Soyad :
Sınıf :

Sevgili öğrenciler,

Aşağıda, öğrenirken neler yaptığınızı ortaya çıkarmaya yönelik 18 adet madde bulunmaktadır. Doğru ya da yanlış cevap yoktur. Lütfen maddelerin her birini dikkatle okuyarak size en uygun gelen kutucuğu işaretleyiniz. Araştırmaya katkılarınızdan dolayı teşekkür ederiz.

	Asla	Nadiren	Bazen	Sık sık	Her zaman
1) Bir şeyi anlayıp anlamadığımı bilirim.					
2) İhtiyacım olduğunda kendi kendime öğrenebilirim.					
3) Daha önce işime yaramış olan çalışma yollarını kullanmaya gayret ederim.					
4)Öğretmenin neyi öğrenmemi istediğini bilirim.					
5) Konu hakkında daha önceden bir şeyler biliyorsam daha iyi öğrenirim.					
6) Şekil ve şema çizmek bir konuyu daha iyi anlamamı sağlar.					
7) Çalışmam sona erdiğinde kendime öğrenmek istediğim konuyu öğrenip öğrenemediğimi sorarım.					
8) Bir sorunu çözmek için birçok yol düşünür, aralarından en iyi olanını seçerim.					
9) Çalışmaya başlamadan önce ne öğrenmem gerektiğini düşünürüm.					
10)Yeni bir şey öğrenirken kendi kendime ne kadar öğrenebildiğimi sorarım.					
11) Önemli bilgileri çok dikkatli dinlerim.					
12) İlgimi çeken konuları daha iyi öğrenirim.					
13) Öğrenirken zayıf yönlerim üstesinden gelmek için bana kolay gelen öğrenme yollarını kullanırım.					
14) Çalıştığım konuya bağlı olarak farklı öğrenme yollarını kullanırım.					
15) Ara sıra durup öğretmenin verdiği görevi zamanında bitirip bitiremeyeceğimi kontrol ederim.					
16) Bazen öğrenme yollarını otomatik olarak kullanırım.					
17) Öğretmenin verdiği bir işi bitirdikten sonra kendime, bu işi yapmanın daha kolay bir yolu olup olmadığını sorarım.					
18) Bir işe başlamadan önce nelerin yapılması gerektiğine karar veririm.					

APPENDIX K: RUBRIC FOR SCORING VIDEO CONTENT QUESTIONNAIRE ABOUT LEAVES

Yellowing and Pouring of Leaves

Question 1

Q: What do you know about leaves? Please write and draw.

Scoring for question 1

Score	Answers
0	• No definition • Irrelative answer • False responses
1	True explanation but it does not include neither of • Color change cycle or foliage or • Foliage and color change process in micro scale or • It does not include photosynthesis reaction
2	Includes both of the below responses • State leaves change color or state color change cycle • Includes foliage and color change process in micro scale

Scoring for question 3

Term 1: Fall of the leaves		
Answer	**Score**	**When student stated:**
I did not hear	0	
I heard but I can't explain	1	
I heard and I explain it like	2	Macro level Causes of foliage of leaves
	3	Macro level Causes of foliage of leaves Minimum 1 sub-category of Processes of Foliage and color change

Term 2: Color Change in Leaves		
Answer	**Score**	**When student stated:**
I did not hear	0	
I heard but I can't explain	1	
I heard and I explain it like	2	Only macro level observations. Besides, the causes of color change. But, do not explain it with the changes in pigments or chlorophyll level.
	3	Explain his macro observations with micro level explanations. Also, should state some Color change processes and Causes of color change.

Term 3: Photosynthesis		
Answer	**Score**	**When student stated:**
I did not hear	0	
I heard but I can't explain	1	
I heard and I explain it like	2	Not able to state photosynthesis reaction.
	3	state photosynthesis reaction with including all reactants and products

Term 4: Chlorophyll		
Answer	**Score**	**When student stated:**
I did not hear	0	
I heard but I can't explain	1	
I heard and I explain it like	2	State one or two of them: • Definition • Place • Function
	3	State at least three of them: • Definition • Place • Function • It's irreparable

Term 5: Pigment		
Answer	**Score**	**When student stated:**
I did not hear	0	
I heard but I can't explain	1	
I heard and I explain it like	2	True explanation but no details: e.g. it gives color.
	3	True explanation with details: • Places • Functions e.g. color pigments are inside the leaf and it gives color to plant

Term 6: Coniferous plants		
Answer	**Score**	**When student stated:**
I did not hear	0	
I heard but I can't explain	1	
I heard and I explain it like	2	Gives examples or mention its form
	3	State at least three of them • Gives examples • Mention its form • no foliage processes • no color change process • Secreting hormone to avoid foliage and color change • Waxy surface • Less surface area to avoid water loss

APPENDIX L: RUBRIC FOR SCORING VIDEO CONTENT QUESTIONNAIRE ABOUT LIGHTNING

Formation of Lightning and Thunder

Question 1
Q: What do you know about lightning? Please write and draw.

Scoring Table for Ligtning

Score	Answers
0	• No definition • Not include formation processes neither in macro nor micro scale • Irrelative answer • False responses
1	True but it does not include: • formation process in macro scale • formation process in micro scale • Definition of it only as sound or light
2	• Defines it as sound or light • Includes formation process in macro scale • Includes formation process in micro scale • Aware of different types of clouds or differentiate lightning and a lightning bolt

Scoring for question 3

Term 1: Electrical Charge	
Score	**Answers**
0	Not heard
1	Heard but not able to explain
2	Partially explains True explanation but does not include: • Relation to protons and electrons
3	Explanation including: • Positive and negative electrical charges and their relation to atom and sub-atomic particles namely protons and electrons

Term 2: Positive Charge	
Score	**Answers**
0	Not heard
1	Heard but not able to explain
2	Partially explained True explanation but does not include: • Positive electrical charge and its relation to atom and protons
3	Explanation including: • Its relation to atom and sub-atomic particles namely protons

Term 3: Negative Charge	
Score	**Answers**
0	Not heard
1	Heard but not able explain
2	Partially explained True explanation but does not include: • Negative electrical charge and its relation to atom and electrons
3	Explanation including: Its relation to atom and sub-atomic particles namely protons

Term 4: static Electricity	
Score	**Answers**
0	Not heard
1	Heard but not able to explain
2	Partially correct True explanation but does not include: • Its relation to atom and sub-atomic particles
3	Explanation including all of the points stated below: • Its relation to atom and sub-atomic particles • Its relation to friction • Gives daily-life examples of static electricity

Term 5: Electrical attraction	
Score	**Answers**
0	Not heard
1	Heard but not able to explain
2	Partially correct or true explanation but does not include: • Positive and negative electrical charges
3	• Its relation to atom and sub-atomic particles namely positive and negative electrical charges

Term 6: Light bolt	
Score	**Answers**
0	Not heard
1	Heard but not able explain
2	Partially explained True explanation but does not include: • Electrical charges • It is between cloud and ground or something on the ground
3	It includes all the points stated below: • Electrical charges • It occurs between the clouds

APPENDIX M: STUDENTS' ORIGINAL RESPONSES

"Yaşımızla ilgili konuysa öğretmene sorarım." Öğr 17, sf. 47, Tablo 6.5
"Ders kitaplarından" öğr 4, sf. 47, Tablo 6.5
"Araştırarak ve deney yaparak." Öğr 28, sf. 48, Tablo 6.6
"Genelde video izliyorum, merak ettiğim şeyleri video ile daha iyi öğreniyorum." Öğr 10
"Okurum." Öğr 27, sf. 48, Tablo 6.6
"Bilen birisine sorarım" Öğr 15, sf. 48, Tablo 6.6
"Hayır, yok." Öğr 19, sf. 48, Tablo 6.6
"Çalışmıyorum çünkü zaten biliyorum." Öğr 9, sf. 49, Tablo 6.7
"Salı ve perşembe günleri çalışırım." Öğr 10, sf. 49, Tablo 6.7
"1 gün sayısal, 1 gün sözel çalışırım." Öğr 11, sf. 49, Tablo 6.7
"Bilgi konusuysa etkinlikler yaparak pekiştiririm. Yorumlama konusu ise testini çözerim." Öğr 7, sf.55, Tablo 6.13
"Yapamadığım konulara daha çok çalışıyorum." Öğr 20, sf.55, Tablo 6.13
"Hangisini daha çok anlamadıysam ona yoğunlaşırım" Öğr 11, sf.55, Tablo 6.13
"Sadece şu zamanda şu konuları çalışırım şeklinde yaparım." Öğr 16, sf.55, Tablo 6.13
"Kendime bir bölüm ayırırım. Bugün buraya kadar çalışacağım derim. O bölüme kadar tüm ayrıntılarına kadar öğrenerek çalışırım. Sonra da zaten 1-2 kere tekrar edersem unutmam." Öğr 7, sf.55, Tablo 6.13
"Önce hangi konuların özetini çıkaracağıma bakıyorum. Çözeceğim testleri önceden test kitabıma işaretliyorum." Öğr 2, sf.55, Tablo 6.13
"Deney yaparak daha iyi öğrendiğimi düşünüyorum. Kendimiz bir şeyi icat ederek düşünürsek başkalarının ne düşündüklerini daha rahat anlarız. Bir şey öğrenmek istiyorsam onu yaparım." Öğr 7, sf.56
"Benim görsel hafızam iyidir. O yüzden görsel şeylerde ezberlemem ve öğrenmem daha kolay olur." Öğr 12, sf.57
"Genelde video izliyorum, merak ettiğim şeyleri video ile daha iyi öğreniyorum. Öğr 10, sf.57
Mesela, bir belgesel izlerken duyduğum şeyleri unutabiliyorum ama okuduğum zaman daha iyi aklımda kalıyor." Öğr 20, sf. 57
"Daha çok test değil de… Testi sona saklarım. Aynı yazılılar gibi önce konuyu iyice öğrenip öyle test çözerim. Yani kolay konuda eğer konuyu bildiğimi düşünüyorsam direk test çözmeye başlarım." Öğr 7, sf. 58
"Mutlu hissederim. Genelde gene ders dinlerim, yine zorlanırsam test çözerim. Test çözdüğümde de olmazsa yine hocaya sorarım." Öğr 13, sf.58
"Evet, yüksek notlar almak istiyorum." Öğr 8, sf.63, Tablo 6.15
"Mühendis olmak" Öğr 7, sf.63, Tablo 6.15
"Doktor olmak" Öğr 11, sf.63, Tablo 6.15
"Fosil bilimci olmak" Öğr 19, sf.63, Tablo 6.15
"Fizikçi olmak" Öğr 28, sf.63, Tablo 6.15
"Fizik dalında Nobel Ödülü almak" Öğr 22, sf.63, Tablo 6.15
"Bir icat yapmak." Öğr 16, sf.63, Tablo 6.15

"Yok." Öğr 21, sf.63, Tablo 6.15
"Fen alanı…. Bilmiyorum" Öğr 27
"Temel bilimsel bilgileri öğrenmek" Öğr 1, sf. 63
"Doğa ve hayatla ilgili her konuda bilgi sahibi yapmak" Öğr 20, sf. 63
"İlgi alanımız olmasa bile fizik ve biyoloji hakkında bilgi edinmemizi sağlamak." Öğr 17, sf.64
"Sadece o konuyu öğrenmek" Öğr 10, sf. 64, Tablo 6.16
"Türkiye 1.si olmak, iyi fen ortalaması." Öğr 7, sf. 64, Tablo 6.16
"İnsanların tehlikeye girmemesi, günlük hayatta yardımcı olur." Öğr 28, sf. 64, Tablo 6.16
"Bilmiyorum" Öğr 4, sf. 64, Tablo 6.16
"Fende herkesin einstein olması" Öğr 29, sf. 64, Tablo 6.16
"Daha az zaman harcarım. Göz gezdiririm." Öğr 2, sf.67, Tablo 6.19
"Sıkılmış hissederim." Öğr 13, sf.67, Tablo 6.19
"Gereğinden daha az çalışmam gerektiğini düşünürüm. Konuyu anlayınca çalışmamı bitiririm." Tablo Öğr 10, sf.67, Tablo 6.19
"Yavaş giderim böyle, sindire sindire çalışırım. Ağırlık veririm böyle zorluk derecesine göre." Öğr 3, sf.68, Tablo 6.20
"Daha odaklanarak ve daha çok çalışmam gerektiğini düşünürüm." Öğr 11, sf.68, Tablo 6.20
"Elimizdeki artı ve eksi, o kısmını tam hatırlamıyorum ama hem bizim elimizde hem de kapının kolunda olduğu için birbiriyle temas edince statik elektrik oluşuyor." Öğr 20, sf.69, Tablo 6.21
"Şimşeklerin birçok türü vardır. Bu türler buluttan buluta ya da buluttan yere de olabilir. Buluttan yere olduğunda biz buna yıldırım deriz." Öğr 13, sf.69, Tablo 6.21
"Aralarında bir bağ vardır. Statik elektriğin şimşeğin bir küçük hali gibi bir şey." Öğr 32, sf.69, Tablo 6.21
"Burada hepsi soğuk hava. Şimşek gelince bunlar sıcak havaya dönüşüyor. Bunlar hareket edince tanecikleri atıyorlar. Onlar çok hızlı bir şekilde kaçınca ses oluşuyor." Öğr 31, sf.69, Tablo 6.21
"Şimşeğin, gök gürültüsünün nasıl oluştuğunu ve buna ek bununla ilgilenen mesleği açıklıyordu." Öğr 16, sf.69, Tablo 6.21
"Artı ve eksi yüklerin birbiriyle etkileşime girdiğini ve yıldırım oluşturduğunu." Öğr 4, sf.70, Tablo 6.22
"Gök gürültüsünü havadaki bulutların çarpışmasıyla oluşan ses olarak biliyordum, ama hava taneciklerinin titreşmesiyle oluşuyormuş." Öğr 27, sf.70, Tablo 6.22
"Yıldırımın bir şimşek türü olduğunu, şimşeğin farklı türleri olduğunu." Öğr 1, sf.70, Tablo 6.22
"Meteorolog. Onun tanımını yaptı. Ayrıntılı tanımlarını öğrendim" öğr 11, sf.70, Tablo 6.22
"Fazla değil zaten çoğunu biliyordum." Öğr 5, sf.70, Tablo 6.22
"(düşünüyor.) İlgimi çeken yer yok da. İşte, öğrendiğim kısımlar yani yıldırımın türleri olduğu" Öğr 1, sf.71
"Gök gürültüsü çünkü bilmediğim için" Öğr 14, sf.71

"Orada yıldırımın, şimşeğin birkaç tane daha çeşidi var demişti onları merak ettim onları öğrenmek isterim." Öğr 23, sf.72 Tablo 6.23
"Şimşekten elektrik üretilebilir mi?" Öğr 4, sf.72 Tablo 6.23
"Bir yıldırım." Öğr 4, sf. 73, Tablo 6.24
"Bulut ve yer arasında gerçekleştiği için bir yıldırım görüyorum." Öğr 3. sf. 73, Tablo 6.24
"Statik elektrik yüklenmiş. Buluttaki ve yerdeki yükler de yer değiştirerek yıldırım oluşmuş." Öğr 7, sf. 73, Tablo 6.24
"Bir defa haber görmüştüm. Adamın kafaya 2 defa yıldırım düşüyor adam ölmüyor." Öğr 5, sf. 73, Tablo 6.24
"Eğer doğru anladıysam, ağaç yine toprağa bağlı. Topraktaki yine artı yüklerden dolayı ağaçlara düşme olasılığı daha yüksek olduğu için önermiyor olabilirler." Öğr 12, sf.74, Tablo 6.25
"Hatırlayamadım." Öğr 10, sf.74, Tablo 6.25
"Yıldırım çeşitleri, şimşek çeşitleri ve gökgürültüsünü, nasıl oluştuğunu." Öğr 13, sf.74, Tablo 6.26
"Gök gürültüsü de yıldırımın havaya uyguladığı ısı nedeniyle taneciklerin sert hareketinden dolayı oluşan gürültü.", Öğr 3, sf.74, Tablo 6.26
"Şimşek bulutların arasındaki elektrik yüklerinden dolayı oluşuyor." Öğr 3, sf.74, Tablo 6.26
"Yaprakların sararmasının ve dökülmesinin nedenleri." Öğr 26, sf.75, Tablo 6.27
"Yapraklarda bulunan, klorofille gün ışığıla ve karbondioksit ve oksijenle besin üretiyor.", Öğr 27, sf.75, Tablo 6.27
"Sonbaharda ağaçların içinde bulunan nörofil pigmentinin su kanallarının daralması yüzünden solarak diğer pigmentlerin ortaya çıkması ve sonbaharda yaprakların dökülmesini sağlayan bir hormonun aktive edilmesi." Öğr 8, sf.75, Tablo 6.27
"Yaprakların besin üretmesinde etkili. Gün ışığı görme süresi azaldığında da yavaş yavaş kuruyorlar." Öğr 2, sf.75, Tablo 6.27
"İğne yapraklıların donma seviyesinde donmaya karşı bir asit içerdiklerini ve o asit sayesinde renklerini koruduklarını ve bu şekilde su tasarrufu yaptıklarını." Öğr 9, sf.75, Tablo 6.27
"Şimdi, güneş ışığı, soğuk gibi etkenler yaprakların sararmasında etkili. Ama en fazla gün ışığı önemli." Öğr 29, sf.76, Tablo 6.28
"Yapraklara eğer yeterli miktarda güneş ışığı gelmezse köklere ve dallara giden kanallar kapanacağından dolayı dökülmeye başlarlar." Öğr 13, sf.76, Tablo 6.28
"…Hiçbir şey bilmiyormuşum meğer…" Öğr 9, sf.76, Tablo 6.28
"Yapraklarda bulunan, klorofille gün ışığı ile ve karbondioksit ve oksijenle besin üretiyor." Öğr 27, sf.76, Tablo 6.29
"Yaprakların renk değişimi ve dökülmesi." Öğr 32, sf.76, Tablo 6.29
"İstemem pek kullanacağımı zannetmiyorum." Öğr 9, sf.77, Tablo 6.30
"Yaprakların neden daha farklı renklere dönüşmediğini. Mesela neden mavi renk olmuyor?" Öğr 19, sf.77, Tablo 6.30

"Galiba ağaç türlerini öğrenmek isteyebilirdim... Şu sarı yapraklı ağaç türleri şunlar şunlardır, kırmızı yapraklı ağaç türleri şunlar şunlardır… diye öğrenebilirdim belki." Öğr 12, sf.77, Tablo 6.30
"Videoda AVP mi ATP mi ne denen bir şey geçiyordu. Onu merak ediyorum. Nedir o?" Öğr 22, sf.77, Tablo 6.30
"İsterim de tam bilmiyorum" Öğr 6, sf.77, Tablo 6.30
"Genelde ağaçların renkleri değişmiş ve yaprakları dökülmeye başlamış. En öndeki şey, çam ağacının yapraklarının rengi değişmemiş dökülmemişler, orada duruyor." Öğr 13, sf.78, Tablo 6.31
"Hepsinin aynı renkte olması lazım hepsi aynı gün ışığı çatısında değil mi?" Öğr 18, sf.78, Tablo 6.31
"Pigmentlerle alakalı. Farklı ağaçlarda şey olmuş. Mesela şu kırmızı olanlarda içinde daha çok şeker kalmış. Ya da türüne göre de değişebiliyor." Öğr 31, sf.78, Tablo 6.31
"…Bir de kaktüslerin iğneleri çam ağaçların yapraklarına benziyor…" Öğr 1, sf.78, Tablo 6.32
"Kaktüsler de renk değiştirmiyor." Öğr 1, sf.78, Tablo 6.32
"Ağaçlar yapraklarla bağlantıyı keser yeterli besin üretmediğinde." Öğr 14, sf.79, Tablo 6.33
Sonbaharda yaprakların renk değiştirdiğini ve döküldüğünü, ama iğne yaprakların dökülmediğini." Öğr 8, sf.79, Tablo 6.33
"Az gün ışığının renk değiştirdiğine sebep olduğunu." Öğr 3, sf.79, Tablo 6.33
"Baya bir şey öğrendim o cümleyi kuramam ama ğaçlar güzeldir." Öğr 9, sf.79, Tablo 6.33