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Cognitive and metacognitive strategies of 6th-grade students to answer multiple-choice questions on "human body systems"

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Abstract

This study aims to scrutinise the cognitive and metacognitive strategies of the 6th-grade students while answering multiple-choice questions on "Human Body Systems" within the domain of their Biology course. In determining these strategies, the characteristics of multiple-choice questions (figures, graphs, explanations, etc.) were also considered. Participants of the study included three 6th-grade students, who were studying in a private school located in the province of Kars. The study was designed as a qualitative "case study". In the selection of the participants, purposive sampling method was adopted in that; the Science teachers' opinion was considered and the students whose overall grade point averages were "Very Good" became eligible. The data were collected during the implementation phase via multiple choice quizzes, video recordings, and semi-structured interviews. For the data analysis, the computer programs for qualitative data analysis were used. The results showed that, the participant students used a diverse range of cognitive strategies such as visualizing, expressing in their own words, analyzing figures, and comparing the given alternative options to answer the multiple-choice questions. Additionally, they also made use of such metacognitive strategies as re-examining the answer, underlining or circling the clues, marking the explanations in the text of the question, and eliminating the incorrect options. The features of the items (figures, graphics, explanations, etc.) were other factors affecting the use of cognitive and metacognitive strategies.

Keywords: Cognitive and metacognitive strategies; "Human Body Systems" unit; multiple-choice test; biology questions

1. Introduction

Kuhn (2000), in her work titled "Development of Metacognition", made recommendations for future research by evaluating the developments since the emergence of metacognition with Flavell in 1979. Kuhn (2000) stated that metacognition

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has theoretical and practical foundations and plays a strategic role in managing knowledge and learning processes. Moreover, she stated that individuals regulate their knowledge acquisition processes and beliefs by metacognition which plays a facilitating role in achieving mental goals. According to Güss & Wiley (2007), metacognition is the observation of one's thinking, and a key cognitive ability that allows individuals to influence and restructure their thinking processes. Georghiades (2004) defined metacognition as "individuals' knowledge about their cognition", or "thinking about one's thinking". Metacognition is the awareness which, learners have about their general academic strengths and weaknesses, cognitive resources they can apply to meet the demands of particular tasks, and their knowledge about how to regulate engagement in tasks to optimize learning processes and outcomes (Winne & Perry, 2000). According to Beeth & Anderson (2009), metacognition is metacognitive information and processes about one's problem-solving strategies, monitoring, and implementation of these strategies. Some researchers (Chi, 1987; Flavell, 1979; Nelson, 1996; Schraw & Moshman, 1995) classified the metacognition to provide a common perspective, to facilitate the definition and interpretation. In one of these classifications, Schraw & Moshman (1995) describe the subtypes of metacognition as "declarative knowledge", "procedural knowledge", and "conditional knowledge". Declarative knowledge includes knowledge about oneself as a learner and about what factors influence one's performance. For example, knowing whether the individual can establish a proportion ratio. Procedural knowledge refers to knowledge about the execution of procedural skills. Individuals with a high degree of procedural knowledge use skills more automatically, are more likely to sequence strategies effectively, and use qualitatively different strategies to solve problems. For example, knowing the necessity of using formula when solving a density problem. Conditional knowledge refers to knowing when and why to apply various cognitive actions. It may be thought of as declarative knowledge about the relative utility of cognitive procedures (Schraw & Moshman, 1995). According to Garner (1987), metacognitive knowledge forms the basis of metacognitive experiences which controls the use of cognitive and metacognitive strategies. Flavell (1979), states that metacognitive experiences activate cognitive and metacognitive strategies. For example, if a student feels that he does not have enough information to pass the exam, this is a metacognitive experience. For this reason, if the student reads the chapter once again, this is a cognitive strategy. If the student asking himself questions from related chapters and checks if he can answer these questions to understand whether he is ready for the exam, this is a metacognitive strategy (Flavell, 1979). Students use cognitive and metacognitive strategies mostly in problem-solving processes (Diken & Yürük, 2019). A considerable amount of literature has been conducted to identify the strategies that affect students' problem-solving processes in the field of science learning (Adelson 1984; Anderson, Greeno, Kline & Neves, 1981; Chi, Feltovich & Glaser, 1981; Clement, 1991; Dhillon, 1998; Finegold & Mass 1985; Gentner & Stevens, 2014; Hegarty, Mayer & Monk,

1995; Malone, 2006; McDermott & Larkin, 1978; Priest & Linsay, 1992; Reif & Allen, 1992; Savelsbergh, de Jong & Ferguson-Hessler, 1986; Simon & Simon, 1978; Sigh, 2002; Tuminaro & Redish, 2007). In some of these studies, performances of successful and unsuccessful problem solvers were compared (Gick, 1986; Savelsbergh, de Jong & Ferguson-Hessler, 1996). These studies had determined that successful problem solvers used a large number and diverse range of strategies while the unsuccessful problem solvers used very few and similar types of strategies. Numerous studies conducted to determine and to define the cognitive strategies used by students in problem-solving (Antonietti, Ignazi & Perego, 2000; Ayres, 1993; Charles, Lester & O' Daffer, 1987; Chi, Bassok, Lewis, Reimann & Glaser, 1989; Chi, Feltovich & Glaser, 1981; Chi, Glaser & Rees, 1982; Çalışkan, Selçuk Sezgin & Erol, 2006; Hammouri, 2003; Seçil Özkaya, 2000; Diken, 2014, Diken & Yürük, 2019; Ferguson-Hessler, 1990; Heyworth, 1999; Karaçam, 2009; Karataş & Güven, 2003; Kramers-Pals, Lambrechts & Wolff, 1983; Kumlu, 2012; Larkin & Reif, 1979; Larkin, 1980; Larkin, 1981; Larkin, 1983; Malloy, 1994; McDermott & Larkin, 1978; Owen & Sweller, 1985; Posamentier & Krulik, 1998; Reif, 1981; Simon & Simon, 1978; Simon, 1978; Smith & Goodman, 1984; Savelsbergh, de Jong & Ferguson-Hessler, 1986; Sweller, 1988; Tutar, Demir & Diken, 2020). Some researchers (Diken, 2014; Diken & Yürük; 2019; Goos, Galbraith & Renshaw, 2000; Karaçam, 2009; Kumlu, 2012, Montague, 1992; Tutar, Demir & Diken, 2020; Victor, 2004; Yimer & Ellerton, 2005) conducted studies to determine the metacognitive strategies used by students in problem-solving.

The most basic way to distinguish between cognitive strategies and metacognitive strategies is to look at the purpose of the strategy (Flavell, 1979). A cognitive strategy is an action that develops knowledge-oriented approach towards a cognitive purpose. Metacognitive strategy evaluates information for the metacognitive purpose by creating another metacognitive experience. Flavell (1976; 1979) and Livingstone (1997), states that cognitive and metacognitive strategies have an intertwined structure. Therefore, a strategy could be defined as cognitive or metacognitive based on its purpose of use. In other words, the key and most important indicator to determine whether a strategy is cognitive or metacognitive is the purpose of using that particular strategy. According to Flavell (1976; 1979), if a strategy is used to carry out mental processes in any part of the solution it is cognitive; if it is used to control, monitor, and evaluate the solution process it is metacognitive.

In their studies, Karaçam (2009), Diken (2014) & Tutar (2016) adopted the approach that Flavell (1976; 1979) and Livingstone (1997) applied to differentiate cognitive and metacognitive strategies. Karaçam (2009), Diken (2014), Tutar (2016) identify the metacognitive strategies as the strategies which students use to control the accuracy of their solution processes or strategies which used to check whether there are any points they missed out; cognitive strategies as the strategies which students use to carry out mental processes in the problem-solving process. Çakıroğlu (2007) stated that

metacognitive strategies ensure achieving the goal by self-questioning whether an individual understands the text; while cognitive strategies help the individual achieve a specific goal to understand a text.

In this study, cognitive and metacognitive strategies were determined which used by 6th-grade private school students who answered multiple-choice questions correctly on "Human Body Systems", whose overall grade averages were at the "Very Good" level. The characteristics of multiple-choice questions (figures, graphs, explanations, etc.) were considered while determining these strategies. Some researchers (Diken, 2014; Tutar, 2016; Diken & Yürük, 2019; Tutar, Demir & Diken, 2020) found that the number and types of cognitive and metacognitive strategies used by students to answer multiple-choice questions related to the learning areas of physics, chemistry, and biology, vary according to the characteristics of the questions. This research is thought to be important in terms of determining and teaching cognitive and metacognitive strategies that are important for students to reach the correct answers of the multiple-choice questions. It is expected that, the students will be more likely to answer the questions correctly if the qualities of the questions are taken into consideration while teaching the key strategies. Hence, Diken (2014) stated that, determining new cognitive and metacognitive strategies and introducing these new strategies to students is an important factor that enables students to reach the correct answer.

2. Method

2.1. Research Design

The study was designed as a qualitative "case study". Students were forming the cases of the study (Yıldırım & Şimşek, 2018). Therefore, the holistic multi-case study approach was adopted.

2.2. Participants Data Collection Tools

The research was carried out with the participation of three students in a private school in the centre of province of Kars. In the selection of the participants, purposive sampling method was adopted in that; the Science teachers' opinion was considered and the students whose overall grade point averages were "Very Good" became eligible. In line with the opinions of a researcher who previously worked on cognitive and metacognitive strategies, enriched data providers were selected in the context of using cognitive and metacognitive strategies while answering the multiple-choice questions. The participants remained anonymous, and they were given nicknames as "S1, S2, and S3".

Participants' school type, their overall grade point averages in the Science class, and corresponding levels are given in Table 1.

Table 1. School Type, Overall Grade Point Averages and Corresponding Levels

School Type	Nicknames of the Students	Overall Grade Point Averages	Level of Overall Grade Point Averages
Private-School	S1	96	Very Good
	S2	92	Very Good
	S3	89	Very Good

As can be seen in Table 1, Science lesson grade average scores of the participants S1, S2, and S3 were 96, 92, 89 respectively. Their overall grade point averages were at the "Very Good" level. Students' overall grade point average levels were determined according to the Regulation on Secondary Education Institutions released by the Ministry of National Education (MEB, 2019). The regulation defines the overall grade point averages of the students that range between "85-100" as "Very Good" (MEB, 2019).

2.3. Participants Data Collection Tools

Yin (2003) states that more than one data collection instrument ought to be used in qualitative research. This study employed multiple data collection instruments to conduct a reliable, consistent, and profound analysis. The data collection tools of the study are given below.

2.3.1. Quizzes: Thinking-Aloud Sessions for the Multiple-Choice Questions on "Human Body Systems" Unit

Students who participated in the study were asked to answer four multiple-choice questions related to four learning areas (circulatory system, respiratory system, digestive system, and excretory system) of the "Human Body Systems" unit. When choosing the multiple-choice questions, we gathered with a science teacher, who had a seven-year experience in the field and taught science to sixth grade students, and examined multiple-choice questions in the High School Transfer Exam (HSTE) prep books. In line with the opinions of a senior science teacher and an experienced researcher who has conducted many studies on cognitive and metacognitive strategies, four multiple-choice questions were selected since they had the potential to enable students to use a higher number of different strategies.

"Human Body Systems" unit was selected due to the significant number of learning outcomes and high probability of being asked in the "Transition to High School Exams (THSE). To determine whether there are any scientific errors, selected questions were examined by a faculty member who is an expert in biology learning. We made corrections in line with the assistant professor's views. Thus we paid a particular attention so that the questions would not contain scientific errors and misconceptions and utilized relevant

studies in the literature concerning this subject (Yilmaz et. al., 2017; Yilmaz et. al., 2017; Yilmaz et. al., 2018).

The order in which questions were asked, level of grade, related course, unit, learning area, and the number of learning outcomes of the units regarding multiple-choice questions on "Human Body Systems" are given in Table 2.

Table 2. Course, Level of Grade, Unit, Learning Area, and Number of Learning Outcomes of the Units Regarding Multiple-Choice Questions

Questions	Course	Level of Grade	Unit	Learning Area	Number of Learning Outcomes of the Unit
Question 1	Biology	6th-grade	Human Body Systems	Circulatory System	11
Question 2	Biology	6th-grade	Human Body Systems	Respiratory System	11
Question 3	Biology	6th-grade	Human Body Systems	Digestive System	11
Question 4	Biology	6th-grade	Human Body Systems	Excretory System	11

Table 2 shows that the multiple-choice questions were selected from the “Human Body Systems” unit. 6th-grade Biology textbook has 11 learning outcomes in “Human Body Systems” unit. From these multiple-choice questions; the first question related to the "Circulatory System" learning area, the second question related to the "Respiratory System" learning area, the third question related to "Digestive System" learning area, and the fourth question related to “Excretory System" learning area. The characteristics of these questions are as follows.

“Question 1” is related to the "Circulatory System" learning area and consists of two figures and explanations. The answer options are in the form of sentences.

“Questions 2” is related to the “Respiratory System” learning area and consist of one figure, and explanations. Explanation listed in the form of items. The answer options are in the form of a descriptive sentence.

“Question” 3 is related to the "Digestive System" learning area, the text of the question includes a description. The answer options are in the form of graphics.

“Question 4” is related to the “Excretory System" learning area, explanations are in the form of items. The answer options are in the form of graphics.

2.3.2. Video recording

Students were asked to answer the multiple-choice questions during the thinking-aloud sessions. Thinking-aloud is a protocol that determines the relationship between problem-solving performances of students and the situations that affect the problem-solving process (Van Someren, Barnard, & Sandberg, 1994). Students were provided with necessary information about the thinking-aloud session before they were asked to answer the multiple-choice questions. The students were asked to express aloud their processes of answering the multiple-choice questions. The process was video recorded. Students were warned by saying “Can you please think aloud” when they remained silent for a long time while solving the questions. Data obtained from the thinking-aloud sessions observations were used to identifying the strategies used by the students and determining whether these strategies are cognitive or metacognitive.

2.3.3. Semi-Structured Interview Form

Semi-structured interviews were conducted with three students to identify the cognitive and metacognitive strategies which they used to answer four multiple-choice questions on the “Human Body System” unit. The interviews were conducted with each student only once after a student answered a multiple-choice question. Semi-structured interview questions were formulated by the researcher. The semi-structured interview form was checked by a faculty member who had previous studies on cognitive and metacognitive strategies.

Semi-structured interview questions designed for determining the key cognitive and metacognitive strategies that students used in answering multiple-choice questions are as follows.

- What did you do to answer the question? Can you explain this process step by step?
- While answering the question you followed different approaches? (Eliminating options, underlining, circling, etc.). Why did you choose these approaches?
- What kind of benefits such approaches provided to you while answering the question (eliminating options, underlining, circling etc.).
- Are you sure that the answer is correct?
- What is your reason for making sure that the answer is correct?
- Which methods helped you answer the question?
- For what purpose and why did you use these methods?

2.3. Data Analysis

The study aimed to determine the cognitive and metacognitive strategies used by 6th-grade students for answering four multiple-choice questions on "Human Body Systems". Data obtained from observation records and semi-structured interviews were analyzed by using a computer-assisted qualitative data analysis software program. To identify whether the strategies used by students were cognitive or metacognitive, categories were specified related to data sections of the observation records of the thinking-aloud sessions and interview records.

A computer-assisted qualitative data analysis software program was used for coding. An experienced faculty member was invited for a discussion during the data coding process to prove the accuracy of the obtained data. The reliability and consistency of the data related to the type of the strategies which were defined as cognitive or metacognitive were discussed with the faculty member.

After the coding of the data completed by the researcher, a data set was also coded by a faculty member, who was assigned as a coder. As a result of the codings, the consistency between the codes was found to be %91. As this value, according to Miles and Huberman (1994) is 80% and above, it is possible to accept this study to be consistent (Arik and Yilmaz, 2017). The researcher and the experienced faculty member discuss on the inconsistent data sections and reached a consensus.

3. Findings

In this study, cognitive and metacognitive strategies were determined which used by three students to reach the correct answers of four multiple-choice questions related to “Circulatory System”, “Respiratory System”, “Digestive System” and “Excretory System” subjects of the "Human Body Systems" unit. Students were studying in the 6th grade of a private school. Their grade point average were at "Very Good" level. The findings obtained for the determination of these strategies are given in Table 3 and Table 4. In Table 3 and Table 4 participants remained anonymous, and they were given nicknames as “S1, S2, and S3”. Overall grade point average level “Very Good” has been abbreviated as “VG”. The word “correct” which means that students answered questions correctly has been abbreviated as "C". Characteristics of questions, relevant learning area, unit, subject, and the order in which questions were asked also represented in Table 3 and Table 4. “Key Cognitive” and “Cognitive Strategies” used by S1, S2, and S3 to answer multiple-choice questions related to "Circulatory System, Respiratory System, Digestive System and Excretory System" subjects on “Human Body Systems” unit are given in Table 3.

Table 3. Key Cognitive and Cognitive Strategies Used by Students to Answer Multiple Choice Questions

LEARNING AREA	BIOLOGY											
UNIT	HUMAN BODY SYSTEMS											
ORDER IN WHICH QUESTIONS WERE ASKED	Question 1			Question 2			Question 3			Question 4		
SUBJECT	Circulatory System			Respiratory System			Digestive System			Excretory System		
CHARACTERİSTİCS OF THE QUESTİONS	Containing figures and explanations			Containing figures and explanations			Containing graphics and explanations			Containing graphics and explanations		
6th-GRADE STUDENTS	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
LEVEL OF OVERALL GRADE POINT AVERAGE	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG
ANSWER	C	C	C	C	C	C	C	C	C	C	C	C
COGNITIVE STRATEGIES												
Visualizing	√	√	√	√	√	√	√	√	√	√	√	√
Starting to Read the Question from the Root	√			√			√	√	√	√	√	√
Underlining the Words While Reading	√			√			√			√	√	
Rephrasing Questions with Own Words	√	√	√	√	√	√	√	√	√	√	√	√
Self-questioning		√										
Associating the data with daily life	√		√				√	√				
Thinking over the question		√	√	√		√				√	√	√
EXAMINE												
Examine the Figures Given in the Text of the Question	√	√	√	√	√	√	√	√	√			
Examine the Graphics Given in the Text of the Question										√	√	√
COMPARISON												
Comparing the Figures Given in the Text of the Question	√	√	√									
Comparing the Answer Options with the Explanations Given in the Text of the Question				√	√	√	√	√	√	√	√	√
Comparing the Answer Options with the Figures Given in the Text of the Question	√	√	√	√	√	√	√	√	√			
Comparing the Explanations Given in the Text of the Question with the Figures				√	√	√						
Comparing the Answer Options	√	√	√	√	√	√	√	√	√	√	√	√

As can be seen in Table 3, S1, S2, and S3 were studying in a private school, their overall grade point averages were at the “Very Good (VG)” level and gave “Correct (C)” answers to all questions. Question 1 is related to the "Circulatory System" and contains figures and explanations. While answering Question 1, participants used cognitive strategies including visualizing, rephrasing questions with own words, examine the figures given in the text of the question, comparing the figures given in the text of the question, comparing the answer options with the figures given in the text of the question, and comparing the answer options. Question 2 is related to "Respiratory System" and includes figures and explanations. While answering Question 2, participants used cognitive strategies including visualizing, rephrasing questions with own words, examine the figures given in the text of the question, comparing the figures given in the text of the question, comparing the answer options with the figures given in the text of the question, and comparing the answer options. Question 3 is related to "Digestive System" and contains graphics and explanations. While answering Question 3, participants used cognitive strategies including visualizing, starting to read the question from the root, rephrasing the question with own words, examine the graphics given in the text of the question, examine the figures given in the text of the question, comparing the options with the explanations given in the text of the question, comparing the answer options with the graphics given in the text of the question, comparing the graphics with the explanations given in the text of the question, and comparing the answer options. Question 4 is related to "Excretory System" and contains figures and explanations. While answering Question 4, participants used cognitive strategies including visualizing, starting to read the question from the root, rephrasing the question with own words, examine the graphics given in the text of the question, thinking over the question, examine the figures given in the text of the question, comparing the answer options with the explanations given in the text of the question, and comparing the answer options. During the interviews all students stated that they used these cognitive strategies as a key to get the right answers.

“Key Metacognitive” and “Metacognitive Strategies” used by S1, S2, and S3 to answer multiple-choice questions related to "Circulatory System, Respiratory System, Digestive System and Excretory System" subjects are given in Table 4.

Table 4. "Key Metacognitive" and "Metacognitive Strategies" used to answer Multiple-Choice Questions

LEARNING AREA	BIOLOGY											
UNIT	HUMAN BODY SYSTEMS											
ORDER IN WHICH QUESTIONS WERE ASKED	QUESTION 1			QUESTION 2			QUESTION 3			QUESTION 4		
SUBJECT TITLE	Circulatory System			Respiratory System			Digestive System			Excretory System		
CHARACTERISTICS OF THE QUESTIONS	Containing Figures and Explanations			Containing Figures and Explanations			Containing Graphics and Explanations			Containing Graphics and Explanations		
6th-GRADE STUDENTS	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
LEVEL OF OVERALL GRADE POINT AVERAGE	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG
ANSWER	C	C	C	C	C	C	C	C	C	C	C	C
METACOGNITIVE STRATEGIES												
Re-Reading	√		√	√		√	√		√			√
Re-Checking Whether the Selected Option is Correct	√	√	√	√	√	√	√	√	√	√	√	√
Re-Reading the Clues in the Text of the Question			√			√			√			√
Underlining the Clues in the Text of the Question	√	√	√	√	√	√	√	√	√	√	√	√
Drawing Circles that Cover Clues in the Text of the Question	√	√	√	√	√	√	√	√	√	√	√	√
Taking Notes	√			√			√			√	√	
RE-EXAMINATION												
Re-examining the Figures	√	√	√	√	√	√						
Re-examining the Graphs							√	√	√	√	√	√
MARKING												
Marking the Explanations in the Text of the Question	√	√	√	√	√	√	√	√	√	√	√	√
Marking the Answer Options	√	√	√	√	√	√	√	√	√	√	√	√
ELIMINATING												
Eliminating Incorrect Answer Options	√	√	√	√	√	√	√	√	√	√	√	√

As can be seen in Table 4, S1, S2, and S3 were studying in a private school; their overall grade point averages were at the "Very Good (VG)" level and gave "Correct (C)" answer to all questions.

Question 1 is related to the "Circulatory System" and contains figures and explanations. While answering Question 1, participants used metacognitive strategies including re-checking whether the selected option is correct, underlining, circling the clues in the text of the question, re-examining the figures, marking the explanations in the text of the question, marking the answer options, eliminating incorrect answer options. Question 2 is related to "Respiratory System" and contains figures and

explanations. While answering Question 2, participants used metacognitive strategies including re-checking whether the selected option is correct, underlining, circling the clues in the text of the question, re-examining the figures, marking the explanations in the text of the question, marking the answer options, eliminating incorrect answer options. Question 3 is related to "Digestive System" and contains graphics and explanations. While answering Question 3, participants used metacognitive strategies including re-checking whether the selected option is correct, underlining, circling the clues in the text of the question, re-examining the graphics, marking the explanations in the text of the question, marking the answer options, eliminating incorrect answer options. Question 4 is related to "Excretory System" and contains figures and explanations. While answering Question 4, participants used metacognitive strategies including re-checking whether the selected option is correct, underlining, circling the clues in the text of the question, re-examining the figures, marking the explanations in the text of the question, marking the answer options, eliminating incorrect answer options. During the interviews, all students stated that they used these metacognitive strategies as a key to get the right answers.

3. Discussion

Many studies in the literature provide results supporting this view. Tutar, Demir & Diken (2020), had determined that students who gave correct answers to the multiple-choice biology questions used different cognitive strategies included visualizing, rephrasing questions with own words, note-taking, underlining the words while reading, comparing the explanations with shapes, graphs, and tables given in the question, and asking oneself questions. In their studies, O'Malley & Chamot (1990), Weir (1999), Alderman, et al. (1993), Çalışkan, Selçuk Sezgin & Erol (2006), Karaçam (2009), Diken (2014), Diken & Yürük (2019) had determined that students used the visualizing strategy while solving problems. Karataş & Güven (2003), Çalışkan, Selçuk Sezgin & Erol (2006), Karaçam (2009), Kumlu (2012), Diken (2014), Diken & Yürük (2019) has found that students use the cognitive strategy of "rephrasing the question with own words" while answering multiple choice questions or reading a text.

Diken (2014), Diken & Yürük (2019), Tutar, Demir & Diken (2020) had determined that, while answering biology multiple-choice questions, students use cognitive strategies including rephrasing the question with own words, comparing the explanations with shapes, graphs, and tables given in the question, comparing the answer options with the explanations given in the text of the question, comparing the answer options with the graphics given in the text of the question, and comparing the answer options. "Self-questioning" strategy was identified by Karaçam (2009), as "asking questions", identified by Smith & Elliot (1986) as "pre-reading questioning strategy", and identified by Weir (1999) as "text-related question creating and answering".

In their studies, Karaçam (2009), Diken (2014), Diken & Yürük (2019), Tutar, Demir & Diken (2020) had determined that students who answered biology multiple-choice questions correctly had used metacognitive strategies such as: underlining or circling the clues in the text of the question, marking the answer options, re-reading, re-examine the figures and graphics, eliminating answer options, reading by underlining words, marking the figures and graphics given in the question, marking the explanations in the text of the question, repeating important points. Çalışkan, Selçuk, Sezgin & Erol (2006), Selçuk Sezgin, Çalışkan & Erol (2007) had determined "underlining the clues" metacognitive strategy. Anastasiou & Griva (2009) determined the "underlining" metacognitive strategy. "Circling the clues in the text of the question" metacognitive strategy was determined as "framing" by Taraban (2004), as "rounding" by Kumlu (2012).

This study determined that students used a large number and diverse range of cognitive and metacognitive strategies to answer four multiple-choice questions correctly. Diken & Yürük (2019) had determined that Science High School and Anatolian High School students, whose overall grade point averages were at the "Very Good" level, and who answered questions correctly used a large number and diverse range of cognitive and metacognitive strategies. Demir, & Diken (2020) determined that while answering questions, Anatolian High School students with a high level of field knowledge used a large number and diverse range of cognitive and metacognitive strategies.

It was also determined that cognitive and metacognitive strategies, which used to answer multiple-choice questions correctly, vary according to the characteristics of the questions (figures, graphics, explanations, etc.). In her study, Diken (2014) determined that, the numbers and types of cognitive and metacognitive strategies used by students to answer multiple-choice questions in the field of science vary according to the characteristics of the questions. Diken (2014) found that, multiple-choice questions in the field of science include features such as figures, graphics, tables, only text, or requiring numerical processing, is affecting the numbers and types of cognitive and metacognitive strategies that students use to answer these questions.

4. Conclusions

In the present study, 6th-grade private school students whose grade point averages are at the "Very Good" level were asked to answer four multiple-choice questions related to "circulatory system", "respiratory system", "digestive system" and "excretory system" subjects of the "Human Body Systems" unit. Cognitive and metacognitive strategies that are effective in answering these questions were determined.

While determining these strategies, the characteristics of multiple-choice questions (figures, graphs, explanations, etc.) were also considered. The results obtained from this research are as follows.

Question 1 is related to the "Circulatory System" and contains figures and explanations. This study had determined that, while answering Question 1, participants used cognitive strategies including visualizing, rephrasing questions with own words, examine the figures given in the text of the question, comparing the figures given in the text of the question, comparing the answer options with the figures given in the text of the question, and comparing the answer options. In addition, metacognitive strategies had determined including re-checking whether the selected option is correct, underlining, and circling the clues in the text of the question, re-examining the figures, marking the explanations in the text of the question, marking the answer options, eliminating incorrect answer options.

Question 2 is related to “Respiratory System” and contains figures and explanations. This study had determined that, while answering Question 2, participants used cognitive strategies including visualizing, rephrasing questions with own words, examine the figures given in the text of the question, comparing the figures given in the text of the question, comparing the answer options with the figures given in the text of the question, and comparing the answer options. Besides, metacognitive strategies had determined including re-checking whether the selected option is correct, underlining, circling the clues in the text of the question, re-examining the figures, marking the explanations in the text of the question, marking the answer options, eliminating incorrect answer options.

Question 3 is related to "Digestive System" and contains graphics and explanations. This study had determined that, while answering Question 3, participants used cognitive strategies including visualizing, starting to read the question from the root, rephrasing the question with own words, examine the graphics given in the text of the question, examine the figures given in the text of the question, comparing the answer options with the explanations given in the text of the question, comparing the answer options with the graphics given in the text of the question, comparing the graphics with the explanations given in the text of the question, and comparing the answer options. Also, metacognitive strategies had determined including re-checking whether the selected option is correct, underlining, circling the clues in the text of the question, re-examining the graphics, marking the explanations in the text of the question, marking the answer options, eliminating incorrect answer options.

Question 4 is related to "Excretory System" and contains figures and explanations. This study had determined that, while answering Question 4, participants used cognitive strategies including visualizing, starting to read the question from the root, rephrasing the question with own words, examine the graphics given in the text of the question, thinking over the question, examine the figures given in the text of the question, comparing the answer options with the explanations given in the text of the question, and comparing the answer options. In addition, metacognitive strategies had determined

including re-checking whether the selected option is correct, underlining, circling the clues in the text of the question, re-examining the figures, marking the explanations in the text of the question, marking the answer options, eliminating incorrect answer options.

In this study, 6th-grade private school students' cognitive and metacognitive strategies were determined which were effective in answering the questions regarding the "circulatory system", "respiratory system", "digestive system" and "excretory system" subjects of the "Human Body Systems" unit. The findings revealed that, visualizing, rephrasing the question with own words, examine the graphics given in the text of the question, and comparing the options cognitive strategies were used to answer all questions. Additionally, metacognitive strategies including re-checking whether the selected option is correct, underlining, circling the clues in the text of the question, marking the explanations in the text of the question, marking the answer options, eliminating incorrect answer options were also used to answer all questions.

Based on the results of this study, by considering the characteristics of the questions, cognitive and metacognitive strategies used to answer multiple-choice questions correctly may be taught to all middle-school students. Thus, students may find the correct answer in a shorter period of time. Additionally, all middle-school students may be aware of what cognitive and metacognitive strategies to use according to the features of the questions. Thus they may know when, where, and how they can apply these strategies. Students preparing for central exams in the multiple-choice question format, may use the cognitive and metacognitive strategies determined in this study, based on the qualities of the questions when answering multiple-choice questions in the field of biology learning. By this way it may be possible to increase the possibility for students to answer the multiple-choice biology questions correctly in central exams.

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