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Examination of Middle School Students' Learning Motivations and Metacognitive Awareness in the Context of Science Education[1]

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Abstract

In this research, which was carried out with the assumption that science lessons establish a ground for an effective learning environment for motivation and metacognitive awareness, it was aimed to examine the middle school students' motivation towards learning science and their metacognitive awareness in terms of various variables in the focus of science education and to determine the relationship between them. A total of 637 students participated in the study. The 'Science Learning Motivation Scale' was used to determine the students' science learning motivation and the 'Metacognitive Awareness Scale B Form' was used to determine their metacognitive awareness. Mann Whitney U and Kruskal Wallis tests were used to analyze the data. As a result of the analysis, it was determined that students' science learning motivation changed significantly according to gender, experimentation, participation in science projects, using science in daily life, grade level and science course grade point average. In addition, it was concluded that there were significant differences in students' metacognitive awareness according to experimentation, participation in science projects, using science in daily life and science course grade point average. Therewithal, it was determined that there was a moderately positive relationship between the middle school students' science learning motivation and their metacognitive awareness. It is seen that teachers' diversification of learning environments with methods and techniques as well as activities and materials in science lessons, which enable students to develop their science learning motivation and metacognitive awareness, will make important contributions.

INTRODUCTION

The characteristics that individuals should have are changing day by day, and in this direction, various attempts are made at times in order to ensure that the necessary target level is reached in the curriculum. Accordingly, it is seen that updates are made in Turkey in certain periods depending on the changing and developing needs in the curriculum. In 2018, the Ministry of National Education (MEB) created a curriculum that guides the use of metacognitive skills, provides meaningful and permanent learning, is associated with previous learning, and integrated with other disciplines and daily life around values, skills and competencies. Considering the recent studies, it is seen that the approaches towards raising individuals with the targeted qualifications, taking into account the dynamics of the changing

and developing age for the science lesson, as in all fields (MEB, 2013, 2017). Regarding the goal of "Educating all students as scientifically literate individuals", which is the vision of the science curriculum; to arouse students' curiosity about scientific and technological developments, to take into account scientific knowledge in order to learn and understand the natural world, to use appropriate scientific process skills in the exploration of nature and to understand its interaction with humans, to find solutions to problems, to develop curiosity, attitude and interest towards events in the environment is intended (MEB, 2013, p2).

In the fundamental philosophy of the science curriculum, it was emphasized that "...the most important power that will direct the individual to learning is the sense of curiosity…" (MEB, 2017). Since the beginning of the twenty-first century, it has been accepted by educators that one of the motivating factors in students' learning is curiosity (Halimoğlu, 2019). From this point of view, it is stated that curiosity motivates students (Edelman, 2007), and it is a prerequisite for learning (Carlin, 1999). At this point, it is emphasized that support such as motivation for learning science is important in order to ensure the continuity of students' curiosity and to educate them as science literate. (Halimoğlu, 2019).

The concept of motivation, which is one of the main factors of learning, has been defined by Schunk, Meece, and Pintrich (2013) as the force that directs the person to the behavior and ensures that the behavior is maintained by determining its severity. Abell and Lederman (2007) expressed motivation as an internal state that enables students to take action, gives direction and maintains their behavior. Explained in similar ways by many researchers (Arslan, 2021; Ertem, 2006; Yıldırım, 2007), the most prominent feature of motivation is that it makes the individual move towards certain goals and act in line with these goals (Demir & Budak, 2016). Therefore, motivation for learning has been one of the subject areas that attracted the attention and interest of educational research due to its positive educational outcomes (Uzun & Keleş, 2012).

Motivation has an important effect on providing meaningful learning, especially in fields such as science, where students have cognitive difficulties (Güvercin, Tekkaya & Sungur, 2010). On the other hand, many concepts in science lessons are difficult to understand by students, and this reduces students' motivation for the lesson. Students should be motivated to learn science concepts better, increase their success in science lessons, and develop scientific process skills (Uzun & Keleş, 2012). Student motivation to learn science is a complex concept influenced by instructional strategies, curriculum, students' individual characteristics, and teachers (Lee & Brophy, 1996). It has been stated by researchers that it is useful and important to determine students' motivation levels for learning science and the variables that affect science learning motivation (Alkan & Bahri, 2017; Buehl; 2003; İnel Ekici, Kaya & Mutlu, 2014; Karakaya, Yılmaz & Avgın, 2018; Molden & Dweck, 2006; Okumuş, 2020; Tuan, Chin & Shieh, 2005; Uzun & Keleş, 2010, 2012; Wood & Kardas, 2002; Yıldırım & Karataş, 2020).

Previously, individuals were considered sufficient only when they had the knowledge, but now they are considered sufficient when they choose the meaningful one among the information, organize this information, and have sufficient knowledge of their deficiencies and competencies (Boran, 2016). For this reason, students are expected to be able to access, organize and use information in a rapidly developing and changing environment (Balcı, 2007). The concept of metacognition, which is explained as being aware of and controlling one's learning (Schraw & Dennison, 1994), comes to the fore at this point.

Flavell used the term metacognition for the first time in his study on metacognitive abilities in children in 1976 and enabled this term to enter the literature. Flavell defined metacognition as "the individual's awareness and control of his or her own cognitive processes" (Flavell, 1976). Swiderek (1996) and Schoenfeld (1987) similarly expressed the concept of metacognition as thinking about one's thoughts. Metacognition emphasizes the awareness of what an individual can do with their own thoughts and knowledge (Özsoy, 2008).

In general, the concept of metacognition means that individuals prepare a plan for realizing their learning task by keeping their learning processes under control, become aware of effective and ineffective methods in their individual learning, choose and use the appropriate method in their new learning, become aware of the positive and negative situations that occur in the learning processes and recall their old knowledge when necessary (Ormrod, 1990). It stands out that metacognition includes cognitive skills aimed at effective learning (Bruning, Schraw & Norby, 2014).

In the concept of metacognition, which appears as a thinking system, the student is an active participant who has an idea about learning by including the external environment in the learning process. At this point, being aware of his or her own cognition is an important factor in ensuring that the student is active. The concept of metacognitive awareness comes to the fore with the individual's awareness of his/her own cognition. According to Özsoy (2008), metacognitive awareness is the individual's knowledge of his/her own cognitive abilities, cognitive strategies and knowing what to do in the problem he/she faces. In this respect, skills such as the individual's ability to decide what needs to be done in a task, to prepare a plan together with the evaluation of this task in his mind, to review this plan from time to time when starting to implement the plan, and to determine and organize the missing parts can be considered as metacognitive awareness (Demir & Özmen, 2011).

It is important to organize learning environments to develop metacognitive awareness in order to raise students who use metacognitive strategies effectively and thus are aware of their own mental activities, can control their learning processes, and take responsibility for learning. The science curriculum (MEB, 2017), which aims to train individuals who question, research, make decisions with logical reasoning, think innovatively and solve problems, offers a suitable ground for students to gain metacognitive skills at this point.

One of the goals of science teaching is to enable students to use the knowledge they have learned in their daily lives. Because the ability of students to associate the information they learn with the events in daily life is an indicator of how well they make sense of the information they learn and how permanent the information is. The ability of students to carry out this process consciously is related to their ability to use their metacognitive skills. In addition, projects are the works that students carry out individually or in groups in order to find a solution to a daily life problem. In this direction, the most basic feature of a project is that the student understands the problem given to him/her, decides on the solution himself/ herself and applies this solution (Kubinova, Novotna & Littler, 1998). Thus, the student uses his/her metacognitive skills. Besides the activities carried out in the traditional classrooms, laboratory experiences also have a special place in increasing the students' metacognitive awareness during the education process. Experiments carried out in the laboratory enable the discovery of science phenomena, while realizing high-level conceptual learning (Çepni, Kaya & Küçük, 2005) and providing meaningful learning (Telli, Yıldırım, Şensoy & Yalçın, 2004; Yavru & Gürdal, 2013). In laboratory activities; it is known that in addition to experimental processes, high-level scientific process skills such as data processing, hypothesis formation, interpretation of findings and

inference are also included (Tan & Temiz, 2003). It is stated that metacognitive skills are an effective factor in the development of high-level scientific process skills (Şahin Kürşad, 2018). It is only possible for students to make sense of what they have discovered through experiments in the laboratory environment by using metacognitive skills. In this context, science teaching provides important opportunities for students to gain and develop metacognitive awareness.

Rationale of the Research

It requires a high level of science learning motivation and metacognitive awareness for students to acquire the necessary knowledge and skills to understand and explain science concepts and use them in daily life. Considering the importance and difficulty of increasing motivation and metacognitive awareness, it is necessary to investigate the factors that may affect these variables. The content and practices of science courses offer a wide variety of opportunities that can be beneficial for the development of students' motivation to learn science and their metacognitive awareness. In the literature, it is seen that students' science learning motivations and metacognitive awareness are investigated in terms of different variables. However, it has not been considered in terms of doing science experiments, participating in science projects, and using science in daily life. The research, framed by these reasons, was carried out with the assumption that various variables in the focus of science education may have an impact on students' science learning motivation and their metacognitive awareness. Accordingly, middle school students' science learning motivation and metacognitive awareness were compared in terms of various variables in the science education focus, such as doing science experiments, participating in science projects, using science in daily life, and science course grade point average, and the relationship between science learning motivation and metacognitive awareness was examined.

There are a limited number of studies in the literature examining the science learning motivation and metacognitive awareness of middle school students together. In related studies, students' science learning motivations and metacognitive awareness were mostly examined according to demographic variables such as gender, class level and socioeconomic level of the family, but no examination was found in the context of science education. In addition, the few research results reporting that there is a positive and significant relationship between students' science learning motivations and their metacognitive awareness necessitate supporting this result with new studies and contributing to its generalizability. This study was guided by the assumption that the existence of the relationship between the variables examined could be a guiding result in increasing the students' science achievement both qualitatively and quantitatively. For these reasons, it is aimed that the results obtained by examining the relationship between middle school students' science learning motivation and their metacognitive awareness will make a new contribution to the science education literature and offer important suggestions for increasing the quality of science learning.

Purpose of the Research

The aim of this study is to examine the science learning motivations and metacognitive awareness of the students in the 6^{th}, 7^{th} and 8^{th} grades in terms of various variables in the context of science education. Within the scope of this purpose, answers were sought to the questions of whether the science learning motivation and metacognitive awareness in middle school students differ significantly according to the variables of doing science experiments, participating in science projects, using science in daily life, science course grade point average, and gender and grade level. In addition, examining the relationship between science learning motivation and metacognitive awareness is another sub-problem of the research.

METHOD

Study Design

In this study, the descriptive correlational design was used since it was aimed to reveal the existing situation by examining the science learning motivations and metacognitive awareness of middle school students in terms of various variables in the focus of science education, and also to examine the relationship between students' science learning motivation and their metacognitive awareness.

Büyüköztürk et al., (2013) state that quantitative research would be the most appropriate method if a research problem requires the determination of factors affecting a result. According to Karasar (2010), the correlational study is the preferred design to determine the existence of co-variance between two or more variables. Since in the survey studies, how the investigated feature is distributed among the individuals in the sample (Fraenkel & Wallen, 2006), in this study, how the science learning motivation of middle school students and their metacognitive awareness change according to various demographic characteristics was investigated with the descriptive correlational survey design.

Participants

According to the National Education Statistics of 2021, the number of students studying in middle schools in the Adapazarı district of Sakarya province, which is determined as the universe of the research, is 15,778. In the research, following the cluster sampling method, 4 middle schools were selected from 35 middle schools in the Adapazarı district of Sakarya province in the 2020-2021 academic year. A total of 637 students from these schools participated in the study voluntarily. The students in the sample group consisted of 6^{th}, 7^{th} and 8^{th} grade students. Since the high level of contribution of the students participating in the study was aimed, the $6t^{h}$, 7^{th} and 8^{th} grade students in the middle school who were considered to be in the formal operational stage of Jean Piaget's theory of cognitive development were preferred in the research. Individuals over the age of 12 who are in the formal operational stage think more analytically, set up more various hypotheses for problem solutions, and reach more accurate results by making use of logic patterns while testing these hypotheses than the individuals in the concrete operational stage (Piaget, 1976). In line with the objectives of the research, the study was conducted with 6^{th}, 7^{th} and 8^{th} grade students aged 12 and over, on the grounds that the motivation and metacognitive awareness of students in the formal operational stage could be more distinctly identified. Of the students in the study, 366 (57.5%) were female students and 271 (42.5%) were male students.

Data Collection

The 'Science Learning Motivation Scale' was used to determine the motivation of the students involved in the study towards learning science. In addition, the 'Metacognitive Awareness Scale B Form' was used to determine their metacognitive awareness. Besides, a 'Personal Information Form' was used to collect data on demographic characteristics.

The "Science Learning Motivation Scale" developed by Dede and Yaman (2008) is a 5-point Likert type scale (strongly agree, agree, undecided, disagree and strongly disagree) and consists of 23 items. In the original study, the reliability coefficient of the scale was reported as 0.80. In this study, Cronbach's alpha value was found to be 0.84. According to these values, it can be said that the scale is a reliable tool for this study.

The “Metacognitive Awareness Scale B Form” was developed by Sperling, Howard, Miller and Murphy (2002) to measure metacognitive skills in 3^{rd}-9^{th} grade students. The validity, reliability

and factor structure of the scale were examined by Karakelle and Saraç (2007) in order to evaluate the usability of the scale in Turkey. This scale is a Likert-type measurement tool prepared for different age groups consisting of A and B forms. The Form B were developed for 6^{th}, 7^{th}, 8^{th} and 9^{th} grade students. The scale includes 18 items and is marked on a five-point Likert-type scale (never, rarely, sometimes, often, always) for each item. In order to determine the reliability of the scale, the Cronbach alpha value for the B form was calculated and found to be 0.80 (Karakelle & Saraç 2007). The internal consistency reliability was calculated for reliability in the original study and it was found to be 0.86 for form B. (Sperling, Howard, Miller & Murphy, 2002). In this study, the Cronbach alpha value for scale reliability was calculated and found to be 0.86. According to these values, it can be said that the Turkish form of the scale is a reliable tool for this study.

With the "Personal Information Form", data were collected on the students' gender, grade level, grade point average in the science course, participation in science projects, experimentation in science lessons, and their ability to use science in daily life.

Data Analysis

The answers of the participants to the data collection form were recorded in the data file created in the SPSS 22.0 program. In order to test whether the data showed a normal distribution, the Kolmogorov-Smirnov test was performed before each analysis and an evaluation was made about the normality of the distribution of the data. According to the results of the preliminary analysis, the data set was analyzed with non-parametric tests and Mann Whitney U and Kruskal Wallis tests were used in the analysis of the data.

The change in the students' science learning motivation and metacognitive awareness according to the variables of gender, experimentation status, participation in science projects and using science in daily life were analyzed with the Mann Whitney U test. Whether students' grade level and science course grade point average cause a difference in their science learning motivation and their metacognitive awareness was analyzed with the Kruskal Wallis test. In order to determine the relationship between students' science learning motivation and their metacognitive awareness, the Spearman Brown Rank Differences Correlation was calculated.

FINDINGS

The sub-problems regarding students' science learning motivation in the study were "Do secondary school students' science learning motivation differ according to the variables of gender, grade level, experimentation status, participation in science projects, using science in daily life and science course grade point average?" The findings obtained as a result of the analyzes are presented below, respectively.

Findings Related to Students' Science Learning Motivation

Table 1 shows the results of the Mann Whitney U Test conducted to determine whether the middle school students' science learning motivations show a statistically significant difference according to their gender, doing experiments, participating in science projects, and using science in daily life.

Table 1. Mann Whitney U test results of middle school students' science learning motivations according to various variables

Personal Information		N	Mean Rank	Sum of Ranks	U	p
Gender	**Female**	366	334.10	122279.5	44067.5	0.016*
	Male	271	298.61	80923.5		

Participating in Science Projects	**Yes**	356	337.60	120184.5	43397.5	0.004*
	No	281	295.44	83018.5		
Doing Experiments	**Yes**	417	348.76	145433.5	33459.5	0.000*
	No	220	262.59	57769.5		
Using Science in Daily Life	**Yes**	497	343.81	170875.5	22457.5	0.000*
	No	140	230.91	32327.5		

*p<0.05

In Table 1, it is seen that middle school students' science learning motivation changes significantly depending on their gender, participation in science projects, doing experiments and using science in daily life (p<0.05). According to the data in Table 1, it is understood that female students' motivation to learn science is higher than male students. Also, students who participate in science projects, students who do experiments in science lessons, and students who can use the information learned in science lessons in daily life have a higher level of science learning motivation.

The results of the Kruskal Wallis test conducted to determine whether the science learning motivations of middle school students differ according to their grade level and science course grade point average are presented in Table 2.

When the Kruskal Wallis test results in Table 2 are examined, it is seen that there is a statistically significant difference between the students' science learning motivations according to the grade level (χ^2=0.848; p<0.05). According to the results of the Mann Whitney U test applied to determine the source of this difference, it was determined that the statistically significant difference was between 6th and 7th grades, 6th and 8th grades and 7th and 8th grades (p<0.05). The mean rank of the 6th grade students (379.85) is higher than the other students. In addition, the mean rank of 7th grade students (317.97) is higher than that of 8th grade students. According to these findings, it can be said that as the grade level increases, the motivation to learn science decreases.

Table 2. Kruskal Wallis test results of middle school students' science learning motivations according to various variables

Personal Information		**N**	**Mean Rank**	**df**	**χ^2**	**p**	**Meaningful Difference**
Grade Level	**Grade 6**	182	379.85	2	0.848	0.000*	Grades 6-7
	Grade 7	159	317.97				Grades 6-8
	Grade 8	296	282.14				Grades 7-8
Science Course Grade Point Average	**(1) 0-44**	14	232.04	4	14.367	0.006*	1-5
	(2) 45-54	27	244.89				2-5
	(3) 55-69	71	277.30				3-5
	(4) 70-84	189	319.77				
	(5) 85-100	336	336.96				

*p<0.05

In Table 2, it is seen that the science learning motivation of the students changes statistically significantly according to the science course grade point average (χ^2= 14.367; p<0.05). According to the results of the Mann Whitney U test applied to find the source of this difference, it was determined that the difference was between students with a grade point average of 85 and above and students with a score below 70 (p<0.05). Students with a grade point average of 85 and above have a higher rank (336.96) than other students. According to these findings, it is

seen that science course grade point average affects science learning motivation in favor of students whose average is 85 and above.

Findings Related to Students' Metacognitive Awareness

In the research, the sub-problems related to the students' metacognitive awareness were "Does the metacognitive awareness of middle school students differ according to the variables of gender, grade level, experimentation status, participation in science projects, using science in daily life and science course grade point average?" The findings obtained as a result of the analyzes are presented below, respectively.

Table 3 shows the results of the Mann Whitney U test conducted to determine whether the metacognitive awareness of middle school students differs according to gender, doing experiments, participating in science projects, and using science in daily life.

Table 3. Mann Whitney U test results of middle school students' metacognitive awareness according to various variables

Personal Information		N	Mean Rank	Sum of Ranks	U	p
Gender	**Female**	366	330.45	120945.0	45402.0	0.068
	Male	271	303.54	82258.0		
Participating in Science Projects	**Yes**	356	341.71	121649.0	41933.0	0.000*
	No	281	290.23	81554.0		
Doing Experiments	**Yes**	417	344.66	143724.5	35168.5	0.000*
	No	220	270.36	59478.5		
Using Science in Daily Life	**Yes**	497	345.99	171956.5	21376.5	0.000*
	No	140	223.19	31246.5		

*p<0.05

According to the values seen in Table 3, it is understood that there is no statistically significant difference between the metacognitive awareness of female and male students (p>0.05). According to this result, it can be stated that gender is not an effective variable on middle school students' metacognitive awareness.

It is seen that the metacognitive awareness of middle school students changes significantly depending on their participation in science projects, doing experiments and using science in daily life (p<0.05). In line with the data in Table 3, it is understood that the metacognitive awareness of the students who participated in the science projects, the students who made experiments in science lessons, and the students who could use the information learned in the science lesson in daily life was higher.

The results of the Kruskal Wallis test conducted to determine whether the metacognitive awareness of middle school students differs according to grade level and science course grade point average are presented in Table 4.

Table 4. Kruskal Wallis test results of middle school students' metacognitive awareness according to various variables

Personal Information		N	Mean Rank	df	χ^2	p	Meaningful Difference
Grade Level	**Grade 6**	182	340.65				
	Grade 7	159	316.44	2	3.800	0.150	
	Grade 8	296	307.06				

	(1) 0-44	14	128.64				1-4
Science	**(2) 45-54**	27	216.26				1-5
Course	**(3) 55-69**	71	245.28	4	43.382	0.000*	2-4
Grade Point	**(4) 70-84**	189	323.68				2-5
Average	**(5) 85-100**	336	348.13				3-4
							3-5

*p<0.05

According to the results in Table 4, it is seen that there is no statistically significant difference between the metacognitive awareness of the 6th, 7th and 8th grade students (χ^2=3.800; p>0.05). Accordingly, metacognitive awareness in the middle school students does not change according to grade level.

When the Kruskal Wallis test results in Table 4 are examined, it is seen that there is a statistically significant difference between the students' metacognitive awareness levels according to the science course grade point average (χ^2=43.382; p<0.05). According to the results of the Mann Whitney U test applied to find the source of this difference, it was determined that the statistically significant difference was between the students with a grade point average of 70 points and above and those with a score below 70 points (p<0.05). Students with a grade point average of 70 and above have a higher grade point average (323.68; 348.13) than other students. According to these findings, it is seen that science course grade point average affects metacognitive awareness in favor of students whose average is 70 and above.

Findings Related to the Relationship between Students' Science Learning Motivation and their Metacognitive Awareness

The other sub-problem of the research is "Is there a significant relationship between middle school students' science learning motivation and their metacognitive awareness?" The results of the Spearman Brown Correlation analysis conducted to determine the relationship between students' science learning motivation and their metacognitive awareness are presented in Table 5.

Table 5 shows that there is a statistically significant relationship between students' science learning motivation and their metacognitive awareness (r=0.615, p<0.05). It is understood that this relationship is moderate and positive. Accordingly, it can be stated that secondary school students' motivation to learn science and their metacognitive awareness tend to change in the same direction.

Table 5. Correlation results between students' science learning motivation and their metacognitive awareness

Variables	**N**	**r**	**p**
Science Learning Motivation	637	0.615	0.000*
Metacognitive Awareness			

*p<0.05

CONCLUSION, DISCUSSION AND SUGGESTIONS

In the study, science learning motivations and metacognitive awareness levels of middle school students were examined in terms of various variables in the context of science education, and it was concluded that activities and practices related to science education were effective on students' science learning motivation and metacognitive awareness levels.

An important result of this research, which was carried out with the assumption that various science practices and activities would provide a suitable environment for the development of science learning motivation and metacognitive awareness; middle school students participating in the science project have a higher level of science learning motivation and metacognitive awareness. According to this result, it can be claimed that the processes of preparing, executing and finalizing science projects positively affect their metacognitive awareness as they require using high-level thinking skills. In addition, it can be stated that participating in science projects increases students' interest in science, thus increasing their science learning motivation. From this result, it can be concluded that participation in science projects helps to increase students' science learning motivation and metacognitive awareness. When the literature is examined, no research has been found that examines science learning motivation and metacognitive awareness with this variable, and it is thought that this result reached in the study will make an important contribution to the relevant knowledge by supporting it with other studies.

The analysis conducted to answer the question "Do experiments, which are an important element of science education, lead to a positive change in secondary school students' science learning motivation and metacognitive awareness?" showed that doing experiments in science lessons positively affects students' science learning motivation and makes a significant difference in their metacognitive awareness. Experimenting involves the processes of changing and controlling variables, and this requires various skills for scientific processes. A student conducting an experiment can set up a suitable mechanism using many necessary materials, obtain data by changing and controlling the variables, record and evaluate these data, interpret the data, and report what has been done by concluding. Thus, he/she actually uses his/her metacognitive skills and as a result, his/her metacognitive awareness is high. According to this result that is in parallel with the study of Karataş and Yıldırım (2018), it is understood that doing experiments in science lessons has a positive effect on science learning motivation. For this result that emerged in the study, it can be thought that the students who made science-related experiments learned meaningfully by better understanding the relationships between science concepts and events, and thus they were more willing to learn science, and all these outcomes might have increased their motivation for learning science.

According to another result reached in the study, it was determined that the science learning motivation and metacognitive awareness of middle school students who stated that they used science in daily life were higher. The fact that students can use the information they learned in their lessons in daily life can be accepted as an indicator of generalization skills, and the information becomes meaningful and useful only in this case. From this point of view, it can be said that students' seeing that what they have learned about science subjects finds its way in daily life and being able to use their knowledge in real life environments affects their motivation positively. Transferring knowledge to daily life requires using higher-order thinking skills while realizing the learning objectives consisting of the steps of remembering, understanding, applying, analyzing, evaluating and creating in the gradual classification of the cognitive domain according to Bloom's Revised Taxonomy, and actually develops metacognitive awareness. There is also a need for other studies examining students' metacognitive awareness levels and their science learning motivation according to the variable of using science in daily life, so that the role of science education in developing students' high-level cognitive skills can be revealed more effectively.

Another conclusion reached in the study is that the science learning motivations and metacognitive awareness of middle school students vary according to the science course grade

point average. It has been determined that science course grade point average affects science learning motivation in favor of students with an average of 85 and above, and metacognitive awareness in favor of students with an average of 70 and above. Accordingly, it can be stated that students who are more successful in science courses have higher science learning motivation and metacognitive awareness levels. When the literature is examined, it is seen that metacognitive awareness is examined according to the academic achievement of students by Bağçeci, Döş and Sarıca (2011), Emrahoğlu and Öztürk (2010), Turan and Demirel (2010). According to the results of these studies, it was observed that the increase in the level of academic achievement also increased the metacognitive awareness. In addition, it has been revealed by the results of the relevant research that metacognitive awareness is a positive predictor of academic achievement. In the study conducted by Karatay (2010) with 6^{th}, 7^{th} and 8^{th} grade students, it was concluded that students with high metacognitive awareness levels are more successful academically. It is understood that the results of the relevant research support the conclusion reached in this study, and it is an expected result that the metacognitive awareness of the students, who show high achievement, is high as a result of being aware of their own learning. It has been determined that this result is also in parallel with the results of other studies (Çetin & Kırbulut, 2006; Glynn, Taasoobshirazi & Brickman, 2009, Karakaya et al., 2018; Yenice, Saydam & Telli, 2012). It is understood that the results of the relevant research support this result reached in the study, and the high motivation of students with high achievement is again an expected result. Since success is an intrinsic motivation source, a high grade point average affects motivation positively by its nature.

When the effect of gender on the variables discussed in this study is examined, it has been concluded that gender is an effective variable in students' science learning motivation, but it was not effective on their metacognitive awareness. It was determined that female students had higher motivation to learn science and this result was in parallel with the results of studies (Akpınar, Batdı & Dönder, 2013; Atay, 2014; Britner & Pajares, 2001; Ekici, 2010; Güvercin et al., 2010; Halimoğlu, 2019; İnel-Ekici et al., 2014; Karataş & Yıldırım, 2018; Khamis, Dukmak & Elhoweris, 2008; Martin, 2004; Okumuş, 2020; Okuyucu & Okumuş, 2019; Uzun & Keleş, 2010; Yaman & Dede, 2007) that concluded that female students' motivation towards science was higher than male students. On the other hand, Aydın (2007), Azizoğlu and Çetin (2009), Çavaş (2011), Çetin and Kırbulut (2006), and Yenice et al. (2012) presented in their studies that gender did not affect the motivation for learning science. In addition to the results of the research showing that there is no statistically significant difference between the metacognitive awareness of female and male students (Kandal & Baş, 2021; Özsoy & Günindi, 2011; Şahin & Küçüksüleymanoğlu, 2015), it is seen that there are research results reporting that metacognitive awareness is in favor of females (Akçam, 2012; Aktağ, Şemşek & Tuzcuoğlu, 2017; Alcı & Altun, 2007; Bağçeci et al., 2011; Gül, Özay Köse & Sadi Yılmaz, 2015; Kaya & Fırat, 2011; Oğuz & Kutlu Kalender, 2018; Öztürk & Serin, 2020; Saban & Saban, 2008) and that metacognitive awareness is higher in male students (Demir & Kaya 2015; Gürefe, 2015). It can be claimed that these inconsistent results in the research are due to the differentiation of the sample groups of the related studies due to various reasons such as age, education level, previous learning experiences. Since gender is a variable that is directly affected by social, cultural and geographical features, it is a common situation to see variability in the results obtained depending on the purpose and scope of the research.

As a result of the analysis to test the research hypothesis that 'the science learning motivation in middle school students varies according to the grade level', it was seen that the research hypothesis was supported. Accordingly, it was concluded that the students in the early classes of middle school had a higher motivation to learn science. It was determined that as the grade

level increased, the science learning motivation decreased. Students are excited and eager to learn in the first grades of secondary school, but as the grade level increases, the subjects become more complex, and distraction is experienced due to the physiological changes required by the adolescence period, and as a result, it becomes difficult for students to be motivated to learn. In addition to these changes, it can be thought that the learning environments created for the examination system (High School Entrance Exam - LGS) carried out in our country for the transition to a higher education level after middle school also have negative effects on motivation towards learning. An examination system-oriented teaching leads to moving away from the gains of the curriculum and, on the other hand, to adopting a learning approach based on rote learning (Şahin, 2009; Erden, 2020). In addition, in order not to be left out of the exam-oriented system, students enter an intensive study process with private lessons, additional lessons and homework. As a natural consequence of all these, students experience a reluctance to learn and a loss of motivation. At the same time, it can be said that LGS causes stress and test anxiety in 8th grade students, and therefore the pressure it creates has a decreasing effect on their motivation levels for learning. This result show parallelism with the studies of Akpınar et al. (2013), Pigeon et al. (2010), İnel Ekici et al. (2014), Tseng et al. (2009), Uzun and Keleş (2010), Yaman and Dede (2007), Yenice et al. (2012). However, it is seen that there is a study that contradicts this result. According to Azizoğlu and Çetin's (2009) study, students' science learning motivation is not affected by grade level. This may be due to the difference between the sample group and the measurement tools used.

When metacognitive awareness was examined according to grade level, it was found that there was no statistically significant difference between the metacognitive awareness of middle school students studying in the 6th, 7th and 8th grades. It is understood that this result is similar to some related research results (Karslı, 2015; Kaya & Fırat, 2011; Özsoy, Çakıroğlu, Kuruyer & Özsoy, 2010; Öztürk & Serin, 2020), but it also differs from research results (Baysal, Ayvaz, Çekirdekçi & Malbeleği, 2013; Oğuz & Kutlu Kalender, 2018; Özsoy & Günindi, 2011; Öztürk, 2017) indicating that metacognitive awareness increases according to grade level. It can be thought that these differences may have arisen from the fact that the age levels of the selected sample in the studies were different from each other, sometimes by working with pre-service teachers sometimes with certain grade levels, and by considering different dimensions of metacognitive awareness with different data collection tools used for the researched problem. Although the increase in the level of metacognitive awareness seems to be one of the possible outcomes as the grade level increases, the lack of a significant difference in cognitive development between the ages of the students in the sample group (12-14) was also reflected in the grade level, and there was no significant difference between the levels of metacognitive awareness.

When the relationship between students' science learning motivation and their metacognitive awareness was examined, it was concluded that there was a statistically significant, moderate and positive relationship. According to this result, it can be said that the metacognitive awareness of students with high motivation to learn science is also high. This result is in parallel with the studies of Okumuş (2020) and Atay (2014). In her study, Okumuş (2020) concluded that metacognitive learning skills play a role in middle school students' science learning motivation. Atay (2014), concluded that there is a positive and significant relationship between middle school students' science learning motivation and their metacognitive awareness. In addition, Kahraman and Sungur (2011) concluded that students who believe that they will learn the science lesson and be successful use metacognitive strategies better. A student with high metacognitive awareness has an increased belief in fulfilling a task and achieving academic success. For this reason, it can be said that it is an expected situation for students with high

metacognitive awareness to increase their science learning motivation. The necessity of motivation for the use of metacognitive skills is an indication that as the science learning motivation increases, metacognitive awareness will also increase.

All these results show that the practices carried out within the scope of science education leads to a positive change in science learning motivation and metacognitive awareness. Based on these results, it can be inferred that diversifying and applying activities and studies that can be used in science lessons; providing science learning environments enriched with different methods and techniques, materials and technologies; participating of middle school students in studies focused on science education will increase students' science learning motivation and metacognitive awareness, and thus enable more qualified learning. In addition, it is underlined that the effective use of science laboratories in science lessons, students' participation in science projects and their active participation in all processes from the preparation of the projects to the conclusion, and the design of science learning environments in a way that allows the transfer of knowledge to daily life will make important contributions to an effective science education.

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