European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.3831123 Volume 7 | Issue 5 | 2020

INVESTIGATING STUDENTS' SCIENTIFIC CREATIVITY AND METACOGNITIVE AWARENESS LEVEL ACCORDING TO RIASEC INTEREST INVENTORY

Ümit Duruk[i]
Adiyaman University
College of Education, Adiyaman,
Turkey

Abstract:
The primary goal of this study was to identify which of the RIASEC categories the students participating in the sample fell into. The other goal was to determine whether the students' scientific creativity and metacognitive awareness scores differed significantly depending on their RIASEC categories and gender. The study was a descriptive survey including 162 students studying in the sixth, seventh and eighth grades of a public middle school in Turkey. The students were asked to fill out the RIASEC Inventory, Scientific Creativity Scale and Metacognitive Awareness Scale. Student t-test and one-way ANOVA were conducted in the statistical analysis. Based on the analyses, it was found that most of the students fell into a single category in terms of the RIASEC category classification. There was no significant difference between the scientific creativity scores of the students in terms of the RIASEC categories. Their metacognitive awareness scores, however, differed significantly depending on the categories. The significant difference between the metacognitive awareness scores was found to be in favor of the students falling into two categories, in comparison to those belong to a single category. Considering the sub-dimensions of metacognitive awareness, it was observed that the difference was in the sub-dimensions of declarative knowledge and procedural knowledge, and in the sub-dimension of monitoring ability in terms of metacognitive regulation. The interpretation of the findings obtained through the analyses led to the conclusion that the students' creativity scores were not influenced by the RIASEC categories to which they belonged, and that their metacognitive awareness scores could be associated with the categories of this model of vocational interest. Implications for practice into the classroom are discussed and further recommendations for future studies provided.

Keywords: scientific creativity, metacognitive awareness, vocational interest, RIASEC Inventory, middle school students

[i] Correspondence: email uduruk86@gmail.com

Copyright © The Author(s). All Rights Reserved.
© 2015 – 2020 Open Access Publishing Group

1. Introduction

In recent years, the field of science education has been shaped under the influence of educational reforms as well as curricula established in accordance with those reforms. One of the important components of curricula is content knowledge. Content knowledge is the answer to the question of what to teach through curricula. However, science teaching that is carried out in a plenty of school hours has most partly become an inefficient activity where content knowledge is transferred directly from teacher to student without allowing students to construct conceptual meanings of their own learning experiences. Therefore, students' experiences at school should be considered as a set of activities that entertain them, motivate them, and intensify their belief that they can be successful in constructing the knowledge and create positive feelings about science learning. In addition, students need to evaluate the knowledge they acquire in the context of daily life and use it to solve the complex problems they often encounter. The use of content knowledge to real-life situations, and thus ensuring deep and meaningful learning, requires the combination of curricula and the understandings of science teaching based on these curricula to set similar and consistent goals (Corlu, Capraro, & Capraro, 2014). Such goals take place in curricula as instructional objectives. Through instructional objectives, an accessible limit is drawn on what cognitive, affective or psychomotor skills will be taught to students. Also, teaching activities are planned by taking into account the acquisition of these objectives.

In line with the latest educational reforms, there are a variety of skills that students are expected to acquire. These skills are generally referred to the 21st century skills. Students with such skills are expected to find more plausible solutions to day-to-day challenges they encounter. To put it in a different way, people of the twenty-first century are supposed to be open to communication, and they are critical and creative. These skills are generally discussed under the framework of scientific literacy (Dierks, Höffler, Blankenburg, Peters, & Parchmann, 2016). Scientifically illiterate people cannot be expected to find effective solutions to problems they often face. This is because it is clear that a person who does not know the fact that the main element distinguishing science from other disciplines of research is the explanations shaped by evidence derived from facts will find it difficult to solve some complex problems requiring creativity to solve. For this reason, the aim should be to educate students to be scientifically literate especially from the elementary school onwards. However, the latest research findings suggest that students' interest in science courses has a declining tendency, in recent decades. It can be said that there are many sources of reasons for this decline, and the reasons vary. Perhaps the most important one is the limited contribution of formal science teaching in schools to educating people who make up the society as scientifically literate people altogether— raising scientifically literate people is one of the long-term goals of societies (Falk, Storkdieck, & Dierking, 2007). It is expected that there is less interest in science lessons in classrooms that are far from being inquiry-based, that do not include authentic learning activities and environments, where students do not have the opportunity to construct their own explanations on the basis of evidence, where students do not get sufficient constructive feedback in monitoring and regulating their own learning processes, and finally, where the teacher is regarded as the primary and ultimate source of knowledge. This negative image is also reflected in the relevant literature. There are indications that students become less interested in science as they get older, and that female students are more distant from careers related to science and technology (Tytler, Osborne, Williams, Tytler, & Cripps Clark, 2008). This is one of the crucial challenges that should be addressed today when diversity of choices of occupations has grown. This is because it is crucial that all types of professions, especially science-based professional groups, be open to anyone, and that every person should be given equal opportunity to choose and pursue any profession. Accordingly, the field of science education of today bears witness to the efforts to include applications specific to the fields of engineering and art in science curricula. These efforts are mainly discussed under the heading of STEM Education. Basic knowledge, skills, emotions and attitudes expected from students have changed as countries review the criteria for curricula and school-level science teaching, and submit new criteria in line with the results obtained from recent long-term reports on science education. As stated earlier, the skills of the new age have been articulated as the twenty-first century skills by taking into consideration the needs of today's technological world (Griffin & Care, 2014). In line with the goal to improve students' attention in lessons, to ensure that they are motivated for lessons, and ultimately to help them sustain their interest for a long time, a curriculum should be planned to focus on the theoretical frameworks for the concept of interest in order to primarily improve the interest of students whom we expect to acquire the 21st century skills in science lessons taught at schools (Göksun & Kurt, 2017).

Interest that helps a person get motivated to carry out long-term plans or facilitate such plans, and in this way, is regarded as a regulator of behavior (Chen, Darst, & Pangrazi, 2001) is considered personal interest when addressed on the basis of professional orientations (Krapp, Hidi, & Renninger, 1992). One explanation why people are more attracted to a certain occupation could be personal interest. Its direct connection with the value system of a person causes it to become a structure that develops and forms in a long term. When the relevant literature was examined, while mainly theoretical studies (Ainley, Hidi, & Berndorff, 2002; Hidi & Renninger, 2006) were dominant, practical studies on the concept of interest that is discussed here were also found (Blankenburg, Hoffler, & Parchmann, 2016; Dierks et al. 2016; Höft, Bernholt, Blankenburg, & Winberg, 2019). What these studies have in common is that they have examined personal interest in line with the RIASEC professional interest categories. Blankenburg et al. (2016) have had the goal to classify sixth-graders in accordance with the aforementioned categories under different subject contexts from the recent past to the present (biology, physics and chemistry). As a result of the study, they found that the students were also in realistic categories, especially in terms of being good at tasks that require researching and hands-on activities. They found that females were in realistic and artistic categories in all contexts, whereas males were interested in physical activities in the social category. The researchers discussed this situation through the nature of the activities used in that context rather than the context itself. In another study, Dierks et al. (2016) determined student profiles and found that academically highly successful students fell into all categories. On the other hand, females were found to be more interested in artistic and social categories. Höft et al. (2019) studied interest in the chemistry course context. In their study carried out on students, they reported that the students' interest decreased over time during the activities they prepared for content and the level of conceptual understanding differed depending on categories. Within the scope of the present study, it was assumed that professional interest profiles may be associated with scientific creativity and metacognitive awareness, and studies in the relevant literature were analyzed through the aforementioned three main concepts simultaneously. It is seen that a small number of scientific creativity studies have been conducted in general on elementary and middle school students (Aktamıs & Ergin, 2007; Baysal, Kaya, & Üçüncü, 2013; Erdogdu, 2006; Karatas & Özcan, 2010). In these studies, it was reported that scientific creativity did not differ based on gender (Baysal et al., 2013), improved academic success and related to science process skills (Aktamıs & Ergin, 2007), and improved attitudes towards science (Demirci, 2007). Again, it is seen that few studies exist in relation to metacognition on prospective teachers in general (Abd-El-Khalick, & Akerson, 2009; Duruk, 2017; Tüysüz, Karakuyu, & Bilgin, 2008). In these studies, it has been concluded that metacognitive awareness that is provided by having students use strategies or that already exists does not differ based on gender (Tüysüz et al. 2008), improves students' nature of science understandings and ensures their retention (Abd-El-Khalick & Akerson, 2009; Duruk, 2017; Peters & Kitsantas, 2010), and improves the use of evidence during the integration of content knowledge and inquiry skills (Peters & Kitsantas, 2010). To sum, little attention has been paid to empirically investigate personal interest in the school context. In the literature, to the best of our knowledge, there has been no study that examines the variable of interest in combination with the creativity and metacognition concepts. To address the gap in the literature, the present study was an attempt to identify which of the RIASEC categories the students in the sample fell into.

The other goal in the study was to determine whether the students' creativity scores and metacognitive awareness scores differed significantly depending on their RIASEC categories. Consequently, the study focused on finding out:

- What is the distribution of middle school students in relation to RIASEC categories?
- Do the students' creativity and metacognitive awareness scores differ significantly depending on their RIASEC categories and grade levels?
- Do the students' creativity and metacognitive awareness scores differ significantly depending on their gender?

2. Theoretical Background

Although interest conceptually has a multidimensional structure, it has both cognitive and affective dimensions. When viewed from this perspective, interest can be considered as a positive feature triggered by cognitive and affective experiences, which directs one's attention to the activity or object of interest (Hidi & Harackiewicz, 2000). Various factors are effective in the formation of interest that is more dominant in affective sense. Environmental factors are effective in the formation of interest arousing with respect to a particular object. Interest that is open to the influence of environmental factors is always content-based (Krapp, 2003; Schiefele, 2009; Hidi & Renninger, 2006). On the other hand, one of the most common opinions in the ongoing discussions in the literature is whether any concept belongs to a general or a specific field. Similar to the concept of interest, this discussion has been ongoing about various other concepts. One of the concepts being the topic of this discussion is creativity. It can be said that establishing interest has an important role in building a positive condition that may be needed in relation to a reference object in the process of creativity. Similar to interest, creativity, too, is content-based and influenced by the context it belongs to. It is known that beyond the debate over whether creativity is a general or a specific field, scientific activities are undoubtedly creative initiatives, and at least even in this respect, people interested in science need a certain level of creativity to produce new ideas and solve problems they face in innovative ways (Liu & Lin, 2014). Based on prominent features that stand out in its various definitions, it is more accurate to treat creativity — which is defined as the act of producing a product by the end of a process based on selective experiences in general — in line with the distinction of artistic and scientific creativity (Kılıç & Tezel, 2012). In artistic creativity, mainly subjective ideas are valued, whereas in scientific creativity, what one knows is transferred to new situations (Kadayıfcı, 2008). Knowledge transferred to new situations plays a role in solving problems with an object or an activity being the subject of the process of creativity (Aktamış & Ergin, 2007). Creative thinking skills that play a functional role in solving problems are based on scientific knowledge of concept(s) referred to in the problems (Kılıç & Tezel, 2012). Because any product, which is expected to be yielded at the end of the creative thinking process, should be based on scientific facts and stem from the knowledge about scientific facts (Hu & Adey, 2002). Creative thinking refers to the act of coming up with a novelty or being authentic, rather than a direct integration of scientific knowledge (Kılıç & Tezel, 2012). Creativity, on the other hand, refers to becoming more sensitive to problems, finding solutions for them, and negotiating and concluding results. In this respect, acquiring the ability to be sensitive to problems in everyday life has a necessary and triggering importance in the activation of creative thinking skills (Torrance, 1995).

The concept of interest is too comprehensive to be considered within a narrow conceptual framework. For this reason, it needs to be addressed in or associated with a framework that is at an upper level than itself. One of these upper-level frameworks is the concept of self-regulated learning. Self-regulated learning puts an emphasis on the learner's mediating role in the learning process (Pintrich, 2000). Consequently, self-regulated learning helps the student set goals for the learning process and achieve these goals (Efklides, 2011). Considering the practices in the classroom environment, it is seen that students are interested in the way that an activity is presented to them in general rather than the content of the activity presented to them (Swarat, Ortony & Revelle, 2012). Students with low self-regulated learning skills have been found to lack awareness of how to use strategies and think that it will be sufficient to use only a few of such strategies (Sungur & Şenler, 2009). Students exhibiting self-regulated behavior actively participate in their own learning processes by bearing in mind their metacognitive characteristics (Zimmerman, 1989). Metacognition is one of the major aspects of self-regulated learning (Boekaerts, 1996). Flavell (1979) grouped metacognition into two categories of knowledge and regulation. Metacognitive knowledge is divided into three components within itself. Knowledge of people is a component that contains information about people's knowledge, beliefs, and strengths and weaknesses of themselves and others. This component also covers information about factors that influence a person's own performance (Schraw, Crippen & Hartley, 2006). Knowledge of tasks indicates a person's knowledge of his or her demands and purposes for a cognitive task. In addition to that, it includes the idea of what knowledge is available while working on a specific task, how variations in the available knowledge can influence the outcomes of that task, and therefore what kind of a cognitive process needs to be carried out to accomplish the intended goal through the available knowledge. Finally, knowledge of strategies is information about why and when a particular strategy will be used (Young, 2010). Metacognitive regulation includes planning, monitoring, evaluation, information management and debugging strategies. Self-regulated learning and metacognition create an intersecting area, especially in terms of monitoring and control functions (Dinsmore, Alexsander & Loughlin, 2008).

On the other hand, students must first have a certain level of metacognitive awareness to be able to activate their metacognitive skills. The use of metacognitive strategies is effective in improving metacognitive awareness (Baraz, 2012) and the persistence of conceptual understandings, in particular (Akerson & Abd-El-Khalick, 2009; Yürük, Beeth, & Anderson, 2009; Duruk, 2017). However, metacognitive awareness plays a role in restructuring conceptual understanding rather than the perpetuation of conceptual meaning (Sackes & Trundle, 2016). As mentioned earlier, creativity is the work of generating new ideas or concepts through existing concepts and relationships between them, accompanied by new observations and experiences (Kılıç & Tezel, 2012). It can, therefore, be said that the path of creativity intersects at the point of production of new concepts with metacognitive awareness, which is referred to as higher-order thinking skills in the relevant literature (Zohar & David, 2009). A review of the conceptual frameworks referred to in a holistic manner leads to the inference that the features specified in most components need operations such as monitoring, regulation and control at the level of cognition and metacognition. With the use of strategies through the monitoring component, it is ensured that the process of knowledge construction is controlled. The role of the act of exerting effort is greater in the effective realization of control. This is because making an effort for a purpose requires a certain level of motivation. In terms of motivating people, it is very important to arouse their interest and make this interest sustainable. Therefore, it may be considered that interest may be related to metacognitive regulation, which requires not only knowing something but also taking action. By this means, interest can be placed in a theoretical framework under self-regulation cognitively and under latent motivational orientations affectively. Consequently, in this study, it was thought that, as stated earlier, it was suitable to define the concept of interest by linking it to creative thinking and metacognition — which are considered to be the conceptual frameworks at a higher level than interest itself.

3. Method

3.1 Model
This study was carried out as a descriptive survey. The characteristics of the group included in the sample were examined and described in terms of a number of variables, and the data were collected through three scales introduced in detail below.

3.2 Sample
This study's sample consisted of 162 students enrolled in sixth, seventh and eighth grades, 79 males and 83 females in total.

3.3. Data Sources
As part of the study, various data collection instruments were utilized. RIASEC Professional Interest Inventory was used to identify and classify the students' professional interests, the Metacognitive Awareness Scale to specify their metacognitive awareness, and, finally, the Scientific Creativity Scale to determine their level of creativity.

3.4 RIASEC Professional Interest Inventory
The inventory takes the theoretical framework of the concepts it contains from the Theory of Vocational Choice, which is based on the occupational environment typology (Holland, 1966). The basic assumption of the theory is that people have different personality types, and people with certain personality types can be happier in social circles linked to certain professions. This inventory explores professional orientations under six occupational categories in terms of interests, attitudes, values and skills. These categories are realistic, investigative, artistic, social, enterprising and conventional categories of professional interest. These categories can be described as follows:

- Individuals with realistic professional interests are interested in hands-on mechanical activities. Such people who known for their practicality are prone to occupations that require technical skills such as tinkering. While such people tend to conduct laboratory experiments in terms of professional activities related to science, they may be interested in close-ended experiments in the classroom.

- People with investigative professional interests can use their verbal skills in a scientific research process by generating ideas with analytical thinking over the tasks they involve. They are known to construct their scientific explanations on the basis of evidentiary findings. For this reason, they can be said to have interest in becoming scientists or researchers. Such people are interested in developing new theories in terms of professional activities related to science, while they focus on solving theoretical problems in terms of classroom activities.
- People with artistic professional interests are interested in artistic activities where subjective ideas and imagination stand out. The use of creative thinking skills is prominent in this category. Such people are expected to use their creativity to come up with new ideas, new theories and new products. For this reason, such people are likely to be interested in careers such as becoming designers, musicians or actors. Such people have an interest in creating written and visual materials or artifacts in terms of professional activities related to science and classroom activities.
- People with social professional interests focus on the development of skills of others through verbal interactions. Such people, who are sympathetic and helpful, like to be within close proximity of other people. For this reason, such people are expected to be interested in careers such as nursing or teaching. Such people have a tendency to teach science in terms of professional activities related to science, while they may turn to teaching their classmates something in terms of classroom activities.
- People with enterprising professional interests are effective, aggressive and self-confident in verbal communications. Such people who are capable of establishing authority are persons who have an ambition to be successful. Therefore, it can be said that such people have tendencies to be leaders, managers or politicians. Such people are interested in conducting science projects in terms of professional activities related to science, and participating in group studies in classroom activities.
- People with conventional professional interest, which is the final category, regularly observe certain criteria in their normal routine lives. Such people are expected to be interested in careers such as secretaries or accounting specialists requiring precise accounting and order while working. They are expected to perform activities such as organizing a science project or lining up chemicals in the laboratory according to their labels (Dierks et al. 2014; Blankenburg et al. 2016; Dierks et al. 2016).

3.5 Metacognitive Awareness Scale

The Metacognitive Awareness Scale developed by Schraw and Dennison (1994) helps perform data analysis through ratings in its original form. The version of it adapted to

Turkish by Cetinkaya (2012) has five-point Likert-type items. There are two sub-dimensions in the scale, mainly knowledge of cognition and regulation of cognition. Knowledge of cognition is divided into three in itself as knowledge of people, tasks, and strategies. Regulation of cognition includes sub-dimensions of planning, using information management strategies, monitoring, using debugging strategies, and evaluation. Metacognitive awareness on this scale is measured through a total of 52 items. Of these items, 17 consist of statements about knowledge of cognition, and the remaining 35 are statements regarding regulation of cognition.

3.6 Scientific Creativity Scale

The Scientific Creativity Scale used in this study is the scale developed by Hu and Adey (2002) and adapted to Turkish by Kadayıfcı (2008). There is a total of seven questions on the scale. The first of these questions asked a piece of glass to be used scientifically. Through this question, the use of artifacts was put into use to reveal scientific creativity. The second question asked which scientific questions could be explored during a space voyage. The aim of this question is to identify the level of sensitivity to a scientific problem one faces. The third question asked what improvements could be made to make an ordinary bicycle more functional and interesting. This question is intended to assess the capacity of the student to design technical products. The fourth question asked students' views about what would happen in the world without gravitational force. This question is intended to measure scientific imagination. The fifth question asked the maximum number of unique methods that could be used to divide a square into four equal parts. The intention through this question was to measure the ability to solve a problem in a creative and scientific way. The sixth question asked what kind of tests could be carried out to identify which of two different kinds of napkins is better. It is intended to determine creative experimental ability through this question. In the seventh question, it was asked to design an apple machine. Through this question, the ability to design creative scientific products was measured.

3.7 Data Analysis

Data collected from the students through the RIASEC Professional Interest Inventory, the Metacognitive Awareness Scale and the Scientific Creativity Scale were analyzed with the SPSS package program. Variables with two options (gender) were analyzed through student t-tests, and variables with more than two options (grade level and RIASEC) were analyzed through One-Way ANOVAs, when analyzing the students' scores on the Scientific Creativity Scale and the Metacognitive Awareness Scale based on their gender, grade levels and RIASEC scores. The results and the interpretation of these results are presented in the Findings section.

4. Findings

This section includes findings based primarily on the descriptive data obtained from the RIASEC inventory. Statistical findings are presented on how scientific creativity and metacognitive awareness scores varied depending RIASEC categories and grade level, sub-dimensions of metacognitive awareness, and finally gender variable respectively.

Table 1: Frequency and percentage values
for the distribution of the categories the students fell into

Single Categories			**Binary Categories**			**Triple Categories**			**Most common categories**	
Category	Frequency	%	Category	Frequency	%	Category	Frequency	%	Category	%
R	1	0.6	RI	1	0.6	RIA	1	0.6	I	18.5
I	30	18.5	RS	4	2.5	RIS	1	0.6	S	16
A	13	8	RE	1	0.6	RIE	1	0.6	IS	13.6
S	26	16	IA	2	1.2	RIC	1	0.6	A	8
E	8	4.9	IS	22	13.6	RAE	1	0.6	C	6.8
C	11	6.8	IE	3	1.9	RAC	1	0.6	M	4.9
Total		**54.8**	IC	4	2.5	RSE	1	0.6	ISE	3.1
			AS	2	1.2	IAS	4	2.5	IC	2.5
			AE	2	1.2	IAE	1	0.6	AC	2.5
			AC	4	2.5	ISE	5	3.1	RS	2.5
			SE	3	1.9	ASE	1	0.6	IAS	2.5
			EC	2	1.2	ASC	1	0.6	IE	1.9
			Total		**30.9**	AEC	1	0.6	SE	1.9
						SEC	3	1.9	SEC	1.9
						Total		**14.3**	AE	1.2
									AS	1.2
									IA	1.2
									EC	1.2

The findings obtained from RIASEC Inventory used to determine the professional tendencies of the students who participated in the study are shown in Table 1. Because the analysis was carried out at the classification level, the table includes the frequencies of the categories and the corresponding percentage values. Considering Table 1, in terms of professional orientations, 54.8% of the students were found to be categorized into a single category, 30.9% into two categories and 14.3% into three categories. In terms of a single category, most students (18.5%) were found to fall into the investigative (I) category, while they least frequently fell into the realistic (R) category (0.6%). In terms of a single category, the students were found to be most frequently in the social (S) category (16%) after the investigative category. This was followed by IS (Investigative-Social) with two categories (13.6%). In other words, these three category classes accounted for almost half of the entire sample (48.1%). It can be said that half of the students participating in this sample were in the investigative, social, or investigative-social categories, which suggests that the students were mainly oriented towards investigative, social or investigative-social occupational groups. On the other hand, in addition to the data in this table, it was seen during the analyses that both females and males were mostly in the investigative and social categories in terms of the gender variable. The difference was found to be in the realistic category, in particular. This rate was found to be 1.51% among females and 9.677% among males. In terms of both categories, females were seen to be ahead of males.

Table 2: Results from analysis of variance of students' scientific creativity and metacognitive awareness scores (one-way ANOVA) based on RIASEC categories and grade levels

	RIASEC	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
Scientific creativity	Between groups	1132.152	2	566.076	1.458	.236
	Within groups	61715.676	159	388.149		
	Total	62847.827	161			
	Grade Level					
	Between groups	710.653	2	355.326	0.909	.405
	Within groups	62137.175	159	390.800		
	Total	62847.827	161			
Metacognitive awareness	**RIASEC**					
	Between groups	4451.090	2	2225.545	3.152	.045*
	Within groups	112270.867	159	706.106		
	Total	116721.957	161			
	Grade Level					
	Between groups	6333.855	2	3166.927	4.562	.012*
	Within groups	110388.102	159	694.265		
	Total	116721.957	161			
* p < .05						

Table 2 shows the findings from the analysis of variance of the students' scientific creativity and metacognitive awareness scores based on RIASEC scores and grade levels. As the table shows, it was found that the scientific creativity scores of the students did not differ significantly depending on RIASEC categories and their grade levels. Metacognitive awareness scores, however, were found to differ significantly depending on the students' RIASEC categories and grade levels. Based on the findings, it was found that the students' metacognitive awareness scores varied significantly at the p <.0.5 level depending on their RIASEC categories and grade levels (p = .045 and p = .012, respectively).

Table 3 shows the results from analysis of variance (one-way ANOVA) of the students' scores on Metacognitive Awareness Inventory sub-dimension items based on RIASEC categories. A review of the table shows that the students' scores on the declarative knowledge and procedural knowledge sub-dimensions of metacognitive knowledge differed significantly depending on their RIASEC categories at p < .05 significance level (declarative knowledge: F = 4.692, p = .045, and procedural knowledge: F = 3.153, p = .010). In the metacognitive regulation sub-dimension, only the scores on the monitoring sub-dimension varied depending on RIASEC categories at p < .05 significance level (F = 3.149, p = .046).

Table 3: Results from analysis of variance (one-way ANOVA) of students' scores on Metacognitive Awareness Inventory sub-dimension items based on RIASEC categories

Sub-dımensıons	Items	RIASEC	Sum of Squares	df	Mean Square	F	p
Knowledge of cognition	Declarative knowledge	Between groups	149.420	2	74.710	4.692	.010*
		Within groups	2531.796	159	15.923		
		Total	2681.216	161			
	Procedural knowledge	Between groups	46.239	2	23.119	3.153	.045*
		Within groups	1165.811	159	7.332		
		Total	1212.049	161			
	Conditional knowledge	Between groups	46.008	2	23.004	2.505	.085
		Within groups	1460.269	159	9.184		
		Total	1506.278	161			
Regulation of cognition	Planning	Between groups	116.738	2	58.369	2.448	.090
		Within groups	3791.737	159	23.847		
		Total	3908.475	161			
	Information management	Between groups	93.108	2	46.554	1.105	.334
		Within groups	6697.090	159	42.120		
		Total	6790.198	161			
	Monitoring	Between groups	148.255	2	74.128	3.149	.046*
		Within groups	3743.356	159	23.543		
		Total	3891.611	161			
	Debugging	Between groups	8.573	2	4.287	0.407	.667
		Within groups	1676.371	159	10.543		
		Total	1684.944	161			
	Evaluation	Between groups	69.048	2	34.524	1.850	.161
		Within groups	2967.397	159	18.663		
		Total	3036.444	161			
* p < .05							

Table 4: T-test results for students' scientific creativity and metacognitive awareness scores based on gender variable

	Group	N	Average	Standard Deviation	t	df	p
Scientific creativity	Female	83	27.29	16.12	-0.362	160	.718
	Male	79	28.42	23.06			
Metacognitive awareness	Female	83	99.64	26.74	-1.185	160	.238
	Male	79	104.65	27.05			

Table 4 shows the results of t-test that was carried out to determine how the students' scientific creativity and metacognitive awareness scores differed based on their gender. Based on the analysis, the p value corresponding to scientific creativity was .718 and that corresponding to cognitive awareness was .238 in relation to gender. That is, there was no statistically significant difference in the students' scientific creativity and metacognitive awareness scores by gender ($p > .05$).

5. Discussion, Conclusion and Recommendations

The present study was conducted as a descriptive survey to answer the research questions represent the focus of the study. When seeking for answers to the first research question — "What is the distribution of middle school students in relation to RIASEC categories?" — the RIASEC inventory was used for classification purposes, and the students were classified according to occupational orientation categories called RIASEC categories. As the findings of the study were analyzed in terms of single categories, it was found that most students (18.5%) were in the investigative category, and the students least frequently included in the realistic category (0.6%). The students were found to most frequently fall into the social category (16%) after the investigative category. These rates were followed by IS as binary categories (13.6%). In other words, nearly half of the students were identified to fall into these three categories. These findings promise hope for the creation of inquiry-based instructional environments in the school settings. This is because the students at the public school where the study was carried out perform science activities with limited facilities, and it is known that their courses are often conducted only through textbooks and far from an inquiry-based investigative structure. The fact that these students were searching for solutions to complex problems using theoretical frameworks or models when performing classroom activities is among the behaviors that were observed. Students can be given the opportunity to receive additional personalized activities in accordance with their long-term investigative professional interests with the help of effective inquiry activities conducted in these classroom environments. Because of the category they belong, these students are more likely to be a scientist or researcher in their later professional lives provided that proper professional guidance is offered to them. However, the students were rarely found to be in the realistic category. It can, therefore, be assumed that this sample of students were less interested in careers involving technical skills. On the other hand, this is important in terms of achieving the goals of the science curricula. This is because the goal of curricula is to educate responsible citizens who investigate and question through inquiry-based learning environments under the slogan of scientific literacy. Instructions that concentrate exclusively on the development of technical skills and favor instructional objectives achieved through close-ended experiments is unlikely to lead to an inquiry-based learning environment, and therefore, students are likely to fall behind the goals of the curriculum. A review of the small number of studies reporting findings specifically on RIASEC shows that sixth-graders were good in both investigative and realistic categories in a study conducted under different contexts of teaching subjects (Blankenburg et al. 2016), that students with high academic success performed well in all categories (Dierks et al. 2016), and that the level of conceptual understanding of high school students varied depending on their categories (Höft et al. 2019). The findings of the current study are only related to the first study mentioned above but contradict it, because the researchers found that the students were often good at the realistic category in addition to the investigative category.

It was found in the present study that both females and males were mostly in the investigative and social categories. In terms of both categories, females were seen to be ahead of males. A distinct difference between the females and males was seen particularly in the realistic category in favor of males. By contrast, Blankenburg et al. (2016) found that females were in realistic and artistic categories in all contexts, while males were interested in physical activities in the social category. Dierks et al. (2016) also confirmed that females were more interested in artistic and social categories. The finding that females are good in the social category is similar to the finding of this study. There were differences in the findings in terms of males being in the social category. In summary, it was concluded that the findings were similar in some aspects and different in some other aspects. It can be argued that this condition has arisen due, for example, to the fact that the studies were conducted in different countries, that the types of curricula of the schools where the students studied differed, that the studies included different groups of students, and that professional orientation tendencies of the countries were different. Because the aforementioned studies present a performance-based categorization process in general, the researchers discussed this situation through the nature of the activities used in that context rather than the context itself.

Tables 3 and 4 present the statistical analyses for the second research question of the present study, "Do the students' creativity and metacognitive awareness scores significantly differ depending on their RIASEC categories and grade levels?" Based on these analyses, it was found that the students' scientific creativity scores were not significantly different depending on RIASEC categories and grade levels (Table 3). Metacognitive awareness scores, however, were found to differ significantly depending on RIASEC categories and grade levels. Based on the ANOVA findings, the students' metacognitive awareness scores varied significantly at the $p < .0.5$ level depending on their RIASEC categories ($p = .045$) and grade levels ($p = .012$) (Table 3). In this difference, RIASEC categories were in favor of the students in only one category in comparison to the students in two categories. The students' scores on the sub-dimensions of the

Metacognitive Awareness Inventory were subjected to analysis of variance based on RIASEC categories. According to the results, there was a significant difference in the declarative knowledge ($F = 4.692$, $p = .045$) and procedural knowledge ($F = 3.153$, $p = .010$) sub-dimensions depending on the RIASEC categories of the students at $p < .05$ level (Table 4). In terms of the metacognitive regulation sub-dimension, only the monitoring scores ($F = 3.149$, $p = .046$) differed based on RIASEC categories at $p < .05$ significance level. No findings in the relevant literature could be found to be directly related to these findings. Instead, grade levels were found to be related to metacognition levels (Tüysüz et al. 2009). The sub-dimension of declarative knowledge, where a significant difference was observed, has been found to be a significant indicator of university students' math success (Kesici, Erdogan, & Ozteke, 2011). Declarative knowledge predicted 2.3% of the variance explained in that study. It was also found that procedural knowledge and evaluation knowledge predicted the success of high school students in geometry courses. On the basis of all these findings, the fact that there was a difference in professional interest, particularly in terms of monitoring skills, was considered to be important within the scope of the current study. It may be useful to more extensively explore the role of this skill — which allows metacognitive regulation in terms of monitoring of the learning process — in the process of professional interest and, more generally, in the process of personal interest development. On the other hand, further research findings are needed to clarify the fact that the students in only one category were significantly better than those in two categories in terms of metacognition.

A review of the t-test results showing how the scores of scientific creativity and metacognitive awareness among the students differed depending on their gender indicated no statistically significant difference (Table 4). In relation to this situation, mixed findings are found in the relevant literature. Similar to the findings of the present study, scientific creativity (Baysal et al. 2013) and metacognitive awareness (Tüysüz et al. 2008) were found not to differ significantly depending on gender. By contrast, Liliana and Lavinia (2011) found that eighth graders varied according to their metacognitive awareness scores. This difference was reported to be seen in metacognitive knowledge subcategories rather than in metacognitive regulation. Males and females were shown to be using their metacognitive knowledge and skills differently in the learning process. The researchers also showed that in general, 8th grade students who took part in that study used their metacognitive knowledge and skills when learning. Consequently, no specific conclusions could be reached about gender, and further research findings are needed on this issue.

In conclusion, the implications are that RIASEC categories can be useful in determining students' personal interests, that students can be offered professional guidance based on these categories, that the distribution in categories can provide a variety of information about students' metacognitive awareness, and more specifically provide information about declarative and procedural knowledge, monitoring knowledge, and potential relationships among them. Studies can be conducted to ascertain the role of various variables in this network of relationships in addition to demographic variables such as gender and grade level as well as to support these inferences. As in this study, more valid predictive studies can be conducted to incorporate RIASEC categories for enabling statistical procedures rather than employing the categories for classification purposes only. RIASEC data from this study were used only as categorical variables and statistical operations were conducted only through scores of creativity and metacognitive awareness. This is one of the limitations of the study. Additionally, in the three previous RIASEC studies mentioned earlier, professional vocational orientations of students were identified on the basis of performance, which also constitutes a limitation for the current study. In future studies, it may be recommended that RIASEC categories be measured based on performance rather than a descriptive list of personal interest categories.

References

Abd-El-Khalick, F., & Akerson, V. (2009). The influence of metacognitive training on preservice elementary teachers' conceptions of nature of science. *International Journal of Science Education*, *31*(16), 2161-2184.

Ainley, M., Hidi, S., & Berndorff, D. (2002). Interest, learning, and the psychological processes that mediate their relationship. *Journal of Educational Psychology*, *94*(3), 545.

Aktamıs, H., & Ergin, O. (2007). Investigating the relationship between science process skills and scientific creativity. *Hacettepe University Journal of Education*, *33*, 11-23.

Baraz, A. (2012). The effect of using metacognitive strategies embedded in explicit-reflective nature of science instruction on the development of pre-service science teachers' understandings of nature of science. *Unpublished master thesis, Middle East Technical University, Ankara*.

Baysal, Z. N., Kaya, N. B., & Üçüncü, G. (2013). Examination of scientific creativity level of fourth grade students in terms of several variables. *Journal of Educational Sciences*, *38*, 55-64.

Blankenburg, J. S., Höffler, T. N., & Parchmann, I. (2016). Fostering today what is needed tomorrow: Investigating students' interest in science. *Science Education*, *100*(2), 364-391.

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

Cetinkaya, G. (2012). Investigation of the relationship between pre-service science teachers' understandings of nature of science and their personal characteristics. *Social Sciences of Middle East Technical University, Ankara*.

Chen, A., Darst, P. W., & Pangrazi, R. P. (2001). An examination of situational interest and its sources. *British Journal of Educational Psychology*, *71*(3), 383-400.

Corlu, M. S., Capraro, R. M., & Capraro, M. M. (2014). Introducing STEM education: Implications for educating our teachers in the age of innovation. *Education and Science*, *39*(171), 74-85.

Demirci, C. (2007). The effects of the creative approach in the science teaching on achievement and attitude. *Hacettepe University Journal of Education*. 32: 65-75.

Dierks, P. O., Höffler, T. N., Blankenburg, J. S., Peters, H., & Parchmann, I. (2016). Interest in science: A RIASEC-based analysis of students' interests. *International Journal of Science Education*, *38*(2), 238-258.

Dierks, P. O., Höffler, T. N., & Parchmann, I. (2014). Profiling interest of students in science: Learning in school and beyond. *Research in Science & Technological Education*, *32*(2), 97-114.

Dinsmore, D. L., Alexander, P. A., & Loughlin, S. M. (2008). Focusing the conceptual lens on metacognition, self-regulation, and self-regulated learning. *Educational Psychology Review*, *20*(4), 391-409.

Duruk, U. (2017). The effect of metacognitive strategies embedded in contextualized nature of science instruction on preservice science teachers' understandings of nature of science and the retention of these understandings. (Unpublished PhD thesis). Adiyaman University, Adiyaman.

Efklides, A. (2011). Interactions of metacognition with motivation and affect in self-regulated learning: The MASRL model. *Educational Psychologist*, *46*(1), 6-25.

Erdoğdu, M. Y. (2006). Relationships between creativity, teacher behaviours and academic success. *Electronic Journal of Social Sciences*, *5*(17), 95-106.

Falk, J. H., Storksdieck, M., & Dierking, L. D. (2007). Investigating public science interest and understanding: evidence for the importance of free-choice learning. *Public Understanding of Science*, 16, 455-469.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist*, *34*(10), 906.

Göksun, D. O., & Kurt, A. A. (2017). The relationship between pre-service teachers' use of 21st century learner skills and 21st century teacher skills. *Education and Science*, *190*, 107-130.

Griffin, P., & Care, E. (Eds.). (2014). *Assessment and teaching of 21st century skills: Methods and approach*. Springer.

Hidi, S., & Harackiewicz, J. M. (2000). Motivating the academically unmotivated: A critical issue for the 21st century. *Review of Educational Research*, *70*(2), 151-179.

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational psychologist*, *41*(2), 111-127.

Holland, J. L. (1966). The psychology of vocational choice: A theory of personality types and model environments. Waltham, MA: Blaisdell.

Höft, L., Bernholt, S., Blankenburg, J. S., & Winberg, M. (2019). Knowing more about things you care less about: Cross-sectional analysis of the opposing trend and interplay between conceptual understanding and interest in secondary school chemistry. *Journal of Research in Science Teaching*, *56*(2), 184-210.

Hu, W., & Adey, P. (2002). A scientific creativity test for secondary school students. *International Journal of Science Education*, *24*(4), 389-403.

Kadayıfçı, H. (2008). Yaratıcı düşünmeye dayalı öğretim modelinin öğrencilerin maddelerin ayrılması ile ilgili kavramları anlamalarına ve bilimsel yaratıcılıklarına etkisi. *Yayınlanmamış Doktora Tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara*.

Karatas, S., & Ozcan, S. (2010). The effects of creative thinking activities on learners' creative thinking and project development skills. *Journal of Kirsehir Education Faculty*, *11*(1), 225-243.

Kesici, S., Erdogan, A., & Özteke, H. I. (2011). Are the dimensions of metacognitive awareness differing in prediction of mathematics and geometry achievement?. *Procedia-Social and Behavioral Sciences*, *15*, 2658-2662.

Kılıc, B., & Tezel, O. (2012). Determining scientific creativity levels of 8th grade students. *Journal of Turkish Science Education*, *9*(4), 84-101.

Krapp, A. (2003). Interest and human development: An educational-psychological perspective. *Development and Motivation*, *2*, 57-84.

Krapp, A., Hidi, S., & Renninger, K. A. (1992). Interest, learning, and development. In K. A. Renninger, S. Hidi, & A. Krapp (Eds.), The role of interest in learning and development (pp. 3-25). Hillsdale, NJ: Erlbaum.

Liliana, C., & Lavinia, H. (2011). Gender differences in metacognitive skills. A study of the 8th grade pupils in Romania. *Procedia-Social and Behavioral Sciences*, *29*, 396-401.

Liu, S. C., & Lin, H. S. (2014). Primary teachers' beliefs about scientific creativity in the classroom context. *International Journal of Science Education*, *36*(10), 1551-1567.

Peters, E., & Kitsantas, A. (2010). The effect of nature of science metacognitive prompts on science students' content and nature of science knowledge, metacognition, and self-regulatory efficacy. *School Science and Mathematics*, *110*(8), 382-396.

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In *Handbook of self-regulation* (pp. 451-502). Academic Press.

Sackes, M., & Trundle, K. C. (2017). Change or durability? The contribution of metaconceptual awareness in preservice early childhood teachers' learning of science concepts. *Research in Science Education*, *47*(3), 655-671.

Schiefele, U. (2009). Situational and individual interest. *Handbook of motivation at school*, 197-222.

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in science education*, *36*(1-2), 111-139.

Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology*, *19*(4), 460-475.

Sungur, S., & Senler, B. (2009). An analysis of Turkish high school students' metacognition and motivation. *Educational Research and Evaluation*, *15*(1), 45-62.

Swarat, S., Ortony, A., & Revelle, W. (2012). Activity matters: Understanding student interest in school science. *Journal of Research in Science Teaching*, *49*(4), 515-537.

Torrance, E. P. (1995). Insights about creativity: Questioned, rejected, ridiculed, ignored. *Educational Psychology Review*, *7*(3), 313-322.

Tüysüz, C., Karakuyu, Y., & Bilgin, I. (2008). Öğretmen adaylarının üst biliş düzeylerinin belirlenmesi. *Abant İzzet Baysal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *17*, 147-158.

Tytler, R., Osborne, J., Williams, G., Tytler, K., & Cripps Clark, J. (2008). Opening up pathways: Engagement in STEM across the primary-secondary school transition. Melbourne, Australia: Deakin University.

Young, A. E. (2010). *Explorations of metacognition among academically talented middle and high school mathematics students* (Doctoral dissertation, UC Berkeley).

Yuruk, N., Beeth, M. E., & Andersen, C. (2009). Analyzing the effect of metaconceptual teaching practices on students' understanding of force and motion concepts. *Research in Science Education*, *39*(4), 449-475.

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology*, *81*(3), 329.

Zohar, A., & David, A. B. (2009). Paving a clear path in a thick forest: A conceptual analysis of a metacognitive component. *Metacognition and Learning*, *4*(3), 177-195.

Creative Commons licensing terms
Author(s) will retain the copyright of their published articles agreeing that a Creative Commons Attribution 4.0 International License (CC BY 4.0) terms will be applied to their work. Under the terms of this license, no permission is required from the author(s) or publisher for members of the community to copy, distribute, transmit or adapt the article content, providing a proper, prominent and unambiguous attribution to the authors in a manner that makes clear that the materials are being reused under permission of a Creative Commons License. Views, opinions and conclusions expressed in this research article are views, opinions and conclusions of the author(s). Open Access Publishing Group and European Journal of Education Studies shall not be responsible or answerable for any loss, damage or liability caused in relation to/arising out of conflicts of interest, copyright violations and inappropriate or inaccurate use of any kind content related or integrated into the research work. All the published works are meeting the Open Access Publishing requirements and can be freely accessed, shared, modified, distributed and used in educational, commercial and non-commercial purposes under a Creative Commons Attribution 4.0 International License (CC BY 4.0).