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AN INVESTIGATION OF THE MIDDLE SCHOOL SCIENCE TEXTBOOKS IN TERMS OF CREATIVE THINKING AND CRITICAL THINKING SKILLS

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ABSTRACT

The aim of this study is to investigate creative thinking and critical thinking skills through the tasks contained in 5th, 6th, 7th, and 8th-grade science textbooks in the 2020-2021 academic year in Turkey. The research utilized document analysis as a qualitative method, and data were collected through the descriptive analysis method. In this study, themes related to creative and critical thinking skills were utilized from the '21st Century Learning and Innovation Skills Themes' developed by the researchers as the data collection tool to assess textbooks. The themes were generated based on a review of literature and verified by experts. The status of both skills in the textbooks was presented in tables for years and tasks; Science Engineering Applications and Activities. Although the number of Science Engineering Applications is lower than Activities, they are more promising for these skills. The low frequency of themes emphasizing problems in both skills indicates a lack of challenging situations. The reason for the low frequency of themes in activities is that they primarily take the form of demonstration activities where students are passive through auditory and visual means. As the years progress, both the number of tasks and the intensity of themes with which these tasks incorporate increases.

Keywords: Science textbooks, middle school, creative thinking skill, critical thinking skill

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ORTAOKUL FEN BİLİMLERİ DERS KİTAPLARININ YARATICI DÜŞÜNME VE ELEŞTİREL DÜŞÜNME BECERİLERİ AÇISINDAN İNCELENMESİ

ÖZET

Bu araştırmanın amacı 2020–2021 eğitim-öğretim yılında basılmış olan 5., 6., 7. ve 8. sınıf Fen Bilimleri ders kitaplarında yer alan faaliyetlerin yaratıcı düşünme ve eleştirel düşünme becerileri açısından incelenmesidir. Nitel yöntemlerden doküman incelemesi yapılan araştırmada toplanan veriler betimsel analiz yöntemiyle incelenmiştir. Çalışmada veri toplama aracı olarak ders kitaplarında becerilerin düzeyini belirlemek için araştırmacılar tarafından geliştirilen "21. Yüzyıl Öğrenme ve Yenilikçilik Beceri Temaları"ndan yaratıcı ve eleştirel düşünme becerilerine yönelik temalar kullanılmıştır. Becerilerinin kitaplarda yer alma durumları frekanslar bazında tablolarda sunulmuş, ünitelerdeki ve faaliyetlerdeki dağılımları incelenmiştir. Fen Mühendislik Uygulamalarının (FMU) sayılarının Etkinliklerden az olmasına rağmen bu becerileri daha çok içerdiği görülmüştür. Her iki beceride de problemlere vurgu yapan temaların düşük olması, öğrenciler için zorlayıcı durumların eksikliğini göstermektedir. Etkinliklerde yer alan temaların düşük olmasının nedeni, bu etkinliklerin genellikle öğrencilerin sadece işitsel ve görsel yollarla pasif olarak katıldıkları gösteri etkinlikleri şeklinde olmalarıdır. Yıllar ilerledikçe, hem faaliyetlerin sayısı hem de bu içerdikleri temaların yoğunluğunun arttığı görülmektedir.

Anahtar Kelimeler: Fen Bilimleri ders kitabı, ortaokul, yaratıcı düşünme becerisi, kritik düşünme becerisi.

1. INTRODUCTION

In today's information society, the skills of comprehending, memorizing, and utilizing information could be more satisfactory in meeting the future needs of individuals to sustain their lives. In this era, where individuals need to be active, open to innovation, and competitive, they must possess higher-order thinking skills such as inquiry, exploration, criticism, analysis, synthesis, evaluation, and design. It is now significant to develop these crucial skills while acquiring knowledge (Yılmaz, 2016). Nowadays, skills in using knowledge are considered more important than acquiring it. According to Temizkan (2014), skills are abilities that individuals can generally acquire through formal education and utilize throughout their lives.

Among the skills individuals need to possess are those referred to as "21st Century Learning Skills" are gaining importance in the education. 21st-century skills are a set of abilities developed based on the lifelong learning approach, encompassing the skills individuals need or will need not only in their school life but also in their personal and professional lives to succeed (Partnership for 21st Century Skills, 2019). These skills were listed as critical thinking, creativity, problem solving, collaboration, and communication skills. Among these skills, creative and critical thinking skills are regarded as the primary cognitive abilities for the current century (OECD, 2009). Indeed, the consideration of creativity and critical thinking as fundamental educational objectives has gained prominence in various countries, including both developed and developing nations, with a particular emphasis on advanced societies (Shaheen, 2010; Taylor et al., 2022).

Creativity is a process aimed at generating original ideas and solutions by utilizing relationships between existing concepts (Torrence, 1984). Yalçın (2018) has defined it as working to create an interesting situation using unusual or unconventional circumstances. It has been characterized as a lifelong skill directly associated with the capacity to express oneself, use intelligence, and employ imagination (Craft, 2003). According to his hierarchy of needs, Maslow (1943) stated creativity as a process experienced by individuals who have fulfilled their basic needs, especially during the self-actualization phase. Creative thinking is innate and present in every individual, and it can be developed through educational environments (Yeşilyurt, 2021). Critical thinking, on the other hand, is not an innate characteristic; it can be acquired and developed through various means (Nosich, 2012). Critical thinking is a cognitive process that involves synthesis and evaluation, enabling easy access to information and the resolution of encountered difficulties (Moore, 2001). Merely acquiring knowledge is insufficient; individuals must possess the ability to evaluate it based on its clarity, precision, accuracy, relevance, depth, breadth, logical consistency, and significance, which are named critical thinking standards (Nosich, 2012; Paul & Elder, 2006). These standards involve a range of skills that include analyzing facts, structuring thoughts, making comparisons and arguments, and drawing conclusions (Özdemir, 2005). Hence, it is a complex cognitive process that involves both inductive and deductive reasoning, as well as creative elements, all working together across various stages of the problem-solving process (Linn, 2000; Philley, 2005).

In recent years, there has been a revision in educational programs and curriculums in many countries towards emphasizing 21st-century skills, aiming to cultivate individuals equipped with the knowledge and skills demanded by the contemporary era. In Turkey, one of the updated curriculums in line with this perspective is the Science Education Curriculum. The first curriculum developed based on a constructivist approach and focusing on processes rather than end products was the 2005 Science and Technology Education Curriculum, aligning with a lifelong learning perspective and emphasizing research and inquiry (Çolak, 2018). During this period, the objective was to nurture individuals who are adept at learning, tolerant of differences, approach events from a scientific perspective, and possess advanced problem-solving, critical thinking, and decision-making skills, thus becoming literate in science and technology (MEB, 2005). This program has undergone revisions in response to evolving needs in 2013 and 2017. The fundamental vision of the 2013 science curriculum was to nurture scientific literacy in students (MEB, 2013). Within the curriculum, four learning domains were established: "Knowledge, Skills, Attitudes, and STSE (Science Technology Society Environment)." The skills dimension encompassed life skills, including creative thinking, decision-making, analytical thinking, communication, teamwork, and entrepreneurship. The life skills embedded in the Science 2013 curriculum align with the 21st century learning and innovation skills (Anagün, Kılıç, Atalay, & Yaşar, 2015). In the 2017 curriculum revision, domain-specific skills were supplemented with engineering and design skills, alongside life skills. The updated curriculum's inclusion of life skills, engineering and design skills aligns with 21st-century learning and innovation skills (MEB, 2017). The transition from

the 2005 science curriculum to the 2017 curriculum highlighted the increasing importance of 21st-century skills, with these skills featuring more prominently in objectives and content (Çolak, 2018).

In line with the updated objectives, content, teaching-learning processes, and assessment components of each curriculum, textbooks to be used in schools have also been revised. In recent years, science textbooks have been developed in accordance with a constructivist approach, which is based on inquiry strategies, and they are prepared and updated in line with the specified learning domains in the curriculum (Kahveci, 2020). Essentially, textbooks are considered to be essential and effective materials that facilitate the achievement of desired goals and skills in students through the curriculums. In this regard, Karamustafaoğlu et al. (2005) stated that students benefit from textbooks as a teaching tool with a rate of 70% or more. Textbooks, which have been used at all levels of education for many years, should also incorporate the 21st-century skills that students need to acquire in accordance with the objectives of new curriculums (Gültekin, 2019). Textbooks that are widely used in educational environments should provide content and activities that adequately support 21st-century skills and should be able to guide students in this context. However, studies in this subject emphasize that books are not sufficient for skill development. For example, Alın Uran (2019) examined the activities in science textbooks for grades 5, 6, 7, and 8 in terms of domain-specific skills specified in the 2018 curriculum (scientific process skills, life skills, and engineering skills) and found that the contents did not sufficiently align with the curriculum. It was noted that the level of inclusion of activities related to life skills, which are frequently emphasized in the curriculum, was low. Furthermore, it was stated that as the grade level increased, there was an increase in the frequency of this skill in the activities, but this increase was not at the desired level. Sarıtaş (2019), on the other hand, examined the activities in 5th, 6th, 7th, and 8th-grade textbooks in terms of critical thinking standards and stated that the activities in the textbooks were more aligned with standards related to clarity and accuracy rather than other standards such as importance/relevance, sufficiency, depth/breadth, and precision. While the curriculum aims to develop critical thinking skills, it was expressed that the content of textbooks did not adequately reflect this goal.

Due to the 21st-century skills being essential for lifelong learning, it is crucial for students to acquire these skills to develop effectively for their future. Middle school level represents a fundamental stage in formal education, and educators bear the responsibility of not only facilitating academic knowledge but also fostering the development of 21st-century skills that students will use throughout their lives (Shin & Lee, 2008). Considering that students begin their effective science education in this level, and that they establish essential knowledge and skills during this period, it is important to provide effective materials during these years. Textbooks, in particular, are significant tools for imparting skills such as creative and critical thinking in science classes.

Therefore, this research holds significance in providing insights into the extent to which middle school science textbooks incorporate these skills that students should acquire from an early age. In this context, this study examines middle school Science textbooks in Turkey in terms of 21st-century learning and innovation skills, specifically focusing on the presence of creative thinking and critical thinking

skills. The study aims to answer the question, "To what extent do Science textbooks in Turkey include creative thinking skills and critical thinking skills, which are part of 21st-century learning and innovation skills?

2. METHOD

2.1. Research Design

This study had a qualitative research design, and data were collected through document analysis. It involves the examination and analysis of written materials containing information about the phenomena under investigation (Yıldırım & Şimşek, 2018). The choice of document analysis method is driven by the research's objective, which is to examine sources in the literature to identify themes defining creativity and critical thinking skills among the 21st-century skills and to analyze the activities present in middle school Science textbooks used in Turkey during the 2020-2021 academic year in terms of these skills. To achieve this objective, the study is carried out in two stages. In the first stage, national and international studies related to creativity and critical thinking skills was reviewed, and main topics and subthemes containing expressions related to these skills were identified. In the second stage, Science textbooks are examined using a checklist developed based on the identified themes, and the findings were interpreted. This study presents a portion of a more comprehensive research that encompasses all learning and innovation skills.

2.2 Development Process of Creativity and Critical Thinking Skills Themes and Checklist

To determine the presence of 21st-century learning and innovation skills in Science textbooks, the researcher developed the "Themes of 21st-Century Learning and Innovation Skills (21st-CLIS)" containing items and themes that describe each skill. The draft items defining the skills were created based on the theoretical framework in the relevant literature, national and international research results, and measurement tools (Atlı, 2019; Çevik & Şentürk, 2019; Çolak, 2018; Gülen, 2013; Saban, 2002; Karakaş, 2015; Seferoğlu & Akbıyık, 2006; Bolat & Balaman, 2017; Gültekin, 2019; Temizkan, 2014; McKay et al., 2012; Yıldız et al., 2017; Baker & Shaw, 1987; Eryılmaz & Ulusoy, 2015; Önür, 2019; Özdemir, 2005; Özgün, 2019; Torrance, 1984; Guilford, 1983; Craft, 2003; Dilekçi, 2021; Facione, 1990; Norris, 1985; Turan, 2019; Paul, 1991; Ennis, 1987; Gibson & Mitchell, 1995; Şahin, 1998; Bayram, 2013; Buluş et al., 2017; Canary & Brain, 1987; Çamlıyer & Çamlıyer, 1997; Owen & Bugay, 2014; Kayapınar, 2017; Aktaş & Yılmaz, 2017; Kaya & Taştan, 2020). Learning and innovation skills are categorized under four subheadings: creativity, critical thinking, communication, and collaboration skills. Table 1 presents the themes that emerged in this study focusing on creative thinking and critical thinking skills. Themes representing each skill were derived from the theoretical definitions and research in the field in the document analysis process. After the themes were identified, the checklist was reviewed by two experts working in this field to assess its content validity. Themes derived from the studies on a skill and their probable indicators in activities and educational processes were presented

under each heading in Table 1. For example, “Developing numerous unique solutions.” and “Finding original solutions to challenges.” are the themes emerged for creative thinking skills. Additionally, “Transferring experiences to different situations” and “Postponing decisions when evidence and reasons are insufficient” are the themes appeared for critical thinking skills. These themes were used as a checklist by the researchers during the investigation of the content in the textbooks, and frequencies were given to the findings as 1 and 0 based on whether the content was present for each theme.

Table 1. The themes for creative and critical thinking skills

Creative Thinking Skills Themes		Critical Thinking Skills Themes:	
C1	Generating original, valuable, and useful products	CT1	Organizing structured, active mental processes
C2	Establishing cause-and-effect relationships among events.	CT2	Eliminating contradictory contradictions
C3	Developing numerous unique solutions.	CT3	Consistent approach
C4	Finding original solutions to challenges.	CT4	Transferring experiences to different situations
C5	Identifying the causes of problems.	CT5	Looking at events, situations, and topics with a questioning eye
C6	Being sensitive to non-existent situations.	CT6	The idea of dealing with the problem
C7	Demonstrating sensitivity towards problems.	CT7	Not allowing information pollution and negative influence
C8	Recognizing strengths and weaknesses.	CT8	Asking questions to oneself and testing
C9	Approaching familiar things with skepticism.	CT9	Making relationships between dimensions of thought
C10	Recognizing unsettling gaps.	CT10	Postponing decisions when evidence and reasons are insufficient
C11	Making assumptions and modifying when necessary.	CT11	Making inferences
C12	Harnessing the power of imagination.	CT12	Classifying information
C13	Creating new connections among relationships.	CT13	Recognizing similarities and differences
C14	Employing analytical thinking while generating ideas.	CT14	Interpreting values and attitudes
C15	Examining relationships and situations from different perspectives and drawing conclusions	CT15	Respecting individuals who do not think like oneself
		CT16	Not ignoring the problem
		CT17	Analytical and conscious judgments for evaluation
		CT18	Justifying and defending obtained results
		CT19	Making logical predictions

2.3. Selection and Analysis Process of Textbooks

The study group of the research consists of the 5th, 6th, 7th, and 8th-grade Science textbooks developed by private publishing houses in the control of Ministry of National Education and distributed free of charge to middle schools in the 2020-2021 academic year in Turkey. The study group was determined using purposive sampling, which is a method used in qualitative research to explore and explain phenomena and events. In selecting the textbooks to be examined in the document analysis, the

aim was to focus on the Science textbooks distributed to schools by the Ministry of National Education in the 2020-2021 academic year, and to include only one textbook from each grade level. Table 2 lists the books and the number of tasks investigated in this study. The contents in the Science textbooks in all grades are organized in units. In this study, only the status of tasks provided within and at the end of each unit under the headings of 'Activities' and “Science and Engineering Applications” (SEA) was examined, and the instructional sections were not included in the study. These sections are mostly text based, focusing on to provide necessary content that the students need to learn passively. On the other hand, the tasks in the textbook have a higher potential and purpose in supporting the skills covered within the scope of the study. As seen in Table 2, In this study, a total of 147 tasks from the four textbooks were analyzed.

Table 2. The science textbooks and number of tasks ınvestigated ın this study

Title	Publisher	Activity *f*	SEA *f*
5. Fen Bilimleri Ders Kitabı	SDR Dikey Yayıncılık	25	3
6. Fen Bilimleri Ders Kitabı	Sevgi Yayıncılık	40	8
7. Fen Bilimleri Ders Kitabı	Tutku Yayıncılık	26	6
8. Fen Bilimleri Ders Kitabı	SDR Dikey Yayıncılık	32	7
	Total	123	24

In the study, data were analyzed using the descriptive analysis method, and they were interpreted by the researcher according to the predetermined themes. The frequencies of themes related to creative and critical thinking skills were determined by analyzing the indicators within the tasks. For example, indicators suggesting the presence of Theme C1, such as terms like product design, originality, and project mentioned within the activities or SEAs, were considered as indicators for this theme and coded as 1. Similarly, statements such as recognizing contradictions and identifying anomalies indicated the presence of Theme CT2. To ensure reliability, three activities were randomly selected from all textbooks and examined by another researcher who is a Science teacher and has a master's degree in Science Education. The interrater reliability rates obtained from the activities examined by the two coders were found to be in the range of 80% to 100% for both skill themes in all textbooks, which is considered a sufficient level of reliability according to Miles and Huberman (1994).

3. FINDINGS

This section presents the findings and interpretations obtained from the research. Firstly, the numbers of activities and SEAs found in the textbooks at the class and unit levels are summarized. Subsequently, the presence of activities and SEAs related to creative and critical thinking skills in all units is examined. Each book consists of a total of 7 units. Table 3 presents the frequencies of activities and SEAs in the books according to grade levels.

3.1. The Tasks in the Textbooks; Activities and SEAs

Table 3 shows that the distributions of activities and SEAs vary by grades and units, and are generally not homogeneous. It is noticeable that in some units, there are very few SEAs and activities. For example, in the 5th-grade book, Unit 1, titled as 'World of Living Beings,' covers no activities and the whole book presents only 1 SEA. When units are generally examined, it becomes evident that the frequencies of SEAs are much lower than the frequencies of activities.

Table 3. The frequencies of activities and SEAs in the science textbooks

	5th Grade Science Textbook		6th Grade Science Textbook		7th Grade Science Textbook		8th Grade Science Textbook	
	Activity	SEA	Activity	SEA	Activity	SEA	Activity	SEA
Unit 1	0	2	0	2	0	1	2	1
Unit 2	1	0	3	1	1	0	3	1
Unit 3	2	1	5	0	6	1	3	1
Unit 4	9	0	9	2	5	2	10	1
Unit 5	7	0	12	2	7	1	2	1
Unit 6	4	0	6	0	2	0	7	1
Unit 7	2	0	5	1	5	1	5	1
Total Frequency	25	3	40	8	26	6	32	7

3.2. Findings Regarding Creative Thinking Skill Themes

The high-frequency (occurring 20 times or more in at least one textbook) and low-frequency (not occurring at least 20 times in none of the textbooks) creative thinking themes in science textbooks are presented in Table 4. In addition, Figure 1 represents the cumulative frequency of themes in each grade. It is observed that the most prominent skill themes in activities and SEAs are 'establishing cause-effect relationships among events (C2),' 'creating new connections among relationships (C13),' 'harnessing the power of imagination (C12),' and 'examining relationships and situations from different perspectives and drawing conclusions (C15).' Upon closer examination of these themes, it becomes evident that they are interconnected. A student attempting to establish cause-effect relationships will also utilize their imagination in the process of creating new patterns among variables. Subsequently, they will make unique inferences during the evaluation stage. The content in the activities and SEAs in the textbooks largely expects students to establish cause-effect relationships in events and connections among variables. Activities primarily aim to enhance abstract thinking, problem-solving, experimentation, reverse thinking, and predictive reasoning skills. The skill theme with the least representation in activities and SEAs is 'making assumptions and modifying when necessary (C11).' This skill theme aligns with scientific process skills, expecting students to formulate hypotheses regarding problems. It is observed that very few activities are problem-based, and the SEAs featured in the textbooks are more geared towards the design process rather than scientific processes. It is evident that the opportunity for students to encounter challenging situations where they can generate original solutions and develop sensitivity towards problems is limited, especially in activities with lower frequencies. Furthermore, the skill themes with the least frequencies are 'finding original solutions to

challenges (C4),' 'identifying the causes of problems (C5),' 'being sensitive to non-existent situations (C6),' and 'demonstrating sensitivity towards problems (C7).' Overall, the activities in the textbooks tend to focus on solutions rather than delving into the causes of existing problems. Insufficient emphasis is placed on fostering empathy and sensitivity towards problems, which are crucial aspects of these skill themes in the provided tasks.

Table 4. The high and low-frequency creative thinking themes in science textbooks

		Science Textbooks			
		5th Grade	**6th Grade**	**7th Grade**	**8th Grade**
		f	*f*	*f*	*f*
High-frequency creative thinking themes in books occurrences	C2	28	46	31	39
	C3	16	32	27	34
	C8	14	34	22	27
	C10	18	37	28	29
	C12	24	46	28	35
	C13	28	48	32	39
	C14	9	19	27	16
	C15	26	45	31	38
Low-frequency creative thinking themes in books occurrences	C1	6	12	10	10
	C4	5	9	7	8
	C5	6	9	7	7
	C6	14	15	9	13
	C7	6	9	8	9
	C9	9	18	18	13
	C11	2	8	6	9

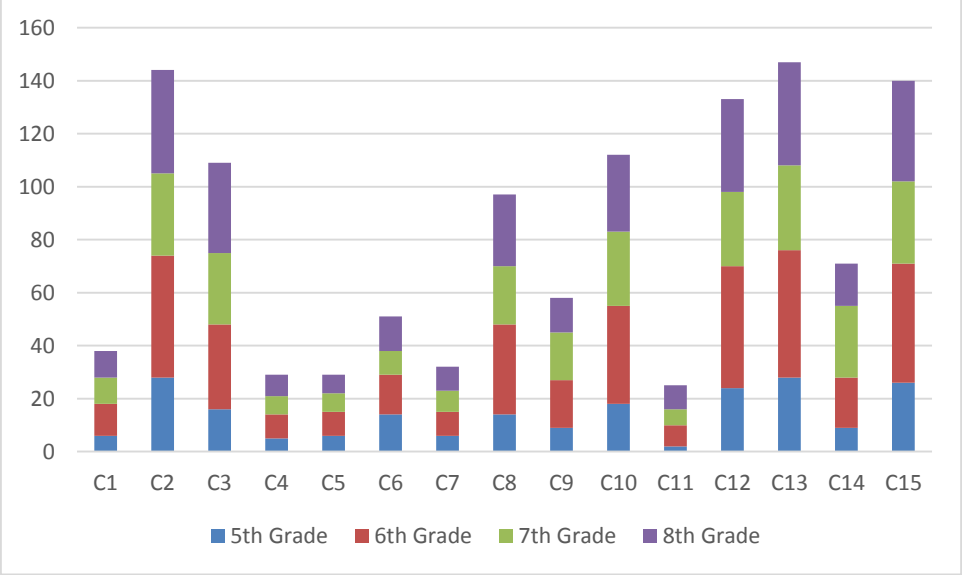

Figure 1. The cumulative frequency graph of creative thinking themes in the books

3.3. Findings Regarding Critical Thinking Skill Themes

The frequencies of the critical thinking skill themes in the textbooks are compared by class presented in Table 5 and Figure 2. As shown in Table 5, it can be observed that the most prominent skill themes in activities and SEAs are 'making relationships between dimensions of thought (CT9)' and 'making inferences (CT11)'. Following these themes are 'recognizing similarities and differences (CT13)', 'analytical and conscious judgments for evaluation (CT17)', and 'justifying and defending obtained results (CT18)'. These themes involve skills in making inferences, establishing connections, evaluating, justifying, and questioning. These skills are related to students' observations and the results they obtain. The skill themes with high frequencies are mostly found in the evaluation sections of activities, where students are asked questions such as '...what changes occurred? Explain.', '...discuss with your friends.', 'What is the reason for this difference? Explain.', 'What kind of relationship exists? Explain.' These processes involve the specified themes in the task.

The skill theme 'looking at events, situations, and topics with an inquiring eye' (CT5) is covered to a low extent in all textbooks except the 7th-grade science book. The reason for the relatively high frequency of CT5 skill theme in the 7th-grade science book compared to other textbooks is primarily the discussion technique included in the final part of most activities. This technique includes skills such as questioning, asking questions, reasoning, and reflecting, which are the indicators of inquiry.

When activities and SEAs are compared, it is seen that SEAs more frequently cover the themes compared to activities. CT11 is found in all activities and SEAs, and this skill is notably common in the evaluation section of experiments. Some themes such as 'interpreting values and attitudes' (CT13), have very low frequencies (CT3, CT10, CT14). These themes may be included in experiments or activities where students are communicating with each other. In the 5th-grade science book, there are very few activities that include social activities or opportunities for students to work together and create. CT3 and CT7 are the critical thinking skill themes with the lowest frequency. Activities generally do not sufficiently include these themes. Similarly, the frequencies of CT6 and CT16 skill themes in activities are low. These themes involve the ability to be sensitive to and cope with problems, nourished by responsibility and empathy feelings. It has been observed that these skill themes are included in activities involving social projects, student interactive work, and active group tasks.

Table 5. The high and low-frequency critical thinking themes in science textbooks

		Science Textbooks			
		5th Grade	**6th Grade**	**7th Grade**	**8th Grade**
		f	*f*	*f*	*f*
High-frequency critical thinking themes in books occurrences	CT1	11	30	19	23
	CT5	6	19	28	12
	CT9	27	43	26	38
	CT11	28	48	32	39
	CT12	7	13	32	15
	CT13	19	33	28	34
	CT17	19	31	31	31
	CT18	20	25	30	30
Low-frequency critical thinking themes in books occurrences	CT2	6	14	12	11
	CT3	2	6	5	1
	CT4	6	16	9	11
	CT6	5	9	6	8
	CT7	4	7	3	7
	CT8	4	9	6	8
	CT10	2	8	10	7
	CT14	2	5	23	8
	CT15	4	10	24	8
	CT16	5	10	7	8
	CT19	12	18	11	9

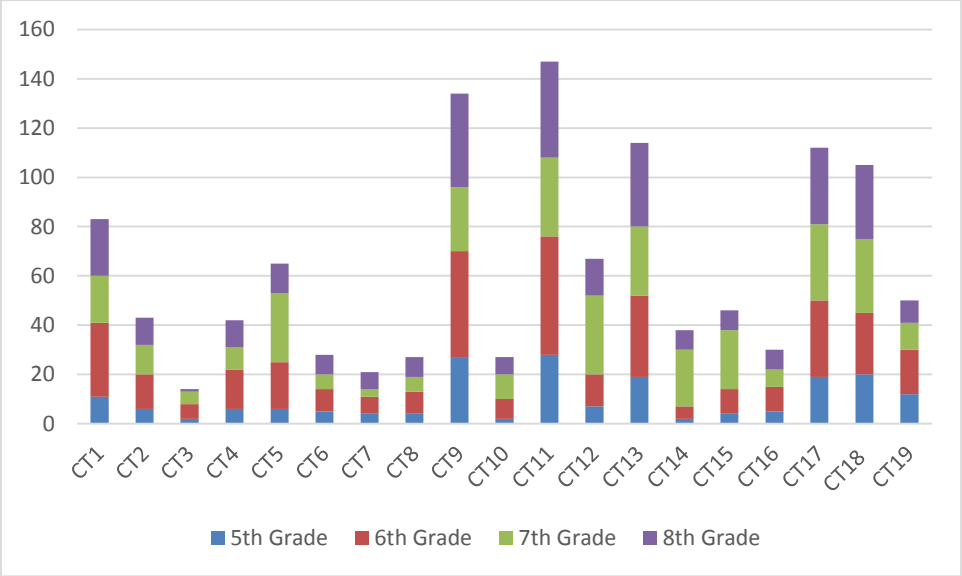

Figure 2. The cumulative frequency graph of critical thinking themes in the books

3.4. Findings Regarding Detailed Investigations of Science Textbooks

Table 6 presents the frequencies of skill themes in each textbook by unit, as well as the tasks they contain. It is evident that SEAs in all science textbooks contain a greater variety of creative thinking

skill themes compared to activities. Design cycle steps have been provided in the introduction section or at the end of the unit in the textbooks as guidelines for SEAs. These design cycle steps given as guidance for SEAs overlap with the creative thinking skill themes created by the researcher. Thus, SEA activities highly encompass creative thinking skill themes. Interesting findings have also been obtained in grade-based comparisons.

In the 5th-grade science textbook, it can be observed that the activities in the 6th unit contain a high level of skill themes (*f*=15). Three out of the four activities in this unit actively involve students in project processes, which support creative thinking. In the 6th-grade science textbook, it is seen that the highest number of skill themes is found in an activity in the 5th unit titled "Design a Soundproof Environment," and this activity expects students to work actively in groups to achieve a product (*f*=11). When examining the 7th-grade science textbook, it is noticed that the units contain skill themes above the average. The discussion method is mostly preferred in the activities in this textbook and it involves an active process that encourages students to think. It aligns with many themes of creative thinking skills. The activity that addresses the most skill themes is the activity of the 4th unit titled "Pure Substances and Mixtures." This activity, compared to other activities, includes a project process and involves social activities. In the 8th-grade science textbook, the activity that encompasses the most skill themes is an activity of the 6th unit titled "Energy Transformations and Environmental Science." In this activity, provided under the heading of "Recycling," students gain environmental awareness as well as the creativity and critical thinking skills.

In terms of critical thinking skills, Table 6 shows that SEAs incorporate critical thinking skills more effectively compared to activities, thanks to their design and product creation processes. SEAs, with their design implementation steps, not only facilitate the emergence of new products but also encourage students to identify problems, conduct analysis, establish relationships, engage in reflection, benefit from their experiences, and adopt a questioning perspective on events. SEAs engage students physically and mentally, drive them to adopt a questioning perspective in problem-solving processes, and encourage them to seek different and novel designs, which is why they encompass critical thinking skill themes to a greater extent. On the other hand, it is noted that, in general, the activities in all science textbooks have a lower frequency of addressing critical thinking skill themes. Activities predominantly expect students to explain and infer observations' results. It is important that the activities in the textbooks, like SEAs, focus more on problem-solving, prompting students to think, as this contributes significantly to enhancing students' critical thinking skills.

In the 5th-grade science book, it can be observed that the highest level of skill themes is addressed in the first three activities of the 6th unit titled "Human and Environment." Two of these activities involve obtaining a product and include a discussion process, while one involves the process of designing a project. These activities, where students actively engage, share their experiences, and grapple with problems, largely encompass critical thinking skill themes. In the 6th-grade science book, it is noted that the activity titled "Design a Soundproof Environment" in the 5th unit contains a high

frequency of skill themes. In this activity, students collaborate to design the best soundproof environment, which involves a cooperative learning process and significantly addresses critical thinking skill themes. Furthermore, when comparing the activities in the 6th unit of the book, the activity titled "What Happened to Me?" stands out for its high frequency of skill themes. This activity involves a social experiment based on disabled individuals and addresses various skill themes. Unfortunately, the 7th-grade science textbook activities do not frequently address critical thinking skill themes, with many of them addressing less than half of the skill themes. However, it is noteworthy that one of the activities in the 4th unit encompasses all skill themes. This activity involves a social activity that emphasizes cooperation, collaboration, and assistance, contains a project evaluation form, and encompasses preparation, implementation, and evaluation stages. Such activities provide the necessary content for acquiring critical thinking skills. Finally, when reviewing the 8th-grade science book, it is found that the units have a lower rate of addressing critical thinking skill themes. The activity under the title "Recycling" has a higher frequency of addressing the themes compared to other activities. In this activity, similar to SEAs, research is conducted towards problem-solving, students actively participate, and they generate solutions.

Table 6. The skill theme frequencies observed in SEAs and activities in science textbook units

The Grade of Science Textbook	Units	Task	Number of task *f*	Creative thinking skill themes *f*	Critical thinking skill themes *f*
5th Grade	1. The Sun, Earth, and the Moon	SEA	2	14	14
		Activity	0	-	-
	2. The World of Living Beings	SEA	0	-	-
		Activity	1	6	6
	3. Measuring Force and Friction	SEA	1	14	13
		Activity	2	6	5
	4. Matter and Change	SEA	0	-	-
		Activity	9	8	6
	5. Propagation of Light	SEA	0	-	-
		Activity	7	8	6
	6. Humans and the Environment	SEA	0	-	-
		Activity	4	15	16
	7. Elements of Electrical Circuits	SEA	0	-	-
		Activity	2	4	5
6th Grade	1.Solar System	SEA	2	15	18
		Activity	0	-	-
	2. Systems in Our Body	SEA	1	15	15
		Activity	0	9	10
	3. Force and Motion	SEA	0	-	-
		Activity	5	6	6
	4. Matter and Heat	SEA	2	15	15
		Activity	9	8	8
	5. Sound and Its Characteristics	SEA	2	15	14
		Activity	12	11	14

	6. Systems in Our Body and Health	SEA	0	-	-
		Activity	6	9	11
	7. Transmission of Electricity	SEA	1	15	14
		Activity	5	8	6
7th Grade	1. Solar System and Beyond	SEA	1	15	14
		Activity	0	-	-
	2. Cells and Divisions	SEA	0	-	-
		Activity	1	7	9
	3. Force and Energy	SEA	1	15	14
		Activity	6	9	9
	4. Pure Substances and Mixtures	SEA	2	15	15
		Activity	5	13	19
	5. Interaction of Light with Matter	SEA	1	15	14
		Activity	7	12	12
	6. Reproduction, Growth, and Development in Living Organisms	SEA	0	-	-
		Activity	2	8	10
	7. Electrical Circuits	SEA	1	15	14
		Activity	5	8	13
8th Grade	1. Seasons and Climate	SEA	1	15	15
		Activity	2	9	6
	2. DNA and Genetic Code	SEA	1	15	15
		Activity	3	7	7
	3. Pressure	SEA	1	15	15
		Activity	3	8	8
	4. Matter and Industry	SEA	1	15	15
		Activity	10	11	9
	5. Simple Machines	SEA	1	15	15
		Activity	2	7	7
	6. Energy Transformations and Environmental Science	SEA	1	15	15
		Activity	7	11	14
	7. Electric Charges and Electrical Energy	SEA	1	15	15
		Activity	5	5	8

To sum up, investigating middle school science textbooks revealed that SEAs contain more skill themes compared to activities. Furthermore, it is observed that creative thinking skills are more prevalent in activities compared to critical thinking skill themes. Particularly, in 7th-grade activities, the deficiencies in critical thinking skill themes are noticeable. The 5th-grade science textbook addresses both creative and critical themes to the least extent compared to other textbooks. The limited number of activities in the 5th grade also contributes to the scarcity of observed themes. Except for the 5th grade, in all other years' textbooks, there is at least one activity that densely encompasses skill themes. As the years progress, an increase is observed both in the number of activities and the intensity of skill themes present in these activities.

4. DISCUSSION AND CONCLUSION

One of the noteworthy findings is that, despite being in fewer numbers in textbooks, SEAs have a higher frequency of incorporating skill themes compared to activities. It has been found that SEA tasks, with their interactive processes, are the most supportive practices for creative thinking skills. Kahveci (2020) also stated that the engineering and design skills adopted in the 2018 Science Curriculum, which is based on constructivism and a holistic approach, are compatible with STEM education and that SEA activities in textbooks are effective in achieving the program's objectives.
Similarly, in terms of critical thinking, it is observed that the tasks that contain the most themes are SEA tasks. The reason for this is that sub-skills that constitute the foundations of critical thinking, such as analysis, elimination of contradictions, problem-solving, making connections, active engagement, making predictions, and adopting an inquisitive approach, are included in the SEA process. In the literature, there are studies that argue that SEA, through the design and scientific research steps they contain, provides environments that support students' critical thinking skills (Kahveci, 2020; Üspolat Yazıcı, 2021; Tezcan, 2018).

In this study, textbooks have been examined at all grade levels, and it has been noticed that SEAs are less in number in textbooks compared to activities. Particularly, in the 5th-grade science textbook, only two SEA studies are observed. Similarly, Tezcan (2018) has suggested that SEA tasks, which are emphasized in the program as providing effective learning environments for students, should be increased at all grade level textbooks.

From 5^{th}-grade to 8^{th}-grades, an increase in the number of SEAs in science textbooks and the intensity of themes within these SEAs has been observed. In the 5th-grade textbook, the products generated within the SEA are constrained by the procedural steps provided in the book, i.e., the guidelines. However, in the 6^{th} and 7^{th}-grade textbooks, alongside the practices outlined in the guidelines, a second phase is introduced where students can create an original product by utilizing their own abilities and creativity. In the 8^{th}-grade science textbook, the SEA is entirely unconstrained by guidelines, leaving it to the students' imagination and abilities. It is believed that restricting the product creation with any guidelines would hinder imagination and creativity (Tezcan, 2018). Similarly, Whitworth and Wheeler (2017) have suggested that in order for students to think innovatively and create designs, a problem should be presented without step-by-step guidance. The evolution of activities in textbooks over the years, allowing students to increasingly showcase their own skills and gradually removing constraints, is considered a positive arrangement for skill development.

The examination of science textbooks in terms of the activities showed that the majority of them are demonstration activities, where students participate in the process mainly through auditory and visual means and mostly assume a passive role. In individual activities, students actively engage in the process through their own experiences and obtain their own products. Therefore, these activities are seen to better support creative thinking skills compared to demonstration activities. Since the activities are mostly intended for demonstration purposes, the frequency of activities including creative thinking skills

may be low. This situation indicates that the activities may not provide a sufficiently supportive process for imparting creative thinking skills to students. Trilling and Fadel (2009) have stated that learning environments that nurture creativity are environments where inquiry-based learning takes place, new ideas emerge, and students take responsibility for their learning, which enhances their confidence. In a study examining high-level thinking skills in science textbooks, Erol (2021) argued that the questions in textbooks need to be developed in terms of creative thinking and decision-making skills, and that all skills should be distributed equally in textbooks. Similarly, Tezcan (2018), in a study on science textbooks, stated that activities in textbooks are limited to the knowledge and comprehension stages in Bloom's taxonomy, have limited relevance to everyday life, and are insufficient in imparting 21st-century skills.

The low frequency of critical thinking skill themes CT5 and CT14 in the 5th, 6th, and 8th-grade science textbooks, while the 7th-grade science textbook shows a significantly high frequency of these themes, is an intriguing finding. The reason for the high frequency of these skill themes, which are referred to as looking at situations and issues with an inquisitive eye (CT5) and making sense of values and attitudes (CT14), in the 7th-grade textbook is the discussion method included in the assessment sections of the activities. Unlike other textbooks, almost all activities in the 7th-grade book incorporate this discussion process. The discussion technique supports these skill themes as it requires the use of imagination, fosters decision-making skills, encourages generating multiple perspectives, involves listening to and respecting other viewpoints, promotes an inquisitive outlook, and encourages asking questions. Seferoğlu et al. (2006), in their study on critical thinking and teaching, also state that the discussion method is more effective than the lecture method in imparting critical thinking skills. The activities included in the 7th-grade textbook can contribute to students' development of critical thinking skills. Indeed, findings from studies examining the critical thinking skills of middle school students by grade level in the literature reveal a significant difference in favor of 7th-grade students (Amanvermez İncirkuş, 2021; Kandemir & Eğmir, 2020).

The themes of CT6 (dealing with problems) and CT16 (not ignoring problems) are skill themes centered around being sensitive to problems. The frequencies of these themes appearing in all textbooks are quite low. It has been found that the activities in the textbooks are generally oriented towards solving problems, but the number of activities that raise awareness about the causes and prevention of problems is very limited. Project-based activities involving students in active communication, collaboration, and social activities generally contain more critical thinking skills. Increasing the number of activities in which students will face problems directly is important. Çınar (2005) emphasized the need for students to encounter real-life problems in order to think critically.

5. SUGGESTIONS

Creative thinking and critical thinking are the skills needed to find solutions to complex problems (OECD, 2019). In light of the findings of this study, it is possible to state that the SEAs

(Science and Engineering Activities) show promise in developing both of these skills in students. On the other hand, a deficiency in supporting these skills was revealed in the existing activities found in the textbooks, which are primarily teacher-centered and take the form of demonstration experiments. Therefore, it is suggested that starting from the 5th grade, activities that actively engage students and provide better support for the development of creative and critical thinking skills should be incorporated. Incorporating problem-based learning, project-based learning, or outdoor learning environments into the curriculum is suggested to develop these skills. Additionally, the themes developed in this study can also be used for further research investigating creative and critical thinking skills. For researchers who intend to use the themes in their own studies, it is recommended by the authors of this study that if more than half of the skill themes are present in the activities, it may be considered sufficient evidence that the activities support the relevant skill. However, activities aiming to fully encompass a skill are expected to include all aspects of that skill.

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GENİŞLETİLMİŞ TÜRKÇE ÖZET

ORTAOKUL FEN BİLİMLERİ DERS KİTAPLARININ YARATICI DÜŞÜNME VE ELEŞTİREL DÜŞÜNME BECERİLERİ AÇISINDAN İNCELENMESİ

1. GİRİŞ

Günümüzde bilgiyi kavrama, ezberleme ve kullanma becerileri bireylerin gerekli ihtiyaçlarını karşılama konusunda yetersiz kalmaktadır. Çağımızda "*21. Yüzyıl Öğrenme Becerileri"* olarak isimlendirilen ve bireylerin sadece okulda değil, yaşamında ve iş hayatında da başarılı olabilmelerini sağlayacak beceriler bulunmaktadır (Partnership for 21st Century Skills, 2019). Özellikle yaratıcı ve eleştirel düşünme becerileri, günümüzün ve geleceğimizin temel bilişsel yetenekleridir (OECD, 2009). Gelişmiş ve gelişmekte olan ülkeler bu becerileri temel eğitim hedeflerinden biri olarak görmektedirler (Shaheen, 2010; Taylor vd., 2022). Yaratıcılık, mevcut kavramlar arasındaki ilişkileri kullanarak orijinal fikirler ve çözümler üretilen bir süreçtir (Torrence, 1984). Eleştirel düşünme ise sentez ve değerlendirmeyi içeren bilişsel bir süreçtir ve zorlukların aşılmasını mümkün kılar (Moore, 2001).

Ülkemizde Fen Bilimleri Öğretimi Programı, 2017'de güncellenerek bu becerilerle uyumlu yaşam, mühendislik ve tasarım becerilerini içermiş, (MEB, 2017) ders kitapları da değiştirilerek, yapılandırmacı yaklaşım ve sorgulama stratejilerine uygun şekilde hazırlanmıştır (Kahveci, 2020). Bu kitapların programların hedeflerine uyarak 21. yy. becerilerini de içermesi gerekmektedir (Gültekin, 2019).

Bu araştırma ortaokul Fen Bilimleri ders kitaplarının, öğrencilerin erken yaşlardan itibaren kazanmaları gereken becerileri ne ölçüde içerdiğinin incelenmesini amaçlamaktdır. Çalışmada, 21. yy. öğrenme ve yenilik becerilerinden özellikle yaratıcı düşünme ve eleştirel düşünme becerilerinin durumuna odaklanılmaktadır. Çalışmanın araştırma problemi, "Fen Bilimleri ders kitapları 21. yy. öğrenme ve yenilik becerilerinden yaratıcı ve eleştirel düşünme becerilerini ne ölçüde içermektedir?" şeklindedir.

2. YÖNTEM

Araştırmada nitel araştırma yöntemlerinden doküman incelemesiyle veriler toplanmıştır. Bu yöntem, becerileri tanımlayan temaların belirlemek ve ortaokul Fen Bilimleri ders kitaplarındaki etkinliklerin bu beceriler açısından analizini yapmak amaçlandığı için tercih edilmiştir. İlk olarak, araştırmacılar tarafından "21. Yüzyıl Öğrenme ve Yenilikçilik Beceri Temaları (YÖYBT)" adlı bir kontrol listesi geliştirilmiştir (Tablo 1). Bu liste, literatürdeki kuramsal yapı, uygulama sonuçları, ölçme araçları ve uzman görüşlerinden yararlanılarak oluşturulmuştur. İkinci aşamada, geliştirilen kontrol listesi kullanılarak Fen Bilimleri Ders Kitapları incelenmiştir.

Araştırmanın çalışma grubu, 2020-2021 eğitim öğretim yılında MEB tarafından ortaokullara ücretsiz dağıtılan, Talim Terbiye Kurulu'nun kontrolünde özel yayın evlerinin geliştirdiği 5, 6, 7 ve 8. sınıf Fen Bilimleri ders kitaplarıdır. Çalışma grubu nitel araştırmalarda olgu ve olayların

keşfedilmesinde ve açıklanmasında yararlanılan amaçlı örnekleme yöntemiyle belirlenmiştir. İncelenen becerileri destekleme potansiyeli daha yüksek olduğu için sadece her ünite içinde ve sonunda Etkinlik ve Fen ve Mühendislik Uygulamaları (FMU) başlıkları altında verilen faaliyetlerin durumları incelenmiş, konu anlatımı kısımları çalışmaya dâhil edilmemiştir.

Analiz sürecinden sonra güven duyulabilirlik için tüm kitaplardan gelişigüzel seçilen üçer faaliyetin Fen Bilgisi öğretmeni olarak görev alan ve yüksek lisans yapmış bir başka araştırmacı tarafından analizi sağlanmış, görüş birliği oranlarının % 80 ve %100 aralığında ve yeterli olduğu görülmüştür (Miles & Huberman, 1994).

3. BULGULAR VE TARTIŞMA

Kitaplardaki ünitelerin etkinlik ve FMU sayıları incelendiğinde homojen dağılmadıkları ve FMU sayılarının etkinliklerden daha az olduğu görülmektedir. Özellikle 5. Sınıf kitabındaki etkinlik ve FMU sayıları düşüktür (Tablo 3). Ayrıca kitaplardaki FMU'nın becerilerin temalarını etkinliklere oranla daha yüksek oranda barındırdığı göze çarpmaktadır (Tablo 6). FMU projeler ve tasarım basamakları içermektedir. Öğrencinin süreçte aktif olacağı proje-tabanlı öğrenme gibi ortamlarının oluşturulması yaratıcı ve eleştirel düşünen bireylerin yetiştirilmesini desteklemektedir (Shearer ve Quinn, 1996; Onur ve Kozikoğlu, 2019). Her iki beceride de problemlere vurgu yapan temaların frekanslarının düşük olması, genellikle sorunların nedenlerinin değil çözümlerinin irdelendiği ve sorunlara karşı hassasiyetin geliştirilebileceği etkinliklerin kitaplarda yeterince bulunmadığına işaret etmektedir. 5. sınıf dışında tüm yıllarda beceri temalarını yoğun bir şekilde barındıran en az bir etkinlik yer alması olumlu bir bulgudur. Ayrıca yıllar ilerledikçe hem faaliyetlerin sayılarında hem de bu faaliyetlerin beceri temalarını barındırma yoğunluklarında bir artış gözlemlenmektedir.

Eleştirel düşünme becerisi ile karşılaştırıldığında, faaliyetlerin yaratıcı düşünme becerileri açısından daha zengin olduğu söylenebilir (Tablo 4 ve Tablo 5). Tüm faaliyetlerdeki en belirgin yaratıcı düşünme beceri temaları C2, C13, C12 ve C15'dir (Şekil 1). Bu temalar birbirleriyle ilişkilidir. Faaliyetlerde, öğrencilerden olaylar arasında nedensel ilişkiler kurmalarını ve değişkenler arasında bağlantılar oluşturmaları beklenmektedir. Öte yandan faaliyetlerde en az yer alan beceri teması C11'dir. Bu tema bilimsel süreç becerisi ile uyumludur ve öğrencilerden probleme yönelik hipotezler kurmalarını beklemektedir. Etkinliklerin çok azı problem temelli kurulmuştur ve FMU da bilimsel süreçlerden ziyade tasarım sürecine yönelik geliştirilmiştir. Hipotez kurmanın sadece bilimsel süreç becerisi içeren FMU'nda olduğu, etkinliklerde ise öğrencilerin orijinal çözümler bulabilecekleri zor ve çelişkili durumlara yeterince yer verilmediği görülmektedir. Bunun yanı sıra en düşük frekansa sahip C4, C5, C6 ve C7, etkinliklerde genel olarak sorunlara karşı hassasiyet geliştirebilecekleri çalışmaların yeterince yer almadığına işaret etmektedir.

Eleştirel düşünme becerileri açısından incelendiğinde faaliyetlerde en çok yer alan temaların CT9 ve CT11 olduğu, bu temaları CT13, CT17, CT18 temalarının takip ettiği görülmektedir (Tablo 5,

Şekil 2). Bu temalar sırasıyla çıkarım yapma, ilişki kurma, değerlendirme, gerekçelendirme ve sorgulama becerileri barındırmaktadır. Bu beceriler öğrencilerin gözlemleri sonucu elde ettikleri sonuçlar ile ilişkilidir. Frekansı yüksek olan beceri temaları daha çok etkinliklerin değerlendirme bölümlerinde yer alan sorularda vurgulanmıştır. CT5 beceri teması 7. sınıf kitabı hariç tüm kitaplarda düşük oranda karşılanmaktadır. 7. Sınıf kitabında faaliyetlerin son bölümünde yer verilen tartışma tekniği, sorgulama, soru sorma, fikir yürütme, yansıtma becerileri barındırır. Buna paralel şekilde, sınıf seviyelerine göre ortaokul öğrencilerinin eleştirel düşünme becerilerini inceleyen çalışmalar, 7. sınıf öğrencileri lehine anlamlı bir farklılık olduğunu ortaya koymaktadır (Amanvermez İncirkuş, 2021; Kandemir ve Eğmir, 2020). CT3, CT10, CT14 temalarının frekansları ise oldukça azdır. Bu temalar öğrencilerin birbirleri ile iletişim halinde olduğu deney ya da etkinliklerde yer alabilmektedir. 5. sınıf fen kitabında sosyal aktivite içeren veya öğrencilerin beraber çalışabileceği etkinlik sayısı yok denecek kadar azdır.

Etkinliklerin temaları içerme frekanslarının düşük olmasının sebebi öğrencilerin işitsel ve görsel olarak sürece katıldığı ve çoğunlukla izleyici rolünde yer aldıkları gösteri etkinlikleri şeklinde olmalarıdır. Benzer şekilde Fen Bilimleri ders kitaplarındaki etkinliklerin üst-düzey düşünme becerilerini içermedeki yetersizliğini vurgulayan çalışmalar mevcuttur (Erol, 2021; Kışoğlu, 2021; Tezcan, 2018).

SONUÇ VE ÖNERİLER

FMU'ların öğrencilerde her iki beceriyi de geliştirmede potansiyel taşıdığı söylenebilir. Ancak mevcut Fen Bilimleri kitaplarındaki etkinlikler, genellikle öğretmen merkezli ve gösteri deneylerine dayandığı için bu becerileri desteklemede yetersizdir. Bu nedenle, 5. sınıftan itibaren daha etkileşimli ve yaratıcı ve eleştirel düşünme becerilerini destekleyen etkinliklerin eklenmesi önerilebilir. Problem ve proje tabanlı öğrenme veya okul dışı öğrenme etkinliklerinin dahil edilmesi, bu becerilerin gelişimini teşvik edebilir. Ayrıca, bu çalışmada geliştirilen temalar, yaratıcı ve eleştirel düşünme becerilerini inceleyen diğer araştırmalar için de kullanılabilir. Araştırmacılar, beceri temalarının yarısından fazlasını içeren bir etkinliğin ilgili beceriyi desteklediğini kabul edebilirler, ancak en ideali bir beceriyi kapsamayı hedefleyen etkinliklerin becerinin tüm yönlerini içermesidir.