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Investigation of the 7th and 8th Grade Science Curriculum Outcomes and Textbook Activities in terms of Scientific Creativity

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ABSTRACT

This study investigated the effect of the present science curriculum and textbook exercises on scientific creativity. This study used document analysis as a form of qualitative investigation. This study used data derived from the academic performance of students in the 7th and 8th grades, specifically focusing on the outcomes of the 2018 scientific curriculum and the activities presented in the associated textbooks. The descriptive analysis technique was applied to examine the results and activities, which are qualitative data. This study comprised an analysis of achievements and activities, concentrating on predefined themes within the sub-dimensions of the Scientific Structure Creativity Model. The study yielded findings that demonstrated a connection between curricular outcomes and textbook activities across all grade levels. In particular, these educational materials effectively included scientific knowledge and phenomena, thus promoting the development of creative thinking skills. It is essential to emphasize that the science curriculum and textbook mainly prioritize creative results and process aspects, whereas characteristics such as fluency, adaptability, and originality, which are crucial to creativity, receive comparatively less emphasis. Furthermore, it was determined that the goals of education and instructional materials for seventh- and eighth-grade students were congruent with the characteristics of scientific creativity.

Keywords: Science education, scientific creativity, curriculum, textbook, document analysis



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Introduction

The education field has undergone significant changes due to the increase in global production and information competition. As a result, there is now a greater focus on cultivating individuals who possess multiple viewpoints, innovative thinking skills, analytical abilities, and developed creative capacities that align with societal demands (Kennedy & Odell, 2014). Cultivating competencies recognized as essential in the 21st-century has become a significant objective in contemporary education. These competencies are intended to reshape people in alignment with the demands and requirements of the current era (Karahan, 2021; Lai & Viering, 2012).

In today's world, designated by changing conditions and changing needs for individual abilities, the concept of education has shifted its emphasis to multiple skills. These skills encompass abilities such as adaptability, collaboration, communication, creativity, critical thinking, entrepreneurship, innovation, leadership, non-routine problem-solving, productivity, responsibility, self-management, and proficiency in information and media technology (Geisinger, 2016; Kylonen, 2012; Partnership for 21st Century Skills, 2019). These competencies are widely acknowledged as crucial factors that improve individuals' ability to engage in lifelong learning and develop their creativity (Dede, 2009; Trilling & Fadel, 2009). Consequently, in the contemporary context, it is imperative to cultivate individuals who can negotiate and react to dynamic circumstances successfully, exhibit openness toward novel ideas, cultivate their proficiencies, and generate innovative solutions to diverse challenges.

As emphasized by Trilling and Fadel (2009), one of the most critical skills required by modern education is the ability to demonstrate creativity and ingenuity. The competencies demanded by today's global economy include various areas such as the creation of products, providing services, marketing, and client service. Within this particular setting, the development of expertise in these specific areas by students will allow them to make stronger advances in their own development as well as in their prospective jobs. In a similar vein, the incorporation of science education in the curriculum will serve to enhance these abilities and reinforce the capacity of pupils for logical thinking, problem-solving, and analytical methods, thereby growing individuals who are more ready for the challenges of the years to come.

In basic terms, the integration of creative applications in the product creation process in educational activities can enhance the general standard of instruction. Due to this justification, it is vital for educators to exhibit willingness toward innovative methods for promoting activities and performances that support the cultivation of creative thinking abilities. In addition, curriculum, learning methodologies, and educational materials must be consistent with each other and reinforce the intellectual abilities and behavioral characteristics that define individuals. The curriculum provides an essential foundation for instruction, offering guidance for setting goals, content, methods, assets, evaluation processes, and the scope of the teaching process (Demirel, 2015; Oliva & Gordon, 2018). Textbooks, which correspond to the tenets stated in this fundamental plan, are created with the objective of assisting the achievement of these objectives and act as an essential tool of the educational framework. Textbooks represent an important part of schools as they have been carefully planned to correspond with established curricula, thus providing essential tools for gaining fundamental information. These books contain subject matter, knowledge, and interactive tasks that are essential elements of the process of learning (Sirin, Tuysuz & Oguz, 2022).

The primary source used by teachers for organizing their teaching methods was found to be textbooks explicitly developed for the course of study (Gulersoy, 2013; Unsal & Bakar, 2022). Textbooks have become widely accepted as a primary and essential educational tool used by both teachers and students inside educational institutions (Kolac, 2009). In the current circumstances, it may be asserted that textbooks play a pivotal role in aiding the effective execution of curricula. In this conceptual framework, it is of the most significant importance to give priority to the investigation of textbooks and curricula in schools that aim to promote creative thinking and skills among students, with a special focus on the viewpoint of science.

When evaluating scientific creativity, it is possible to use a comprehensive approach by examining both the curricula and textbooks used by educators and students. In this context, the problem statement of the research was determined as follows: "What are the distribution of science curriculum results and activities in 7th- and 8th-grade textbooks with regard to scientific creativity?". In the context of this research problem, the following sub-problems were formed:

- What is the distribution of the 7th-grade science curriculum objectives and activities of textbooks in terms of scientific creativity?
- What is the distribution of 8th-grade science curriculum objectives and activities in textbooks in terms of scientific creativity?
- How do the seventh- and eighth-grade science curriculum objectives and textbook activities compare in terms of scientific creativity?

The purpose of this study was to investigate to what extent scientific creativity plays a role in the development of science knowledge among individuals, especially through the execution of science curriculum results and textbooks published by the Ministry of National Education (MoNE) in 2018. In light of this explanation, the current investigation investigates the scientific imagination displayed in the achievements and textbook exercises of the 2018 science curriculum, which was implemented during the research period.

Creativity

The value and importance of creativity are continuously rising in today's society, which is characterized by rapid change and evolution. Creativity is an essential ability that serves a vital part in successfully adapting to the complicated and dynamic nature of modern life. This skill holds an essential place throughout different fields, including solving problems, developing innovative approaches, and promoting creativity, along with enabling flexible thinking and adaptability. Recognizing the significance of fostering and assisting creativity is an essential effort in navigating the complexity and competition of today's society, thus enhancing our awareness of the inherent worth of this fundamental skill.

The development of creativity has significant value in helping individuals make meaningful contributions to society and in promoting the generation of distinctive and original ideas. Creativity refers to the innate ability of individuals to generate new and socially significant creations, which manifest through gaining knowledge and participating in educational endeavors (McWilliam, 2009; Plucker, Beghetto & Dow, 2004). According to Andreasen (2009), creativity is the natural ability of individuals to see and recognize unique and new circumstances and occurrences. Creativity is an organized process in which humans produce novel and innovative products by conceiving diverse solutions to existing challenges (Astutik & Prahan, 2018). In the present situation, it is fundamental to encourage and promote the development of creative thinking in a manner that promotes the discovery of individuals' creative capabilities and contributes to the advancement of societal innovation.

The concept of creative thinking is complex and comprises different elements. Hence, scholars have endeavored to provide a systematic framework for its assessment and quantification to enhance comprehension and explain the nature of creativity (Ozkale, Kilic & Yelken, 2020). Various definitions and classifications in the literature involve the investigation and questioning of the creative individual (Guilford, 1968), the dynamic and evolutionary nature of the creative process (Benami, 2002; Guilford, 1968; Koberg & Bagnall, 1974; Torrance, 1963; Yavuzer, 1989), and the resulting creative work (Abra, 1997; Ausubel, 1964; San, 1993; Takala, 1993).

The growth of creativity is a manifestation of the constant interaction among an individual's creative mindset, the process of generating new concepts, and the resulting products of creativity. In his studies on creativity, Torrance (1966) discusses the abilities of individuals to take on problem identification, solution search, and theory formation. Erika (1974) emphasizes the importance of combining creative

thinking with new concepts as a critical aspect of creativity. Amabile (1996) illustrates the ability to understand the different phases that comprise the process of product creation and the significance of flexibility, sophistication, and navigating skills in promoting creativity. Higgins and Morgan (2000) highlighted the importance of creating knowledge originally. Albrecht (2005) highlighted the importance of implementing various viewpoints to recognize problems and expect creative possibilities. Landau emphasized the ability to integrate distinct relationships through the construction of new cognitive frameworks, thus encouraging the creation of new concepts and products (San, 2003).

According to Wallas (1926), creativity can be viewed as a method of problem-solving, including various phases, notably planning, incubation, realization, and confirmation. During the initial stages, the individual with a creative tendency participates in an in-depth examination of the problem, gathers pertinent knowledge, and generates numerous potential remedies. It is common for the ideas that are produced during this stage to stop short of producing the expected results or fail to reveal the intended creative thought. During the incubation phase, individuals are not involved in conscious thought about the subject at hand. Instead, the mind performs a subconscious analysis of the problem

During the incubation phase, mental procedures persist and operate subconsciously, leading to the emergence of a solution or concept in the mind during the moment of "realization." The development of this idea occurs entirely in the absence of conscious awareness. During the validation phase, the solution's accuracy, appropriateness, or efficiency is assessed. Following the conclusion of this examination, the answer undergoes reorganization or clarification, completing the creative process. The development of creativity has significant value for individuals as it allows them to make meaningful societal contributions and promote the generation of new and unique ideas. Creativity can be defined as the inherent ability of individuals to produce novel and socially significant creations, which are evident through the process of gaining knowledge and formal education.

Similar to how individuals engage in creative processes during the creation of significant discoveries, regular people also employ creative processes when addressing the challenges they face in their everyday lives (Dogan, 2011; Sak, 2009). According to Ozturk (2004), creativity can be observed not only in scientific innovations but also in the creation of unique designs or creative expressions. Creativity plays a significant role, particularly during the problem-solving process, specifically in generating a novel and innovative product by using an individual's knowledge (Paulus, 2000; Torrance, 1963; Yenilmez & Yolcu, 2007). Hence, it can be inferred that the integration of creativity in the production process leads to the creation of significant and captivating products (Csikszentmihalyi, 1996). Consequently, it becomes evident that the cultivation of creativity necessitates a continuous focus on the acquisition of knowledge and skills, as well as the generation of innovative outputs (Chapman, 1978; Rowe, 2007).

The evaluation of creativity involves considering ideas that go beyond the final result, with an emphasis on the qualities of creativity that extend beyond the product itself (Runco, 2014). Hence, it is imperative to consistently foster and endorse creativity to enhance individuals' capacity, bolster their aptitude for problem-solving, and cultivate novel viewpoints. Within the present framework, scholarly investigations underscore the necessity of tailoring approaches to managing creativity according to the distinct requirements of diverse domains, including art and science (Sak & Ayas, 2013). Hence, the imperative to approach creativity from an interdisciplinary standpoint underscores the need to provide a framework that integrates novel cognitive processes across several domains.

Scientific Creativity

According to Karakas (2016), the development of creative goods or ideas in the realm of science relies heavily on an in-depth comprehension of the subject matter. Scientific understanding and imaginative thinking are intricately intertwined, working in tandem to propel scientific advancements to higher levels. When addressing scientific challenges, individuals must employ scientific methodologies and techniques with inventive approaches to arrive at practical answers. Individuals must exhibit inventiveness, originality, and flexibility while engaging in this process. Additionally, individuals should approach instances and circumstances with advanced cognitive abilities. According to Rasul,

Zahrinan, Halim, Rauf, and Amnah (2018), it is imperative for people engaged in scientific processes to effectively apply their knowledge to novel and diverse contexts, as well as show scientific creativity in problem-solving endeavors.

Previous research (Atasoy, Kadayifci & Akkus, 2007; Hu & Adey, 2002) has argued that scientific creativity entails the generation of technical products through cognitive processes informed by scientific knowledge. These products are specifically tailored to address scientific trends and problems. Furthermore, the evaluation of academic creativity is contingent upon the acceptance of a product by a particular group of individuals, with emphasis placed on the resultant outcome (Amabile, 1996).

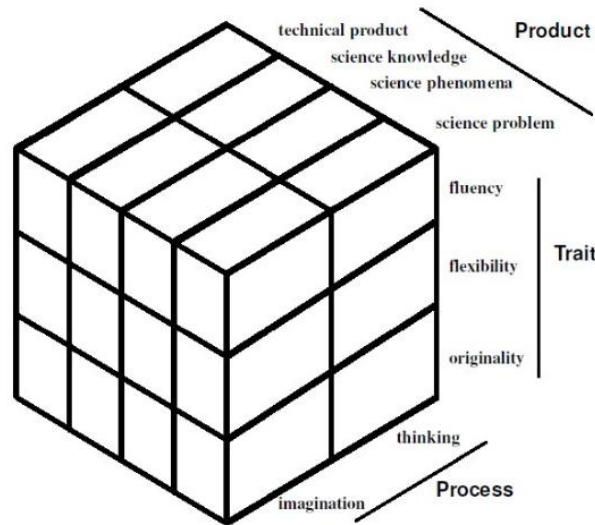
Utilization of innovative concepts throughout the design phase of product development creates unique and practical merchandise. Modifications transpire within the material in accordance with the requirements and desires determined during the product design procedure (Simon, 1996). During this process, individuals are required to generate innovative solutions by providing multiple viewpoints while developing resolutions to various challenges (Gupta & Sharma, 2019; National Academy of Engineering, 2010). Utilization of creativity in design processes by students, particularly within the area of science education, holds significant benefits in terms of improving scientific thinking capacity and enhancing their ability to produce solutions for real-world problems.

Scientific creativity is of greatest significance in the realm of science education because it plays a pivotal role in fostering students' scientific thinking abilities and facilitating a deeper understanding of scientific concepts. This pedagogical approach promotes active engagement among students, encompassing not only the rote memorization of knowledge but also active involvement in many cognitive processes, including issue definition, premise formulation, experimental design, and interpretation of results (Cheng, 2004; Demirhan, Onder & Besoluk, 2018; Meador, 2003; Sahin Pekmez, Aktamis & Can, 2010). According to Gupta and Sharma (2019), the instillation of creative thinking abilities in students enables them to effectively apply scientific knowledge to address real-world challenges and generate viable solutions. The studies conducted by Wahyudi, Verawati, Ayub, and Prayogi (2019) and Zulkarnaen, Supardi, and Jatmiko (2018) recommend that scientific creativity can stimulate students' curiosity and inclination to engage in exploratory activities.

The incorporation of many perspectives and the establishment of connections within the fields of science offer pupils a heightened level of interest and significance in the learning process. Moreover, the cultivation of scientific creativity has been found to enhance students' critical thinking and problem-solving abilities (DeHaan, 2009; Karaca, 2017; Liu & Lin, 2014; Treffinger & Isaksen, 2005). This facilitates pupils' acquisition of knowledge, encompassing theoretical understanding and practical application. Scientific creativity serves as a pedagogical framework that imparts the fundamental concepts of science and educates students on the effective use of information to successfully address and resolve practical issues.

To develop a more comprehensive understanding and evaluation of scientific creativity within the field of science education, Hu and Adey (2002) developed a conceptual framework known as the "Scientific Structure Creativity Model." This model facilitates an understanding of scientific creativity's fundamental parts and constituents, elucidating their interplay and the resultant creative process and outcome. The initial dimension of the "Scientific Structure Creativity Model" established by Hu and Adey (2002) encompasses the sub-dimensions of "imagination" and "thinking" inside the creative process. The second dimension comprises the sub-dimensions of "fluency," "flexibility," and "originality" as characteristics of creativity. Finally, the third dimension includes the sub-dimensions of "technical product," "scientific knowledge," "scientific phenomenon," and "scientific problem" as the elements of the creative product (see Figure 1).

Figure 1. Scientific Structure Creativity Model (Hu & Adey, 2002)



The creative process dimension of the concept encompasses the cognitive processes of creative thinking and imagination. Divergent thinking refers to the cognitive capacity to generate multiple solutions or responses to a given problem using an array of perspectives. Within the realm of imagination, the paramount element is imagination, which is the generation of a cognitive occurrence or events using existing objects or thoughts (Hu & Adey, 2002; LeBoutillier & Marks, 2003). To determine the degree to which a situation is the outcome of creative thinking, one can assess the dimensions of fluency (the ability to generate multiple ideas), flexibility (the ability to generate diverse ideas in response to the same stimulus), and creativity (the ability to generate novel and unique ideas). These dimensions define the nature of thoughts, as outlined by Guilford (1986), Hu and Adey (2002), and Torrance and Goff (1989). In the fluency dimension, people generate many ideas and propose detailed solutions to the problem (Hu & Adey, 2002; Jaarsveldt, 2011). They also express their thoughts verbally or in other ways.

In the dimension of flexibility, individuals demonstrate the ability to effectively adjust to various circumstances or settings by considering the situation from diverse viewpoints and generating novel concepts (Hu & Adey, 2002). Conversely, in the dimension of originality, individuals engage in inventive endeavours while seeking solutions to problems, recommending ideas or products that have not been previously attempted or produced, and presenting novel solutions that have not yet been generated (Hu & Adey, 2002; Jaarsveldt, 2011). Fisher (1995) posits that a child's elevated intellectual vigour indicates a commensurate amount of creativity. The framework's creative product component emphasizes technical products that originate via the application of creative thinking. The items mentioned above ought to possess a foundation of scientific knowledge, be intrinsically linked to a scientific occurrence, and be purposefully crafted to address a scientific quandary (Hu & Adey, 2002; Ustundag, 2014).

The integration of scientific knowledge into these products facilitates students' comprehensive understanding of science while simultaneously fostering their acquisition of scientific reasoning and methodologies. This, in turn, enhances their capacity to apply their knowledge and skills to real-world challenges. The objective of incorporating scientific creativity into science education is to cultivate students' abilities to think creatively and independently rather than passively taking in information. This technique facilitates the acquisition of the abilities necessary for problem solving in future professional and personal contexts. Simultaneously, scientific creativity engender self-assurance among students, augments their enthusiasm for acquiring knowledge, and fosters a disposition toward continuous

learning. Hence, it is critical to foster and endorse scientific creativity within science education procedures and instructional resources to cultivate this aptitude.

Methods and Materials

In this study, science curriculum objectives and textbook activities were examined in terms of scientific creativity using the document analysis approach, a qualitative research method. The document review method is a systematic process that involves examining analyzing and evaluating primary or secondary sources that are printed or electronically available (Creswell, 2007; Ozkan, 2021; Saldana, 2011). Therefore, because the content of the documents used in the process is categorized and interpreted, it can be used as a method as well as a data analysis method (O'leary, 2004; Saldana, 2011). Document review is the scanning of documents containing information focused on the intended target in terms of specific words and concepts (Miles & Huberman, 2016). In the context of the purpose of this study, the document analysis method was used to examine the dimensions of scientific creativity in terms of the content of the primary sources, science curriculum outcomes, and activities of the determined textbooks. In this context, the latest science curriculum updated in 2018 in Turkey and the currently used textbooks were determined.

Research Data Sources

The study used data sources comprising the scientific curriculum outcomes for the 7th and 8th grades in 2018, as well as the activities included in the corresponding textbooks. In this context, the 7th and 8th grade levels, which will reflect the themes of scientific creativity among the achievements of the science curriculum and textbook activities, were selected with the criterion sampling technique from purposeful sampling methods. The reason for choosing the purposive sampling method within the scope of the study is that it allows in-depth study of situations that are thought to have rich information and helps researchers in discovering and explaining events and phenomena (Yildirim & Simsek, 2011). Criterion sampling is the study of situations that meet predetermined criteria. In this study, the criterion is that the outcomes and activities to be sampled reflect the themes of scientific creativity.

Curriculum outcomes are the specific goals and objectives that are intended to be achieved through the implementation of an educational curriculum. The study uses a data set comprising 128 objectives extracted from the 2018 scientific curriculum for the 7th and 8th grades, with 67 objectives for the 7th grade and 61 objectives for the 8th grade (MoNE, 2018). Table 2 presents the grade level, unit, subject area, and number of objectives of the curriculum analyzed in the context of this study.

Activities in the textbook: An additional data source employed in the study comprises the content of scientific textbooks used for seventh- and eighth-grade instruction in both regular secondary schools and imam hatip secondary schools throughout various provinces in Turkey during the academic year 2022-2023. The reason why seventh- and eighth-grade books were chosen for the study is that the development of creativity for students at these grade levels is different from the previous grades. In this period, students' mental and emotional abilities are more mature and they have more freedom and responsibility. In addition, since this is the last level of middle school, students should have a more creative potential for the next level. To select appropriate textbooks, it was deemed necessary to analyze the textbooks used at a public school affiliated with the Ministry of National Education, chosen at random. The criteria for the eligibility and exclusion of textbooks are as follows: It should be a textbook prepared for public schools in Turkey for the 2022–2023 academic year 2022–2023, approved for use, and determined based on certain standards. This is because these textbooks are usually determined on the basis of a country's educational policies, laws, and the needs of educational institutions. These criteria ensure that educational materials meet certain standards and that students have equal educational opportunities. In addition, the textbooks used as data sources are currently used in schools. Table 1 provides details regarding the imprint of the books.

Table 1. 7th and 8th grade science textbook information analyzed as a document

Book title	Publisher	Author(s)	Year of publication - place of printing	Number of pages
Secondary and Imam Hatip Secondary School Science 7 th Grade Textbook	Aydin Publishing	İsmail GEZER	2018-Ankara	226
Secondary and Imam Hatip Secondary School Science 8 th Grade Textbook	Adim Matbaa Publishing	Adim Erhan YİĞİT	2022-Ankara	241

The information for the seventh grade was gathered from statements and questions included in various areas of the science textbook, including the scientific workshop/activity, science workshop/poster, science workshop/tool design, science workshop/experiment, and science workshop/research sections. Data for the 8th grade were gathered from several portions of the science textbook, including the lab activity, study and presentation, brainstorming, and project task design sections. The chapter substance variations might be attributed to the distinct formal frameworks employed in the respective volumes. During the chapter selection process, input was sought from three experts in the field of scientific education. The activities to be evaluated were subsequently decided on the basis of the collective decisions made by these experts. In the context of this research, a comprehensive analysis was conducted on 95 activities, comprising 49 activities from the 7th grade and 46 activities from the 8th grade. Table 2 provides information regarding the grade level, unit, topic area, and number of activities associated with the evaluated books.

Table 2. Grade Level, Unit, Subject Area, Number of Activities, and Number of Outcomes of the Science Curriculum and Textbooks

Grade Level	Subject Area	Number of activities	Number of outcomes
7	Solar System and Beyond (Earth and the Universe)	2	10
	Cells and divisions (living things and life)	2	8
	Force and energy (physical phenomenon)	6	8
	Pure Matter and Mixtures (Matter and its Nature)	14	16
	Interaction of Light with Matter (Physical Phenomena)	12	12
	Reproduction, Growth, and Development in Living Things (Living Things and Life)	9	7
	Electric Circuits (Physical Phenomena)	4	6
8	Seasons and Climate (Earth and Universe)	1	3
	DNA and the Genetic Code (Living Things and Life)	5	13
	Pressure (Physical Phenomena)	6	3
	Matter and Industry (Matter and its Nature)	11	17
	Simple machines (physical phenomena)	6	2
	Energy Transformations and Environmental Science (Living Things and Life)	6	12
	Electric charges and electric energy (physical phenomena)	11	11

Data Analysis

The data obtained from various sources were subjected to descriptive analysis, which is a qualitative data analysis technique. The descriptive analysis method involves methodical grouping and clear explanation of data, focusing on cause-and-effect linkages rather than quantification or generalization (Fern, 2001). Furthermore, the data are analyzed and organized based on predetermined themes (Yildirim & Simsek, 2011). This study examined the analysis of curriculum outcomes and textbook activities, focusing on the planned themes within the sub-dimensions of Hu and Adey's (2002) Scientific Structure Creativity Model. The analysis of the research uncovered several themes, namely "technical product," "scientific knowledge," "scientific fact," and "scientific problem" within the domain of creative product. Additionally, the themes of "fluency," "flexibility," and "originality" have been identified within the realm of creativity. Finally, the themes of "imagination" and "thinking" have emerged within the context of the creative process.

The evaluation of scientific curricular objectives and textbook activities encompassed multiple sub-dimensions within the research scope. The studies involved the examination of each outcome and activity, taking into consideration whether these aspects were included or excluded. As a case study, within the context of the seventh-grade curriculum, specifically the subject area of "Earth and Universe," the initial objective of the "Solar System and Beyond" unit, denoted as "F.7.1.1.1. Explains Space Technologies," was established to encompass the overarching themes of "scientific knowledge, scientific phenomena, and thinking." Correspondingly, the primary educational task featured in the associated textbook for this objective was designated as "Science Workshop/Activity Let's Do: Let's Recognize Space Vehicles," which effectively incorporated all of the aforementioned themes.

In the domain of "Earth and the Universe" within the eighth-grade curriculum, the initial goal of the "Seasons and Climate" unit, precisely outcome "F.8.1.1.1. Makes predictions about the formation of seasons," has been identified to encompass various key elements such as scientific knowledge, scientific fact, scientific problem, fluency, flexibility, originality, imagination, and thinking. Similarly, the primary exercise featured in the corresponding textbook for this particular outcome, titled "Experiment: I Demonstrate the Earth's Circulation Around the Sun with a Model," has been determined to incorporate the following themes: scientific knowledge, scientific fact, scientific problem, fluency, flexibility, originality, and thinking. The results generated by the studies of the outcomes and activities determined in this manner are presented organized.

During the outcome analysis, two professionals in the field of scientific education collaboratively reached a consensus and jointly assessed the results. Both experts independently analyzed 128 objectives in the science curriculum and 95 activities in the textbook in the context of scientific creativity themes. To compare the consistency of the analyses made by different experts, the objectives and activities with "disagreement" and "consensus" were determined. The reliability of the study was calculated using Miles and Huberman's (1994) reliability formula " $\text{Reliability} = \frac{\text{Consensus}}{\text{Consensus} + \text{Disagreement}}$ ". As a result of the calculation, the reliability coefficient was determined to be 91%. Because the reliability coefficient was greater than 70%, it was concluded that the reliability of the analysis was high. Then, in the evaluation process, a third science education expert was consulted for the acquisitions that the science education experts could not agree on. The outcomes and activities on which there was no consensus were discussed by the three experts, and a common decision was reached. The individuals involved in the evaluation process and those whose opinions were sought were notable academics specializing in the domains of science education and creativity, possessing a minimum of a doctoral degree.

Validity and Reliability of the Study

To improve the study's validity and reliability, the analysis employed triangulation. Within this particular framework, the data were analyzed by two experts in the field of science education in collaboration. In addition, a third expert in science education was consulted for instances where a consensus was achieved, leading to a collective conclusion after a thorough discussion. Furthermore,

the methodology employed for conducting the analyses was elucidated through the provision of illustrative instances within the framework of learning outcomes and activities. The study involved the selection of two distinct-grade levels to establish any differences in objectives and textbooks. In the process of conducting a descriptive analysis of the data of the reliability of the study, the viewpoints of three experts specializing in the field of science education were considered to assess the appropriateness of the science curriculum and textbook in relation to the themes identified within the sub-dimensions of the Scientific Construction Creativity Model. The concurrent nature of the researcher's data collection and interpretation processes implies that personal attitudes, thoughts, and behaviours can influence the results (Buyukozturk, Kilic Cakmak, Akgun, Karadeniz & Demirel, 2016). To safeguard the internal validity of the study, the data were transferred without any form of interpretation or alteration. The study procedure was thoroughly elucidated and precisely described to ensure the absence of any potential uncertainty.

Ethical Considerations

In this study, all rules stated to be followed within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive" were followed. None of the actions stated under the title "Actions Against Scientific Research and Publication Ethics", which is the second part of the directive, were taken. Because the study has a single author, there is no conflict of interest in the study. In addition, because this study was not conducted on any living subjects, it does not require ethics committee approval.

Findings

This chapter examines the acquisitions and textbook exercises in the seventh- and eighth-grade science curriculum, concentrating on the themes of scientific creativity. The findings obtained from this analysis are presented below in the context of the sub-problems of the research.

Findings Related to the 7th Grade Science Curriculum and Textbook

The distribution of the seventh-grade science curriculum acquisitions according to the themes of scientific creativity was examined, and the findings are shown in Figure 2.

Figure 2. Distribution of 7th Grade Science Curriculum Objectives based on Scientific Creativity Themes

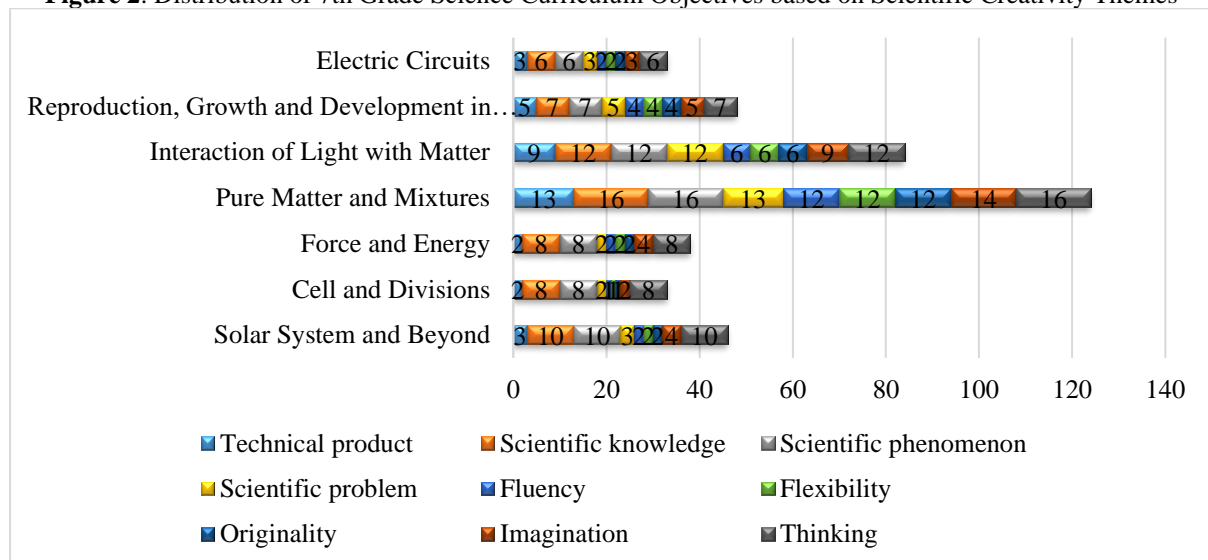
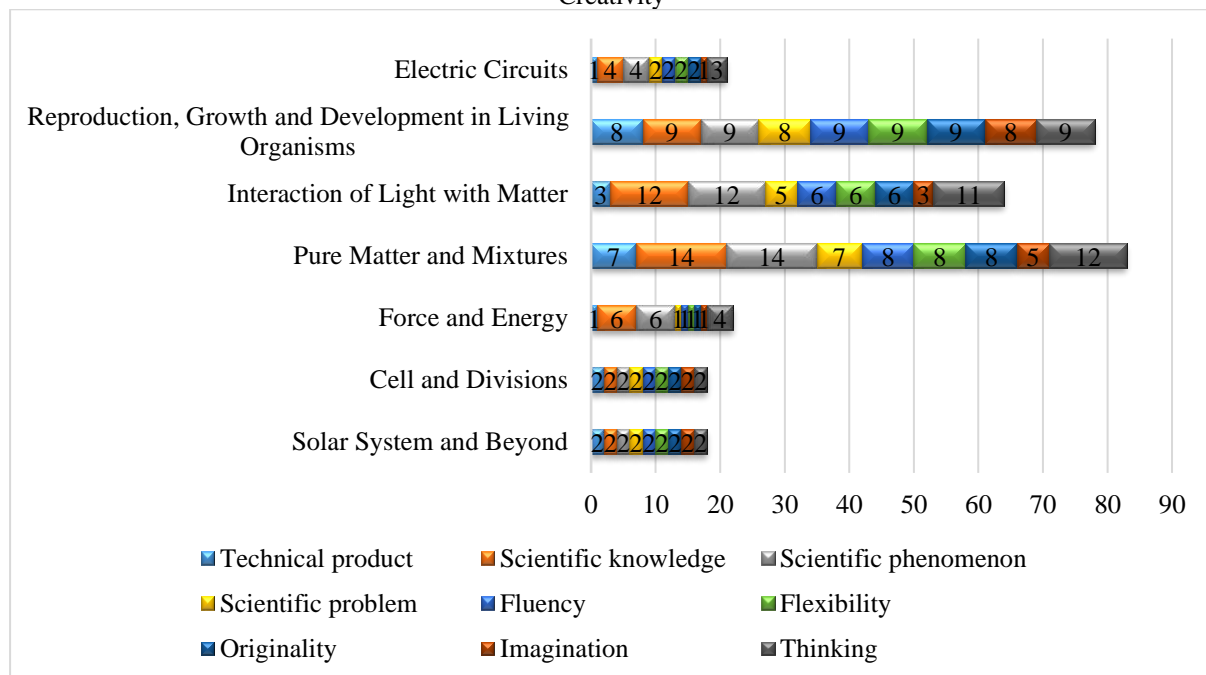


Figure 2 illustrates the categorization of the objectives within the seventh-grade science curriculum based on the various topics associated with scientific innovation. Thus, the learning outcomes

encompass the overarching topics of "scientific knowledge, scientific phenomena, and critical thinking" of scientific creativity. The aforementioned issues received particular emphasis within the curriculum and were duly represented in the designated learning outcomes. Furthermore, the curriculum was discovered to encompass the following themes: inventiveness, scientific problem-solving, technological product development, fluency, flexibility, and uniqueness.

It has been established that the various learning outcomes encompass distinct facets of scientific creativity, particularly when examined within the framework of cohesive units where these themes mutually enhance one another. Furthermore, it has been discovered that the curriculum specifically caters to the creative aspects of both product and process, encompassing themes such as "technical products, scientific knowledge, scientific phenomena, scientific problems, imagination, and thinking". Nevertheless, it was concurrently established that the attributes of "fluency, flexibility, and originality," which encompass the essence of creativity, were given relatively less significance. In alternative terms, the curriculum allocates comparatively less attention to these particular topics. The distribution results of the seventh-grade science course textbook activities in terms of the scientific creativity subscales are in Figure 3.

Figure 3. Distribution of 7th Grade Science Textbook Unit Activities according to Themes of Scientific Creativity



The arrangement of exercises in the seventh-grade science textbook, categorized by themes of scientific innovation, is illustrated in Figure 3. Based on the provided information, it can be inferred that all the activities encompass themes related to scientific knowledge, scientific phenomena, and scientific creativity. The aforementioned issues were given significant emphasis within the curriculum and were duly represented in the activities provided in the textbook. Furthermore, it was determined that the textbook included the following themes: thinking, fluency, adaptability, creativity, scientific problem, technological product, and imagination

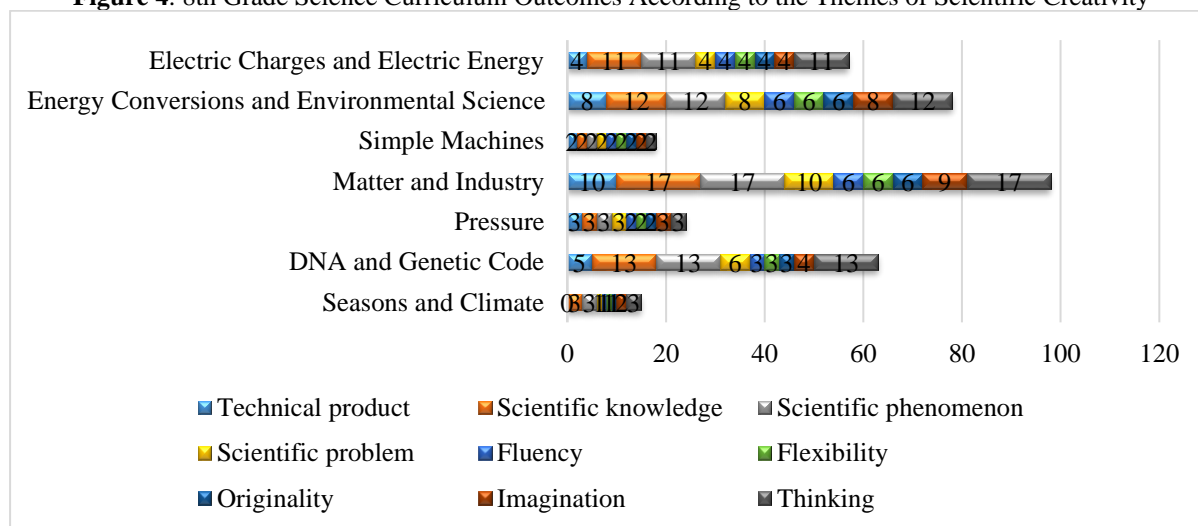
This observation indicates that each of the activities encompasses distinct aspects of scientific creativity, particularly when examined within the framework of the units whereby these topics mutually enhance one another. Furthermore, it can be observed that the textbook provides backing for the topics of "scientific knowledge, scientific phenomena, and scientific problems," particularly within the creative product dimension. Nevertheless, it has been established that the concepts of "fluency, flexibility, and

originality" on the dimension of creativity character, as well as the concept of "imagination" within the creative process dimension, were comparatively less substantiated. In other words, it was concluded that the textbook provided less coverage of these characteristics.

Findings Related to the 8th Grade Science Curriculum and Textbook

The results of the distribution of the eighth-grade science curriculum outcomes according to the themes of scientific creativity are shown in Figure 4.

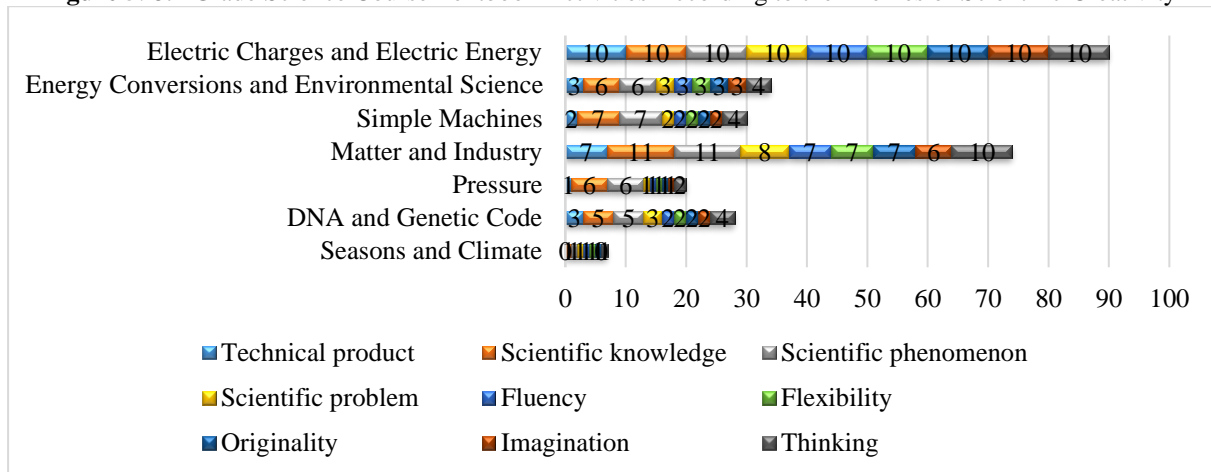
Figure 4. 8th Grade Science Curriculum Outcomes According to the Themes of Scientific Creativity



The distribution of the objectives of the eighth-grade science curriculum, categorized by the themes of scientific creativity, is illustrated in Figure 4. As per observations, it was noted that the learning outcomes encompassed the topics of "scientific knowledge, scientific phenomena, and thinking" in relation to scientific creativity. The identification was made that these elements were specifically stressed within the curriculum and manifested in the learning results. Furthermore, it was determined that the curriculum effectively incorporates the following themes: scientific problem, imagination, technical product, fluency, adaptability, and uniqueness.

Upon careful examination, it was found that the learning outcomes of the unit "Seasons and Climate" did not have any content related to the topic of "technical product." However, all other units did incorporate all themes of scientific creativity, with each unit containing at least one learning outcome of these themes. In addition, it should be noted that the science curriculum for seventh grade typically aligns with the creative aspects of scientific creativity, encompassing the development of technological products and the acquisition of scientific knowledge, facts, and problem-solving skills. Moreover, it fosters the cultivation of imaginative thinking, which is fundamental to the creative process in science. However, the elements of "fluency, flexibility, and originality," which comprise the essence of creativity, are comparatively less significant. The results of the distribution of eighth-grade science course textbook activities in terms of scientific creativity themes are shown in Figure 5.

Figure 5. 8th Grade Science Course Textbook Activities According to the Themes of Scientific Creativity



The sequence of exercises throughout the eighth-grade science textbook, categorized by themes of scientific innovation, is depicted in Figure 5. Thus, it can be observed that all activities encompass topics of scientific creativity, namely, those pertaining to scientific knowledge and scientific phenomena. The aforementioned issues were given significant attention within the curriculum and were duly represented in the various activities. Furthermore, the textbook encompassed the following themes: thinking, scientific problem-solving, technological product development, fluency, adaptability, creativity, and imagination. Therefore, it can be observed that the activities encompass several facets of scientific creativity within the framework of the units, wherever these subjects mutually enhance one another.

It was found that the "Seasons and Climate" unit lacked any content on the themes of "technical product and imagination." However, it was observed that all other units included at least one activity that covered all themes of scientific creativity. Furthermore, it was determined that the textbook provided substantial support for the dimension encompassing technical products, scientific knowledge, scientific facts, and scientific problems, particularly in relation to creative products. Another notable discovery indicated that the creativity character dimension, specifically the themes of "fluency, adaptability, originality," and the creative process dimension, particularly the subject of "imagination," received much less support. In other words, it was concluded that the textbook provided less coverage of these elements.

Comparison of the 7th and 8th Grade Science Curriculum and Textbook Findings

The distribution of 7th- and 8th-grade science curriculum outcomes and textbook activities according to the themes of scientific creativity is shown in Figure 6.

Figure 6. Distribution of 7th and 8th Grade Curriculum Objectives and Textbook Activities according to the Themes of Scientific Creativity

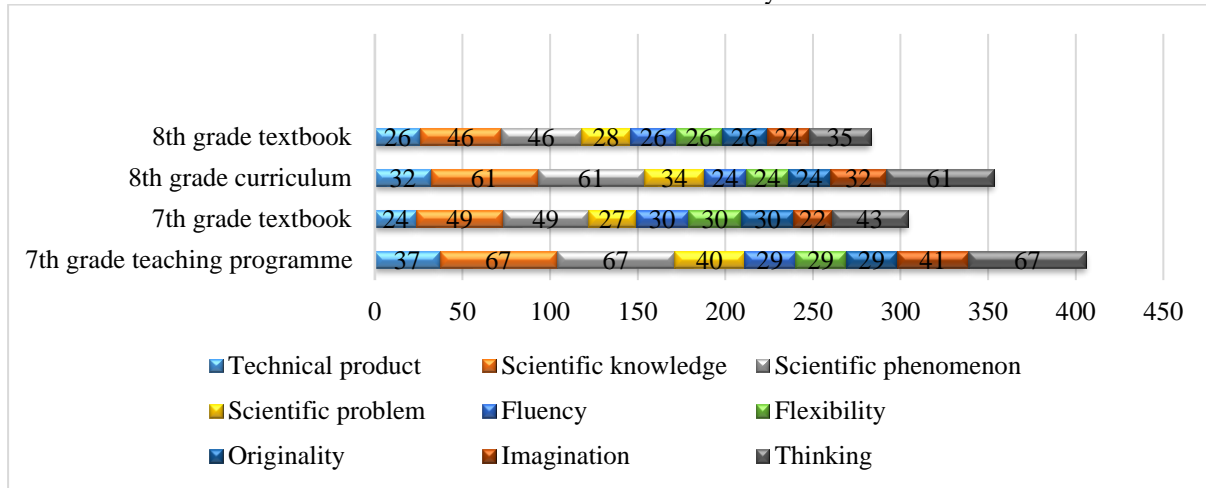


Figure 6 illustrates the comparative allocation of the content encompassed in the science curriculum outcomes and textbook exercises for the 7th and 8th grades, classified based on the themes of scientific creativity. Consequently, an in-depth examination revealed that the curriculum outcomes and textbook exercises incorporated the overarching themes of "scientific knowledge and scientific phenomena." The previously mentioned concepts received significant emphasis within the curriculum and texts and were evident in the learning outcomes and activities. Furthermore, the curriculum and textbook adhered to the themes of "thinking, scientific problem-solving, technical product development, imagination, fluency, flexibility, and originality."

This observation demonstrates the complementary nature of the results and activities at the seventh and eighth grade levels. Nevertheless, it has been established that both the curriculum and the textbook align with the themes of "technical product, scientific knowledge, scientific phenomenon, scientific problem" concerning the creative product dimension and "imagination and thinking" concerning the creative process dimension. However, it has been observed that the themes of "fluency, flexibility, originality" within the context of the dimension of creative character receive comparatively less support. In alternative terms, it is noteworthy that the textbook provides comparatively less coverage of these dimensions. Furthermore, upon closer examination of Figure 6, it becomes evident that the curriculum outcomes and activities of the themes of scientific creativity are proportionally aligned in both the seventh and eighth grades.

Discussion

This study aimed to analyze science curriculum outcomes and textbook activities of seventh- and eighth-grade students, focusing on scientific creativity. Additionally, the study assessed the extent to which these dimensions were reflected in the curriculums and activities, considering the students' grade levels. Based on the assessments conducted, it was concluded that across various grade levels, the curriculum outcomes and textbook activities encompassed the aspects of scientific knowledge and scientific phenomena, aligning with the parameters of the creative product. This scenario potentially provides students with the chance to enhance their capacity to comprehend and employ scientific disciplines. The increasing number of educational initiatives focused on fostering students' creative abilities in schools can be attributed to scholarly investigations on the correlation between creativity and knowledge (Ategoz, 2021). The inclusion of creativity into educational curricula has facilitated the exploration of the relationship between knowledge and creativity, given that knowledge is widely recognized as a key component of comprehension (Craft, 2005).

Numerous academic papers claim that the acquisition of knowledge is a crucial factor in the process of creativity. These sources concur that individuals lacking sufficient knowledge may not be able to fully explore the boundaries of their creative potential (Baer, 2012; Boden, 2001; Csikszentmihalyi, 1996; Gero & Maher, 2013; Feldhusen, 1995; Ivcevic, 2007; Kulkarni & Simon, 1988). According to Weisberg (2006), the fulfilment of domain-specific knowledge is a prerequisite for engaging in creative endeavors. In the realm of science education, the provision of a complete and accurate information base to students can significantly enhance their ability to participate in creative thinking and make meaningful contributions to scientific discoveries. Thus, science education focuses on building a science-based knowledge base by providing students with scientific foundations (Bati, 2013). This gives students a solid understanding of basic science concepts, theories, and principles. Moreover, science education provides students with many opportunities to develop creative thinking skills, such as analyzing problems, developing hypotheses, and drawing conclusions through experimental work (Rizal, Putra, Suharto & Wirahayu, 2022; Suchyadi, Safitri & Sunardi, 2020). This gives students the ability to become individuals who are not only limited to rote learning of information but also capable of generating their own solutions (Ciftci, Saglam & Yayla, 2021). In addition, by increasing students' ability to make meaningful contributions to scientific discoveries, they may have the opportunity to conduct original science research (Ozata Yucel & Kanyilmaz, 2018). This enhances students' potential to contribute to the world of science and their ability to contribute to scientific progress. Within this particular framework, the use of scientific knowledge and factual information in the realm of science education emerges as a pivotal component that facilitates students in acquiring a more comprehensive understanding of the universe. Moreover, it enables them to employ scientific reasoning in their everyday activities while honing their fundamental abilities (Driver, Leach, Millar, & Scott, 1996). Consequently, placing a strong emphasis on scientific information and phenomena within science curricula and textbooks has the potential to facilitate students in harnessing their scientific curiosity and maximizing their potential.

In the given research environment, it is worth mentioning that the science curriculum and textbooks predominantly prioritize the creative product and process dimensions. However, relatively less emphasis is placed on the elements of creativity, such as fluency, flexibility and ingenuity. This scenario highlights the necessity of placing greater emphasis on these factors to foster the development of pupils' creative thinking abilities. The emphasis on students' capacity to invent and innovate by adopting interdisciplinary approaches to problem-solving is a prominent feature of the scientific curriculum outlined by the MoNE in 2018. Scientific creativity plays a crucial role in developing students' problem-solving skills (Siew, Chong & Lee, 2015). Problem-solving activities in science learning facilitate the construction of new scientific knowledge and promote creativity (Mukhopadhyay, 2013). There is a strong association between creativity and problem-solving activity, as both involve investigating problems and finding innovative solutions (Mukhopadhyay, 2013). Innovative and varied learning activities are essential for promoting students' problem-solving skills and creative thinking (Pujawan et al., 2022). Mastery of knowledge and scientific process skills also contributes to the enhancement of scientific creativity and problem-solving abilities (Zulkarnaen, Supardi & Jatmiko, 2018). Training programs that target creativity and problem-solving skills have been found to have a complementary effect on performance (Blissett & McGrath, 1996). Additionally, students are encouraged to employ diverse tactics to enhance the development of the goods they create. Hence, it is anticipated that students will cultivate inventive solutions to challenges by developing novel and unique ideas beyond the mere acquisition of subject-specific knowledge (Guilford, 1986; Hu & Adey, 2002; Jaarsveldt, 2011; Torrance & Goff, 1989).

A further conclusion of this study shows that the objectives and activities outlined in the seventh- and eighth-grade curriculum are congruent concerning the dimensions of scientific creativity. The findings of this study underscore the significance of incorporating both scientific creativity and critical thinking components in a well-rounded approach to science education. Scientific creativity plays a crucial role in the development of students' critical thinking skills (Runco, 1993). Divergent thinking, which is a component of creativity, has been linked to critical thinking abilities (Runco, 1993). In addition, critical thinking disposition has been found to mediate the relationship between creative self-efficacy and scientific creativity (Qiang et al., 2018). This recommend that individuals with a higher disposition for

critical thinking are more likely to exhibit scientific creativity (Qiang et al., 2018). Therefore, fostering scientific creativity can contribute to the enhancement of students' critical thinking skills. The lack of contextual information related to the technical product sub-dimension in the "Seasons and Climate" unit's curriculum acquisitions further supports the aforementioned results. Similarly, the textbook activities lack contextual information for both the technical product and imagination themes. The results of this study indicate a general alignment between the science curriculum and textbooks in terms of fostering scientific creativity. However, the analysis also reveals a deficiency in the inclusion of characteristics related to scientific creativity within the "Seasons and Climate" unit, both in terms of desired objectives and the content of the curriculum. The lack of contextual information on the technical product sub-dimension does not support the development of creativity in students' ability to gain practical experience in this field and develop their creative thinking skills. In addition, the recurring motif of a dearth of imagination recommends that students may encounter constraints in cultivating their capacity for creativity and generating novel concepts. These limits may hinder students' ability to fully harness their potential for imaginative thinking in science and explore many elements of creativity.

Conclusion

The results of this study show that science curricula and textbooks generally support the concept of creativity. Curricula and textbooks offer the potential to convey scientific knowledge and facts to students while encouraging creative products. However, this study reveals that the elements that characterize creativity, especially fluency, flexibility, and originality, are insufficient. Although students are offered the opportunity to develop their ability to understand and apply scientific topics, the importance of creative thinking and products could be further emphasized. Seventh and eighth-grade curricula and textbooks were found to be compatible in terms of scientific creativity dimensions. However, there was a lack of content on the theme of technical products and imagination in certain units. These deficiencies may limit students' ability to fully evaluate and develop their scientific creativity potential. As a result, we can conclude that science curricula and textbooks should support the creativity dimension more effectively.

Limitations and recommendations

The focus of this study was limited to the science curriculum outcomes specifically designed for seventh- and eighth-grade students, as well as the activities outlined in the selected textbooks. This limitation was made to focus the study on a specific age group in the context of scientific creativity and to help present and understand the research process and results more effectively by conducting a more in-depth examination. The science curriculum outcomes of other-grade levels and textbook activities were excluded from the study. Furthermore, the exclusion of topic content information and end-of-unit evaluations from the scope is also observed. In this particular context, it is advisable to undertake a longitudinal investigation pertaining to the impact of science curricula and textbooks authored by various publishers on the multifarious aspects of scientific innovation. In this context, future studies should examine the science curriculum outcomes of the seventh- and eighth-grade levels in terms of scientific creativity. In addition, the subject content information and end-of-unit evaluations of textbooks can also be examined in terms of scientific creativity. This study demonstrates that the qualities of fluency, flexibility, and originality, which constitute the key components of scientific innovation, are inadequately represented in curricula and textbooks. Hence, it is recommended that future curricula and textbooks include a more significant number of exercises that strengthen these dimensions.

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