INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 14, Issue 11, (2024) E-ISSN: 2222-6990

The Application of Science Teachers' Creative Thinking Skills in Teaching Students and its Relationship with their Brain Dominance in Oman

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To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v14-i11/23887 DOI:10.6007/IJARBSS/v14-i11/23887

Published Date: 29 November 2024

Abstract

The present study aimed to investigate the application of science teachers' creative thinking skills in teaching students and its relationship with their brain dominance in the Sultanate of Oman. Additionally, it sought to explore the impact of gender and years of teaching experience on the degree of skill application. The study sample consisted of 438 science teachers, who were assessed using two instruments: a 40-item questionnaire distributed across four creative thinking skills, and a 21-item brain dominance scale. The reliability coefficients for the two instruments were 0.49 and 0.70, respectively. The key findings revealed that the application of creative thinking skills by science teachers ranged between moderate and high levels. No statistically significant differences were found between male and female teachers in the application of flexibility, fluency, and originality skills. However, statistically significant differences were observed in the application of the problem sensitivity skill, favoring female teachers. Furthermore, the results indicated no statistically significant differences in the application of creative thinking skills based on years of teaching experience. The findings also revealed that the integrated brain dominance style was the most prevalent among the sample, with a percentage of 66.7%. A statistically significant relationship was found between the application of creative thinking skills in teaching and the integrated brain dominance style. Based on these findings, the study recommended providing pre-service and in-service training for teachers to enhance their practice of creative thinking skills in teaching. Additionally, it emphasized the importance of administering the brain dominance scale to both teachers and students to identify their dominant styles. The study further recommended fostering creative thinking and innovative outcomes among teachers and students at the school and governorate levels.

Keywords: Creative Thinking Skills, Brain Dominance

Introduction

In an era of rapid scientific and technological advancements, coupled with significant social, educational, and economic transformations, fostering creativity has become a critical objective for nations striving to keep pace with global progress. Creative thinking has emerged as a cornerstone of innovation, garnering substantial attention from educators and psychologists (Al-Ubaidi, Al-Ubaidi, & Al-Ubaidi, 2010). Since Guilford introduced his "Structure of Intellect" theory in 1950, numerous studies, including those by Torrance and Jackson, have explored methods to identify and develop creative individuals (Saadah, 2003; Al-Surour, 2002). This global emphasis has extended to the Arab world through initiatives like the Arab Creativity Development Association and the Arab Scientific Conference for Gifted and Talented Students (Al-Balushi, 2010).

Creative thinking, defined by Torrance as "the process of sensing problems, generating and evaluating ideas, and implementing the most appropriate solutions" (Abu Al-Nasr, 2008, p. 18), and by Mednik as "the ability to use concepts innovatively" (Hamadnah, 2014, p. 14), is increasingly studied in the context of brain dominance. Brain dominance, described by Springer and Deutsch (1998) as the reliance on one hemisphere over the other for cognitive activities, has been linked to creativity. Some studies suggest stronger associations with the right hemisphere (Mihove et al., 2010), while others highlight the importance of hemispheric integration (Lindell, 2011).

Education plays a pivotal role in nurturing creative thinking. Teachers, in particular, significantly influence students' creative potential through strategies that promote exploration and problem-solving (Al-Azmi, Al-Qallaf, & Khidr, 2009). However, traditional teaching methods and a lack of creative thinking skills among educators often hinder this development (Al-Balushi, 2001; Mu'awwad, 2005). Science education, with its practical and exploratory nature, offers a fertile ground for fostering creativity by engaging students with real-world problems and environmental contexts (Al-Kayyal, 2012).

This study responds to calls for research into the relationship between brain dominance and creative thinking (Abdelhaq & Al-Ajeeli, 2015; Al-Balushi, 2013). As Pajares (1992), emphasized, teachers' awareness of brain dominance can influence their instructional practices and students' creative capacities. The study, therefore, examines the extent to which science teachers apply creative thinking skills and how this relates to their brain dominance, addressing a critical gap in the existing literature.

Study Problem

Classroom observations in many schools reveal that students often play a limited and passive role in the educational process, confined to mere reception and memorization. This marginalization stems from traditional teacher-centered curricula, where students are primarily engaged in rote learning without comprehension. The reliance on traditional teaching methods negatively impacts students, often leading to intellectual stagnation (Mustafa, 2005).

Previous studies indicate a lack of implementation of creative thinking skills in classrooms. For instance, Al-Nefaie (2009) found weaknesses in teachers' practices of creative thinking skills, while studies by Al-Freihat (2013), Hamadnah (2009), and Qashou (2001) concluded that teachers demonstrated a moderate level of creative thinking application. Conversely, the study by Zidan and Al-Oudah (2008) indicated a high degree of creative thinking skill use among teachers.

Al-Zadjali (2006) identified a lack of diversity in the teaching practices of science teachers, which has led to inadequate development of students' thinking skills. This shortfall is attributed to inappropriate classroom practices and insufficient attention to fostering various thinking skills. Similarly, studies by Al-Balushi and Al-Azri (2010) and Al-Shehab (2003) revealed that science teachers applied creative thinking skills at a moderate level.

Another study by Samidah and Grace (2014), analyzing the performance of Arab countries in the 2011 TIMSS (Trends in International Mathematics and Science Study), showed that Arab students generally performed below average. Most students in eighth grade demonstrated limited proficiency, confined to basic facts and concepts, with minimal application of higher-order thinking skills. The study highlighted that teaching practices in Arab countries predominantly relied on traditional activities such as observation, memorization, and theoretical explanations, with limited emphasis on experimental or fieldwork activities. Oman ranked 36th out of 50 participating countries in average science scores in TIMSS 2011, further underscoring the need for improved teaching practices (Samidah & Grace, 2014).

An exploratory interview with 21 science teachers revealed limited familiarity with creative thinking skills among teachers. Their instructional approaches were largely confined to rote memorization and reproduction of textbook content. While some teachers attempted to adopt modern strategies like problem-solving and practical experimentation, these efforts rarely extended beyond following the prescribed steps in the curriculum without fostering broader principles of thinking or creativity. Al-Balushi (2013) argued that teaching methods are influenced by teachers' brain dominance, with a positive correlation between the two. Similarly, Afaneh and Al-Jaish (2009) emphasized that brain dominance affects teachers' performance and classroom practices.

These findings motivated the present study, which seeks to address the following research questions:

1. To what extent do science teachers apply creative thinking skills in teaching students in grades 5–10?
2. What type of brain dominance characterizes science teachers teaching grades 5–10?

Study Hypotheses

1. There are no statistically significant differences at the level of ($\alpha \leq 0.05$) in the application of creative thinking skills in teaching by science teachers attributed to the gender variable.
2. There are no statistically significant differences at the level of ($\alpha \leq 0.05$) in the application of creative thinking skills in teaching by science teachers attributed to the experience variable.
3. There is no statistically significant relationship at the level of ($\alpha \leq 0.05$) between the use of creative thinking skills in teaching by science teachers and their brain dominance.

Literature Review

Theories of Creative Thinking

Several theories have attempted to explain creative thinking, among which the most prominent are:

Cognitive Theory

Cognitive theorists focus on mental processes and skills as the foundation of thinking. They sought to explain cognitive phenomena and provided alternatives to the behaviorist concepts in learning, thinking, and problem-solving. According to cognitive theory, creative thinking involves the dominance of awareness and intellectual interaction in creative situations, indicating that it comprises several mental processes, such as focus, perception, awareness, and organization, to produce novel experiences (Ghanem, 2004).

Factorial Theory

Proponents of this theory view creativity as "a product of the mind, an offspring of thought, an enlightened act achieved by a mature mind in control of itself, driven by a will illuminated by the light of thought" (Abdel Aal, 2005, p. 73). Among the key factorial models addressing creativity is Guilford's "Structure of Intellect" model, which identifies three dimensions: mental operations, content, and output (Al-Qatami, 2001).

Abu Ghraiba (2008) clarified these three dimensions as follows:

- **Mental operations**: Include convergent thinking, divergent thinking, and evaluation.
- **Content**: Can be sensory, symbolic, linguistic, or behavioral.
- **Output**: Takes forms such as units, groups, relationships, systems, transformations, or applications.

Through test analyses, Guilford concluded that individuals' mental processes are influenced by two capabilities: convergent thinking and divergent thinking. He found that convergent thinking involves providing a single correct answer to a situation, whereas divergent thinking allows for multiple answers in different directions, which aligns with creativity. Based on this conclusion, Guilford linked divergent thinking to creativity, which he utilized in developing tests to measure fluency, flexibility, originality, and sensitivity to problems (Abu Ghraiba, 2008).

Guilford's "Structure of Intellect" Theory

Guilford's model is one of the most significant contributions to understanding creativity as a cognitive process. His model encompasses three dimensions, each comprising a set of specific cognitive abilities, totaling 120 abilities (Hussein, 2002). These abilities are represented in a cube model containing 120 cells, each symbolizing a mental factor, as illustrated in Figure 1.

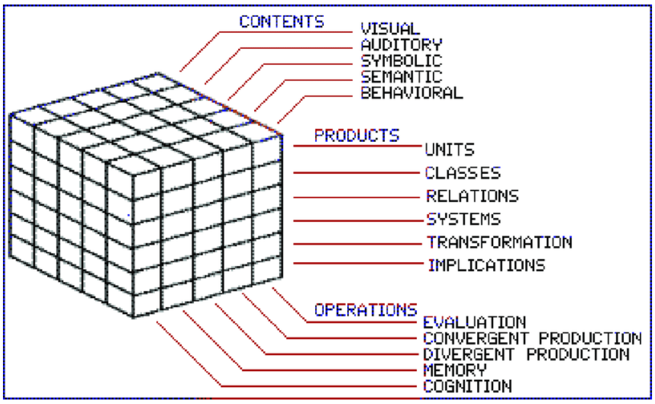

Figure 1: Guilford's Three-Dimensional Model

Mental processes are classified into five main categories:

- **Perception or cognition factors**: The ability to recognize and understand information.
- **Memory factors**: The capacity to retain and retrieve information when needed.
- **Convergent thinking factors**: A type of thinking that requires arriving at one correct answer or selecting the best option.
- **Divergent thinking factors**: Enables individuals to think in multiple directions, exploring differences and seeking varied solutions.
- **Evaluation factors**: Involve forming judgments about the accuracy and validity of prior or new information (Al-Huwaidi, 2007).

Guilford considered divergent thinking to be the most critical element in his Structure of Intellect model due to its significant influence on creative thinking. Both divergent thinking and creative thinking share core elements such as originality, fluency, flexibility, and sensitivity to problems. Guilford explained that divergent thinking enhances and refines available information, generating new ideas and outcomes. Unlike convergent thinking, which seeks one correct answer, divergent thinking explores multiple, unconventional answers, embodying the essence of creativity (Al-Huwaidi, 2007).

As such, Guilford's theory is among the most prominent frameworks for understanding creativity and creative thinking. This study is based on his theory to explore the extent to which science teachers apply creative thinking skills in teaching.

The Nature of Creative Thinking

In 1950, Guilford urged psychologists to focus on creativity, noting its neglect in psychological research. At that time, less than 2% of psychological studies addressed creativity (Isa, 2008). In his famous address to the American Psychological Association, Guilford stated, "Creativity is a natural resource, and efforts to foster it will benefit society as a whole." He emphasized that creativity could be studied objectively and spent the next 35 years proving this assertion (Alawneh, 2011, p. 19).

Guilford's call sparked a wave of research into creativity (Al-Freihat, 2013). Although scholars agree on the importance of creativity as a type of cognitive activity, they differ in their approaches and definitions due to varying theoretical and methodological perspectives (Al-Zubaidi, 2012).

Olsen (1999) defined creativity as a cognitive process where ideas are generated and modified based on prior knowledge to develop new solutions to problems. Similarly, Al-Heila (2002, p. 54) described it as "a purposeful mental activity driven by a strong desire to find solutions or produce original outcomes that were not previously known. It consists of fluency, flexibility, originality, elaboration, and sensitivity to problems." Rogers, as cited in Abu Al-Nasr (2008, p. 18), viewed creative thinking as "the emergence of new outcomes resulting from an individual's interaction with experiential materials."

Despite varying definitions, common elements of creative thinking emerge:
a) It involves producing something new based on prior knowledge.
b) It comprises multiple skills, including fluency, originality, flexibility, and sensitivity to problems.
c) It is fundamentally a cognitive process.
Creative thinking can thus be defined as a cognitive process characterized by unconventional approaches to generating novel and useful ideas.

Creative Thinking Skills

Literature reviews indicate that creative thinking encompasses several skills, including fluency, flexibility, originality, sensitivity to problems, elaboration, and maintaining direction. The current study focuses on measuring the first four skills:

Fluency

Torrance defines fluency as "the ability to generate as many appropriate ideas as possible within a given time for a specific problem or stimulating situation" (Ibrahim, 2005, p. 173). Hasan (2007, p. 145) describes it as "producing multiple ideas within a set timeframe and articulating them verbally." Fluency is categorized into five types: verbal fluency, ideational fluency, expressive fluency, associative fluency, and figural fluency (Saadah, 2003).

- **Verbal Fluency**: Defined as "the speed at which an individual generates words and phrases in a specific sequence" (Al-Titi, 2004, p. 53).
- **Ideational Fluency**: Refers to "the ability to quickly produce a large number of ideas or mental images in response to a situation, with less emphasis on the quality of responses and more on their quantity" (Hammad & Badr, 2014, p. 79).
- **Expressive Fluency**: The ability to easily express and articulate ideas in coherent, meaningful words (Saadah, 2003).
- **Associative Fluency**: Defined as "generating as many items as possible that share certain comparable features, often resulting from divergent associations of meanings" (Abu Jadu, 2004, p. 30).
- **Figural Fluency**: According to Abu Jadu and Nofal (2007, p. 160), it is "the ability to quickly draw numerous examples, details, or modifications in response to a visual or situational stimulus."

Fluency emphasizes the capacity to generate numerous alternatives or solutions within a set period. Its importance in teaching lies in providing students with opportunities to freely express their ideas.

Flexibility

Flexibility refers to "the ability to generate different types of ideas and shift thinking from one perspective to another" (Ryan, 2016, p. 219). It is categorized into two types:

- **Spontaneous Flexibility**: Defined as the capacity to produce multiple responses from various categories (Ali, 2011). Al-Khalili (2005, p. 140) describes it as "the speed of generating diverse ideas linked to a problem or stimulus, characterized by spontaneous initiative rather than merely reacting."
- **Adaptive Flexibility**: Al-Titi (2004, p. 53) defines it as "finding solutions to problems or adapting to situations based on feedback from the context." Additionally, it is "the ability to change thought processes and mental orientation quickly to address new and changing challenges, fostering innovative and unconventional solutions" (Al-Ma'ayta & Al-Buwaleez, 2004, p. 182).

Flexibility enables individuals to think in various directions, producing diverse responses to a given problem. In teaching, it encourages students to explore multiple approaches to solving problems and fosters acceptance of alternative viewpoints.

Originality

Originality is the ability to generate novel and rare ideas that do not replicate previous thoughts (Al-Surour, 2002). Shawahin (2003, p. 24) describes it as "uniqueness and freedom from constraints." It is often synonymous with creativity, reflecting an individual's capacity to create genuinely new outcomes. As such, originality is measured by the ability to produce unconventional ideas. In teaching, this skill can be fostered by encouraging students to experiment and seek innovative solutions to challenges (Hammad & Badr, 2014, p. 84).

Sensitivity to Problems

Sensitivity to problems is "the awareness of existing issues, needs, or weaknesses in the environment or situation" (Al-Freihat, 2013, p. 26). Hammad and Badr (2014, p. 83) define it as "the ability to identify problems in objects, tools, or social systems that others might overlook, or to propose improvements to these systems."

This skill reflects an individual's capacity to critique and recognize areas needing improvement or change. Training students to identify problems in their surroundings fosters motivation to devise creative and unconventional solutions, contributing to their problem-solving abilities in an innovative manner.

Creative Thinking and Education

In the current era of significant scientific progress, it has become essential to teach students various thinking methods to enhance their knowledge and skills, enabling them to achieve higher levels of competence in any field they pursue. Educational theorists argue that thinking can be developed and trained when appropriate educational contexts and tools are provided. Consequently, one of the modern goals of education is to train students in critical thinking and equip them to address challenges both within and outside the school environment (Eisam Eldin, 2003).

Achieving this goal heavily depends on teachers, who play a pivotal role in fostering and nurturing creativity. Even with a well-designed curriculum, its success is limited if implemented by a teacher unqualified to fulfill this significant role (Tafesh, 2004). Al-Azmi, Al-Qallaf, and Khidr (2009) supported this notion in their study, which examined the role of teachers in fostering creativity and innovative thinking among high school students in Kuwait. The study, involving 140 teachers across various disciplines, found that teachers significantly contributed to developing students' creativity through daily classroom practices. The study also revealed no statistically significant differences in the use of innovative thinking based on gender or years of experience.

Carter (1992), emphasized that fostering creativity is a teacher's responsibility, requiring them to translate creativity into classroom practices by understanding students' developmental stages and needs and creating a stimulating learning environment. Similarly, Carroll (1991) investigated the level of creative thinking among seventh-grade students in Western Australia and identified teaching strategies that could enhance students' creative potential. Using intelligence and Torrance creative thinking tests on a sample of 600 students, the study concluded that creative thinking exists among students, but its realization and development depend significantly on the teacher's role.

These findings from prior studies underscore the importance of teachers in nurturing creativity and creative thinking at all educational levels.

Science Teaching and Creative Thinking

Developing and training students in creative thinking skills is a key strategy in modern science education. For this to succeed, the educational environment must encourage students' creative potential at all levels. Science teaching cannot be effective if it solely emphasizes memorization and rote learning while neglecting broader educational goals. Instead, it requires innovative teaching methods that strengthen students' creative thinking skills (Salameh, 2002).

The science teacher plays a vital role as a catalyst for their students' creative thinking. Their responsibility extends beyond delivering knowledge to creating an environment that stimulates students' minds and encourages them to apply creative thinking skills. A science teacher must be innovative and capable of delivering the curriculum in a way that fosters students' creative abilities (Al-Hujaili, 2008).

Numerous studies have highlighted the role of science teachers in promoting students' creative thinking skills. Naga (2011) explored the level of creative thinking among high school students and the extent to which science teachers encouraged it from the students' perspective. Using a sample of 48 teachers and 73 students in Khan Younis, the study utilized a creative thinking test and a questionnaire to measure teachers' encouragement of creativity. Results indicated that science teachers strongly encouraged creative thinking during teaching, with a high rating of 83.73%. No significant differences were found based on gender or years of experience.

Similarly, Zidan and Al-Oudah (2008), investigated how elementary science teachers in Hebron implemented creative thinking patterns in their teaching. The study involved 80 teachers, using an observation checklist of 46 items. Results revealed that the application of creative thinking patterns was substantial, with no statistically significant differences based on gender. However, differences emerged based on years of experience, favoring more experienced teachers.

Modern educational approaches emphasize replacing traditional teaching methods focused on rote learning with strategies that engage students intellectually, enabling them to actively participate in the learning process (Habash, 2002). Studies further validate the importance of teaching strategies that enhance learners' creative thinking abilities. For example, Al-Ghafri and Ismail (2014) examined the impact of integrating creative and critical thinking strategies on fifth-grade science students in Malaysia. Using a sample of 68 students across two schools, the study employed creative thinking and science tests. Results revealed statistically significant differences between the control and experimental groups in favor of the experimental group, highlighting the importance of adopting teaching strategies that enhance creative thinking skills.

These findings emphasize the need for teachers to implement innovative instructional strategies to improve students' creative thinking abilities and overall educational outcomes.

Safwat's (2008) study investigated the impact of certain teaching methods on the level of creative thinking skills and students' attitudes toward science. The study involved 79 sixth-grade students from Amman Governorate. The tools used included a creative thinking test, a scientific attitudes scale, and a scientific concepts test. The results showed statistically significant differences between the mean scores of the experimental group and the control group in favor of the experimental group, highlighting the importance of teaching methods in fostering creative thinking among students.

Similarly, Al-Mohsen (2000) conducted a study aimed at evaluating the effectiveness of a proposed teaching method in developing creative thinking skills among middle school students in science. The study sample consisted of 150 first-grade middle school students from the Al-Madinah Al-Munawarah region. The study used a test to measure creative thinking skills (fluency, flexibility, and originality) for both the control and experimental groups. The results indicated significant improvement in the experimental group's creative thinking skills, both individually and collectively, emphasizing the value of the proposed teaching method in developing creative thinking in science education.

Zielinski and Sarachine's (1994) study focused on the impact of creative thinking strategies on high school students in biology. The study included 39 students divided into control and experimental groups. Results showed that the experimental group achieved higher levels of creative thinking compared to their baseline scores and the control group, demonstrating the effectiveness of creative thinking strategies.

The findings of these studies underscore the importance of employing teaching methods that foster creative thinking skills to enhance students' cognitive abilities. The current study aligns with previous research, such as Naga (2011) and Zidan and Al-Oudah (2008), in measuring the application of creative thinking skills by science teachers. However, it differs in its targeted sample, focusing on science teachers instructing grades 5–10 students. Moreover, this study diverges from research by Al-Ghafri and Ismail (2014), Safwat (2008), Al-Mohsen (2000), and Zielinski and Sarachine (1994) in its methodology. While prior studies employed experimental methods, the current study adopts a correlational approach.

Additionally, this research uniquely explores the relationship between science teachers' application of creative thinking skills in teaching and their brain dominance, a topic not addressed in the aforementioned studies.

Creative Thinking and the Brain

In recent years, neuroscientists have uncovered the fundamental structure and functions of the brain, thanks to advanced technology that has revealed its secrets and psychological processes (Al-Salti, 2004).

Several theories have been proposed to explain brain functions, with Roger Sperry leading the way through his Split-Brain Theory (Al-Surour, 2002). Sperry discovered that the two hemispheres of the brain are identical in structure and vital functions but differ in psychological functions and thinking processes (Balto, 2003).

The experiments conducted by Gazzaniga (2002) on the anatomical structure of the brain confirmed that it is divided into two hemispheres: the left and the right. The left hemisphere converts incoming information into symbols, while the right hemisphere retrieves this information when needed. This division illustrates that the two hemispheres are functionally independent yet structurally unified.

Sousa (2001) explains that the left hemisphere is responsible for analytical, linguistic, and mathematical thinking, whereas the right hemisphere specializes in creative, visual, intuitive, and synthetic thinking. Researchers have found that individuals tend to use one hemisphere more than the other when processing information, a phenomenon later termed brain dominance. The following table illustrates the primary functions of the brain's hemispheres:

Table 1
Primary Functions of Brain Hemispheres

Left Hemisphere Processing	Right Hemisphere Processing
Focuses on constituent parts	Focuses on the whole and Gestalt forms
Analyzes partial details	Integrates parts into a cohesive whole
Analytical (whole to part)	Relational, structural (part to whole)
Sequential and linear processing	Simultaneous and spatial processing
Verbal – encoding – decoding speech, math, and melody	Visual – spatial – musical processing

(Afaneh & Al-Jaish, 2009, p. 21)

The above information highlights that each brain hemisphere has distinct functions, and individuals rely on one hemisphere more than the other for performing various tasks, a phenomenon known as brain dominance.

Brain Dominance

The term "brain dominance" is attributed to John Jackson, who proposed the concept of the dominant side of the brain, leading to the formulation of brain dominance theory. Jackson asserted that the two hemispheres of the brain cannot be identical (Eid, 2009). Torrance defined brain dominance as "the use of information by individuals to address problems, represented by the use of functions of the left and right hemispheres, or both, in mental processes or behavior" (Murad & Ahmad, 2001, p. 13). Similarly, Hassanain and Al-

Shehat (2001, pp. 81–82) described it as "the hemisphere an individual tends to rely on more when processing information and solving problems."

Bewington (2009, p. 18) defined brain dominance as "a set of processes essential for individuals to interact with their academic and practical environments, evident in their preference for the dominant pattern, reflected in their behavior and thought processes as they process information in the brain."

Nofal (2007) categorized brain dominance into three types:

1. Right Brain Dominance: Dependence on the right hemisphere for processing information and situations.
2. Left Brain Dominance: Use of the left hemisphere to process encountered situations.
3. Integrated Brain Dominance: Reliance on both hemispheres for interaction with situations.

Mihove, Denzler, & Foster (2010) noted that many studies conducted in the late 20th century on the neurological and physiological processes of creativity yielded contradictory results. While most studies supported the dominance of the right hemisphere in creative thinking activities, others highlighted the role of the left or integrated hemispheres in such activities.

Razumnikova & Volf (2012) conducted a study exploring the relationship between brain hemispheres and creativity, considering gender differences. Using the Torrance Tests of Creative Thinking (verbal and non-verbal) on a sample of men and women in Russia, the study found that originality was associated with right hemisphere functions, regardless of gender.

Abdel-Haq and Al-Ajeeli (2015) investigated the relationship between creative thinking and brain dominance patterns among university students in Jordan, considering demographic variables. The study involved 303 students selected using a cluster sampling method. Tools included the Hemispheric Dominance Inventory (HDI) and one of Torrance's verbal creative thinking tests. Results revealed that creative thinking correlated with the right hemisphere, as students with right brain dominance scored significantly higher in fluency, flexibility, originality, and overall creative thinking than those with left or integrated brain dominance. The study also noted that left brain dominance was prevalent among participants.

Whitman, Holcomb, & Zanes (2010) conducted a study in the United States to test the hypothesis that integrated brain dominance is associated with creative activities. Using a sample of 48 psychology students from Wayne University, participants were subjected to the Torrance Test of Creative Thinking. To assess the cooperation between hemispheres, participants were asked to make decisions about visual stimuli displayed on a screen from various positions. Results indicated that individuals with high creative thinking scores demonstrated greater use of both hemispheres, supporting the link between creative thinking and integrated brain dominance.

Lindell (2011) reviewed specialized literature and analyzed physiological and psychological studies on the contributions of both hemispheres to creativity. The study concluded that interaction between the hemispheres is crucial for creativity, as it facilitates integration between separate and diverse cognitive abilities, enhancing creative thinking.

Furthermore, the study found that creativity is distributed across both hemispheres rather than being confined to the right hemisphere.

In summary, brain dominance can be defined as the hemisphere that predominantly governs an individual's practices and behaviors in various situations. Researchers generally agree that each hemisphere is responsible for specific thought patterns, including creative thinking. However, there is disagreement on which hemisphere is primarily responsible for creativity. Studies such as Abdel-Haq and Al-Ajeeli (2015) and Razumnikova & Volf (2012) supported the dominance of the right hemisphere in creative thinking. In contrast, Whitman, Holcomb, & Zanes (2010) and Lindell (2011) emphasized the role of integrated brain dominance. This inconsistency in previous findings necessitates further research. Consequently, the current study aims to investigate the relationship between brain dominance patterns among science teachers and their application of creative thinking skills in teaching.

The Relationship between Creative Thinking and Brain Dominance

It is well established that each individual exhibits a unique brain dominance pattern, reflected in their behavior and thought processes, particularly in how they analyze and process various situations (Abu Shaisha, 2002). While previous studies have varied in identifying the specific brain dominance pattern associated with creative thinking, all concur on the role of brain dominance and its relationship to creativity. Consequently, interest in studying thinking styles, learning approaches, and brain dominance has grown (Jensen, 2001). As creativity development is closely tied to the type of education an individual receives, there is a need for teaching methods that foster students' cognitive skills and creative abilities (Al-Harthi, 2003). Teachers, therefore, must understand their brain dominance patterns and adopt teaching strategies that enhance students' creative thinking skills.

Brain Dominance in the Educational Process

The significant advancements in scientific and intellectual domains have led to substantial progress in understanding human personality, including its traits and components, particularly how individuals respond to various situations. An individual's success in personal, social, or educational contexts is strongly linked to their brain dominance pattern and how they handle challenges (Nofal, 2007).

Modern research has increasingly focused on the functions of the brain and their relationship to human behavior, including the role of brain dominance in processing information and its outcomes in the educational process (Healey & Rockledge, 2009). Brain dominance is a critical factor in education, as identifying individuals' brain dominance patterns can provide insights into their information-processing methods and learning styles, which apply to both learners and educators (Hammouda, 2015).

Hermann (1995) highlighted the significant role of brain dominance in determining how individuals learn and handle different life situations. Similarly, Kaur and Shikha (2012) explored the relationship between personality traits and brain dominance among secondary school science and arts students in Punjab, with a sample of 200 participants. Using personality dimensions and learning and thinking styles tests, the study found a statistically significant relationship between brain dominance and certain personality traits, such as creativity and self-discipline.

Afaneh and Al-Jaish (2009) emphasized that teachers' dominant brain hemisphere influences their teaching methods in the classroom. This awareness requires teachers to recognize their brain dominance patterns and those of their students. Al-Balushi's (2013) study supports this, investigating the relationship between chemistry teachers' brain dominance patterns and their classroom practices in Oman. The study, which involved 370 teachers, utilized a brain dominance scale and a classroom practice observation checklist. Results showed that participants frequently aligned their classroom practices with their brain dominance patterns, with left-brain dominance being the most prevalent.

The evidence underscores the importance of brain dominance in education and its influence on the teaching styles and practices adopted by educators in the classroom. Teachers' understanding of their brain dominance patterns encourages them to engage in activities that stimulate the non-dominant hemisphere, promoting a more balanced and varied teaching approach. This alignment ensures harmony between both brain hemispheres, enhancing the effectiveness of instructional methods.

Study Methodology

The methodology of the current study outlines the procedures used to collect the required data. It includes a description of the study population and sample, the development and validation of the study instruments, and the design, implementation, and statistical processing of the study.

Study Population

The study population consists of all science teachers teaching students in grades 5–10 at government schools in Al-Batinah North Governorate in Oman. The table below presents the distribution of science teachers by gender and district, based on data obtained from the General Directorate of Education in Al-Batinah North.

Table.2
Number of Science Teachers in the Study Population

District	Males	Females	Total
Al-Khaboura	62	61	123
Al-Suwaiq	96	121	217
Sohar	101	115	216
Saham	66	79	145
Shinas	46	56	102
Liwa	24	39	63
Total	395	471	866

Study Sample

The study sample was selected using stratified random sampling to account for the categories of gender (male and female) and districts in the population. The sample size was determined using the method described by Mills, Gay, & Airasian (2006). The table below shows the distribution of the sample by gender and district.

Table .3
Number of Science Teachers in the Study Sample

District	Male Teachers in Sample	Female Teachers in Sample	Male Ratio	Female Ratio	Total Teachers
Al-Khaboura	31	31	50%	50%	123
Al-Suwaiq	42	68	44%	56%	217
Sohar	47	61	47%	53%	216
Saham	30	43	46%	54%	145
Shinas	21	31	45%	55%	102
Liwa	9	24	38%	62%	63
Total	180	258	46%	54%	866

Study Design

The study employs a correlational design, which is appropriate for identifying relationships and their nature between the study variables (Mills, Gay, & Airasian, 2006). After randomly selecting the stratified sample, comparisons will be made among participants regarding the following variables: the level of application of creative thinking skills, gender, years of experience, and brain dominance patterns.

Study Instruments

1. Questionnaire on Science Teachers' Application of Creative Thinking Skills
Step1: Gathering Information on Questionnaire Dimensions

A review of related studies was conducted, including research by Al-Oudah & Zidan (2008), Al-Ghamdi (2009), Al-Freihat (2013), Al-Balushi (2010), Qashou (2001), Yaqub (2007), Al-Balushi & Al-Azri (2009), and Al-Zu'bi, Al-Shdeifat, & Al-Homaila (2009).

Step 2: Identifying Questionnaire Dimensions

Based on the reviewed literature, the study focused on the following creative thinking skills: fluency, flexibility, originality, and problem-solving.

Step 3: Selecting and Formulating Statements

Preliminary statements were drafted for each dimension of creative thinking. The number of statements for each skill was as follows: fluency (10), flexibility (10), originality (11), and sensitivity to problems (9). In total, the questionnaire contained 40 items, each rated on a 5-point Likert scale to reflect the degree of application by science teachers as follows:

- Very high
- High
- Moderate
- Low
- Very low

Step 4: Scoring the Questionnaire

The questionnaire was scored based on the following scale:

- Very high: 5 points
- High: 4 points
- Moderate: 3 points
- Low: 2 points
- Very low: 1 point

Brain Dominance Scale

The Brain Dominance Scale developed by Al-Balushi (2013) was chosen for this study for several reasons:

- The scale was adapted to suit the Omani environment by the researcher.
- It has a suitable length, making it easy to complete, as it includes 21 items, each with only two options (A) or (B), unlike other relatively longer scales.
- The scale is recent, having been developed in 2006 by Diane Connill.

Timing the Brain Dominance Scale

To determine the time required to complete the Brain Dominance Scale, the following formula was used:

Time = (Time taken by the fastest respondent + Time taken by the slowest respondent) ÷ 2

Based on this calculation, the time required to complete the scale was set at 10 minutes (Al-Balushi, 2013).

Scoring the Brain Dominance Scale

The final version of the scale consists of 21 items, each with two options (A) and (B). Respondents select one option per item. The scoring method is shown in Table 4.

Table .4
Scoring Method for the Brain Dominance Scale

Option	Items	Score per Item
A	1, 2, 3, 7, 8, 9, 13, 14, 15, 19, 20, 21	1
B	4, 5, 6, 10, 11, 12, 16, 17, 18	1

Scoring details:

- A score of 1 is given for choosing option **A** for items: 1, 2, 3, 7, 8, 9, 13, 14, 15, 19, 20, 21.
- A score of 1 is given for choosing option **B** for items: 4, 5, 6, 10, 11, 12, 16, 17, 18.
  The total score is calculated by summing the scores for options A and B. The interpretation of the scores is as follows (Al-Balushi, 2013):
- 0–8: Left hemisphere dominance.
- 9–13: Integrated brain dominance.
- 14–21: Right hemisphere dominance.

Validity of Study Instruments

The validity of the study instruments was established using content validity, focusing on item validity and representativeness (Mills, Gay, & Airasian, 2006).

Questionnaire on Science Teachers' Application of Creative Thinking Skills

The initial version of the questionnaire, consisting of 40 items, was reviewed by experts from the College of Education at Sultan Qaboos University and a group of educators. Experts evaluated the relevance of the questionnaire's dimensions, the clarity of its items, and the accuracy of its language. Based on their feedback, some items were rephrased. The final version consisted of 40 items distributed across four dimensions: fluency, originality, flexibility, and problem-solving.

Brain Dominance Scale

The initial version of the scale, containing 21 items, was reviewed by specialists in psychology at Sultan Qaboos University. Experts assessed the appropriateness, clarity, and language of the scale items. Based on their feedback, some items were revised, and the final version consisted of 21 items.

Reliability of Study Instruments

Questionnaire on Science Teachers' Application of Creative Thinking Skills

The reliability of the questionnaire was determined using the test-retest method. It was administered to a pilot sample of 30 science teachers from outside the study sample, distributed across three districts in Al-Batinah North: Shinas (16), Sohar (6), and Al-Khaboura (8). After a set period, the questionnaire was re-administered, and Pearson's correlation coefficient was calculated between the two applications, as shown in Table 5 (Mills, Gay, & Airasian, 2006).

Table .5
Pearson Correlation Coefficient Between First and Second Applications of the Questionnaire

Application	**Mean**	**Standard Deviation**	**Pearson Correlation**	**Significance**
First	3.54	0.37	0.49	0.006
Second	3.63	0.40		

The table shows a strong positive correlation with a significance level of 0.05, indicating the reliability of the instrument (Mills, Gay, & Airasian, 2006).

Brain Dominance Scale

The reliability of the Brain Dominance Scale was confirmed by adopting the reliability coefficient reported by Al-Balushi (2013), which was 0.89. The recentness of the study and its application to all chemistry teachers in Oman included some of the current study's participants, justifying the adoption of this coefficient. Additionally, the scale was applied to a pilot sample of 30 science teachers from outside the study sample, and the internal consistency of the items was calculated using Cronbach's alpha, as shown in Table .6 (Mills, Gay, & Airasian, 2006).

Table .6
Reliability Coefficient for the Brain Dominance Scale

Number of Items	Cronbach's Alpha
21	0.704

The Cronbach's alpha coefficient of 0.70 indicates good reliability, confirming the scale's suitability for actual application.

Statistical Analysis

The responses of the sample were analyzed after encoding and organizing them into representative tables using the Statistical Package for the Social Sciences (SPSS). The study hypotheses and questions were tested as follows:

- To ensure the reliability of the questionnaire and the Brain Dominance Scale, the internal consistency of the scale items was calculated using Cronbach's alpha, while Pearson's correlation coefficient was used to evaluate the reliability of the questionnaire.

- Descriptive statistical methods, including mean, standard deviation, and percentages, were used to answer the first and second questions for each item and the overall items. Additionally, the second question involved calculating degrees of freedom, chi-square, and significance levels.
- For the first hypothesis, the independent samples t-test was applied.
- For the second hypothesis, a one-way analysis of variance (ANOVA) was used.
- For the third hypothesis, Pearson's correlation coefficient was used to determine the relationship between science teachers' application of creative thinking skills in teaching and their brain dominance patterns.

Results

The researcher addressed the study questions and validated the hypotheses based on the results obtained through the various statistical tools specified in this study, after applying the study instruments to the participants. This chapter presents the results in line with the sequence of the study questions and hypotheses, as follows:

Results for the First Question

To answer the first research question:

What is the degree of science teachers' application of creative thinking skills in teaching students in grades 5–10?

Arithmetic means and standard deviations were calculated for the responses of the study sample, along with the ranking of the four creative thinking skills. Additionally, arithmetic means and standard deviations were calculated for each item representing the four skills. To determine the level of agreement in this study, the five-point Likert scale was used, which is commonly employed in this type of research.

To determine the range of each level, the interval (5-1=4) was calculated and divided by the number of scale levels to obtain the correct length of the cell (4/5=0.8). This value was then added to the lowest value on the scale (1.0) to determine the upper limit of each cell. The range of levels is shown in Table .7

Table .7
Degree of Agreement

Range	Degree
4.20 – 5	Very High
3.40 – <4.20	High
2.60 – <3.40	Moderate
1.80 – <2.60	Low
1 – <1.80	Very Low

Table .8
Arithmetic Means, Standard Deviations, and Rankings of the Four Creative Thinking Skills

Skill Number	Skill	Rank	Number of Items	Mean	Standard Deviation	Degree
1	Fluency	1	10	3.60	0.52	High
2	Flexibility	2	10	3.59	0.58	High
4	Sensitivity to Problems	3	9	3.33	0.58	Moderate
3	Originality	4	11	3.29	0.67	Moderate
-	Combined Skills	-	40	3.45	0.55	High

From Table 8, it is evident that the arithmetic means ranged between 3.60 (highest for fluency) and 3.29 (lowest for originality). The degree of agreement varied between high and moderate, as perceived by senior teachers and educational supervisors. To further explore the degree to which science teachers applied creative thinking skills in teaching students in grades 5–10, the arithmetic means and standard deviations were calculated for the responses of the study sample for each item of the four creative thinking skills (Mills, Gay, & Airasian, 2006).

First Skill: Fluency

Table 9 below presents the arithmetic means and standard deviations for the responses of the study sample on the items related to fluency skill.

Table .9
Arithmetic Means and Standard Deviations for Fluency Skill Items

No.	Item	Rank	Mean	Standard Deviation	Degree
6	Encourages students to accept and respect all ideas.	1	4.14	0.76	High
1	Encourages students to express their ideas freely.	2	4.08	0.82	High
2	Asks students questions such as: "What if...?", "How could...?".	3	4.00	0.87	High
4	Accepts all students' ideas regardless of their number.	4	3.97	0.76	High
9	Helps students derive as many benefits as possible from a topic.	5	3.89	0.86	High
10	Avoids making critical judgments about students' responses.	6	3.85	0.92	High
5	Asks students to suggest practical applications for the studied laws.	7	3.80	0.82	High
3	Poses issues requiring a large number of ideas within a set time.	8	3.07	1.13	Moderate
7	Poses scientific problems with no direct solutions.	9	2.67	1.08	Moderate
8	Asks students to list synonyms for a single concept.	10	2.59	1.05	Low

The results indicate that the degree to which science teachers applied the fluency skill in teaching students in grades 5–10 ranged from High to Moderate, with arithmetic means ranging between 4.14 (highest) and 2.59 (lowest). The highest-ranked item was "Encourages students to accept and respect all ideas," with a mean of 4.14. The second highest was "Encourages students to express their ideas freely," with a mean of 4.08. The lowest-ranked item was "Asks students to list synonyms for a single concept," with a mean of 2.59, followed by "Poses scientific problems with no direct solutions," with a mean of 2.67.

Second Skill: Flexibility

Table 10 below presents the arithmetic means and standard deviations for the responses of the study sample on the items related to the flexibility skill.

Table 10
Arithmetic Means and Standard Deviations for Flexibility Skill Items

No.	Item	Rank	Mean	Standard Deviation	Degree
5	Accepts different methods for solving mathematical problems.	1	3.97	0.82	High
7	Accepts students' differing opinions on discussed topics.	2	3.95	0.81	High
6	Gives students the opportunity to express themselves through their ideas.	3	3.90	0.83	High
2	Encourages differing opinions among students on discussed topics.	4	3.88	0.81	High
8	Allows students to view a topic from multiple perspectives.	5	3.84	0.86	High
9	Encourages students to solve a problem in more than one way.	6	3.83	0.91	High
4	Provides opportunities for students to apply their learning in various contexts.	7	3.77	0.86	High
1	Poses problems requiring multiple solutions.	8	3.54	0.90	High
3	Encourages students to use various methods to identify relationships between variables.	9	2.65	1.08	Moderate
10	Uses open-ended questions.	10	2.62	1.06	Moderate

The results indicate that the degree to which science teachers applied the flexibility skill in teaching students in grades 5–10 ranged from High to Moderate, with arithmetic means ranging between 3.97 (highest) and 2.62 (lowest). The highest-ranked item was "Accepts different methods for solving mathematical problems," with a mean of 3.97, followed by "Accepts students' differing opinions on discussed topics," with a mean of 3.95. The lowest-ranked item was "Uses open-ended questions," with a mean of 2.62, preceded by "Encourages students to use various methods to identify relationships between variables," with a mean of 2.65.

Third Skill: Originality

Table 11 below presents the arithmetic means and standard deviations for the responses of the study sample on the items related to the originality skill.

Table .11
Arithmetic Means and Standard Deviations for Originality Skill Items

No.	Item	Rank	Mean	Standard Deviation	Degree
9	Shows interest in students' creativity and new ideas.	1	3.89	0.90	High
4	Rewards students for expressing new ideas.	2	3.86	0.88	High
11	Guides students toward imagination and creative ideas.	3	3.63	0.97	High
2	Raises scientific questions that require further research and experimentation.	4	3.59	0.96	High
3	Encourages students to use innovative methods to present their findings to peers.	5	3.59	0.93	High
7	Encourages students to apply and experiment with their innovative ideas whenever possible.	6	3.51	1.01	High
5	Asks students to use electronic technologies in innovative ways.	7	3.50	1.05	High
6	Encourages students to give unconventional (new) explanations for various situations.	8	2.67	1.08	Moderate
8	Presents unusual and unconventional ideas for discussion.	9	2.67	1.08	Moderate
1	Asks students to think of unconventional uses for common objects.	10	2.66	1.07	Moderate
10	Asks students to redesign a tool or device to improve its functionality.	11	2.58	1.11	Low

The results indicate that the degree to which science teachers applied the originality skill in teaching students in grades 5–10 ranged from High to Moderate, with arithmetic means ranging between 3.89 (highest) and 2.58 (lowest). The highest-ranked item was "Shows interest in students' creativity and new ideas," with a mean of 3.89, followed by "Rewards students for expressing new ideas," with a mean of 3.86. The lowest-ranked item was "Asks students to redesign a tool or device to improve its functionality," with a mean of 2.58, preceded by "Asks students to think of unconventional uses for common objects," with a mean of 2.66.

Fourth Skill: Sensitivity to Problems

Table 12 below presents the arithmetic means and standard deviations for the responses of the study sample on the items related to the sensitivity to problems skill.

Table 12
Arithmetic Means and Standard Deviations for Sensitivity to Problems Skill Items

No.	Item	Rank	Mean	Standard Deviation	Degree
9	Links students to local environmental issues and problems.	1	4.03	0.84	High
2	Draws students' attention to environmental problems related to the subject.	2	3.88	0.84	High
7	Encourages students to explore and investigate.	3	3.78	0.94	High
4	Develops students' adventurous spirit and reduces fear of mistakes.	4	3.76	0.91	High
1	Motivates students to complete unfinished ideas.	5	3.75	0.89	High
3	Encourages students to adopt positions on future scientific problems.	6	3.03	1.09	Moderate
6	Directs students' attention to ambiguous elements in the subject.	7	2.72	1.05	Moderate
5	Encourages students to think about solutions to others' problems.	8	2.60	1.09	Moderate
8	Tends to present information with an element of uncertainty.	9	2.42	1.07	Low

The results indicate that the degree to which science teachers applied the sensitivity to problems skill in teaching students in grades 5–10 ranged from High to Moderate, with arithmetic means ranging between 4.03 (highest) and 2.42 (lowest). The highest-ranked item was "Links students to local environmental issues and problems," with a mean of 4.03, followed by "Draws students' attention to environmental problems related to the subject," with a mean of 3.88. The lowest-ranked item was "Tends to present information with an element of uncertainty," with a mean of 2.42, preceded by "Encourages students to think about solutions to others' problems," with a mean of 2.60.

Results of the Second Question

To answer the second research question:

What is the type of brain dominance among science teachers teaching grades 5–10?

The frequencies for each type of brain dominance were calculated, followed by applying the Chi-square test to examine apparent individual differences (Mills, Gay, & Airasian, 2006). Table 13 presents the results.

Table 13
Frequencies, Percentages, and Chi-Square Test for Brain Dominance Scale

Brain Dominance Type	Frequency	Percentage	Mean	Degrees of Freedom	Chi-Square	Significance Level
Left	120	27.4%	6.87	2	249.26	0.00*
Integrated	292	66.7%	10.53		0.00*	
Right	26	5.9%	14.65		0.00*	

*Statistically significant at the 0.05 significance level (Mills, Gay, & Airasian, 2006).

From Table 7.4, it is clear that the most common brain dominance type among the study sample was integrated dominance (66.7%, n=292), followed by left dominance (27.4%, n=120), and finally right dominance (5.9%, n=26).

Results of the First Hypothesis
To test the first hypothesis:
"There are no statistically significant differences at ($\alpha \leq 0.05$) in the application of science teachers' creative thinking skills in teaching due to the gender variable," an independent samples t-test was used (Mills, Gay, & Airasian, 2006). Table 14 shows the results.

Table 14
Arithmetic Means, Standard Deviations, and T-Test for Gender

Skill	Gender	Sample Size	Mean	Standard Deviation	T	Significance
Fluency	Male	180	3.57	0.57	1.00	0.32
	Female	258	3.63	0.49		
Flexibility	Male	180	3.54	0.62	1.58	0.12
	Female	258	3.63	0.55		
Originality	Male	180	3.23	0.67	1.57	0.12
	Female	258	3.33	0.66		
Sensitivity to Problems	Male	180	3.25	0.57	2.63	0.009*
	Female	258	3.39	0.58		
Combined Skills	Male	180	3.40	0.57	1.80	0.07
	Female	258	3.49	0.53		

*Statistically significant at the 0.05 significance level (Mills, Gay, & Airasian, 2006).

Findings: There were no statistically significant differences at ($\alpha \leq 0.05$) between male and female teachers in the application of fluency, flexibility, and originality skills. However, statistically significant differences were found in the sensitivity to problems skill, favoring females.

Results of the Second Hypothesis
To test the second hypothesis:
"There are no statistically significant differences at ($\alpha \leq 0.05$) in the application of science teachers' creative thinking skills in teaching due to the experience variable," a one-way ANOVA was conducted (Mills, Gay, & Airasian, 2006). Tables 15 and 16 present the results.

Table .15
Means and Standard Deviations for Creative Thinking Skills by Years of Experience

Skill	Years of Experience	Sample Size	Mean	Standard Deviation
Fluency	≤ 5 years	23	3.57	0.41
	6–10 years	215	3.57	0.52
	≥ 11 years	200	3.64	0.54
Flexibility	≤ 5 years	23	3.52	0.49
	6–10 years	215	3.56	0.56
	≥ 11 years	200	3.64	0.61
Originality	≤ 5 years	23	3.26	0.53
	6–10 years	215	3.24	0.66
	≥ 11 years	200	3.34	0.69
Sensitivity	≤ 5 years	23	3.28	0.53
	6–10 years	215	3.31	0.57
	≥ 11 years	200	3.37	0.59
Combined Skills	≤ 5 years	23	3.41	0.45
	6–10 years	215	3.42	0.54
	≥ 11 years	200	3.50	0.57

Table .16
One-Way ANOVA for Creative Thinking Skills by Years of Experience

Skill	Comparison	Sum of Squares	Mean Square	Significance
Fluency	Between Groups	0.52	0.26	0.39
	Within Groups	119.84	0.28	
Flexibility	Between Groups	0.67	0.34	0.37
	Within Groups	147.87	0.34	
Originality	Between Groups	1.14	0.57	0.27
	Within Groups	192.66	0.44	
Sensitivity	Between Groups	0.43	0.22	0.53
	Within Groups	145.57	0.34	
Combined Skills	Between Groups	0.67	0.33	0.33
	Within Groups	132.10	0.30	

Findings: There were no statistically significant differences in the application of creative thinking skills attributable to years of experience, confirming the second hypothesis.

Results of the Third Hypothesis

To test the third hypothesis:
"There is no statistically significant relationship at ($\alpha \leq 0.05$) between science teachers' use of creative thinking skills in teaching and their brain dominance patterns," Pearson's correlation coefficient was used (Mills, Gay, & Airasian, 2006). Table 17 presents the results.

Table.17

Pearson Correlation Between Creative Thinking Skills and Brain Dominance Patterns

Measure	Mean	Standard Deviation	Correlation Coefficient	Significance
Creative Thinking Skills	3.41	0.59	-0.03	0.73
Left Brain Dominance	6.87	1.25		
Creative Thinking Skills	3.48	0.53	0.89*	0.006*
Integrated Brain Dominance	10.53	1.34		
Creative Thinking Skills	3.42	0.55	0.14	0.50
Right Brain Dominance	14.65	1.02		

*Statistically significant at the 0.05 significance level (Mills, Gay, & Airasian, 2006).

Findings: A statistically significant positive relationship was found between creative thinking skills and integrated brain dominance ($r = 0.89$, $p < 0.05$). Approximately 79% of the variance was accounted for, leaving 21% unexplained. For right brain dominance, a positive but non-significant relationship was observed, explaining only 1.96% of the variance. A weak negative and non-significant relationship was found with left brain dominance, accounting for just 0.09% of the variance.

Discussion of Results

Discussion of the First Question Results

The results indicate that the degree of application of creative thinking skills by science teachers for grades 5–10 was high for the skills of fluency and flexibility, as perceived by senior teachers and educational supervisors. This could be attributed to the training science teachers received on methods and approaches related to higher-order thinking skills, particularly those emphasized in the student assessment guidelines for science subjects in grades 5–10. However, the application of originality and sensitivity to problems was moderate. This may be due to insufficient training for teachers in these skills and their reliance on textbook information without encouraging students to develop innovative applications or explore problems related to students or the community. Consequently, teachers may not be fully equipped to implement these skills effectively.

These findings align partially with studies by Zidan and Al-Oudah (2008), Al-Azmi, Al-Qallaf, and Khudr (2009), and Al-Naqa (2011), which demonstrated a high level of application of creative thinking skills among study participants.

Discussion of the Second Question Results

As shown in Table13, the integrated brain dominance type was the most prevalent among the study sample (66.7%), followed by left brain dominance (27.4%) and right brain dominance (5.9%). This could be attributed to the divergent nature of creative thinking, a higher-order mental ability requiring the activation and integration of both brain hemispheres. Science teachers appeared to recognize the importance of involving both hemispheres by adopting teaching methods that align with the dual theoretical and practical nature of science and cater to students with varying brain dominance types.

This result contrasts with findings by Abdul Haq and Al-Ajeely (2015) and Al-Balushi (2013), which identified left brain dominance as the most prevalent among study participants.

Discussion of the First Hypothesis Results

From Table 14, no statistically significant differences were found at ($\alpha \leq 0.05$) between male and female teachers in applying the skills of fluency, flexibility, and originality. However, significant differences were observed in the application of sensitivity to problems, favoring female teachers. This could be because female science teachers tend to be more motivated to innovate, stay updated on educational advancements, and respond to the higher academic aspirations of their female students, who often exhibit a stronger interest in learning and achievement. These factors may encourage female teachers to implement modern teaching methods, such as problem-solving strategies.

This finding is consistent with studies by Zidan and Al-Oudah (2008), Al-Azmi, Al-Qallaf, and Khudr (2009), and Al-Naqa (2011).

Discussion of the Second Hypothesis Results

As shown in Table 16, no statistically significant differences were found in the application of creative thinking skills based on years of experience. This suggests that the use of creative thinking skills by science teachers does not depend on their experience, likely due to the training workshops provided by the Ministry of Education, which are accessible to all teachers regardless of their years of experience. These workshops offer equal opportunities to acquire and develop teaching skills.

This result is consistent with studies by Al-Azmi, Al-Qallaf, and Khudr (2009) and Al-Naqa (2011) but differs from Zidan and Al-Oudah (2008), who reported statistically significant differences favoring more experienced teachers in their use of creative thinking skills.

Discussion of the Third Hypothesis Results

From Table 17, a statistically significant positive correlation was found at ($\alpha \leq 0.05$) between the use of creative thinking skills in teaching and the integrated brain dominance type. No significant correlations were observed between creative thinking skills and the left or right brain dominance types. This could be due to the dual nature of science, requiring integration of the left hemisphere for encoding and storing information and the right hemisphere for translating it into motor skills.

These findings align with studies by Whitman, Holcomb, and Zanes (2010) and Lindell (2011), which found a significant relationship between creative thinking and integrated brain dominance. However, they contrast with Abdul Haq and Al-Ajeely (2015) and Razumnikova and Volf (2012), which identified a significant relationship between creative thinking skills and right brain dominance.

Summary of Results

The study on the application of creative thinking skills by science teachers for grades 5–10 and their relationship with brain dominance revealed the following:

- Science teachers still rely on traditional teaching methods, as evidenced by moderate application levels for problem-solving and originality—skills most closely linked to creativity.
- Gender did not influence the application of creative thinking skills, except for problem-solving, where females performed better, likely due to their commitment to innovative teaching methods.

- Years of experience did not impact teachers' application of creative thinking skills, possibly due to the similar training opportunities provided by the Ministry of Education.
- A significant positive correlation was found between creative thinking skills and integrated brain dominance, with 66.7% of participants exhibiting this dominance, followed by 27.4% with left brain dominance and 5.9% with right brain dominance.

Recommendations

Based on the findings, the following recommendations are proposed:

1. Train teachers before and during service on implementing creative thinking skills in teaching.
2. Utilize and enhance the current study tools to include specific practices that science teachers should follow to foster creative thinking.
3. Apply the brain dominance scale to teachers and students to identify their dominance patterns and design teaching methods accordingly.
4. Promote creative thinking and outcomes among teachers and students at the school and governorate levels.

Suggestions for Future Research

1. Conduct a comparative study on the application of creative thinking skills by science teachers in public and private schools across various variables.
2. Develop and assess a program for creative thinking skills for teachers and students under different variables.
3. Replicate the current study in other Omani governorates.
4. Explore other types of thinking in the Omani educational context.

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