



TEACHERS' CREATIVE THINKING TENDENCIES AND THEIR CREATIVITY- FOSTERING CLASSROOM PRACTICES IN STEM EDUCATION

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Abstract

This study examined the link between teachers' creative thinking tendencies and their creativity-fostering classroom practices in the context of STEM education. Employing a correlational research design, data were collected from 338 in-service teachers actively integrating STEM approaches into their instruction. Two standardized instruments were used: the Marmara Creative Thinking Tendencies Scale and the Creativity-Fostering Teacher Behavior Index. Descriptive statistics and inferential analyses (t-tests and one-way ANOVA) were conducted to examine group differences based on gender, subject area, and participation in training programs. Findings revealed no significant gender or subject-area differences in creative thinking tendencies; however, teachers who had participated in multiple training programs exhibited significantly higher scores. In contrast, female teachers demonstrated significantly higher creativity-fostering behaviors than male teachers, and preschool teachers outperformed ICT teachers in these behaviors. No significant differences were found regarding participation in STEM training programs and creativity-fostering behaviors. The findings underscore the nuanced role of teacher characteristics in promoting creativity within STEM education and suggest implications for professional development and educational design.

Keywords: STEM education, creative thinking, creativity-fostering behaviors, teacher characteristics, professional development

Introduction

As in all areas of life, education has been significantly influenced by the rapidly evolving and transforming global context. In an era where originality and distinctiveness are increasingly demanded in production, industry, and professional life, there is a growing need for individuals who can think creatively and generate innovative ideas. The fundamental aim of education, therefore, is not merely to train individuals to replicate what has previously been done, but to cultivate the capacity to develop novel approaches and solutions (Sungur, 1997, p. 31). In contemporary educational systems, the role of teachers has expanded beyond the transmission of factual knowledge; they are now also expected to guide and inspire students to engage in creative thinking (Aydeniz, 2017, p. 110). Teachers employ a variety of methods, techniques, and instructional practices to foster, develop, and encourage creative thinking skills in students. Among these practices, the integration of STEM education (Science, Technology, Engineering, and Mathematics) into classroom instruction plays a significant role. Through STEM education, students are not only able to enhance their potential but also improve their cognitive abilities, including creative thinking, as well as their self-efficacy in problem-solving (Çorlu & Aydın,

2016). In Turkey, STEM education has been officially included in instructional programs since 2018. In alignment with STEM education, the 2017 Science Curriculum introduced “Engineering Design Skills” under the skill acquisition domains, and in 2018, “Science, Engineering, and Entrepreneurship Practices” were also added (Ministry of National Education [MoNE], 2017; MoNE, 2018). Furthermore, creative thinking skills have been explicitly emphasized both in the general objectives of the national curriculum and in the specific objectives of the Science Curriculum. Considering the teacher’s role as a guide and facilitator in the implementation of curricula, it is essential that teachers adopting STEM practices in their classrooms serve as mentors who support students’ creativity and actively encourage them to engage in creative thinking. To effectively fulfill this role, teachers themselves must first possess creative thinking skills at an individual level. Indeed, becoming a creative role model requires, above all, an understanding of what creativity entails (Senemoğlu, 1996). It is useful to begin with one of the earliest and most well-known definitions of creativity: it was originally conceptualized as a divine or quasi-divine phenomenon, often described as a form of supernatural inspiration (Vexliard, 1966, p. 111). Torrance (1963), who developed one of the first standardized instruments for measuring creativity, defined it as “the process of sensing problems, gaps in information, missing elements, or disharmonies; identifying the difficulty; searching for solutions; making guesses or formulating hypotheses; and ultimately producing a solution” (as cited in Sünbül, 2000). As these definitions suggest, creativity is not limited to mental processes such as inspiration or problem-solving; rather, it encompasses both ideational and practical dimensions. It involves the generation of tangible products and the application of these products for various purposes, thus constituting a holistic process that includes both cognitive and behavioral components.

According to Henry (1991), creativity was defined as an innate ability. He suggested that if individuals are able to overcome cognitive barriers, creativity can naturally emerge and develop. While creativity exists inherently in every individual, its continuity, level of development, and modes of expression vary significantly from person to person (Tekin & Taşgın, 2008, p. 207). Several factors, such as intelligence, gender, and age, play a role in the development of creativity (Güleryüz, 2001). Numerous studies have indicated that creativity and intelligence are correlated up to a certain threshold (Getzels & Jackson, 1962; Jauk et al., 2013; Wallach & Kogan, 1978). In addition, Furnham and Bachtar (2008) have argued that personality traits have a significant impact on an individual’s creative capacity. Another factor widely considered to influence creative thinking is education. Hallman (1967) has suggested that although individuals are born with creative potential, they often remain unaware of it; and it is through education that this latent potential can be realized.

Although the foundations of creativity are laid during early childhood and primary education, there is substantial evidence suggesting that student creativity can be further developed within school settings. However, certain prerequisites must be met in order to effectively foster creativity in students. Chief among these is the teacher’s role as a creative role model—requiring that teachers themselves possess creative thinking skills. Teachers who demonstrate creative thinking are more likely to design and structure learning environments that promote creativity and actively guide students in developing their own creative potential. Creative thinking typically flourishes in environments that are free from pressure, not constrained by time limitations, and that foster a sense of enjoyment and psychological comfort. Teachers who possess creative thinking abilities contribute to students’ creative development by cultivating such environments and thoughtfully organizing the learning space. Given that creative thinking is inherently a process, time constraints constitute one of the primary barriers to student creativity. Teachers, recognizing the process-oriented nature of creative thinking, should avoid placing students under time pressure. Instead, they should support students in exploring alternative possibilities, encourage focused reflection, and convey an appreciation for their creative efforts. Within the

context of problem-solving, teachers should expose students to a variety of strategies and approaches, thereby modeling flexible thinking. Rather than emphasizing the importance of arriving at a single, predetermined solution, teachers should embody open-mindedness by accepting diverse solutions and fostering a classroom culture that values multiple perspectives. Moreover, they should help students move beyond the tendency to seek immediate answers or fixate on only one possible solution (Senemoğlu, 1996).

Research has demonstrated a significant relationship between teachers' attitudes toward creative behaviors and the quality of students' creative outputs (Üstündağ, 2003, p. 130). While the existing literature includes studies on creative thinking and tendencies toward creative thinking, there remains a notable gap in detailed investigations focusing specifically on teachers' behaviors that encourage creativity. Accordingly, this study examines the relationship between the creative thinking tendencies of teachers who implement STEM activities in their classrooms and their behaviors aimed at fostering creativity. The findings of this research are expected to offer valuable insights into how teachers can engage in activities that enhance their own creativity and serve as guiding figures in nurturing creative skills among students. Therefore, the present study holds particular significance. It is anticipated that the outcomes will inform not only practicing teachers and pre-service teachers but also curriculum developers and educational researchers.

Purpose of the Study and Research Questions

This study aimed to examine the link between the creative thinking tendencies of teachers who implemented STEM practices in their classrooms and their behaviors aimed at fostering creativity. In this context, the following research questions were addressed:

1. Do teachers' creative thinking tendencies and behaviors that encourage creativity significantly differ based on:
 - a. gender,
 - b. subject area, and
 - c. the number of STEM-related training courses they have attended?
2. Is there a statistically significant relationship between the creative thinking tendencies of teachers who utilize STEM practices and their behaviors that promote creativity?

Research Methodology

Design

This study adopts a quantitative, non-experimental approach and is based on a correlational survey design. Correlational research is appropriate when the aim is to identify and interpret relationships between variables without manipulating them (Karasar, 2020, p. 114). Given that this research examined naturally occurring associations between teachers' cognitive dispositions and classroom practices without any intervention, the correlational design is methodologically justified. The study was conducted in 2023, with participants selected from various regions in Turkey to ensure diversity across teaching fields and experience levels.

Study Group

The study group consisted of 338 in-service teachers from various cities across Turkey, selected through purposive sampling. This method allows for the intentional inclusion of participants who meet specific criteria aligned with the study's objectives and scope (Çokluk et al., 2014). The primary inclusion criterion was the active implementation of STEM practices in classroom instruction. No restrictions were applied regarding subject areas, ensuring diversity across disciplines such as primary education, science, mathematics, and the arts. This heterogeneity was intended to enhance the interpretability and applicability of the findings. The sample size of 338 was considered adequate for correlational analyses. According to Cohen's (1988) power analysis guidelines, a minimum of 85 participants is required to detect a medium effect size ($r = .30$) with 80% power at the .05 significance level. Therefore, the current sample provides a statistically reliable basis for drawing valid inferences. The distribution of participants by demographic variables is presented in Table 1.

Table 1
Distribution According to Demographic Variables

		<i>n</i>	%
Gender	Female	252	74.6
	Male	86	25.4
Teaching Subject (Field)	Science	86	25.4
	Primary School (Classroom Teaching)	99	29.3
	Preschool Education	56	16.6
	Social Studies	6	1.8
	Mathematics	15	4.4
	English	11	3.3
	Turkish	6	1.8
	Physics	2	0.6
	Chemistry	6	1.8
	Biology	7	2.1
	Information and Communication Technology	12	3.6
	Turkish Language and Literature	6	1.8
	Visual Arts	3	0.9
	Technology and Design	8	2.4
	Music	2	0.6
	Philosophy	1	0.3
	Geography	2	0.6
	Other	10	3.0
Number of STEM Training Courses Attended	I have not attended any.	66	19.5
	I have attended once.	110	32.5
	I have attended more than once.	162	47.9

Data Collection Tools

The data for this study were collected using three instruments: the “Personal Information Form,” the “Marmara Creative Thinking Tendencies Scale,” and the “Teacher Behaviors Index for Encouraging Creativity.”

Personal Information Form: A personal information form was used to gather data regarding the demographic variables of the participants, including their gender, subject area, and the number of STEM-related training courses they have attended, which were identified as the key variables for this study.

Marmara Creative Thinking Tendencies Scale: To measure the creative thinking tendencies of teachers who use STEM practices in their classrooms, a valid and reliable scale was employed. For this purpose, the Marmara Creative Thinking Tendencies Scale, developed by Özgenel and Çetin (2017), was deemed appropriate. The scale consists of 25 items and six factors. The overall Cronbach's alpha reliability coefficient of the scale was reported by Özgenel and Çetin (2017) as .87.

In this study, “doubt” refers to the tendency to internally question one's own thoughts or assumptions, whereas “skepticism” involves a critical stance toward external claims or information. Although closely related, they are treated as distinct subdimensions within the scale framework.

Teacher Behaviors Index for Encouraging Creativity: Another instrument used in this study is the Teacher Behaviors Index for Encouraging Creativity, developed by Soh (2000) and adapted into Turkish by Akar (2014). The scale contains 45 items and 9 subdimensions. The overall Cronbach's alpha reliability coefficient for the scale was found to be .95, as reported by Akar (2014).

Data Analysis

To determine whether there was a significant correlation between teachers' creative thinking tendencies and their behaviors encouraging creativity in STEM-based classrooms, Pearson's correlation coefficient was calculated. In addition, *t*-tests and one-way ANOVA were employed to examine whether scale scores differed according to demographic characteristics. An independent samples *t*-test was used for comparisons between two groups, while ANOVA was applied for comparisons among variables with more than two groups ($k > 2$) (Büyüköztürk et al., 2020, pp. 69–73). Where significant differences were detected, Tukey's post hoc test was conducted to identify which groups differed from each other. All statistical analyses were performed using SPSS 24.0 software.

Prior to conducting parametric analyses, the assumptions of normality and homogeneity of variances were assessed. The Shapiro–Wilk test and visual inspection of histograms indicated that the data were approximately normally distributed. Levene's test results confirmed the assumption of homogeneity of variances across groups. These results justified the use of parametric tests in this study.

Ethical Considerations

All procedures performed in this study were in accordance with the ethical standards of the institutional and national research committee, as well as with the 1964 Declaration of Helsinki and its subsequent amendments. Ethical approval was obtained from the Ethics Committee of Zonguldak Bülent Ecevit University (Türkiye) under protocol number 07, dated January 29, 2023. Informed consent was obtained from all participants prior to data collection.

Research Results

Differences in Teachers' Creative Thinking Tendencies by Gender, Subject Area, and STEM Training

To analyze whether there are significant differences in the creative thinking tendencies and sub-dimensions of teachers who implement STEM practices in their classrooms based on gender, subject area, and the number of STEM training courses attended, t-test results were used. The results of these analyses, which examine whether the creative thinking tendency scores and the "Teacher Behaviors Index for Encouraging Creativity" scores (and their sub-dimensions) differ by gender, are presented in Table 2.

Table 2
Teachers' Creative Thinking Tendencies by Gender, Subject Area, and STEM Training Attendance

Subdimensions of Creative Thinking	Gender	<i>n</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>p</i>
Self -discipline	Female	252	4.41	0.50	1.647	.101
	Male	86	4.31	0.47		
Seeking novelty	Female	252	4.48	0.47	1.084	.279
	Male	86	4.42	0.45		
Courage	Female	252	4.32	0.56	1.628	.105
	Male	86	4.21	0.54		
Curiosity	Female	252	4.62	0.44	1.160	.247
	Male	86	4.55	0.44		
Doubt	Female	252	4.51	0.53	1.613	.108
	Male	86	4.40	0.52		
Flexibility	Female	252	4.52	0.44	1.340	.181
	Male	86	4.45	0.44		
Creative thinking tendencies	Female	252	4.46	0.42	1.593	.112
	Male	86	4.38	0.41		
Independence	Female	252	5.55	0.51	3.626	.001*
	Male	86	5.32	0.50		
Integration	Female	252	5.56	0.50	4.684	.001*
	Male	86	5.27	0.50		
Motivation	Female	252	5.48	0.50	2.939	.004*
	Male	86	5.30	0.52		
Judgment	Female	252	5.39	0.56	2.861	.004*
	Male	86	5.19	0.61		
Flexibility	Female	252	5.51	0.49	3.244	.001*
	Male	86	5.31	0.52		

Evaluation	Female	252	5.37	0.59	2.968	.003*
	Male	86	5.15	0.55		
Inquiry	Female	252	5.67	0.42	3.877	.001*
	Male	86	5.43	0.52		
Opportunities	Female	252	5.64	0.43	4.325	.001*
	Male	86	5.38	0.51		
Frustration	Female	252	5.66	0.45	4.705	.001*
	Male	86	5.39	0.49		
Creativity-fostering teacher behaviors index	Female	252	5.54	0.44	4.254	.001*
	Male	86	5.30	0.45		

* $p < .05$

As shown in Table 2, the creative thinking tendencies score and its sub-dimensions did not show statistically significant differences based on gender ($p > .05$). However, the scores for the Teacher Behaviors Index for Encouraging Creativity — including the independence ($t = 4.25, p < .05$), integration ($t = 3.62, p < .05$), motivation ($t = 4.68, p < .05$), judgment ($t = 2.93, p < .05$), flexibility ($t = 3.24, p < .05$), evaluation ($t = 2.96, p < .05$), questioning ($t = 3.87, p < .05$), opportunity ($t = 4.32, p < .05$), and frustration ($t = 4.70, p < .05$) sub-dimensions — showed statistically significant differences by gender. According to the average scores, women scored higher than men.

Table 3
Creative Thinking Tendencies and Encouraging Creativity Scores by Subject Area

Creative Thinking	Subject Area	<i>n</i>	<i>M</i>	<i>SD</i>	<i>F</i>	<i>p</i>	Tukey Test
Self-Discipline	Science ¹	86	4.26	0.47	2.955	.008*	1-4
	Primary School ²	99	4.44	0.48			
	Preschool ³	56	4.49	0.46			
	Mathematics ⁴	15	4.67	0.45			
	English ⁵	11	4.44	0.44			
	Information Technologies ⁶	12	4.25	0.60			
	Other ⁷	59	4.31	0.52			
Seeking Novelty	Science ¹	86	4.40	0.43	1.627	.139	
	Primary School ²	99	4.47	0.43			
	Preschool ³	56	4.57	0.48			
	Mathematics ⁴	15	4.68	0.41			
	English ⁵	11	4.40	0.47			
	Information Technologies ⁶	12	4.31	0.70			
	Other ⁷	59	4.43	0.48			

Courage	Science ¹	86	4.25	0.54	0.742	.616	
	Primary School ²	99	4.31	0.57			
	Preschool ³	56	4.37	0.54			
	Mathematics ⁴	15	4.35	0.46			
	English ⁵	11	4.34	0.48			
	Information Technologies ⁶	12	4.04	0.73			
	Other ⁷	59	4.26	0.58			
Curiosity	Science ¹	86	4.54	0.41	1.298	.257	
	Primary School ²	99	4.59	0.45			
	Preschool ³	56	4.70	0.42			
	Mathematics ⁴	15	4.78	0.35			
	English ⁵	11	4.58	0.45			
	Information Technologies ⁶	12	4.50	0.63			
	Other ⁷	59	4.60	0.44			
Doubt	Science ¹	86	4.35	0.56	1.684	.124	
	Primary School ²	99	4.49	0.48			
	Preschool ³	56	4.61	0.50			
	Mathematics ⁴	15	4.63	0.48			
	English ⁵	11	4.55	0.57			
	Information Technologies ⁶	12	4.38	0.61			
	Other ⁷	59	4.49	0.57			
Flexibility	Science ¹	86	4.41	0.44	1.020	.412	
	Primary School ²	99	4.55	0.42			
	Preschool ³	56	4.57	0.45			
	Mathematics ⁴	15	4.53	0.41			
	English ⁵	11	4.48	0.48			
	Information Technologies ⁶	12	4.44	0.56			
	Other ⁷	59	4.49	0.46			
Creative Thinking Tendencies	Science ¹	86	4.36	0.38	1.793	.100	
	Primary School ²	99	4.46	0.41			
	Preschool ³	56	4.54	0.42			
	Mathematics ⁴	15	4.62	0.35			
	English ⁵	11	4.44	0.43			
	Information Technologies ⁶	12	4.30	0.60			
	Other ⁷	59	4.41	0.44			

Independence	Science ¹	86	5.37	0.51	4.490	.001*	1-3 3-6 3-7
	Primary School ²	99	5.57	0.44			
	Preschool ³	56	5.71	0.41			
	Mathematics ⁴	15	5.53	0.50			
	English ⁵	11	5.42	0.42			
	Information Technologies ⁶	12	5.20	0.73			
	Other ⁷	59	5.38	0.60			
Integration	Science ¹	86	5.43	0.51	4.009	.001*	1-3 3-7
	Primary School ²	99	5.52	0.46			
	Preschool ³	56	5.74	0.39			
	Mathematics ⁴	15	5.45	0.47			
	English ⁵	11	5.42	0.44			
	Information Technologies ⁶	12	5.28	0.64			
	Other ⁷	59	5.33	0.63			
Motivation	Science ¹	86	5.37	0.50	2.554	.020*	3-6
	Primary School ²	99	5.43	0.45			
	Preschool ³	56	5.63	0.44			
	Mathematics ⁴	15	5.57	0.43			
	English ⁵	11	5.45	0.43			
	Information Technologies ⁶	12	5.18	0.69			
	Other ⁷	59	5.35	0.63			
Judgement	Science ¹	86	5.22	0.62	3.174	.005*	1-3 3-7
	Primary School ²	99	5.37	0.52			
	Preschool ³	56	5.56	0.49			
	Mathematics ⁴	15	5.53	0.49			
	English ⁵	11	5.44	0.43			
	Information Technologies ⁶	12	5.05	0.60			
	Other ⁷	59	5.24	0.68			
Flexibility	Science ¹	86	5.41	0.52	3.127	.005*	1-3 3-7
	Primary School ²	99	5.49	0.49			
	Preschool ³	56	5.69	0.38			
	Mathematics ⁴	15	5.44	0.49			
	English ⁵	11	5.35	0.40			
	Information Technologies ⁶	12	5.25	0.60			
	Other ⁷	59	5.34	0.58			

Evaluation	Science ¹	86	5.19	0.65	2.930	.008*	1-3
	Primary School ²	99	5.37	0.52			
	Preschool ³	56	5.52	0.59			
	Mathematics ⁴	15	5.43	0.57			
	English ⁵	11	5.33	0.48			
	Information Technologies ⁶	12	5.00	0.46			
	Other ⁷	59	5.24	0.57			
Inquiry	Science ¹	86	5.54	0.46	2.350	.031*	3-6
	Primary School ²	99	5.63	0.42			
	Preschool ³	56	5.75	0.36			
	Mathematics ⁴	15	5.63	0.50			
	English ⁵	11	5.49	0.39			
	Information Technologies ⁶	12	5.30	0.66			
	Other ⁷	59	5.59	0.51			
Opportunities	Science ¹	86	5.53	0.46	2.113	.051	
	Primary School ²	99	5.59	0.44			
	Preschool ³	56	5.74	0.41			
	Mathematics ⁴	15	5.47	0.51			
	English ⁵	11	5.56	0.42			
	Information Technologies ⁶	12	5.33	0.63			
	Other ⁷	59	5.54	0.50			
Frustration	Science ¹	86	5.52	0.49	2.115	.051	
	Primary School ²	99	5.60	0.44			
	Preschool ³	56	5.75	0.36			
	Mathematics ⁴	15	5.59	0.49			
	English ⁵	11	5.49	0.45			
	Information Technologies ⁶	12	5.35	0.74			
	Other ⁷	59	5.60	0.50			
Creativity-Fostering Teacher Behaviors Index	Science ¹	86	5.40	0.45	3.500	.002*	1-3 3-6 3-7
	Primary School ²	99	5.51	0.41			
	Preschool ³	56	5.68	0.37			
	Mathematics ⁴	15	5.52	0.45			
	English ⁵	11	5.44	0.38			
	Information Technologies ⁶	12	5.22	0.60			
	Other ⁷	59	5.40	0.50			

* $p < .05$

The ANOVA results, conducted to examine whether there were statistically significant differences in creative thinking tendencies and their subdimensions, as well as in the scores of the Teacher Behaviors Index for Encouraging Creativity, based on subject area, are presented in Table 3.

As shown in Table 3, the self-discipline score exhibited a statistically significant difference across subject areas, $F(df_1, df_2) = 2.95, p < .05$. A Tukey post hoc test was conducted to identify which subject areas differed significantly in teachers' creative thinking tendencies. The analysis revealed a significant difference between the first and fourth groups, indicating that Mathematics teachers scored higher than Information Technology teachers. In terms of total scores for creative thinking tendencies, Mathematics teachers had the highest mean score ($M = 4.62$), while Information Technology teachers had the lowest ($M = 4.30$). No statistically significant differences were found in the novelty-seeking, courage, curiosity, skepticism, and flexibility subscales, nor in the overall score ($p > .05$).

Regarding teacher behaviors for encouraging creativity, several subdimensions showed significant differences by subject area. As shown in Table 3, statistically significant differences were found in the independence ($F = 4.49, p < .05$), integration ($F = 4.00, p < .05$), motivation ($F = 2.55, p < .05$), judgment ($F = 3.17, p < .05$), flexibility ($F = 3.12, p < .05$), evaluation ($F = 2.93, p < .05$), and inquiry ($F = 2.35, p < .05$) subscales, as well as in the total score of the Teacher Behaviors Index for Encouraging Creativity ($F = 3.50, p < .05$).

Follow-up analyses using Tukey post hoc tests indicated significant differences in independence and total creativity behavior scores between the following subject areas: Science and Preschool (groups 1 and 3), Preschool and Information Technology (groups 3 and 6), and Preschool and Other branches (groups 3 and 7). In each comparison, Preschool teachers had higher scores. Additionally, significant differences in integration, judgment, and flexibility subscales were observed between Science and Preschool teachers (groups 1 and 3), and between Preschool and Other subject areas (groups 3 and 7), with Preschool teachers scoring higher.

Significant differences in the motivation and inquiry subscales were found between Preschool and Information Technology teachers (groups 3 and 6), again favoring Preschool teachers. For the evaluation subscale, a significant difference was observed between Science and Preschool teachers (groups 1 and 3), with Preschool teachers again demonstrating higher scores.

In terms of the overall score for the Teacher Behaviors Index for Encouraging Creativity, Preschool teachers had the highest average ($M = 5.68$), while Information Technology teachers had the lowest ($M = 5.22$). No significant differences were found for the opportunity and frustration subscales ($p > .05$).

Table 4
Creative Thinking and Creativity-Fostering Behaviors by Number of STEM Training Courses Attended

Creative Thinking	Course attended	<i>n</i>	<i>M</i>	<i>SD</i>	<i>F</i>	<i>p</i>	Tukey Test
Self-Discipline	Did not take ¹	66	4.22	0.55	9.084	.001*	1-3 2-3
	Took once ²	110	4.32	0.51			
	Took more than once ³	162	4.49	0.43			
Seeking Novelty	Did not take ¹	66	4.38	0.49	6.342	.002*	1-3 2-3
	Took once ²	110	4.38	0.50			
	Took more than once ³	162	4.56	0.40			
Courage	Did not take ¹	66	4.14	0.65	10.656	.001*	1-3 2-3
	Took once ²	110	4.17	0.58			
	Took more than once ³	162	4.43	0.46			
Curiosity	Did not take ¹	66	4.52	0.48	4.494	.012*	1-3 2-3
	Took once ²	110	4.54	0.50			
	Took more than once ³	162	4.67	0.36			
Doubt	Did not take ¹	66	4.38	0.60	4.651	.010*	1-3 2-3
	Took once ²	110	4.41	0.55			
	Took more than once ³	162	4.57	0.48			
Flexibility	Did not take ¹	66	4.46	0.47	3.234	.041*	2-3
	Took once ²	110	4.43	0.47			
	Took more than once ³	162	4.56	0.41			
Creative Thinking Tendencies	Did not take ¹	66	4.34	0.46	8.892	.001*	1-3 2-3
	Took once ²	110	4.36	0.44			
	Took more than once ³	162	4.54	0.36			
Independence	Did not take ¹	66	5.45	0.58	0.989	.373	
	Took once ²	110	5.45	0.56			
	Took more than once ³	162	5.53	0.45			
Integration	Did not take ¹	66	5.43	0.57	1.880	.154	
	Took once ²	110	5.43	0.54			
	Took more than once ³	162	5.54	0.48			
Motivation	Did not take ¹	66	5.33	0.61	4.045	.018*	1-3
	Took once ²	110	5.38	0.52			
	Took more than once ³	162	5.51	0.45			

Judgment	Did not take ¹	66	5.29	0.60	3.049	.049*	2-3
	Took once ²	110	5.25	0.63			
	Took more than once ³	162	5.42	0.53			
Flexibility	Did not take ¹	66	5.38	0.56	1.265	.284	
	Took once ²	110	5.45	0.50			
	Took more than once ³	162	5.50	0.49			
Evaluation	Did not take ¹	66	5.23	0.61	3.710	.025*	2-3
	Took once ²	110	5.23	0.64			
	Took more than once ³	162	5.40	0.52			
Inquiry	Did not take ¹	66	5.55	0.48	.516	.598	
	Took once ²	110	5.62	0.46			
	Took more than once ³	162	5.62	0.45			
Opportunities	Did not take ¹	66	5.51	0.50	.813	.444	
	Took once ²	110	5.60	0.46			
	Took more than once ³	162	5.59	0.46			
Frustration	Did not take ¹	66	5.55	0.50	.555	.575	
	Took once ²	110	5.58	0.48			
	Took more than once ³	162	5.62	0.46			
Creativity-Fostering Teacher Behaviors Index	Did not take ¹	66	5.42	0.50	1.896	.152	
	Took once ²	110	5.44	0.47			
	Took more than once ³	162	5.53	0.42			

* $p < .05$

The ANOVA results, conducted to examine whether there were statistically significant differences in creative thinking tendencies and teacher behaviors for encouraging creativity based on the number of STEM training courses attended by teachers, are presented in Table 4.

As shown in Table 4, significant differences were found in the self-discipline ($F = 9.08, p < .05$), novelty seeking ($F = 6.34, p < .05$), courage ($F = 10.65, p < .05$), curiosity ($F = 4.49, p < .05$), doubt ($F = 4.65, p < .05$), and flexibility ($F = 3.23, p < .05$) subdimensions, as well as in the total creative thinking tendencies score ($F = 8.89, p < .05$). Tukey's post hoc test revealed that participants who attended more than one STEM course scored significantly higher than those who attended once or not at all. This pattern was observed in the self-discipline, novelty seeking, courage, curiosity, and doubt subdimensions. For the flexibility subdimension, a significant difference was found between participants who attended once and those who attended more than once. Regarding the total score, the highest mean was found in Group 3 ($M = 4.54$), while the lowest was in Group 1 ($M = 4.34$).

In terms of creativity-promoting teacher behaviors, significant differences by training frequency were observed in motivation ($F = 4.04, p < .05$), judgment ($F = 3.04, p < .05$), and evaluation ($F = 3.71, p < .05$) subdimensions. Post hoc analyses indicated that participants who attended more than one STEM course scored significantly higher than those in the other groups. For motivation, the difference was found between Group 1 (no attendance) and Group 3 (more than once); for judgment and evaluation, differences were observed between Group 2 (once) and Group 3. The highest total mean score for creativity-promoting behaviors was found in Group 3 ($M = 5.53$), while the lowest was in Group 1 ($M = 5.42$).

No statistically significant differences were observed for the independence, integration, flexibility, questioning, opportunities, or frustration subdimensions, or in the total score of the Teacher Behaviors Index for Encouraging Creativity ($p > .05$).

Table 5
Correlation Values for Creative Thinking Tendencies and Creativity-Promoting Teacher Behaviors

Creative Thinking Tendencies (Subscales)		Self-Discipline	Seeking Novelty	Courage	Curiosity	Doubt	Flexibility	Creative Thinking Tendencies
Independence	<i>r</i>	.439**	.541**	.433**	.377**	.428**	.498**	.539**
	<i>p</i>	.001	.001	.001	.001	.001	.001	.001
	<i>n</i>	338	338	338	338	338	338	338
Integration	<i>r</i>	.486**	.534**	.462**	.368**	.399**	.483**	.548**
	<i>p</i>	.001	.001	.001	.001	.001	.001	.001
	<i>n</i>	338	338	338	338	338	338	338
Motivation	<i>r</i>	.418**	.552**	.445**	.377**	.351**	.456**	.527**
	<i>p</i>	.001	.001	.001	.001	.001	.001	.001
	<i>n</i>	338	338	338	338	338	338	338
Judgment	<i>r</i>	.409**	.474**	.414**	.280**	.401**	.449**	.483**
	<i>p</i>	.001	.001	.001	.001	.001	.001	.001
	<i>n</i>	338	338	338	338	338	338	338
Flexibility	<i>r</i>	.414**	.516**	.433**	.389**	.394**	.461**	.518**
	<i>p</i>	.001	.001	.001	.001	.001	.001	.001
	<i>n</i>	338	338	338	338	338	338	338
Evaluation	<i>r</i>	.459**	.501**	.443**	.315**	.381**	.450**	.513**
	<i>p</i>	.001	.001	.001	.001	.001	.001	.001
	<i>n</i>	338	338	338	338	338	338	338
Inquiry	<i>r</i>	.378**	.488**	.389**	.408**	.405**	.437**	.491**
	<i>p</i>	.001	.001	.001	.001	.001	.001	.001
	<i>n</i>	338	338	338	338	338	338	338
Opportunities	<i>r</i>	.374**	.496**	.414**	.389**	.398**	.441**	.495**
	<i>p</i>	.001	.001	.001	.001	.001	.001	.001
	<i>n</i>	338	338	338	338	338	338	338
Frustration	<i>r</i>	.390**	.522**	.454**	.409**	.404**	.485**	.525**
	<i>p</i>	.001	.001	.001	.001	.001	.001	.001
	<i>n</i>	338	338	338	338	338	338	338
Creativity-Fostering Teacher Behaviors Index	<i>r</i>	.478**	.584**	.492**	.415**	.449**	.525**	.586**
	<i>p</i>	.001	.001	.001	.001	.001	.001	.001
	<i>n</i>	338	338	338	338	338	338	338

** $p < .01$

A moderate positive correlation was found between teachers' total scores on the Teacher Behaviors Index for Encouraging Creativity and their total scores on the Creative Thinking Tendencies Scale ($r = .58, p < .01$). This suggests that higher levels of creativity-fostering behaviors are associated with stronger creative thinking tendencies.

Discussion

The present study aimed to examine the link between teachers' creative thinking tendencies and their classroom behaviors aimed at fostering creativity within STEM-focused instruction. One of the most striking findings was that while creative thinking tendencies did not significantly vary by gender, female teachers consistently scored higher on nearly all dimensions of creativity-fostering classroom behaviors. This may be attributed to gender-related differences in pedagogical approach and emotional labor. Female educators often emphasize relational and socio-emotional dimensions in teaching, which may naturally translate into more creativity-supportive behaviors (Karakuş, 2001; Çayhan, 2020). The current findings resonate with Türkdoğan (2019), who reported similar gender-based variations in affective aspects of creativity. However, the lack of gender difference in cognitive creative tendencies aligns with Kılıç (2017), suggesting that while behavioral expressions may vary, underlying creative dispositions remain stable across genders.

Subject area also emerged as a significant factor, particularly in the subdimension of self-discipline, where mathematics teachers outperformed their peers. This could be due to the inherently structured nature of mathematics instruction, which may require higher degrees of planning, focus, and persistence—traits linked to creative regulation (Jauk et al., 2013). Conversely, preschool teachers scored significantly higher in several creativity-fostering behavior dimensions. Early childhood education environments often encourage exploration, play-based learning, and open-ended instruction, creating a natural context for creative expression (Runco & Acar, 2012). These findings are consistent with Çalıkoğlu (2019), but contrast with Emir et al. (2004), who found no subject-based differentiation—possibly due to variation in instruments or educational cultures.

Another notable pattern was the impact of repeated STEM-related professional development. Teachers who participated in STEM training more than once reported higher scores in both creative thinking and creativity-supportive behaviors. This suggests that sustained engagement with STEM pedagogy, particularly when it includes hands-on or interdisciplinary approaches, enhances not only content knowledge but also teachers' pedagogical creativity (Çakır, 2018; Aydeniz, 2017). These results emphasize the need for structured, long-term professional learning opportunities that foster both cognitive and behavioral aspects of creativity (Craft, 2005).

Perhaps the most theoretically significant finding was the moderate yet statistically significant positive link between teachers' creative thinking tendencies and their creativity-fostering behaviors. This relationship supports the dual-pathway model of teacher creativity, which suggests that cognitive tendencies and classroom practices are mutually reinforcing (Beghetto, 2007; Sternberg, 2006; Sternberg & Lubart, 1991). In other words, teachers who tend to approach problems with curiosity, flexibility, and courage are more likely to create classroom environments that nurture similar traits in students. These findings align with prior research emphasizing the interplay between teacher disposition and instructional behavior in cultivating student creativity (Aydın, 2019; Özgenel, 2017; Üstündağ, 2003).

These findings also carry relevance in the international context. As STEM education becomes a global priority (OECD, 2021), understanding what drives teacher creativity is essential for designing future-oriented, innovation-driven educational systems. Countries like Finland and Singapore have already embedded creativity as a core competency in teacher training pro-

grams, with an emphasis on reflective practice, flexibility, and interdisciplinary problem-solving (Darling-Hammond et al., 2020). Thus, although this study was conducted in Turkey, the results offer practical insights for a broader educational community. The emphasis on long-term professional development, supportive teaching cultures, and individual creative dispositions may serve as a model for other countries seeking to integrate creativity more systematically into STEM education.

Conclusions and Implications

This study aimed to examine the link between teachers' creative thinking tendencies and their classroom behaviors that promote creativity within the context of STEM education. The findings revealed that while gender did not significantly influence creative thinking tendencies, it was a significant factor in creativity-fostering behaviors, with female teachers scoring higher across most subdimensions. Additionally, the subject area and the number of STEM training courses attended were found to significantly affect both creative thinking and creativity-supportive practices. Teachers who participated in STEM-related professional development more than once demonstrated stronger creative competencies and classroom practices.

A moderate and statistically significant link was also found between teachers' creative thinking tendencies and their creativity-promoting behaviors. This highlights the importance of supporting not only teachers' cognitive dispositions but also their instructional strategies. These findings suggest that teacher education and professional development programs should provide sustained, context-specific training that nurtures creativity as both a mindset and a pedagogical skill.

In a broader context, the results offer insights relevant to global efforts in STEM education reform. As many education systems aim to cultivate 21st-century competencies such as creativity and innovation, the present findings highlight how targeted professional development and supportive teaching environments can enhance creative capacity in STEM classrooms. These implications underscore the value of fostering creativity not only at the individual teacher level but also through institutional and policy-level initiatives.

Institutional Review Board Statement

The article was approved by Zonguldak Bülent Ecevit University (Türkiye) Ethics Committee with the protocol number 07 on 29.01.2021.

Declaration of Interest

The authors declare no competing interest.

References

- Adıgüzel, D. Ç. (2016). *The relationship between primary school teachers' creative thinking skills and their behaviors contributing to students' creative thinking skills* [Unpublished Master's thesis]. Pamukkale University, Institute of Educational Sciences.
- Akar, İ. (2014). Adaptation of the Creativity-Fostering Teacher Behaviors Index (CFTBI) into Turkish. *Abant İzzet Baysal University Journal of Faculty of Education*, 14(1), 304–328. <https://doi.org/10.17240/aibuefd.2014.14.1-5000091514>
- Aydeniz, M. (2017, October). *Eğitim sistemimiz ve 21. yüzyıl hayalimiz: 2045 hedeflerine ilerlerken, Türkiye için STEM odaklı ekonomik bir yol haritası* [Policy report]. University of Tennessee, Knoxville. https://trace.tennessee.edu/cgi/viewcontent.cgi?article=1019&context=utk_theopubs
- Aydın, T. (2019). *The relationship between preschool teachers' creative thinking tendencies and classroom management skills* [Unpublished Master's thesis]. Çanakkale Onsekiz Mart University, Institute of Educational Sciences.

- Ballı, A. (2019). *The effect of organizational culture on teachers' creative thinking tendencies* [Unpublished Master's thesis]. Istanbul Sabahattin Zaim University, Institute of Social Sciences.
- Beghetto, R. A. (2007). Toward a pedagogy of possibility in the teaching of creativity. In A. G. Tan (Ed.), *Creativity: A handbook for teachers* (pp. 191–203). World Scientific.
- Büyüköztürk, Ş. (2020). *Handbook of data analysis for social sciences* (27th ed.). Pegem Academy.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.
- Craft, A. (2005). *Creativity in schools: Tensions and dilemmas*. Routledge.
- Çakır, Z. (2018). *The effect of STEM activities based on the Montessori approach on pre-service preschool teachers* [Unpublished Master's thesis]. Erzincan Binali Yıldırım University, Institute of Science.
- Çalıkoğlu, U. (2019). *The relationship between teachers' perceptions of organizational silence and their creative thinking tendencies* [Unpublished Master's thesis]. Istanbul Kültür University, Graduate Education Institute.
- Çayhan, G. (2020). *The effect of expressive art therapy practices on pre-service teachers' levels of creativity and creativity-enhancing behaviors* [Unpublished Master's thesis]. Dokuz Eylül University, Institute of Educational Sciences.
- Çelik, B. B. (2020). *An investigation of primary school teacher candidates' creative and reflective thinking tendencies* [Unpublished Master's thesis]. Kırşehir Ahi Evran University, Institute of Social Sciences.
- Çer, Ö. Y. (2020). *An investigation of pre-service teachers' critical and creative thinking tendencies* [Unpublished Master's thesis]. Ankara University, Institute of Educational Sciences.
- Çokluk, Ö., Şekercioğlu, G., & Büyüköztürk, Ş. (2014). *Multivariate statistics for social sciences: SPSS and LISREL applications*. Pegem Academy.
- Çorlu, M., & Aydın, E. (2016). Evaluation of learning gains through integrated STEM projects. *International Journal of Education in Mathematics, Science and Technology*, 4(1), 20–29.
- Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, 24(2), 97–140. <https://doi.org/10.1080/10888691.2018.1537791>
- Durnacı, Ü., & Ültay, N. (2020). Primary school pre-service teachers' critical and creative thinking tendencies. *Turkish Journal of Primary Education*, 5(2), 75–97.
- Emir, S., Ateş, S., Aydın, F., Bahar, M., Durmuş, S., Polat, M., & Yaman, H. (2004). Creativity levels of pre-service teachers. *Abant İzzet Baysal University Journal of the Institute of Social Sciences*, 2(9), 105–112.
- Furnham, A., & Bachtar, V. (2008). Personality and intelligence as predictors of creativity. *Personality and Individual Differences*, 45(7), 613–617. <https://doi.org/10.1016/j.paid.2008.06.023>
- Getzels, J. W., & Jackson, P. W. (1962). *Creativity and intelligence: Explorations with gifted students*. Wiley.
- Güteryüz, H. (2001). *The language of curricula and creative learning*. Pegem Academy.
- Hallman, R. J. (1967). Techniques of creative teaching. *The Journal of Creative Behavior*, 17(1), 3–13.
- Henry, J. (1991). *Creative management*. Sage Publications.
- Jauk, E., Benedek, M., Dunst, B., & Neubauer, A. C. (2013). The relationship between intelligence and creativity: New support for the threshold hypothesis by means of empirical breakpoint detection. *Intelligence*, 41, 212–221. <https://doi.org/10.1016/j.intell.2013.03.003>
- Karakuş, M. (2001). Education and creativity. *Education and Science*, 26(119), 3–7.
- Karasar, N. (2020). *Scientific research method: Concepts, principles, techniques*. Nobel Publishing.
- Kılıç, A. F. (2017). The examination of teachers' behaviours on creative thinking supportiveness. *Adıyaman University Journal of Educational Sciences*, 7(1), 87–115. <https://doi.org/10.17984/adyuebd.325237>
- Korucuk, M. (2021). *The effect of flipped learning practices on university students' creative thinking tendencies, communication skills, motivation, and academic achievement* [Unpublished Doctoral dissertation]. Atatürk University, Institute of Educational Sciences.
- MEB. (2017). *Science course curriculum (Primary and Secondary Grades 3–8)*. Board of Education and Discipline.

- MEB. (2018). *Science course curriculum (Primary and Secondary Grades 3–8)*. Board of Education and Discipline.
- OECD. (2021). *Future of education and skills 2030: Conceptual learning framework*. <https://www.oecd.org/education/2030>
- Özgenel, M., & Çetin, M. (2017). Development of the Marmara Creative Thinking Tendency Scale: Validity and reliability study. *Marmara University Atatürk Faculty of Education Journal of Educational Sciences*, 46, 113–132.
- Öztekin, E. (2013). *An investigation of pre-service science teachers' creative thinking levels in terms of various variables* [Unpublished Master's thesis]. Mehmet Akif Ersoy University, Institute of Educational Sciences.
- Reyhan, Ö. G. (2018). *An investigation of the relationship between 8th grade students' creative thinking tendencies, perceptions of problem solving, and academic achievement* [Unpublished Master's thesis]. Çukurova University, Institute of Social Sciences.
- Runco, M. A., & Acar, S. (2012). Divergent thinking as an indicator of creative potential. *Creativity Research Journal*, 24(1), 66–75. <https://doi.org/10.1080/10400419.2012.652929>
- Senemoğlu, N. (1996). Creativity and teacher qualifications. In *Creativity and Education Panel*. Turkish Military Academy.
- Soh, K. C. (2000). Indexing creativity-fostering teacher behavior: A preliminary validation study. *The Journal of Creative Behavior*, 34(2), 118–134.
- Sternberg, R. J. (2006). The nature of creativity. *Creativity Research Journal*, 18(1), 87–98. https://doi.org/10.1207/S15326934CRJ1801_10
- Sternberg, R. J., & Lubart, T. I. (1991). An investment theory of creativity and its development. *Human Development*, 34(1), 1–31. <https://doi.org/10.1159/000277029>
- Sungur, N. (1997). *Creative thinking*. Evrim Publishing.
- Sünbül, A. M. (2000). Creativity and developing creativity in the classroom. *Necmettin Erbakan University Journal of Faculty of Education*, 10, 82–94.
- Şahin, G. (2016). *An investigation of the relationships between teachers' perceptions of school culture, creative personality, and creative environment* [Unpublished Master's thesis]. Istanbul Sabahattin Zaim University, Institute of Social Sciences.
- Tekin, M., & Taşgın, Ö. (2008). Investigation of the relationship between creativity and multiple intelligence areas of secondary school students who do and do not participate in sports. *Niğde University Journal of Physical Education and Sport Sciences*, 2(3), 206–214.
- Torrance, E. P. (1963). *Education and creative potential*. University of Minnesota Press.
- Torrance, E. P. (1965). *Rewarding creative behavior: Experiments in classroom creativity*. Prentice-Hall.
- Türkdoğan, M. (2019). *The relationship between teachers' creative thinking tendencies and school climate* [Unpublished Master's thesis]. Istanbul Sabahattin Zaim University, Institute of Social Sciences.
- Türkmen, N. (2014). *Comparison of education faculty students' critical thinking tendencies and creativity levels* [Unpublished Master's thesis]. Erciyes University, Institute of Educational Sciences.
- Üstündağ, T. (2003). *Journey to creativity* (2nd ed.). Pegem Publishing.
- Vexliard, A. (1966). Theories of creativity and education. *Ankara University Faculty of Languages, History and Geography Journal of Philosophy*, 4, 107–128.
- Wallach, M. A., & Kogan, N. (1965). *Modes of thinking in young children*. Holt, Rinehart and Winston.
- Yazıcı, F. (2021). *An investigation of the relationship between social studies pre-service teachers' creative thinking tendencies and entrepreneurial skills* [Unpublished Master's thesis]. Afyon Kocatepe University, Institute of Social Sciences.
- Yıldırım, B. (2006). *The relationship between preschool teachers' perspectives on creativity and the creativity levels of preschool children according to the creativity level of the teacher* [Unpublished Master's thesis]. Hacettepe University, Institute of Social Sciences.
- Yıldız, F. (2021). *An investigation of pre-service elementary mathematics teachers' problem posing self-efficacy beliefs and creative thinking tendencies* [Unpublished Master's thesis]. Fırat University, Institute of Educational Sciences.
- Yıldız, Y. (2018). *An investigation of music pre-service teachers' creative thinking skills* [Unpublished Master's thesis]. Cumhuriyet University, Institute of Educational Sciences.
- Zeytun, S. (2010). *The relationship between creativity and problem-solving levels of preschool teacher candidates* [Unpublished Master's thesis]. Dokuz Eylül University.

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