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# From Creativity to Confidence: Predicting Teachers' Perspectives on STEM Integration

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**Abstract:** The study examines the advantages of the STEM (Science, Technology, Engineering, and Mathematics) educational approach, including improved academic performance, increased motivation, and heightened interest among students, as well as the development of higher-order thinking skills. These benefits significantly rely on teachers' self-efficacy, their innovative teaching methods, and their positive attitudes towards integrating STEM into their curriculum. By examining 163 teachers familiar with STEM, the research utilized an attitude questionnaire to assess their views on STEM implementation, analyzing variables such as teaching experience and grade level through descriptive statistics, t-tests, and ANOVA. Findings revealed no significant differences based on teaching experience or grade level; however, a statistically significant correlation was found between independent variables, such as self-efficacy and creative teaching skills, and teachers' attitudes towards STEM integration. The study aimed to develop a predictive model for teachers' attitudes regarding STEM implementation, highlighting the influence of self-efficacy and innovative teaching practices. Limitations include a small sample size, which raises concerns about the generalizability of the results, and a narrow focus on specific predictive factors without considering broader influences. Consequently, the study offers valuable insights for educators and policymakers on shaping positive attitudes towards STEM in education.

**Keywords:** Creative Teaching Skills, Self-Efficacy, STEM Approach, Teachers' Perspectives, STEM Education.

## 1. Introduction

The world is undergoing rapid changes on both technological and cognitive scales. Therefore, there is an urgent need for the development of a generation that, through acquired skills and abilities, would be able to keep up with changing dimensions. The old framework of education no longer meets the new objectives in conformity with advancement. Thus, new education systems must be developed to accommodate such innovations. The contemporality lies in assisting today's generation to navigate the new industrial revolution and its ongoing changes through enhanced problem-solving skills, analytical thinking, and innovativeness. Another such need lies in making them employment-ready for the future by enhancing their collaborative skills.

The developing trend in education necessitates a comprehensive approach to STEM, thereby affording students the opportunity to engage in experiential learning (Saldívar-Almorejo *et al.,* 2024). This entails utilizing the scientific knowledge and skills they have obtained to seek solutions to tangible problems within their local community and society; furthermore, it facilitates the acquisition of academic, technological, and social competencies. Consequently, this implies that the integration of scientific, technological, engineering, and mathematical concepts and principles within the framework of engineering design fosters enhanced creativity among students, encourages innovative thinking, and bolsters their self-confidence (Nur Basyir et al., 2018); (Ergül & Kargın, 2014); (Tekmen-Araci, n.d.); (Morrison, 2006).

The amalgamation of science, technology, engineering, and mathematics represents a prevailing global trend and an essential educational strategy that has transformed the landscape of teaching and learning (Smith-Mutegi *et al.,* 2025). This pedagogy reinforces collaboration among students and engages all their senses through a series of practical activities, and thus goes beyond mere information retention and passive listening. Through it, therefore,

the educational approach better prepares students to make creative contributions in society while, at the same time, honing their communication skills through different forms of acquisition of vital life skills with which to contend with modern developments and challenges. Additionally, working with the STEM format provides an educational space in which knowledge assimilation is aimed at creativity and innovation. (Le Pichon *et al*., 2025). This allows students to evaluate their interests, as is required in the many topics and projects covered under this approach (Fırat, 2020); (May *et al.,* 2022).

While recognizing that teachers are the pillars of the educational system, responsible on the ground for the implementation of numerous programs and playing a cornerstone role in students' educational and intellectual achievements, personality development, and active participation within the pedagogical and instructional paradigm, the burden of responsibility falls most heavily on their shoulders. Therefore, it is essential to provide teachers with the appropriate conditions so that they can discharge their duties up to the limits of their potential. Understanding teachers' perceptions regarding modern pedagogical techniques is essential in estimating their current implementation, as a positive perception can increase the potency of the pedagogical system and support the realization of intended targets. To ensure the efficacy of any educational technique or method, it is essential that educators' perceptions and attitudes towards it are well understood, as they will transmit these patterns to students, thus determining their actions and predetermining their future actions (Obied & Alajmi, 2024).

The teacher plays a pivotal role in the success of any educational system aimed at nurturing a generation characterized by access to diverse sources of information and a universal knowledge base. Consequently, educational administrations must prioritize equipping teachers with innovative teaching skills that empower them to cultivate the abilities of this generation, enabling them to keep pace with scientific and technological advancements (Andere, 2015).

The teacher plays a pivotal role in the success of any educational system aimed at nurturing a generation characterized by access to diverse sources of information and a universal knowledge base (Obied **&** Hijazi, 2025). Consequently, educational administrations must prioritize equipping teachers with innovative teaching skills that empower them to cultivate the abilities of this generation, enabling them to keep pace with scientific and technological advancements (Chiu, 2009).

Although there are varying opinions among teachers regarding the specific skills that constitute creative thinking, such as originality, flexibility, fluency, attention to detail, prediction, and evaluation, there is a consensus on their significance in the educational learning process. These skills are essential in generating new ideas that are novel, original, and beneficial, regardless of whether they are referred to as abilities, traits, or skills (Yang & Zhao, 2021).

The teaching profession is recognized as one of the demanding fields that necessitate teachers to stay abreast of rapid and continuous changes. Teachers face significant professional and psychological pressures stemming from the evolving nature and demands of the educational process, which aim to achieve optimal outcomes and adapt to ongoing developments and challenges. Then, teachers must manage numerous tasks and competing demands that influence their effectiveness and instructional practices, which subsequently affect students' achievements (Obied & Alajmi, 2024).

A strong belief in self-efficacy greatly influences teachers' behaviors. Teachers with high self-efficacy demonstrate enhanced performance, a strong passion for teaching, and a willingness to exert additional effort to inspire students' motivation for learning (Barni et al., 2019); (Emiru & Gedefaw, 2024). This naturally fosters a heightened confidence in the teacher's abilities and in their capacity to design educational strategies that lead to success in achieving desired student outcomes. Moreover, it can substantially contribute to cultivating positive attitudes toward the academic achievements of their students and the educational process (Cheng, 2020); (Pumptow & Brahm, 2021).

The research sets out to evaluate self-confidence influence teachers' perceptions and how innovative teaching abilities and in undertaking the STEM methodology. The significance of the study cannot be overstated, as it allows decisive insight into how teachers develop their approaches and perceptions in embedding STEM aspects in their teaching methodologies. The research evaluates the dynamics among the factors in generating meaningful results, which can impact the valuable implementation of the STEM methodology.

Therefore, the value of the study is provisionally outlined in the following points. First, the study centres on a primary, or central, trend toward a STEM modern style whose aim is to put in motion the wheel of educational efficiency in order to generate a creative generation. Secondly, the study value lies in addressing the selected sample of teachers, who are taken as the pivot point in the education process. The creation of assessment instruments on self-efficacy, creative teaching ability, and attitudes in order to incorporate STEM activities is essential.

## 2. Literature View

The philosophy of STEM education is geared toward building a cadre of professionals who have acquired and developed innovative thinking and creation by enhancing students' ability to build knowledge in science and apply it across the integrated fields of science, technology, engineering, and mathematics (Hafni *et al.,* 2020); (Ammar *et al.,* 2024).

A common critique of the conventional educational approach, characterized by separate curricula in most traditional schools, is its divergence from the holistic objectives of education, which seek to integrate students' personalities. Human development is a unified entity comprising the body, mind, and spirit, influenced by and influencing the natural world, where all sciences, including physics, chemistry, mathematics, and biology, are interconnected. In response to this perspective, the National Science Foundation (NSF) in the United States of America has formulated curricula based on the integrative approach (STEM) to address this issue (Gonzalez & J.Kuenzi, 2012).

Integration of science, technology, engineering, and mathematics (STEM) curricula in education is grounded in a philosophy that intentionally combines educational concepts and practices in mathematics and science with those in technology and engineering (Chamo & Broza, 2025). This approach attempts to break down traditional barriers between academic fields, thus encouraging the creation of original knowledge within a particular situation and a project-based, exploratory curriculum. It encourages students to question, deal with fuzzy challenges, think in creative and innovative ways, and work with instructors or business professionals outside the classical classroom setting. A great deal of evidence confirms that students in integrated curricula outperform students in discrete curricula. Additionally, they demonstrate greater scholarly accomplishment, greater appreciation of the learning process, and greater motivation (Thibaut et al., 2018) (Sanders, 2008).

The STEM approach is grounded in the philosophy of immersing students in performance-based experiences that necessitate creating an active learning environment that enables them to engage in diverse activities, such as tasks, challenges, and problems (Santangelo *et al.,* 2021). These activities serve to stimulate students' thinking and encourage them to apply prior knowledge to novel situations and problems, thereby enabling them to participate in society and authentic science (Abu Khurma *et al.,* 2023). This requires a shift in the teacher's role from being a prompter to a facilitator or contributor, in addition to equipping students with productive skills, such as problem-solving and creative thinking, enhancing the quality of education, fostering economic and industrial development, promoting education for sustainable development, and facilitating communication between schools, society, and the labor market. The teacher's role is limited to direction and guidance, and they work to involve students in defining tasks and train them to develop social skills and generate scientific knowledge (Seyranian et al., 2018).

STEM is defined as an education system based on the solution of real-world problems by practically teaching its fields: science, technology, engineering, and mathematics. It has been defined as follows:

- Science refers to the process of learning and understanding the world and how it works through exploration, data collection, relation and pattern searching, and idea generation.
- Technology: Tools devised to satisfy human needs, for example, weighing scales, lenses, and digital tools like computers, tablets, and cell phones.
- Engineering can be defined as processes and procedures required for designing tools, systems, and structures that assist humans and solve their problems.
- Quantity, solidity, shape, space, and transformation: the science of math (Fırat, 2020).

Therefore, there is teaching on the application of problem-solving skills and practical and scientific procedures to situations from everyday life. Real applications form a basis for the activities used. This increases the enjoyment in the field by the students and their efficiency as well.

The students have to learn how, and that is the factor distinguishing the STEM methodology from traditional teaching since it concentrates on the development of twenty-first-century skills and enhances the student's self-abilities and self-confidence, as well as discovery, research, teamwork, and pace with the rapidly developing technology in the modern era (Gonzalez & J.Kuenzi, 2012), (Al Salami *et al.,* 2017). Also, the STEM approach is unique in its different levels of students and diversity and integration in activities, performance tasks, and realistic projects; it allows learning through educational activities, hands-on experience, practical thinking activities, and lifelong learning (Gleason, 2018). It does not depend on visual and verbal learning inside the class, confined to books, blackboards, and pictures. More than this, the approach to developing the sound attention of the student wakes his interest in meaningful learning, increases the effectiveness of learning, and transforms the process of learning concepts from static to dynamic, enhanced by mental activities and focusing on thinking skills; hence, sustaining the impact of learning (Song, 2020).

A set of activities and practices the approach is based on is: The STEM approach is based on a set of activities and practices, which are: (Song, 2020), (Aguilera & Ortiz-Revilla, 2021).

1. Transdisciplinary: This means integrating curricula-mathematics, science, engineering, and technology through designing an integrated project that includes content, processes, outcomes, and environment.
2. Learning Inquiry-Based: Students research and investigate real problems and challenges, and deepen their understanding of environmental phenomena and issues (brainstorming and problem solving).
3. Project-Based Learning: Through this, students design practical, innovative projects in cooperation.
4. Each group designs its final project at the end of the school year and calls it an innovative project.

Given that the teacher plays a pivotal role in the educational process, shaping generations and imparting fundamental values and principles, the attainment of educational and societal objectives hinges on the presence of dedicated and effective educators (Kraft *et al.,* 2021). A successful teacher, committed to the profession and its ideals, forms the bedrock for nurturing creative minds capable of understanding their future roles in society. Therefore, it is imperative to comprehensively assess and support teachers, fostering their development, realizing their aspirations, and providing conducive environments based on cooperation, empathy, and teamwork. Consequently, the attitudes of teachers towards the teaching profession, its components, modern pedagogical techniques, and various approaches such as STEM carry significant weight due to their impact on the social conduct and guidance of educators. As the linchpin bearing the responsibility of education and the development of students' educational abilities and inclinations, teachers wield a prominent influence on the success or failure of any curricular reform in education (Rachmadtullah *et al.,* 2020).

(Song, 2020) underscores the escalating significance of education in the realms of science, engineering, mathematics, and related disciplines on a global scale. This heightened emphasis has resulted in shifts like knowledge, with a growing focus on interdisciplinary domains that underscore the interconnections among subjects derived from diverse fields.

Given that the teacher plays an active and pivotal role in the educational process, researchers emphasize the significance of understanding their perceptions and inclinations. Preparing a creative generation with favourable attitudes toward science and societal engagement necessitates teachers with positive perceptions and attitudes toward implementing the STEM approach, as they are responsible for fostering an environment conducive to effective learning that encourages students to engage in distinctive, original thinking. A student lacking in innovation may also lack confidence in their critical thinking as they mature and may continue to rely on others (Nguyen et al., 2020).

Creativity and innovative teaching represent crucial facets of teachers' competencies for twenty-first-century skills and are focal points in teacher training programs. Creativity is regarded as the cornerstone of scientific advancement and an imperative in the era of knowledge proliferation. This has prompted a shift from traditional educational paradigms and rote learning to a creative educational approach that emphasizes unconventional problem-solving and new solutions. Fostering creativity among learners necessitates the full engagement of qualified

teachers who employ teaching methods designed to stimulate students' motivation and attention, fostering interaction between the teacher and students, as well as among the students themselves (Conradty & Bogner, 2020).

Since creativity is one of the most important educational goals that societies seek to achieve because it is linked to the progress and development of nations, scientific progress cannot be achieved without developing the creative capabilities of humans. Creativity is a thinking process that leads to a product or work characterized by novelty and originality (Rahman, 2019). It is the highest level of cognitive activity, and through it is achieved. Producing multiple solutions to a single problem, which Guilford defines as preparatory traits such as fluency of thinking, originality, and sensitivity to problems. Researchers believe that there is great responsibility for the school, especially the teacher, in preparing creative people and sponsoring them. The teacher must have the skills of creative teaching to understand the needs of the students, and they can provide suitable environments to integrate them into learning tasks and enable them to express their thoughts and opinions freely and in unusual ways to ensure that they obtain the best learning experiences (Aguilera & Ortiz-Revilla, 2021).

In creative teaching, knowledge is considered a means and not an end, meaning that the goal of knowledge is to develop higher-order cognitive mental processes. and metacognition among students (Anisimova *et al.,* 2020).

Torrance emphasized the necessity of focusing on fostering creativity in teachers. It is essential to provide in-service training courses and programs for teachers to cultivate an appreciation for creativity and recognize its significance. This enables them to nurture creativity among their students and inspire a shift in students' attitudes from passive contemplation of nature, the universe, and life to active observation, experimentation, and the pursuit of innovation in seeking unconventional solutions to address encountered challenges. Educational literature has highlighted the diverse roles of creative teachers, including creating a positive and secure environment, promoting genuine freedom, encouraging voluntary participation in activities, stimulating motivation and interest, demonstrating empathy, providing support, and considering differences and variations in abilities and characteristics (Baker & Robinson, 2016).

Creative teaching entails the implementation of diverse instructional methods and practices, including adapting to the educational context, fostering and enhancing students' critical thinking, showcasing scholars' creativity, posing divergent questions, flexibly employing teaching strategies, and integrating them cohesively to stimulate students' creative potential. This underscores the notion that creativity is a form of thinking synonymous with problem-solving to attain innovative solutions, which we regard as creative outcomes (Sanjar & Doston, 2022).

The self-efficacy of the teacher significantly influences the successful implementation of the STEM approach, as it is associated with the teacher's capacity for self-regulation, thereby enhancing effectiveness in employing educational strategies, managing time efficiently, and positively impacting students (John *et al.,* 2016).

The objectives of this study are as follows: ***Firstly***, to identify the differences in mean scores of teachers in creative teaching skills, self-efficacy, and their attitudes toward implementing the integrative science (STEM) approach, based on their years of experience. ***Secondly***, to determine the direction, strength, and correlation between the mean scores of creative teaching skills and their dimensions (faculty members's creative characteristics, stimulating creativity among students, motivation towards creativity and its development) and the attitudes of public-school teachers toward implementing the STEM-based approach. ***Thirdly***: to determine the direction, strength, and correlation between the mean scores of self-efficacies and their dimensions (efficiency of teaching strategies, competence in classroom management, competence in activating student participation) and the attitudes of public-school teachers toward implementing the STEM-based approach. ***Finally***, to determine the predictive value of creative teaching skills and the self-efficacy scale in predicting public school teachers' attitudes toward implementing the STEM-based approach.

This study is significant due to the findings of previous research that have highlighted the correlation between self-efficacy and emotional factors (Bandura, 2007) have emphasized the importance of self-efficacy as a motivator for overcoming challenges and the degree of tolerance when facing such challenges, leading to the enhancement of positive emotional and physiological states. More studies likewise showed that it is necessary to concentrate on educators by cultivating affirmative dispositions regarding pedagogy and supplying them with Modern pedagogical approaches to equip students for future academic canters that value creativity. Teaching and enabling students to acquire 21st-century skills (Rankin & Brown, 2016). The findings of these studies are aligned with concepts and

intentions underlying the integrative sciences (STEM) paradigm; therefore, researchers hope that self-efficacy and innovative pedagogical capability would prove to be appropriate indicators of teachers' attitudes toward implementation of STEM methodology. The goal of these studies is to illuminate this problem further.

## 3. Theoretical Framework

Bandura *et al.* (1987) described a detailed system of self-efficacy based on postulates of social cognitive theory that stressed its essential role in explaining the motivations affecting people's performance in several spheres. He also highlighted that recognizing the conception of self-efficacy facilitates knowing and identifying the diverse range of personal behaviors that comprise adaptive and stable actions springing from distinctive situational conditions, self-regulatory behaviors, and orientation to goal achievement, and forming interests in specific specializations. A fundamental theoretical assumption and determinant underlying the theory is that individuals possess the capacity to construct symbols that enable the formation of internal models to assess the efficacy of actions before executing and testing them. This hypothesis involves predicting outcomes and linking intricate ideas. The majority of behaviors are guided by the ability to contemplate the future and make predictions. Bandura also underscored individuals' capability for self-reflection, analysis, and evaluation of personal thoughts and experiences, enabling self-regulation of thoughts and behaviors. Furthermore, he posited that individuals process, evaluate, and integrate diverse information sources related to their capabilities, regulate their voluntary behaviors, and determine the effort required for these capabilities. Consequently, expectations linked to self-efficacy encompass creative abilities, the specific selection of goals and goal-directed events, and perseverance in confronting challenges, difficulties, and emotional experiences. The psychologist (Bandura, 2007) characterized it as perceived procedural capability, which is associated with the teacher's attributes and their belief in their capacity, irrespective of the resources at hand. Bandura also delineated between: ***Firstly***, ***efficacy expectations***, representing the teacher's confidence in their ability to execute teaching duties to attain specific objectives. ***Secondly, response-outcome expectancies*** signifying the teacher's anticipation that their performance of these duties will lead to the achievement of these objectives.

Bandura's social-cognitive theory provides a relevant framework for understanding the predictive ability of creative teaching skills and self-efficacy in teachers' attitudes toward implementing the STEM approach. According to Bandura, self-efficacy, which refers to an individual's belief in their capability to execute courses of action required to achieve specific performance, plays a crucial role in shaping behavior and attitudes. Within the context of this approach to STEM, highly self-efficacious teachers tend to disclose better attitudes toward integrating STEM in their teaching practices. Motivation, resilience, and the adoption of new teaching strategies depend on whether an individual has self-efficacy beliefs or not in Bandura's theory. Therefore, Bandura's theory is especially relevant to this study, titled "The Predictive Ability of Creative Teaching Skills and Self-Efficacy in Teachers' Attitudes Towards the Implementation of the STEM Approach," when looking into the interaction between self-efficacy and creative teaching skills while considering teachers' attitudes toward STEM implementation.

In addition to Bandura's psychoanalytic point of view, self-efficacy and innovative teaching capacity can be considered socially constructed. Peers, colleagues, and society all contribute to teachers' perceptions of themselves as having talent. Professional capital (Procaccini, 2012) in turn, explains that individual talent, along with shared cultures and facilitating policies, are responsible for maintaining innovation and self-efficacy. This shows that teachers' individual approaches come from the intersection of individual agency and social conditions, and are not different properties.

This induction of the Palestinian Ministry of Education into the approach of STEM is in line with establishing a comprehensive framework that encompasses various activities and strategies identified for implementation. These will include the training of students on research and inquiry, working in teams, organization of exploratory events in collaboration with local universities, and interaction with scientists and researchers in sharing successful stories that can act as an inspiration to becoming enthusiastic and passionate. Besides, it is supposed to develop students' interest in different scientific fields, integrate various methods and approaches into the system of STEM education, and include those practices into curricula of higher education to enhance teachers' competencies and motivation, and encourage their active participation in local and regional exploratory events. In 2019, a STEM approach pilot program started in cooperation with Palestinian universities to enhance students' higher-order thinking, creativity,

and life skills, in addition to developing positive attitudes towards science, technology, engineering, and mathematics (Abboushi & Shana, 2022).

Based on a series of studies, seminars, and conferences, recommendations were drawn up by the researchers on teacher preparation, acquiring skills, such as creative teaching ability, elements of the STEM approach, and attitude development in these aspects. Furthermore, there is a call for further research into the factors influencing teachers' effectiveness in delivering science, technology, engineering, and mathematics education in an integrated manner. These insights were drawn from studies by (Newcombe, 2016); (Anisimova et al., 2020); (Kartal & Taşdemir, 2021) and (Aguilera & Ortiz-Revilla, 2021). The latter emphasized the significance of enhancing students' capabilities and nurturing diverse thinking skills to prepare them for the study of future sciences in the twenty-first century.

As a result of these perspectives, there has been a growing emphasis on developing integrated programs, particularly those based on integrative sciences (STEM), aimed at delivering effective and high-quality education. The overarching goal is to cultivate a creative generation capable of keeping pace with scientific advancements, with a focus on practical application and the integration of learning with real-life contexts. This approach aims to foster investigative skills, promote dialogue, and nurture critical and creative thinking among students, ultimately enhancing genuine creativity stemming from the synergy between the scientist, the technician, and the designer.

In consideration of the aforementioned points, this research aimed to address the following primary inquiry: What is the predictive ability of creative teaching skills and self-efficacy in teachers' attitudes toward implementing the STEM approach? The primary question was subdivided into the following set of sub-questions:

- Are there statistically significant variances, at a significance level of ($\alpha \leq 0.05$), in the mean scores of teachers in creative teaching skills, self-efficacy, and their attitudes toward implementing the integrative sciences (STEM) approach, based on their years of experience?
- Are there statistically significant variances, at a significance level of ($\alpha \leq 0.05$), in the mean scores of teachers in creative teaching skills, self-efficacy, and their attitudes toward implementing the integrative sciences (STEM) approach, based on their educational stage?
- Can the attitudes of public-school teachers towards implementing the STEM-based approach be predicted based on their scores on the creative teaching skills scale and the self-efficacy scale?

As shown in Figure 1, conceived on the basis of Social Cognitive Theory by Bandura, the developed conceptual model suggests that educators' innovative teaching ability, as well as self-efficacy, contribute toward shaping their attitudes in promoting STEM integration. The model, in addition to encapsulating Bandura's emphasis on the relationships among beliefs, behaviors, and social influences, served as a point of reference in designing and in research inquiries in the study.

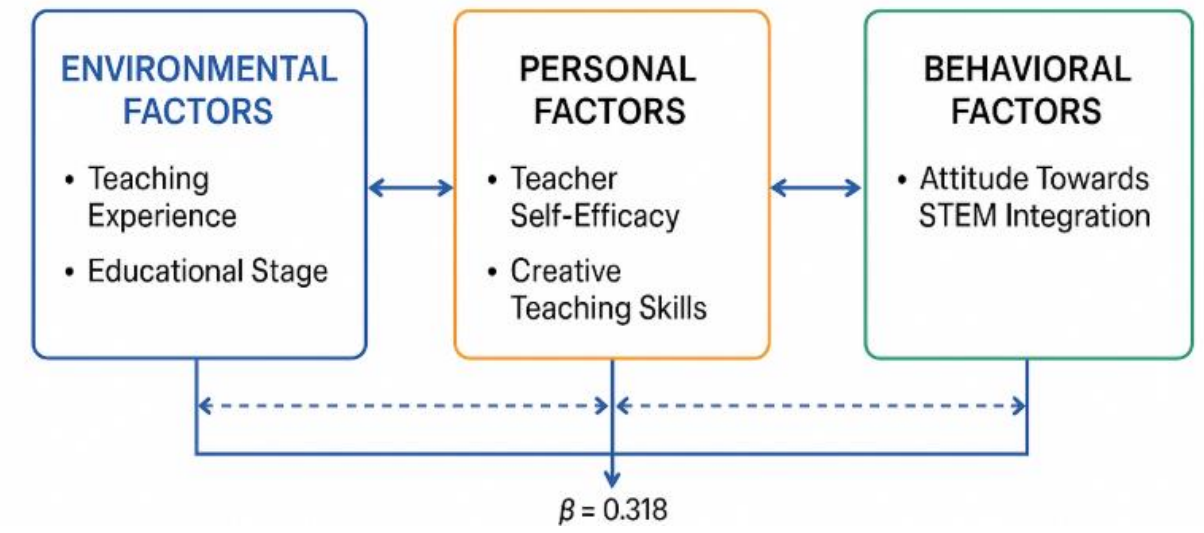


**Figure 1.** Revised Conceptual Framework Based on Bandura's Social Cognitive Theory

Figure 1 presents Bandura's (1986) triadic reciprocity model, uncovering the inter-action between personal, environmental, and behavioural factors. Regression analysis identified high predictive correlations (β = 0.397, β = 0.318), represented by solid arrows. Dashed arrows indicate the postulated moderation effects of environmental variables (educational phase and teaching experience), investigated but not reaching significance. Bidirectional arrows indicate the reciprocal effects of the three domains on one another, a cornerstone assumption of Social Cognitive Theory.

## 4. Methodology

In line with the study's objectives, which aim to derive a predictive model for public school teachers' attitudes regarding the implementation of the STEM-based approach, incorporating self-efficacy and creative teaching skills, we employed a descriptive, correlational approach, deemed most suitable for the study's nature and objectives.

The deliberate selection of the study sample includes 163 male and female teachers who are knowledgeable about the STEM approach from governmental schools in the basic stage (low and high basic stage) in Tulkarm, Palestine, during the academic year 2023/2024. Table 1 presents the distribution of the study variables among the sample:

**Table 1.** Sample Descriptive & Distribution by Demographic Variables

| Variables | | Frequency | Percent |
|---|---|---|---|
| experiences | Less than 6 years | 36 | 22.1% |
| | From 6 years to less than 12 years | 54 | 33.1% |
| | More than 12 years. | 73 | 44.8% |
| Educational stage | low basic stage | 75 | 46.0 |
| | high basic stage | 88 | 54.0 |

The research questionnaire was designed to encompass three scales: the self-efficacy scale, the creative teaching skills scale, and the teacher's attitudes scale toward implementing the STEM-based approach. These three scales were originally designed in line with the Palestinian culture and were never replicated from foreign work. The development entailed the reading of seminal work in Arabic and in the locality, securing endorsement by ten education specialists among Palestinians, and a pilot test among 50 teachers. Tests for construct validity and reliability suggested that the instruments were suitable in the context and were psychologically valid. This self-efficacy scale was developed based on a review of the related literature in education and relevant measurement scales, such as the works of (Conradty & Bogner, 2020); (Cheng, 2020); (Bandura, 2007). This scale comprised 18 items categorized into three dimensions: (1) efficacy of instructional methods (1–7). (2) proficiency in classroom management (8–12). (3) Ability to motivate students (13 –18). The review of the educational literature and related scales, such as the works of (Baker & Robinson, 2016) and (Yang & Zhao, 2021) was conducted in order to develop the creative teaching skills scale. This scale contains a total of 19 items across three dimensions, namely: (1) creative traits of faculty members, which are items (19 –25). (2) stimulation of creativity among students, which contains items (26-32). (3) motivation toward creativity and its development, items (33-37).

In developing a measure of teacher attitudes toward applying the STEM-based approach, educational literature and related measures were reviewed, including works (Kartal & Taşdemir, 2021) (Sanders, 2008). The scale comprised 12 items (38-49). To establish the validity of the three scales: the self-efficacy scale, the creative teaching skills scale, and the teacher's attitudes scale toward implementing the STEM-based approach, the researchers employed two validation methods, as outlined below:

***Firstly, experts' validation***: The initial questionnaire was presented to (10) educational experts and university lecturers, whose feedback was utilized to refine the wording of certain items, incorporate new items, and remove others. ***Secondly, construct validity***: The questionnaire was administered to an exploratory sample

comprising 50 male and female teachers, and correlation coefficients were computed between each item and its corresponding dimension yielding Table 2, which displays the correlation coefficients between the individual items and the overall score of the self-efficacy dimension:

**Table 2.** The correlation coefficients between the individual items and the overall score of the self-efficacy dimension

| Effectiveness of teaching strategies | | Proficiency in classroom management | | Competence in fostering student engagement | |
|---|---|---|---|---|---|
| Paragraph # | correlation coefficients | Paragraph # | correlation coefficients | Paragraph # | correlation coefficients |
| 1 | 0.889** | 8 | 0.607** | 13 | 0.599** |
| 2 | 0.609** | 9 | 0.889** | 14 | 0.857** |
| 3 | 0.729** | 10 | 0.743** | 15 | 0.576** |
| 4 | 0.822** | 11 | 0.889** | 16 | 0.526** |
| 5 | 0.654** | 12 | 0.661** | 17 | 0.603** |
| 6 | 0.472* | | | 18 | 0.587** |
| 7 | 0.577* | | | | |

*Statistically significant at the significance level (0.05).

** Statistically significant at the significance level (0.01).

The questionnaire was administered to an exploratory sample comprising 50 male and female teachers, and correlation coefficients were computed between each item and its corresponding dimension yielding Table 3, which displays the correlation coefficients between the individual items and the overall score of the creative teaching skills dimension:

**Table 3.** The correlation coefficients between the individual items and the overall score of the creative teaching skills dimension

| Creative traits of a faculty member | | Stimulating creativity among students | | Motivation towards creativity and its development | |
|---|---|---|---|---|---|
| Paragraph # | correlation coefficients | Paragraph # | correlation coefficients | Paragraph # | correlation coefficients |
| 19 | 0.812** | 26 | 0.504* | 33 | 0.458* |
| 20 | 0.596** | 27 | 0.797** | 34 | 0.664** |
| 21 | 0.668** | 28 | 0.74** | 35 | 0.524** |
| 22 | 0.765** | 29 | 0.718** | 36 | 0.503** |
| 23 | 0.578** | 30 | 0.608** | 37 | 0.629** |
| 24 | 0.61** | 31 | 0.618** | | |
| 25 | 0.543** | 32 | 0.702** | | |

*Statistically significant at the significance level (0.05).

** Statistically significant at the significance level (0.01).

The questionnaire was administered to an exploratory sample comprising 50 male and female teachers, and correlation coefficients were computed between each item and its corresponding dimension, yielding Table 4 displays the correlation coefficients between the individual items and the overall score of the teacher's attitude dimension towards implementing the STEM-based approach:

**Table 4.** The correlation coefficients between the individual items and the overall score of the teacher's attitudes dimension towards implementing the STEM-based approach

| Paragraph # | correlation coefficients | Paragraph # | correlation coefficients |
|---|---|---|---|
| 38 | 0.781** | 45 | 0.48* |
| 39 | 0.514** | 46 | 0.778** |
| 40 | 0.748** | 47 | 0.783** |
| 41 | 0.714** | 48 | 0.854** |
| 42 | 0.59** | 49 | 0.692** |
| 43 | 0.755** | | |
| 44 | 0.744** | | |

*Statistically significant at the significance level (0.05).

** Statistically significant at the significance level (0.01).

It is noted that the correlation coefficients are all statistically significant and have an acceptable degree, and therefore, none of its paragraphs have been deleted. To ensure the reliability of the research questionnaire and its dimensions (self-efficacy, creative teaching skills, and teachers' attitudes toward implementing the STEM approach), two methods were employed: test-retest reliability and internal consistency. The questionnaire was administered to a pilot sample of 50 male and female teachers, and the results are presented in Table 5:

**Table 5.** Internal consistency coefficients and regression method correlation coefficients for the study questionnaire

| Scale | dimension | Test-retest | Internal consistency |
|---|---|---|---|
| self-efficacy | Effectiveness of teaching strategies | 0.84 | 0.80 |
| | Proficiency in classroom management | 0.91 | 0.85 |
| | Competence in fostering student engagement | 0.82 | 0.79 |
| creative teaching skills | Creative traits of a faculty member | 0.79 | 0.77 |
| | Stimulating creativity among students | 0.81 | 0.80 |
| | Motivation towards creativity and its development | 0.83 | 0.79 |
| teacher's attitudes scale towards implementing the STEM-based approach | | 0.90 | 0.87 |

All the coefficients in Table 5 are deemed acceptable and suitable for the objectives of this study, as they exceed the threshold of 0.70. The questionnaires were distributed, retrieved, sorted, and analyzed through the use of statistical analysis (arithmetic averages of the items and standard deviations were calculated and the use of an independent group t-test), one-way ANOVA, and regression analyses.

## 5. Results and Discussion

The findings about the first research question indicate whether there are any statistically significant differences ($\alpha \leq 0.05$) between the mean scores of teachers in self-efficacy, creative teaching skills, and their attitudes toward implementing the STEM approach based on their years of experience. To address the first research question, the One-Way ANOVA test was utilized to identify any differences based on the teacher's teaching experience, and the outcomes are presented in the subsequent table (6):

The research's first question was interested in the differences in self-efficacy, creative teaching skills, and teachers' attitudes toward applying STEM in terms of experience. There are no significant respondents' scores on the overall scale, and the subscales significantly differed based on teachers' experience in teaching.

**Table 6**. The ANOVA results are based on participants' experience in teaching.

| | | Sum of squares | df | Mean square | F | Sig. |
|---|---|---|---|---|---|---|
| SFF | Between groups | .535 | 2 | .267 | 1.480 | .231 |
| | Within groups | 28.911 | 160 | .181 | | |
| | Total | 29.446 | 162 | | | |
| CTC | Between groups | .659 | 2 | .329 | 1.556 | .214 |
| | Within groups | 33.859 | 160 | .212 | | |
| | Total | 34.517 | 162 | | | |
| TAT | Between groups | .160 | 2 | .080 | .327 | .721 |
| | Within groups | 39.156 | 160 | .245 | | |
| | Total | 39.316 | 162 | | | |

*SFF= Self-efficacy;*
*CTC= creative teaching skills;*
*TAT= Teachers' attitudes towards applying STEM Approach.*

The research's first question was interested in the differences in self-efficacy, creative teaching skills, and teachers' attitudes toward applying STEM in terms of experience. There are no significant respondents' scores on the overall scale, and the subscales significantly differed based on teachers' experience in teaching.

The reason there are no differences for the teaching experience variable in both self-efficacy, creative teaching skills, and attitudes towards applying the approach based on integrative sciences (STEM) may be due to the following reasons:

***Firstly,*** self-efficacy refers to an individual's belief in their abilities and teaching skills, which is not significantly influenced by the passage of time. The guidance and support of educational supervisors and colleagues can help sustain this confidence, particularly in overcoming obstacles and challenges. Teachers at different stages of their careers strive to apply what they have learned and link it to their academic knowledge, which cumulatively increases their experience and self-efficacy. Additionally, the Ministry of Education offers various courses and competitions that encourage teachers to engage in dialogue and discussions with one another. The study revealed a high level of self-efficacy among teachers, which is a positive indicator of internal motivation toward continuous development and improvement in the teaching process. These findings differ with previous studies such as (Gil Flores, 2016). ***Secondly,*** it is evident that educators, collectively, exhibit a notable degree of competence in formulating instructional plans and executing teaching methods that are marked by innovation, flexibility, and curiosity. The Ministry of Education's commitment to staying abreast of the latest developments in teaching methods, modern approaches, and techniques, as well as organizing training sessions and disseminating informative materials to teachers, has significantly contributed to fostering a creative learning environment. This is evident from the involvement of teachers in both national and global competitions, a trend exhibited by all teachers regardless of their level of experience. A teacher with elevated creative cognition can induce creativity in their students. ***Finally,*** in terms of the adoption of STEM, there is a growing interest among all teachers in Palestine, although it has not yet been officially implemented in schools. Instead, introductory meetings and workshops have been conducted in collaboration with universities. Regardless of their level of teaching experience, all teachers recognize the significance of applying STEM. As a modern teaching approach, STEM aims to make education more meaningful by emphasizing the importance of learning science, technology, engineering, and mathematics for both teachers and students. The findings about the second research question indicate whether there are any statistically significant differences in ($\alpha \leq 0.05$) between the mean scores of teachers in self-efficacy, creative teaching skills, and their attitudes towards implementing the STEM approach based on their educational stage.

To answer the second study question, the t-test was used to determine the differences according to the teacher's educational stage, and the results are as in the following table (7):

Table 7 indicates that there are no statistically significant differences at ($\alpha \leq 0.05$) level in self-efficacy, creative teaching tasks, and teachers' attitudes towards implementing STEM based on the stage of education being taught by the teacher (low basic stage or high basic stage). Findings about the third question: Can the attitudes of

public-school teachers towards implementing the STEM-based approach be predicted based on their scores on the creative teaching skills scale and the self-efficacy scale?.

Several assumptions, including multivariate normality, homoscedasticity, and multicollinearity, were verified before conducting multiple linear regression analyses. The histogram and normal P-P plot of regression-standardized residuals in Figures 2a and 2b indicated that the multivariate normality assumption was satisfied.

**Table 7.** Two-sample t-test based on the educational stage

| | Educational stage | N | Mean | Sd | t | df | sig |
|---|---|---|---|---|---|---|---|
| SFF | Low basic stage | 75 | 4.35 | 0.387 | 0.472 | 161 | .637 |
| | High basic stage | 88 | 4.32 | 0.459 | | | |
| CTC | Low basic stage | 75 | 4.22 | 0.463 | -0.070 | 161 | .944 |
| | High basic stage | 88 | 4.22 | 0.463 | | | |
| TAT | Low basic stage | 75 | 4.38 | 0.455 | .506 | 161 | .614 |
| | High basic stage | 88 | 4.34 | 0.525 | | | |

*SFF= Self-efficacy;*
*CTC= creative teaching skills;*
*TAT= Teachers' attitudes towards applying STEM Approach.*

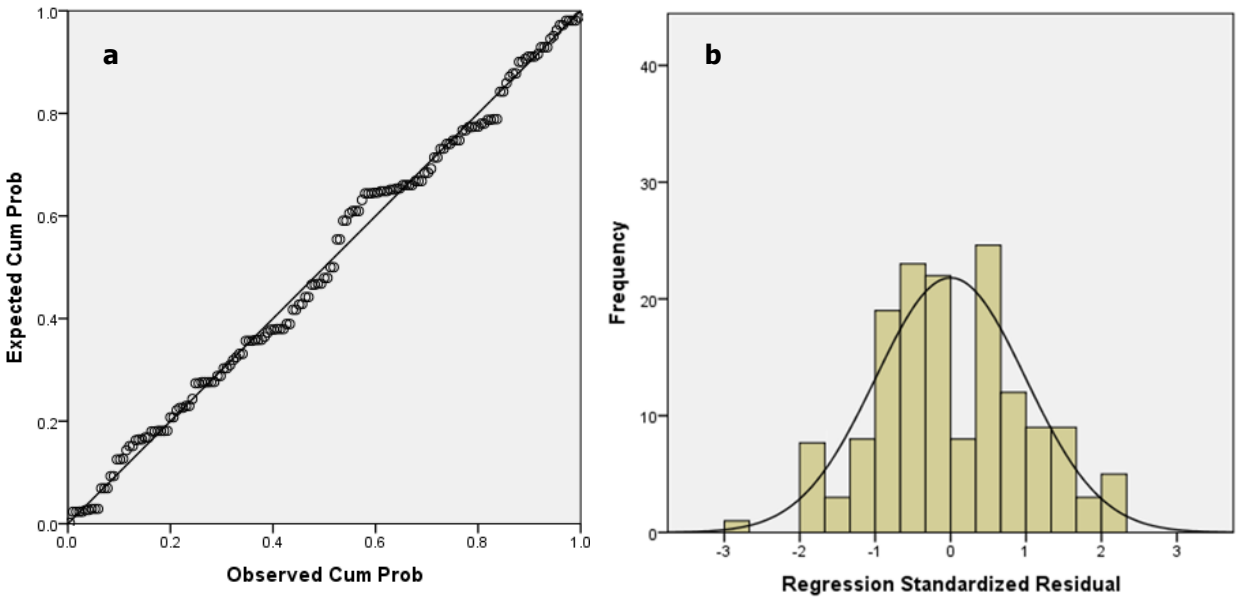


**Figure 2.** Normal P-P plot of regression-standardized residual, Histogram Source: The authors

**Table 8.** Significant coefficients for the model predicting teachers' attitudes toward applying the STEM approach (TAT)

| Variables | B | $SE(\beta)$ | $\beta$ | t | *P* | VIF |
|---|---|---|---|---|---|---|
| constant | 0.941 | 0.292 | | 3.229 | 0.002 | |
| SFF | 0.458 | 0.121 | 0.397 | 3.778 | 0.000 | 3.323 |
| CTC | 0.340 | 0.112 | 0.318 | 3.032 | 0.003 | 3.323 |
| *R=0.685;* $R^2 = 0.47$; *F=70.8; P<0.01* | | | | | | |

*SFF= Self-efficacy;*
*CTC= creative teaching skills;*
*TAT= Teachers' attitudes toward applying STEM Approach.*

Table (8) shows the model with sig. predictors. It was found that (47%) of the variance in teachers' attitudes toward applying the STEM approach can be explained by predictors in this study (self-efficacy, creative teaching skills).

$$\widehat{TAT} = 0.941 + 0.458 \times SFF + 0.34 \times CTC + e$$

This outcome can be attributed to the components of creative teaching, including the capacity of teachers to employ instructional strategies that prompt novel and uncommon responses, foster exploration of new associations from the information, pose queries, present diverse viewpoints, confront students with open-ended scenarios, and promote the expression of ideas and solutions. These aspects align to a great extent with teachers' inclinations toward implementing the STEM approach, which seeks to align scientific concepts in academic curricula with real-world applications, address genuine environmental, social, and economic challenges in innovative ways, foster creative problem-solving, generate diverse ideas for solutions, and facilitate the exchange of ideas among students.

Furthermore, the teacher's confidence in their self-efficacy, their belief in their capability to execute teaching responsibilities, their persistence in confronting challenges, their willingness to enhance their expertise (Bandura, 2007), and their openness to engaging with experts, mentors, and peers across various disciplines align with the STEM approach. This approach aims to bolster learners' capacity to generate and construct scientific knowledge in an interconnected fashion across its four elements (science, technology, engineering, and mathematics) to comprehend the world holistically rather than in isolation.

These findings also have social implications. Social pressure, institutional support, and access to professional support all make a big difference in teachers' imagination and confidence and. Creativity in teaching at a professional level relies on talent as well as support systems and working environments that foster collaboration and experimentation with new things (Procaccini, 2012).

Moreover, teachers' self-confidence as well as innovation are impacted by their perceptions, as well as by what society expects, their women /men perspectives in teaching, and how STEM fields are considered in society. These can support or hinder teachers' confidence and intention towards innovation, revealing how important it is that there be support by schools and culture so STEM integration can be effective (Procaccini, 2012); (Rachmadtullah et al., 2020); (Obied & Alajmi, 2024).

Additionally, teachers' self-belief and innovativeness are determined by teachers' perceptions, expectations from society, their conception on teaching as a function of their gender, and the social status of STEM subjects. These either encourage or discourage teachers' confidence and their tendency towards innovation, emphasizing the role of culture and institutional support in effective STEM integration (Procaccini, 2012); (Rachmadtullah *et al.,* 2020); (Obied & Alajmi, 2024).

## 6. Conclusions, Recommendations, Limitations, and Future Studies

Indeed, the study specifically identifies that the advantages of the STEM approach to students would be enhanced academic performance, improved attitude, motivation, and interest in the STEM approach, besides the development of higher-order thinking skills. These will only be realized when educators can possess self-efficacy, creative teaching competence, and a positive attitude toward including science, technology, engineering, and mathematics (STEM) in their teaching practices.

Based on this, it gave several recommendations to enhance the implementation process of the STEM approach. This included intensive courses and training workshops on the STEM approach for teachers and supervisors. The adoption of the STEM approach when teaching the subjects of science, technology, engineering, and mathematics at all levels of education could be done to suit the available resources and reality. It recommends thirdly the use of the STEM approach by re-developing the curricula and the contents of prescribed books to their standards.

In addition to tailored professional learning initiatives, we suggest institutionalized reforms for the greater good of enriching professional capital of teachers. Such reforms include collaboration policies among teachers, schools working on and exercising innovative pedagogy, and involving communities in scientific, technological, engineering, and mathematics-related endeavors. Such strategies guarantee the cultivation of self-efficacy and

innovative pedagogical preparation at the micro level while simultaneously guaranteeing social organizations and facilitating education infrastructure.

These recommendations would improve the quality of STEM education and enhance the benefits that students could get from it.

Study's limitations: The sample size might be too small to generalize to a larger population of teachers. Particularly limiting in the prior work is the small sample size, which was only 163 teachers from government schooling systems within the Tulkarm region, thereby restricting the generalizability of the findings in larger sociocultural settings. Educators' beliefs in STEM integration are most likely context-dependent and draw on prevailing social norms, gender dynamics, and access to educational resources. Accordingly, future work ought to incorporate larger and more diverse samples, as well as comparisons within and across various geographical regions and in both rural and urban settings, in an effort to increase external validation on the results as well as contribute greater value toward social science knowledge in educators' perceptions regarding STEM incorporation. The study might focus only on the predictive power of creative teaching skills and self-efficacy in teachers' attitudes toward the implementation of the STEM approach and might not take into consideration any other potential factors that can affect attitudes toward STEM. The study may hence be representative because it might have been derived from a small catchment area of people and thus could not be generalized well in other regions or countries.

Future studies on the predictive power of creative teaching skills and self-efficacy in teachers' attitudes toward implementing the STEM approach could focus on the following aspects: Mixed-methods studies: A mixed-methods study could be conducted by integrating quantitative and qualitative data to get further depth on the predictive power of creative teaching skills and self-efficacy in teachers' attitudes toward implementing of the STEM approach.

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## Authors' Contributions

Mosab M. Aboushi: Conceptualization, Methodology, Writing - Original Draft, Formal Analysis. Asem S. Obied: Data Curation, Investigation, Writing - Review & Editing, Visualization, Supervision. Both the Authors have Read and Agreed to the Published Version of the Manuscript.

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## Does this article screen for similarity?

Yes

## Conflict of Interest

The authors have no conflicts of interest to declare. There is also no financial interest to report. The author certifies that the submission is original work and is not under review at any other publication.



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