An-Najah National University

Faculty of Graduate Studies

EXPLORING EIGHT – NINTH GRADE MATHEMATICS TEACHERS' PERSPECTIVES, AND PRACTICES: A COMPREHENSIVE STUDY ON CREATIVITY, CHALLENGES, AND PROFESSIONAL DEVELOPMENT IN PALESTINIAN CLASSROOMS

By

Sultan Amin Issa Kowkas

Supervisors

Prof. Saida Affouneh

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This Dissertation is submitted in Partial Fulfillment of the Requirements for the Degree of PhD in Learning and Education, Faculty of Graduate Studies, An-Najah National University, Nablus, Palestine.

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In accordance with An-Najah National University Deans Council regulations for the award of Doctor of Philosophy, the following paper has been published after its extraction from the dissertation:

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Dedication

To the souls of my parents, whose everlasting memories are the source of my inspiration. Your unbounded love, incomparable sacrifices, wise guidance and continuous encouragement were always the factors of every success I have achieved.

To my dear sisters and brothers, for your encouragement and support while carrying out this work.

To my beloved wife and kids, for your patience, support, help and understanding during this journey. For giving up lots of the fun time that I was supposed to spend with you and I have spent it on my studies.

Finally, to the free will, to the unrestrained minds and to Creative thinking, especially in Mathematics learning, the core of this research and the thrust behind innovation in Mathematics Education. May this work contribute to the transformative strength of creativity in releasing hidden potential of learners and to the development of Mathematics Education.

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Declaration

I, the undersigned, declare that I submitted the thesis entitled:

EXPLORING EIGHT – NINTH GRADE MATHEMATICS TEACHERS' PERSPECTIVES, AND PRACTICES: A COMPREHENSIVE STUDY ON CREATIVITY, CHALLENGES, AND PROFESSIONAL DEVELOPMENT IN PALESTINIAN CLASSROOMS

I declare that the work provided in this Dissertation, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student's Name: [illegible]

Signature: [illegible]

Date: ٢٠/١٢/٢٠٢٤

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Abstract

Introduction: The concept of creativity is multifaceted and constantly evolving as it is interpreted differently across various disciplines and cultures, resulting in a diverse array of viewpoints, from the notion of divine inspiration embraced by early philosophers to the modern ideas of originality and problem-solving abilities. Through this dissertation, the researcher delve into a thorough investigation of creativity within the realm of mathematics education, specifically examining the perspectives and methods of Palestinian math teachers in eighth and ninth grade classrooms. In the context of mathematics, creativity manifests in a distinct manner of that in Art and Literature, blending newness with practicality and displaying agility, adaptability, and ingenuity in thought. There is an inevitable conclusion that mathematical creativity entails a fusion of originality and significance. This comprised of three essential qualities: fluency, flexibility, and originality. It is worth noting that mathematical intelligence and creativity have a complementary relationship, with each strengthening the other.

Objectives: This research aims to delve into the perceptions and methods of Palestinian math teachers teaching eighth and ninth graders, with a focus on nurturing Mathematical Creativity (MC). The researcher also seeks to investigate factors that influence these teaching practices.

Methodology: A mixed-methods approach was utilized, incorporating both quantitative and qualitative data collection techniques. In order to quantitatively evaluate their opinions and approaches towards MC, a questionnaire was administered to mathematics teachers. Furthermore, comprehensive interviews were conducted to gain a profound qualitative understanding of their experiences and teaching methods.

Main Results: The research discovered that female teachers, teachers with B.A. degree, and teachers with more experience were more inclined to use creative teaching methods. Main difficulties consisted of inflexible textbooks, short time, and overcrowded classrooms. Even with these challenges, successful approaches like problem posing and practical applications were recognized. Nevertheless, there were no notable interactions between educational attainment and years of experience, underscoring the importance of personalized training opportunities.

Contribution: The researcher proposed three innovating teaching practices to accompany the known teaching practices to foster Mathematical Creativity. In addition to a new teaching methodology that was reviewed by official supervisors of Mathematics teachers.

Conclusion: This research emphasizes the significance of promoting MC in schools with specialized training and adaptable curriculums. Improving in these areas can boost creative teaching methods, ultimately creating a more innovative and engaging learning atmosphere for students.

Keywords: Mathematical Creativity, Teachers’ practices, Fostering creativity, Palestinian Math teachers, eighth – ninth grades Palestinian students

Chapter One

Introduction and Theoretical Background

Along the ongoing gradually evolving stage of Education, Mathematics teachers play a crucial role in nurturing Creativity, addressing up-coming obstacles and promoting their professional development. This dissertation explores the perspectives and practices of eight to ninth-grade Mathematics teachers in Palestinian classrooms. As these teachers engage in a complex educational environment, they face a multitude of opportunities and challenges that are specific to the Palestinian context. By exploring these teachers' experiences and insights, this study aims to shed light on the connections and interactions between Creativity, teachers' perceptions and practices, and professional development in the field of Palestinian Mathematics education. Thus, this dissertation aims to provide a deeper understanding and useful insights for researchers, Palestinian educators, and policy makers in the pathway for improving the quality of Mathematics education in Palestine.

Background

In the field of Mathematics Education, fostering Creativity among students has long been highlighted by educational researchers for its significance as an aspect of Mathematical thinking (Sawyer & Henriksen, 2023). Creative thinking in Mathematics is the core of rational thinking in every subject in general and in science particularly. Thus, fostering Creativity in Mathematics leads to fostering learning in general. Here comes the importance of exploring Creativity in Mathematics in order to guide Mathematics educators and help them cultivate MC among students, even at an early age (Haavold, 2018).

In this Literature Review section, a comprehensive summary of previous studies that are related to the main aspects of the existing body of research. The current research focuses on the main knots of Creativity, MC, teachers' practices that foster MC and teachers' perspectives about MC.

Therefore, having this Literature Review as a cornerstone upon which the current study would rely. Synthesizing various web-knots from the literature, making rational connections and synthesizing the trends and theoretical frameworks in order to build a roadmap for the exploration of Palestinian eighth and ninth-grade mathematics teachers' perspectives, practices, and professional development experiences.

Through the following pages, I will illustrate a thorough intellectual pathway through the complexities of Creativity in Mathematics education, the dynamic interactions between teachers' perspectives and practices. With an emphasis on fostering Creativity among students, my goal is to improve Mathematics teaching in Palestinian classrooms through this research. Additionally, I hope to make a valuable contribution to the realm of Mathematics Education, both locally and globally.

Creativity

Is there a consensus among people on the conception of "Creativity"? Throughout history, there have been widely varying conceptions of Creativity, with different individuals and disciplines emphasizing aspects such as ingenuity, originality, divine inspiration, innate ability, or problem-solving skills. The complexity of the term creativity has led to different interpretations and definitions in different disciplines. People observe creativity based on their perspective of interest; such as professors of art considered creativity in terms of imagination and originality, along with prosperity and willingness to try out new ideas (Sawyer & Henriksen, 2023).

Early philosophers, such as Plato and Socrates, considered Creativity as a kind of "Madness" or "Divine Inspiration" (Gonzalez, 2011). Then in late eighteenth century, the great philosopher Immanuel Kant, thought of creativity as an innate ability that expresses itself through imagination, and for more than 60 years, the definition of creativity has been the subject of broad agreement; most scholars now concur that creativity is, in some way, a combination of two fundamental components. Newness, novelty, or uniqueness comes first. The second is task-fitness, usefulness, or significance (Helfand et al., 2016).

Afterwards, Creativity was redefined as the capacity to produce things that are original and valuable (Sawyer & Henriksen, 2023). While Creativity, traditionally, has been linked to the arts and literature, but since the early 20th century, science has also been seen as a creative endeavor. However, In contrast to art and literature, in which it is usually sufficient to create an original work, a creative scientific idea requires both originality and appropriateness, it does not only generate novel ideas but also aspires to produce a verifiable representation of an objective truth (Xu et al., 2024). Physicists, such as Einstein, perceived Creativity as an intelligence having fun, and David Bohm, looked at Creativity as “an instantaneous thought-feeling action” (Bohm, 2004). Additionally, a business professor, Teresa Amabile, defined creativity as the production of novel and appropriate solutions to open-ended problems in any domain of human activity (Amabile, 2011).

Creativity, as viewed through various lenses, includes concepts such as imagination, originality, problem solving, and even divine inspiration. The different interpretations in various disciplines illustrate the richness and complexity of this fundamental human trait, Creativity is frequently viewed as the creation of original and beneficial ideas or solutions to issues. It has been viewed as a mental capacity, a process, and a human behavior. People may have high creativity if they possess the personality features of a creative person (Seidel et al., 2010).

Mathematical Creativity

There is no clear definition of MC, and there are conflicting views on the relative importance of innate talent and acquired skills. The consensus among academics is that MC, however, combines novelty or uniqueness with task-fitness or usefulness and exhibits fluency, flexibility, and originality in the way that one thinks (Levenson et al., 2018). Thus, there is no universal agreement on how much mathematical ability or mathematical innovation is inherent and how much is learned. MC is seen as a thinking process that manifests in three ‘products’, or aspects: fluency, flexibility and originality (Molad et al., 2020). Fluency in the number of different correct solutions and discussions, and the ability to produce several solution strategies to a problem in the Mathematics learning process (Levenson et al., 2018); flexibility in the number of categories of those solutions and discussions; and originality in their uniqueness and insights (Weiss & Wilhelm, 2022). In addition, it was found that mathematical intelligence and MC have a reciprocally relationship; that is, mathematical intelligence leads to MC and vice versa (Tyagi, 2017). Therefore, fluency, adaptability, and originality are all aspects of MC that produce a variety of sound conclusions and thought-provoking debates. Additionally, mathematical intelligence and creativity are mutually supportive of one another, one fostering the other.

In assessing creativity, the most common barriers mentioned in the literature research were a lack of time, a lack of training, a crammed curriculum, a lack of resources and standardized assessments (Bereczki & Kárpáti, 2018). Other factors, as mentioned by teachers, that hinder creativity were classroom settings (students' ideas not shared, ignored ideas, forbidden mistakes and single unique answers), activities (drill work and worksheets), teachers' attitude (controlling) and educational system's (Rafsanjani et al., 2019).

Factors Affecting Mathematical Creativity

The practice of guessing, considering alternative viewpoints, and utilizing a variety of mathematical skills fosters creativity in mathematicians. It promotes the development of original concepts, novel strategies, and novel approaches to problem solving. Mathematical reasoning fosters the growth of creativity because it necessitates speculating and separating viewpoints in order to address a given scenario (Grégoire, 2016). Creativity in Mathematics education is built on knowledge (Bolden et al., 2010) as a result of the inevitable connection between Mathematics teaching and Creativity. It involves creating something new, getting rid of the traditional methods of thinking, evaluating fresh options, and utilizing a wide variety of mathematical expertise. Mathematical brilliance and talent do not come from copying the work of others; but from hard work and self-awareness (Gunawan et al., 2022), and from applying mathematics in novel ways to solve problems (Singer et al., 2017). Alongside, MC is a crucial component for developing Mathematical talent (Grégoire, 2016) and so, enabling creative students to use new, out of situation and unusual strategies in their solutions (Barraza-García et al., 2020). Moreover, promising young math students were identified by the 'National Council of Teachers of Mathematics Task Force On The Mathematically Promising Students' based on their aptitude, drive, self-efficacy, and opportunities/experience (Sheffield, 2006). Other study's findings revealed that there was a positive correlation between MC and Mathematical ability along with a confirmatory indicator that MC (in students) is a subcomponent of their Mathematical ability (Kattou et al., 2013). Furthermore, by combining more than one representation tool (pictures, graphs, symbols, drawings, and writings), multiple representations (MRs) externalize internal mathematical notions and ideas (Tripathi, 2008). Therefore, teachers ought to be taught how to use MRs in their Mathematics teaching at any school stage in order to help students better understand Mathematical concepts and thus, develop their creative thinking in mathematics (Bicer, 2021a). In order to develop mathematical aptitude, MC is a crucial component. This requires employing creative approaches and a variety of representations to comprehend issues. Teachers can empower pupils to understand mathematical topics more efficiently and foster their creative potential by encouraging creative thinking in mathematics education.

On the other hand, the learning milieu plays a very important role in influencing and fostering creativity. Students and teachers agree that a classroom setting that fosters creativity gives more options to students, accepts various viewpoints, builds self-confidence and focuses on students' interests and strengths (Rafsanjani et al., 2019). Other factors that affect Creative teaching are teachers' internal features such as good will, persistence, trying new teaching methods, and being imaginative (Cayirdag, 2017). Additionally, other factors that are related to family aspects and school administration policies (Paek & Sumners, 2019). Moreover, teachers' professional and personal domain are of the main components that ensure creative teaching in Mathematics (Anthony & Walshaw, 2009). It was also argued that rather than lecturing, teachers should act more as facilitators, learning partners, inspirers, or navigators in order to enhance students' creativity (Paek & Sumners, 2019).

Students' educational needs may be met in a variety of ways by encouraging equitable thinking through the use of creativity strategies in mathematics. Techniques such as including divergent thinking exercises, concept-based problem solving, and class discussion, aid students in honing their creative thinking abilities (Ritter et al., 2020). In addition, students are more challenged to consider all of the potential solutions when an open inquiry or creative problem is presented through a worksheet (Apino & Retnawati, 2017).

Science-technology-society (STS) approaches support student critical thinking, logical reasoning, the use of inquiry, and more creative approaches to problem-solving (Lee & Erdogan, 2007). There are effects of the visual mnemonic devices on creative performance, and thus enhancing creativity (Cioca & Nerișanu, 2020). Cooperative learning, the use of technology and manipulates, and other elements are also identified as potential contributors in developing students' creativity (Sánchez et al., 2022). Technology plays an effective role in fostering creativity by problem-solving from one side, and through trying and experimenting strategies in learning (Flores et al., 2018).

Moreover, technology can foster creative and divergent mathematical thinking, problem solving and problem posing, creative use of dynamic, multimodal and interactive software by teachers and learners, as well as other digital media and tools in mathematics classroom (Freiman & Tassell, 2018).

A number of authors use problem-posing and problem-solving exercises to foster and assess creativity (Sriraman, 2009). Other researchers used fluency, flexibility, and originality as indicators of creativity in students' problem solving, (Kontorovich et al., 2011). Moreover, mathematics achievement and motivation are important determinants of MC (Haavold, 2018). A creative learning environment is one that exposes students to the psychological and social aspects of creativity so that they are inspired to explore new things on their own (Cochrane & Antonczak, 2015). Moreover, in order to promote creativity, students should be encouraged to discover their own answers (Kobsiripat, 2015).

The use of mathematical modeling techniques helps students better understand the connection between mathematics and real-world issues, and these techniques are crucial in establishing a realistic learning environment for Mathematics (Bonotto, 2007). Mathematical modeling has been considered to be an effective medium to prepare students to deal with unfamiliar situations by thinking flexibly and creatively and to solve real-world problems (Suh et al., 2017). The use of Model Eliciting Activities (MEAs) can help students develop their MC (Winda et al., 2018).

Teachers' Perspectives

In the context of Mathematics education, it is very crucial to understand teachers' perspectives, beliefs and attitudes, since these factors significantly influence their teaching strategies and students learning outcomes. Moreover, teachers' beliefs and attitudes also shape their instructional practices (Fives & Buehl, 2016). These attitudes and beliefs can also influence students' learning outcomes because students often adopt the attitudes of their teachers (Sarma et al., 2021). Therefore, it is important to gain insights and learn about teachers' perspectives for educational improvement and pedagogical development.

In a study by Levenson (2013), when analyzing and reasoning the tasks that teachers have chosen when the goal was to promote creativity in their classes, findings revealed that teachers seemed to view creativity as something different from the norm, like tasks done outside or using tools differently (Levenson, 2013). Another study investigates teachers' conceptualizations of Creativity in China, Germany and Japan. A questionnaire was used to assess teachers' beliefs about the nature of creativity, characteristics of creative students and the factors fostering or hindering creativity. Similarities and differences across cultures were observed. While all teachers perceived Creativity as innovative, diverse thinking that is irrelevant to scholastic achievement. German teachers believed that Creativity was more autonomous, while the Chinese saw it as more process-oriented. Imagination and curiosity were regarded as essential characteristics for students in the three countries. As for stimulating and fostering Creativity, Germans prioritized encouragement and independence, while Chinese concentrated on critical thinking (Zhou et al., 2013). While another study has found that education can have an impact on knowledge, unique ideas, and intrinsic motivation, even if each person's creative potential is determined by their unique personality qualities and intellectual prowess. Students' MC can be developed by training teachers to be specialists who can encourage creative thinking through open-ended challenges, and in order to cultivate intrinsic drive, students should be free to experiment, make mistakes, and come up with creative solutions (Grégoire, 2016).

Mathematics Teaching Practices

There is no common definition of 'practices' by researchers, however, it is very often referred to as "instructional" (Swars et al., 2018). Whilst teachers' instructional practices maybe referred to as the teaching methods and strategies that are being used in the classroom in order to stimulate and enhance students' learning and academic achievement (Stipek & Byler, 2004). Several studies have explored the teaching practices of Mathematics teachers, and it has been found that there is a positive correlation between teachers' beliefs and self-reported teaching practices (Perera & John, 2020). Some concentrate on the deliberate acts of teachers in inquiry-based classrooms (Johnson, 2013). Others have investigated Mathematics teachers' knowledge and practices when applying technology in the Mathematics class (Muhtadi et al., 2017).

In a systematic review (Gallagher et al., 2022) of 19 studies (1975 – 2014), the researchers have found adaptive teaching in mathematics typically involves a teacher noticing a student stimulus, reflecting on it, and then taking action to adapt their instruction. In addition, to the potential for curricula to act as stimuli and the crucial role of teachers' direct reflection on students' thinking and actions.

Conclusively, observing the book "Principles to Actions: Ensuring Mathematical Success for All (2014)", the National Council of Teachers of Mathematics (NCTM) identifies eight research-based essential Mathematical Teaching Practices which are (Leinwand, 2014):

- Establish mathematics goals to focus reasoning. Effective teaching produces clear goals of the Mathematics to be learned, situates goals within learning progressions.
- Implement tasks that promote reasoning and problem solving. Effective teaching engages students in solving problems and class discussions that promote Mathematical reasoning.
- Use and connect mathematical representations. Effective teaching engages students in making connections among Mathematical representations, and thus, deepen understanding of concepts and solution strategies.
- Facilitate meaningful mathematical discourse. Effective teaching facilitates students' discussions that would build shared understanding of ideas by analyzing and comparing.
- Pose purposeful questions. Effective teaching addresses purposeful questions that assess, advance and stimulate students' reasoning.
- Build procedural fluency from conceptual understanding. Effective teaching establishes procedures' fluency based on deep understanding of concepts.
- Support productive struggle in learning mathematics. Effective teaching provides students with opportunities and supports to engage in productive tackle with Mathematical ideas on individual or group basis.
- Elicit and use evidence of student thinking. Effective teaching makes use of students' own thinking in the assessment of the progress of Mathematical understanding, and thus to frequently adjust instructional strategies in order to support and promote students' learning.

While research studies have highlighted the great importance of teachers' intentional actions, knowledge and attitudes in the effective teaching practices of problem-solving strategies, inquiry-based learning and technology integration in Mathematics teaching, the practices that are identified by the ‘NCTM’ indicate clear descriptions of what both, teachers and students, should expect to be doing when the practice is being used, thus guiding the teachers that their actions should include directing the students’ role as well.

Challenges in Mathematics Education

There are many different types of difficulties for math teachers in Palestinian classrooms. Some of the main difficulties arise from the nature and abstractness of Mathematics and the anticipated mathematical activities in the Palestinian textbooks, especially the Geometry curriculum (Alshwaikh & Straehler-Pohl, 2016). Noticing that abstract mathematical reasoning is introduced and emphasized at an early age in Palestine compared to other countries such as England (Alshwaikh & Morgan, 2015). Other challenges facing Mathematics education in Palestine include poor performance (among students), rote learning via teacher-centered teaching, learning geometry (as a result of teachers’ weak geometric knowledge) and lower standards of Palestinian textbooks compared to the NCTM (Alshwaikh & Straehler-Pohl, 2016). Accordingly, there are many challenges in the face of Mathematics education in the Palestinian classroom, some of which are common among other countries and others are unique to the Palestinian context.

Professional Development for Mathematics Teachers

In an interpretive study of 156 articles on teachers’ professional development (PD) (2009 – 2019), the researchers proposed a definition for PD as a continuous process that accompanies the teachers from the preparation stages of pre-service teachers and throughout the career’s years. Their framework of definition for the PD contains main concepts such as teacher characteristics, teaching strategies, learning content, student outcomes, school context, curriculum and policies (Sancar et al., 2021). Accordingly, each of these concepts influence and are influenced by the PD. Continuous PD is of great significance in the career life of Mathematics teachers, as PD improves teachers’ pedagogical skills, refresh their content knowledge, adaption to updated educational contents and learning new technological tools (Johari et al., 2022). These PD programs ought to be designed to fulfil the teachers’ needs, including teamwork collaboration, learning new teaching strategies and modern thinking about Mathematics. Nonetheless, it is important to notice that for these programs to be effective, teachers' willingness to change and their commitment is a necessary.

Palestinian Education Context

This study is carried out on Palestinian teachers in East Jerusalem (EJ) and in the West Bank (WB). The educational system in Palestine has been developed and undergone several changes due to the dramatic political phases throughout modern history (since the twentieth century), from the Ottoman rule to the present day. Under Ottoman rule, the education system was divided with distinct schools catering to various religious groups. During the British Mandate period, there was a rise in school attendance, but Muslim, Christian, and Jewish student numbers were not proportionate. The establishment of the state of Israel in 1948 resulted in Jordan annexing the West Bank and Egypt annexing the Gaza Strip, leading to the implementation of their education systems. Following the Israeli occupation in 1967, the Israeli government took control of the education system, implementing policies that hindered the progress of Palestinian education. This involved shutting down schools, controlling the content of textbooks, and limiting entry to colleges and universities. Establishment of the Palestinian National Authority in 1994 led to the formation of a cohesive Palestinian education system, which still encounters obstacles concerning infrastructure, resources, and the effects of the ongoing conflict. The Palestinian Ministry has advanced in education by introducing a standardized curriculum, incorporating new subjects, and utilizing national textbooks, despite obstacles like political instability, Israeli occupation, and economic issues influencing teachers. Efforts are concentrated on improving education quality and matching it with the needs of the labor market (Quneis & Rafidi, 2023).

The education in Palestine is divided into three types of school systems: state (public) schools, private (denominational) schools linked to one of the church communities and (exclusively for refugees) the United Nations Relief and Works Agency (UNRWA) schools. In all the governorates of Palestine, there are 1896 public schools, 402 private schools and 96 UNRWA schools (PMOE, 2022). Out of the three types, the education at the private schools has the highest ratings. It is worth noting that the three types of school systems obey the rules of the Palestinian ministry of education. The state (public) schools and the UNRWA schools use and teach the Palestinian curriculum texts. As for the private (international) schools, they also teach the Palestinian curriculum texts except for the foreign language texts, which are English and another language (German, French, Spanish and Greek). These second and third languages are taught through foreign curriculum texts from the countries to which they belong. Moreover, private schools usually have a foreign stream beside the Palestinian Tawjihi stream through which students are prepared and take a general high school exam (instead of the Tawjihi), such as the British General Certificate of Secondary Education (GCSE), the German Abitur (DIA), the prestigious International Baccalaureate Organization (IB) and the American SAT exam (UNESCO, 2011).

Definitions of Concepts

As this research focuses on mathematics teachers' perspectives; practices, creativity, challenges, and professional development in Palestinian classrooms, here are definitions of the main concepts in the study.

Mathematics Education

The field of Mathematics education is multifaceted, encompassing various aspects such as curriculum design, teaching strategies, and the crucial role of teachers. Mathematics teachers play an essential role in the development of curriculum, requiring appropriate resources and time (Saifulloh, 2016). In support of equity and social justice, (Jacobsen, 2012) emphasizes the significance of mathematics teacher education, calling for a deliberate focus on these objectives during teacher training. While (Da Ponte, 2012) highlights the diverse range of programs available for mathematics teacher education, stressing the importance of considering program quality and meeting the demands of society. Additionally, (Kooloos et al., 2020) addressed the crucial role of teachers in fostering classroom discourse and suggests that their pedagogical approaches can significantly influence classroom dynamics. These studies emphasize the importance of the role of teachers in framing Mathematics education and hence, the need for continuous professional development that would strengthen and enrich that role.

Creativity

There are several factors involved in creativity including the newness of a designed object, its relevance to others, effectiveness and some individual as well socially oriented points (Cropley, 2011). Innovation refers to the art of discovering new ways of solving problems in an intuitive, free-minded manner (Baccarani, 2005). Although it is significant, there are no agreements on its definition (Valcheva, 2019). Creativity entails the creation of unique works and ideas that are associated with energetic people who have a lot of ideas (Kanematsu & Barry, 2016).

Dynamically, potential and effectiveness are main requirements of Creativity, combining inconclusiveness and achievement within the process (Corazza, 2016). (Walia, 2019) provided a dynamic definition of Creativity as "Creativity is an act arising out of a perception of the environment that acknowledges a certain disequilibrium, resulting in productive activity that challenges patterned thought processes and norms, and gives rise to something new in the form of a physical object or even a mental or an emotional construct".

Mathematical Creativity

There is no standard definition of MC due to difficulty in describing its structure or characteristics. MC is a complex concept that is influenced by several factors, some of which are: the product, person, process and press (Pitta-Pantazi et al., 2018), while (Leikin et al., 2009) considered MC as a dynamic property of the human mind that can be either promoted or weakened.

Divergent thinking is considered as one of the prevalent descriptors of MC (Chamberlin & Moon, 2005). On the other hand, (Haavold, 2018) defined MC as the process whose outcomes are insightful solutions in an unusual manner, regardless of the level of complexity. While (Varshney, 2019) defined it as the ability to create a variety of products within the mathematical situations. In a systematic review of 210 studies, (Bicer, 2021b) defined MC ability at the K-16 school level as "An ability to generate new mathematical ideas, processes, or products that are new to the students but may not necessarily be an innovation, by discerning and selecting acceptable mathematical patterns and models".

Teachers' Perspectives

How people think and feel influences their behavior (Tyng et al., 2017). Accordingly, teachers' beliefs affect their teaching practices in the classroom. This, in turn, would affect their instructional strategies and thereby affecting their students' achievement (Minarni et al., 2018). Therefore, it is of great importance to explore and study teachers' beliefs and take them into consideration in educational research, in designing teachers' professional programs.

Teachers' Instructional Practices that Foster MC among Students

Various instructional practices have been identified as practices that foster MC among students. Some of these practices are problem-solving, problem-posing, open- ended questions and tasks with multiple solutions foster MC among students (Bicer, 2021b). In addition to creating open-classroom atmosphere that motivates students' participation and sharing their ideas (Zhang et al., 2020). Similarly, implementation of Mathematical practices that involves students' interaction and engagement, which promotes knowledge and develops their mathematical skills, would foster their MC (Matsko & Thomas, 2015). Other findings indicated that using geometrical puzzle game in the Mathematics classroom also develops Creative Mathematical ability (Susiaty et al., 2021).

Statement of the Problem

In the school education, there is a notable lack of knowledge regarding how teachers, especially Mathematics teachers, view and incorporate creativity, in their teaching methods. In spite of the global research concern about creative learning, the exceptional socio-political situation in Palestine lead to particular challenges and obstacles before teachers. Consequently, it becomes an urgent request for teaching methods that foster creativity among students, especially in such a unique troubled environment where traditional teaching methods prevail.

Being a Mathematics teacher, who has an M.A. in Pure Mathematics, and has been teaching Mathematics for middle school students for 25 years and instructing pre-service teachers for 7 years at an Education College; I was able to observe the challenges and opportunities of fostering MC among students. This lengthy teaching experience along with the content matter knowledge in Pure Mathematics have imparted me with clear insights of the teaching practices that are most effective in fostering MC; as well as those practices that would hinder it. In particular, while many students are able to master complicated direct problems; they face difficulty in approaching open-ended problems or extreme case problems that require creative thinking. This has stimulated my interest in exploring 'fostering MC among students' issue more closely.

This research aims to highlight the teaching practices of the 8^{th} and 9^{th} grade Palestinian Mathematics teachers and to explore the connection, between their understanding of creativity and the specific approaches they use to encourage or hinder their students' creative abilities and talents.

The focus of the research is twofold; firstly, to understand how Mathematics teachers, in 8th and 9th grade perceive creativity in the context of Palestinian Education. Secondly, to investigate the teaching practices that they use to foster creativity or unintentionally hinder it in their students. The significance of the problem has been driven by the several sophisticated factors affecting the Palestinian education system, such as diverse school types, classroom sizes, cultural considerations, political issues and limited financial support. Therefore, by focusing on 8^{th} and 9^{th} grade Mathematics teachers, the researcher aims to provide insights that could lead to effective interventions and enhancements that foster a more creative learning environment in Palestinian (8^{th} – 9^{th} grade) classrooms.

Rational and Purpose of the Study

There have been massive attention paid to value Creativity in recent decades, as for both individuals and societies; Creativity has become a valuable resource as it has critical influences on both, personal and professional success (Glăveanu, 2018). It would make it possible for people to take advantage of fresh possibilities and come up with the best solutions to threats and obstacles. Innovation should be a profession in teaching. Teachers need to be enthusiastic about their subject, curious about new things, and interested in every part of their cycle of impact (Roxå & Marquis, 2019). Since curiosity and the drive to understand are traits unique to children and humans, the senses that come with knowledge are more significant than information itself.

Moreover, studies have provided a viable account of how mathematical idealizations can play explanatory roles in physical theory and natural sciences in describing, explaining and predicting phenomena (Leng, 2021). "Mathematics is a rich source of structures and when some mathematical theory finds applications in empirical science, it is clear that the mathematics captures certain important structural relations in the system in question" (Bueno & Colyvan, 2011).

Concerns about fostering MC among students is a crucial matter for its significant influence on their success and progress in the subject. In addition, MC is an essence of the intellectual abilities and personal traits of a person (Grégoire, 2016). Thus, integrating well designed and meticulously selected instructional practices, enthusiastically, into the Mathematics classroom would provide opportunities for students to recognize and discover their potential Mathematical creative abilities (Bicer, 2021b).

The main purpose of the study is to investigate the best teachers' practices that foster MC in the classroom for the Palestinian case. The research also attempts to add to the body of research done for the Palestinian case; for different international studies may not apply for the Palestinian teachers' case. In addition, the study focuses on the school setting whereas similar studies on MC are usually done for higher education. Moreover, this study aims to provide perceptive description of how Palestinian teachers foster MC in a useful and appropriate classroom setting.

Research Questions

1. How do Palestinian 8th – 9th grade mathematics teachers perceive and define mathematical creativity, and how does this perception influence their teaching practices?
2. In what ways do Palestinian 8th – 9th grade mathematics teachers intentionally design and implement their teaching practices to foster mathematical creativity within the classroom setting?
3. How do Palestinian 8th – 9th grade mathematics teachers create learning experiences that facilitate the development of students' mathematical creativity?
4. What are the challenges and the obstacles that Palestinian 8th – 9th grade mathematics teachers face in fostering mathematical creativity in the classroom?
5. Is there a significant difference in the responses of the in-service mathematics teachers fostering students' creativity in mathematics with respect to teachers' gender?
6. Is there a significant difference in the responses of the in-service mathematics teachers fostering students' creativity in mathematics with respect to teachers' academic degree?
7. Is there a significant difference in the responses of the in-service mathematics teachers fostering students' creativity in mathematics with respect to seniority?
8. Are there significant interaction effects between teachers' academic degree and seniority on the dependent variable of enhancing students' creativity in mathematics?

Research Hypothesis

Qualitative Research Hypothesis

The hypothesis of the qualitative research method of this study posits that Palestinian eighth-ninth grade Mathematics teachers who either have a deeper understanding of MC and perceive its importance in education, believe in their students' potentials, and intentionally employ strategies to foster creativity within the classroom setting will demonstrate more effective practices in nurturing their students' MC compared to those who do not possess these attributes.

Quantitative Research Hypothesis

Research Question 1: Hypothesis 1: There is a significant difference in the responses of in-service mathematics teachers fostering students' creativity in mathematics with respect to teachers' gender.

Research Question 2: Hypothesis 2: There is a significant difference in the responses of in-service mathematics teachers fostering students' creativity in mathematics with respect to teachers' academic degree.

Research Question 3: Hypothesis 3: There is a significant difference in the responses of in-service mathematics teachers fostering students' creativity in mathematics with respect to seniority.

Research Question 4: Hypothesis 4: There are significant interaction effects between teachers' academic degree and seniority on the dependent variable of enhancing students' creativity in mathematics.

Summary

This chapter discussed the main aspects of MC, its definition and constructive components of novelty (uniqueness), fluency, flexibility and originality. It highlights how these aspects play the role of an indicator of a Mathematical creative person (student), in order to assist teachers pinpoint those students and to assess any interference from their side.

Moreover, the chapter discusses innovating as well as hindering factors of MC in the Palestinian classroom including the learning milieu, teaching practices and local challenges in the country. Additionally, the chapter highlights the influence of teachers' perceptions of creativity on their teaching practices (on or off the track of promoting MC among students).

Consequently, the chapter points out the essential request and need for effective interference to nurture and adopt particular teaching practices that, according to previous scientific studies, are believed to foster MC in the classroom. As will be indicated in the next chapter (The Methodology), these teaching practices are problem solving, using technology, guessing and trying, mathematical reasoning, divergent thinking, problem posing and research, applying Mathematics to real life situations, using imagination and relating mathematics to arts and music. The next chapter illustrates the investigation procedure through the research methods that were used in order to delve into aspects of the research problem aiming to understand and make connections between teachers ' perceptions and their teaching practices aiming to foster MC among students.

Chapter Two

Methodology

The Methodology chapter is an essential component that outlines the research design, methodological approaches and data-collection procedures (MacFarlane, 2020). This chapter outlines the methodical framework that guides the study's implementation in order to ensure rigor, dependability, and validity in the investigation of Mathematics teachers' perspectives in encouraging MC among students in Palestinian classrooms. Thus, the main purpose of this research is to explore the complex nature of MC within the context of eighth and ninth-grade Mathematics education in Palestine. By employing a mixed-methods approach, this research investigates the perceptions, behaviors, and experiences of Mathematics teachers, shedding light onto the interconnected interaction between pedagogical strategies, teachers' perception and the cultivation of Creativity in Mathematical learning environments.

Planned Study Design

Mixed-Methods Approach

The researcher used mixed methods approach. The complications of the research questions spur information of several nature and from several sources, and thus lead the researcher to carry a mixed method approach, which based on the principle of triangulation, would reduce the limitations of singular methods (Turner et al., 2017). Tashakkori and Creswell (2007) defined mixed methods as "the study or program of inquiry in which the investigator collects and analyzes data, integrates the findings, and develops conclusions utilizing both qualitative and quantitative approaches" (Tashakkori & Creswell, 2007). Combining quantitative and qualitative data in mixed methods research has a variety of benefits including deeper insight and thorough understanding of complex issues (Almeida, 2018), as well as providing a more holistic and enriched understanding of the research problems (Tariq & Woodman, 2013). Furthermore, mixed methods are useful, particularly in PhD research due to its ability to provide a comprehensive understanding of complex phenomena (Jogulu & Pansiri, 2011), in addition to the desire to obtain more holistic and enriched understanding of the research problem (Tariq & Woodman, 2013).

Challenges Encountered

The mixed method that was planned to be used in this research consists of a qualitative method composed of semi structured interviews and observations, and a quantitative method using a questionnaire. However, the Palestinian education faced a very hard situation due to the Israeli-Gaza war in October 2023. Being at war, the Israeli authorities has created the closure of all main roads in and between cities, towns and villages in the Palestinian territories. Several check points that either were closed or caused a lengthy time consuming which made regular school attendance difficult for both teachers and students. As a result, the Palestinian MOE has decided to conduct hybrid learning of three days of face-to-face teaching and two days of online teaching via Teams 2. Teams 2 is a template in Microsoft Teams for Education which has several features of creating and posting educational materials, organizing the learning process and is very beneficial for teachers (Guzmán, 2021). On the other hand, the hybrid learning, besides offering flexibility, has negative influence on the teaching – learning process. Teachers have trouble in the management of the workload, engaging students and transitioning between both teaching procedures (Singh & Singh, 2023). While students may also experience less levels of class engagement and interaction in Hybrid classes (Li et al., 2023). As a result, teachers declined to accept my request of classroom observations (neither face-to-face nor online observations) due to shortage of time that requires from teachers to focus only on covering the content material without elaboration, not having fully attendant or active students and technical problems.

The interviews to answer the first four research questions, while the questionnaire to answer the last four questions. Elaborately, the researcher's methods of collecting data are arranged into two phases, the quantitative phase and the qualitative phase.

Quantitative Phase: Questionnaire

A questionnaire is defined as a sequence of questions asked to individuals in order to obtain statistically useful information about a given topic (Roopa & Rani, 2012). Moreover, a 5-scale Likert questionnaire is a popular research tool that is used to explore and measure attitudes and perceptions with response options: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. In addition, the process of designing a questionnaire involves defining the required information, selecting the appropriate questions, and pre-testing the questionnaire to ensure its effectiveness.

Study Population (Participants)

Participants: the questionnaire will be administered to Palestinian 8^{th} – 9^{th} grade Mathematics teachers to explore their teaching practices related to Mathematics Creativity and their difference based on gender, academic degree and seniority (Last four Research Questions). According to the statistics data of the year 2023 by the Palestinian MOE (PCBS, 2023), the number of Palestinian Mathematics teachers who teach 8^{th} – 9^{th} grades is 947 and 869 respectively summing up to a total of 2964 teachers, as shown in Table A1 (Appendix A).

Sampling

Krejcie (1970), based on the formula published by The National Education Association in the article "Small Sample Techniques", has presented a simple formula to calculate the sample size of a population along with a reference table which provides the sample size satisfies a confidence level of 95% that the real value is within ±5% of the measured/surveyed value (Krejcie & Morgan, 1970). The formula is:

$$s = X^2NP(1-P) \div d^2(N-1) + X^2P(1-P)$$

$s =$ Required sample size

$X^2 =$ The table value of chi-square for 1 degree of freedom at the desired confidence level

$N =$ The population size

$P =$ The population proportion

$d =$ The degree of accuracy expressed as a proportion (.05)

The researcher uses the previous formula for the study population of 2964 Mathematics teachers and calculated that 341 participants should be included in the research in order to have a margin of errors of 5%. However, the number of participants that participated in answering the questionnaire were only 240 teachers. This may be explained by the fact that teachers are loaded with too much schoolwork for the hybrid teaching and many found it an extra load to give some of their time. The number of 240 participants led to a margin of errors of 6%. Although this is higher than the desired 5% margin of errors, but still, a margin of errors of 6% is acceptable in exploratory research, as it allows for a degree of flexibility in the data collection process (Mason et al., 2010) as a margin of errors of higher than 6 % was also used in research (Silliman & Schleifer, 2023). And since the nature of the current study belongs to the family of exploratory researches, since it includes Qualitative and Mixed methods, the research design allows for Flexibility and adaptation as it gathers more information, not restricting the study to predefined hypotheses, but instead, seeking understanding a wide range of perspectives and practices.

The teachers where chosen randomly from various school types in the main three Palestinian regions, illustrated in Table A2 (Appendix A), and the demographic characteristics of the participants; presented in the Tables A3, A4 and A5 (Appendix A).

Data Collection Procedure

The sample of 240 teachers were randomly chosen from three resources, public schools were chosen from the lists of schools provided to me by the Palestinian Ministry of Education by sending emails to the principles of those schools, private schools were approached through principles of those schools via WhatsApp messages by sending to them the questionnaire link and UNRWA schools from a list provided by the Education officers in each governance via email.

Sampling Process

The sampling process was conducted to ensure a diverse and representative sample of eighth and ninth-grade Palestinian Mathematics teachers from different types of schools across all governorates in Palestine. The process involved the following two steps.

- Stratified Sampling: A technique that involves dividing the population into homogeneous subgroups, strata, based on specific characteristics and then run a random sampling from each subgroup, stratum (Taherdoost, 2016). This process increases accuracy and facilitates result interpretation. Thus, schools were divided into three strata based on their type (Public, Private, UNRWA), and then schools were randomly selected within each stratum.
- Selection of teachers: An invitation was sent to the selected schools, clarifying the purpose of the research and asking for their voluntarily participation.

Response Rate

Out of the 341 teachers invited to participate, 240 agreed to complete the questionnaire, resulting in a 70.4% response rate, which is above the minimum recommended responds rate of 70% (Al Khalaf et al., 2022).

Designing the Questionnaire

As it is important to go through a thorough literature review in the phase of designing a research questionnaire (Torres-Carrion et al., 2018), the researcher synthesized from literature the main themes that compose the main aspect of the research problem which is Mathematics teachers' practices that motivate, foster and incorporate MC into the Mathematics class, whose contributing themes were found to be: Concept-Based Problem Solving (Sánchez et al., 2022), Utilizing a Variety of Mathematical Skills, Class Discussion and problem solving (Bicer, 2021b; RahayuniNgsiH et al., 2021), implementation of technology (Yushau et al., 2005), Guessing (Hansen, 2022), Mathematical Reasoning (Sriraman, 2009), Divergent Thinking Exercises (Schoevers et al., 2019; Zhang et al., 2020), Problem posing and research (Bicer, 2021b), Applying Mathematics to real life problems (Nilimaa, 2023), Using imagination (Ulfah et al., 2017) and Relating to Art and/or Music (Arias-Alfonso & Franco, 2021).

The questionnaire (Appendix E) consists of thirty-four items constructing the nine main aspects of the teachers' practices that can contribute, foster and nurture MC among students in the classroom. Table 1 illustrates the component items of the questionnaire.

Table 1

Composition of the questionnaire items

The construct (component)	The questions representing the construct
Problem Solving.	Questions 1 – 8
Using of technology in teaching and learning.	Questions 9 – 11
Guessing and trying.	Questions 12 – 14
Mathematical Reasoning.	Questions 15 – 18
Divergent thinking.	Questions 19 – 21
Problem posing and research.	Questions 22 – 25
Applying Mathematics to real life problems.	Questions 26 – 28
Using imagination.	Questions 29 – 31
Relating Mathematics to Art and/or music.	Questions 32 - 34

Variables

- Independent variables: These are teachers' demographics: Teachers' Gender, Educational Level and Seniority.
- Dependent variables: These are the components of the questionnaire representing the nine teaching practices.

Validity and Reliability

Internal consistency

To test the internal consistency of the questionnaire, I have run a reliability analysis on a randomly selected 30 participants other than the 240 participants, as a pilot sampling, by calculating the Cronbach's Alpha that helps determining whether the items in the questionnaire are measuring the same underlying construct consistently (Tavakol & Dennick, 2011). The selected 30 items lead to a Cronbach's Alpha of.958, Table A6 (Appendix A), indicating excellent internal consistency.

After thorough reading of literature on the subject of teachers' practices that foster and nurture MC among students in class, the researcher synthesized nine main constructs, which are: Problem solving, Using technology (as a learning tool), Guessing and trying, Mathematical thinking and Reasoning, Divergent thinking, Problem posing and research, Applying Mathematics to real life problems, Using imagination, and Learning by Multiple Representations. The researcher designed a questionnaire consisting of thirty-four questions that covers, as groups, these nine constructs. Seven professors in Mathematics Education from local and regional universities reviewed the questionnaire. Each one of the reviewers accepted the questionnaire with some formal modifications concerning the language and/or constructs of few questions. The researcher has done all the reported modifications and designed the final copy that met the reviewers' recommendations. The questionnaire questions are presented in Table A7, Appendix A.

Construct Validity

The construct dimensions of the questionnaire should be tested by verifying the factor structure of the questionnaire. This is done by the statistical technique, Exploratory Factor Analysis (EFA), which identifies underlying factors that account for patterns of collinearity among variables. This statistical test is conducted in SPSS 26, followed by Confirmatory Factor Analysis.

Factor Extraction

An Exploratory Factor Analysis (EFA) was conducted in order to understand the underlying structure of the questionnaire items. This is done by reducing the number of variables via removing the irrelevant items and retaining the most important information, and thus, understanding the latent components that are related to Mathematics teachers' practices that foster MC. EFA was employed to identify the underlying structure of the data without imposing any preconceived structure. This method allows for the discovery of latent variables that explain the patterns of correlations among observed variables.

Objectives, Model Assumptions and Application

EFA is a theory-driven method that assumes the presence of underlying factors that causes the correlations, aims to identify latent constructs that explain the observed correlations among variables. Moreover, EFA assumes that the underlying factors influence the observed variables and thus includes variances and error terms. Thus, EFA is used to identify and interpret underlying factors.

Exploratory Factor Analysis (EFA) and Data Suitability

Prior to performing the EFA, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity were applied to evaluate the appropriateness of the data for factor analysis. The results of the KMO measure indicated excellent sampling adequacy and the Bartlett's Test of Sphericity was significant, confirming that the suitability for factor analysis.

Communalities for the Exploratory Factor Analysis (EFA)

Communalities indicate the amount of variance in each variable accounted for by the factors. Higher communalities (closer to 1) suggest that the extracted factors explain a substantial portion of the variance, whereas lower communalities (closer to 0) indicate that less variance is captured (Watkins, 2018). Moreover, a guideline table, Table B3, (Appendix B), was composed for interpreting the results of the communalities (Hair, 2010).

The Total Variance Explained Test, Exploratory Factor Analysis (EFA)

Conducting total variance explained analysis is important in exploratory factor analysis to determine the optimal number of factors to retain. The total variance explained by the extracted factors indicates the proportion of the total variance in the observed variables that is accounted for by the factors.

Rotation Sums of Squared Loadings for the Exploratory Factor Analysis (EFA)

The Rotation Sums of Squared Loadings is a crucial step in EFA, aiming to improve the interpretability of results. This process of factor rotation is conducted to accomplish an easier interpretable factor structure. The rotation sums of squared loadings' process can provide insights into how the factors contribute to explaining the overall variance in the dataset, and helps in achieving a more interpretable solution (Despois & Doz, 2021).

Rotated Component Matrix for the Exploratory Factor Analysis (EFA)

The rotated component matrix shows the factor loadings for each variable on the extracted factors before and after rotation. The Varimax rotation, a commonly used orthogonal rotation method, was used to achieve a simpler and more interpretable factor structure. The rotated component matrix is important for having deep insights into the relationships and the redistribution of variance among the factors after rotation, and thus illustrating how the factors were readjusted to represent the underlying structure of the data better. The correlation values are categorized into three ranges that are described as high, moderate and low correlation, indicating the stability, moderate and significant change in the factor after rotation, respectively. The guideline Table C2l, Appendix C.

Data Analysis

The researcher will use SPSS program to analyze the outputs of the second part of the questionnaire. Mean and Standard Deviation tests will be conducted firstly on the responses of in-service mathematics teachers on fostering students' creativity in mathematics (Descriptive statistics). Then, the assumptions tests were conducted.

Assumptions Tests

Checking assumptions before running any statistical tests is of great importance, these assumptions include ensuring the independence of observations, testing for normality and homogeneity of variance.

Independence of Observations

In order to ensure independence of observations, the questionnaire was carefully designed, as mentioned previously. Its items were constructed based on thorough review of previous research studies concerning the subject of teachers' practices fostering MC among students. The questionnaire was designed with clear instructions and the responds were received via google form, an aspect of individual data collection. Both, individual data collection and clear instructions are crucial for ensuring the independence of observations. Moreover, in order to have a deeper understanding and a holistic comprehension of the statistical analysis, a new variable was defined as 'Comprehensive Teah Practices' which is the average of the nine main teaching practices.

Assessing Normality

To decide the suitable statistical tests for analyzing the data, the Kolmogorov-Smirnov test with Lilliefors significance correction and the Shapiro-Wilk test were used to test the Normality of the composite variables representing teaching practices. The Lilliefors test for Normality is a modification of the Kolomogorov-Smirnov test of goodness of fit, while the Shapiro-Wilk test is considered the best and most powerful Normality test, especially for large samples.

The results revealed that the data do not follow a normal distribution, thus, non-parametric tests were used to run the desired statistical analysis.

Assessing Homogeneity of Variance

In order to ensure the efficiency and appropriateness of further statistical analysis, it is important to assess the homogeneity of variances across the independent variables' groups. While Levene's Test is usually used to assess homogeneity, but since the study's dataset is nonparametric, then the Brown-Forsythe Test is a powerful appropriate alternative for nonparametric dataset. The Brown-Forsythe Test evaluates the equality of variances using the median (instead of the mean) makes it an appropriate test for non-normally distributed data. However, SPSS software does not have a built-in procedure that runs the Brown-Forsythe Test. Therefore, it has to be computed (in SPSS) by a manual procedure, which consisted of the following steps; for each dependent variable (teaching practices), the median was computed within each level of an independent variable by aggregating the data. Then, new variables were defined (by compute variable) as the absolute value of the difference between the dependent variable and its median. Afterwards, a One-Way-ANOVA was conducted by using the previously measured absolute differences as the dependent variable with the independent variable as the factor for the analysis, the presented F value in the output is the Brown-Forsythe value. The procedure was carried out for every combination of the dependent and the independent variables, thus producing a robust analysis of variance homogeneity.

Correlation Analysis between teachers' teaching practices and teachers demographic variables (gender, academic degree and seniority)

Exploring the relationship between teachers' teaching practices and their demographic attributes can offer deeper insights of how various aspects affect teaching practices. Utilizing nonparametric analysis, especially by using Spearman's rho and Kendall's tau_b coefficients to explore these relationships. This nonparametric analysis is an effective method for investigating such possible relationships.

The results of the Correlation analysis (Spearman's rho and Kendall's tau_b coefficients) were interpreted according to several guidelines (Schober et al., 2018). These guidelines are summarized in Table C9, Appendix C. The correlation analysis via the Spearman's rho and Kendall's tau_b coefficients were carried out to explore the relationship between teaching practices and teachers' gender, between teaching practices and teachers' academic degree, and between teaching practices and teachers' seniority.

Addressing The Last Four Research Questions using Nonparametric Analysis of Teaching Practices

This section present the nonparametric methods that were conducted in order to address the last four Research Questions (Q. 5 – Q. 8) by investigating the factors that influence Creativity fostering teachers' practices. In virtue of the nonparametric nature of the dataset of this study, then nonparametric methods were employed. In particular, the Mann-Whitney U test, the Kruskal-Wallis H test and Aligned Rank Transform (AMT) were used to analyze differences in the teaching practices with regard to teachers' gender, educational qualification and seniority, in addition to the interaction effects among these factors. Exploring these interactions effects, pairwise and combined, between the demographic factors (as independent variables) highlights deep insights into the influences of these factors on teachers' teaching practices.

Research Question 5

"Is there a significant difference in the responses of the in-service Mathematics teachers fostering students' creativity in mathematics with respect to teachers' gender?"

The Mann-Whitney U Test for Gender Differences in Teaching Practices

To assess the significant differences in the responds of two groups of an independent variable (here, male and female of teachers' gender) on an ordinal dependent variable (teaching practices), the Mann-Whitney U test was employed. The findings of Mann-Whitney U test will help identifying significant differences in the teaching practices between male and female teachers.

Research Question 6

"Is there a significant difference in the responses of the in-service mathematics teachers fostering students' creativity in mathematics with respect to teachers' academic degree?"

Kruskal-Wallis H Test for Academic Degree Differences in Teaching Practices

Since teachers' educational qualifications, academic degree, consist of four components, B.A., B.Ed., M.A. and PhD, then the Kruskal-Wallis H Test is employed to assess statistical significant differences between the four groups on the (ordinal) dependent variable (teaching practices). The findings of Kruskal-Wallis H Test will help identifying significant differences in the teaching practices among teachers' various academic degrees.

Since the results from the Kruskal-Wallis H Test indicated significant differences in various teaching practices, then conducting a post-hoc analysis is necessary in order to assess these differences and compare between groups to determine which specific group had the significant difference. Moreover, since the dataset of the study is nonparametric, then Mann-Whitney U Test is conducted in order to carry pairwise comparisons. However, when the Mann-Whitney U test is employed to a heterogeneous dataset, it may cause inflated Type 1 errors. Type 1 error happens when a null hypothesis is falsely rejected; i.e. when falsely deducing that there is an effect. In order to deal with the problem of possible occurrence of Type 1 errors, Bonferroni correction is applied. Bonferroni correction is a method that involves making statistical significance more stringent. Making a statistical significance more stringent means decreasing its significant threshold level, the p-value, via dividing it by the number of comparisons, and so reducing the significance criterion, making the significant level more strict. Mann-Whitney U Tests with Bonferroni Correction across the groups of Academic degree and comparisons were carried out between teachers with B.A. and those with B.Ed., between teachers with B.A. and those with M.A. and between teachers with B.A. and those with PhD.

Addressing Research Question 7

"Is there a significant difference in the responses of the in-service mathematics teachers fostering students' creativity in mathematics with respect to seniority?"

The Kruskal-Wallis H Test was conducted to determine if there were significant differences in the teachers' teaching practices concerning their teaching experience (Seniority). Similarly, the Kruskal-Wallis H Test was followed by Post-Hoc Pairwise Comparisons Using Mann-Whitney U Tests with Bonferroni Correction. Comparisons were made between each pairwise combination of the seniority groups; (1 – 5) years with (6 – 10) years, (1 – 5) years with (more than 10 years) and between (6 – 10) years with (more than 10 years).

Addressing Research Question 8

"Are there significant interaction effect between teachers' academic degree and seniority on the dependent variable of enhancing students' creativity in Mathematics?"

Interaction Effects of Academic Degree and Seniority on Teaching Practices

At this stage, it is ought to assess whether there are significant interaction effects between teachers' academic degree and teachers' seniority on their teaching practices that foster MC among students. Since the data are nonparametric, then the Aligned Rank Transform (ART) method is used. The Aligned Rank Transform (ART) is useful in assessing interaction effects for nonparametric data. It is a procedure of robust validity for dealing with data that is not parametric. However, since SPSS does not have a built in function to run Aligned Rank Transform, the researcher had to carry out a comprehensive, thorough analysis using Excel and SPSS. The procedure consisted of transforming the data into adjusted ranked data, then conducting multivariate MANOVA in SPSS on the transformed data, a procedure inspired by the work of (Leys & Schumann, 2010).

First, painstaking computations were carried out in Excel to achieve an adjusted rank transformation on the nonparametric data. This was done via several steps: for each dependent variable (the teaching practices), the ranks were computed, then in order to control any biases that may arise due to the independent variables, these ranks were adjusted by centering them about the overall mean rank, and hence improving the accuracy of the analysis of the interaction.

Secondly, the adjusted rank-transformed data was imported into SPSS to run a Multivariate Analysis of Variance (MANOVA) in order to assess the main effects of teachers' education and seniority along with the interaction effects on the dependent variables. Running the Multivariate Analysis of Variance on the rank-transformed data is an efficient alternative procedure to the Aligned Rank transformation, which is run in other software programs such as R (Leys & Schumann, 2010).

A summary of the steps in the procedure
Tests conducted in Excel (Adjusted Rank Transformation)

Data was sorted by Education and Seniority.
Ranks for each dependent variable were computed.
Mean ranks for each group of Education and Seniority were computed.
Adjusted ranks were computed by centering these ranks around the overall mean rank.

Multivariate Analysis in SPSS:
The adjusted ranked transformed data were imported into SPSS.

A MANOVA was conducted on the imported data using the General Linear Model procedure, in which Education, Seniority and their interaction were taken as the fixed factors.
Interpreting the results by assessing the multivariate test statistics (Pillai's Trace, Wilks' Lambda, Hotelling's Trace, Roy's Largest Root).
Carrying out a Univariate ANOVA for each dependent variable.
Running Post-Hoc tests to investigate pairwise differences

The descriptive statistics table, Appendix A, summarizes the means and standard deviations for each teaching practice across the various levels of teachers' academic degree and their seniority.

Qualitative Phase: Interviews

Qualitative methods are important in understanding complex phenomena offering a deeper understanding of experiences, phenomena, and context, addressing "how" and "why" questions. The qualitative method consists mainly of semi-structured interviews are common qualitative tools that are considered effective for obtaining in depth information and exploring teachers' attitudes, beliefs, motivations, and practices.

Semi-structured interviews

Semi-structured interviews are intended to cover as many topics as possible. The researcher uses a pre-prepared interview protocol to monitor the interview as it progresses to avoid following a predetermined order in covering these topics. This allows the researcher to use discursive methods to get the discussion back on track when the participant's comments deviate from the planned topic. In the event that new and intriguing details emerge during the interview, the researcher may also impromptu pose questions beyond the scope of the protocol. In addition, semi-structured interviews are mostly based on open- ended questions that encourage participants to elaborate on their ideas and opinions, provide their opinions on the topic from their own unique perspectives, share personal experiences, and use their own language are the mainstay of semi-structured interviews. In qualitative research, semi-structured interviews are an invaluable instrument that facilitate comprehensive topic analysis and adaptability in data gathering, especially in exploring complex and new issues.

Research Design and Rational

The researcher decided to use semi-structured interviews as the qualitative method that would complement the quantitative method and to elaborate on its findings. Semi-structured interviews would allow for exploring the particular aspects deeply with flexibility that let participants expose their ideas and perceptions freely.

Participants

Twenty Palestinian Mathematics teachers participated voluntarily in the semi-structured interviews. An invitation was sent to a large number of schools all around the country in order to get enough number of participants and to ensure diversity. The participants were selected as to shape a good representation of the demographical aspects and of fair reflection to those in who participated in the quantitative research. Table B1, Appendix B, illustrates the demographics of the participants.

Sampling

The researcher conducted semi-structured interviews with in-service teachers. The researcher was aiming to conduct about 18 – 25 interviews, since a range of twenty to thirty semi-structured interviews is commonly recommended (Hennink et al., 2017). There is no universally agreed minimum number of interviews for PhD research in Education, however, some studies have shown that 9-17 interviews are typically sufficient to reach saturation, while others argued that the sufficient number of interviews is 12 (Guest et al., 2006). Other studies have shown that the number of semi-structured interviews needed in order to adequately identify themes and codes is 6 – 9 interviews (Young & Casey, 2018).

However, the researcher stopped when theoretical saturation was accomplished after the 20^{th} interview. Theoretical saturation in semi-structured interviews is the point at which additional interviews do not provide new information.

Data Collection

The interviews were conducted online via video conferencing, Zoom platform, and they were recorded. Interviews duration was 45 – 60 minutes. The interviews were recorded after the participants' consent. The recordings were transcribed and each transcript was organized into a table of one column in order to separate questions from answers; allowing for an proper and easier coding process.

The interviews were carried out in Arabic language, also transcribed and coded in Arabic in order to keep exact, proper descriptive wordings in their original form. Finally, the resulting codes and themes were translated to English, as well as the quotes to be presented in the PhD dissertation. In order to maintain accuracy and authenticity of the original transcripts, the researcher used a back-translation procedure. The researcher had the transcripts of the interviews translated into English by an English teacher, and then another English teacher translated the translated version back into Arabic. Finally, the researcher and a third English translator made a comparison between the back-translated version with the original transcripts; proper modifications were made on the English-version of the transcripts to be closest in meaning to the original text. It should also be noted that the Arabic-English translations were not literally done; some ‘locally-used’ phrases were interpreted and translated to the most proper English words that describe that phrase. The back-translation procedure was repeated few rounds for each interview, 2 – 4 rounds until final translation was closest in meaning to the original Arabic text.

Interview Guide

The interview guide, Table B2 (Appendix B), was painstakingly designed according to several qualitative methodology textbooks. Moreover, since designing the interview guide requires a rich conceptual reference, the researcher carried out a thorough studying of scientific research papers that covers comprehensively the contextual aspects of the research topics, namely MC, teachers’ teaching practices that foster this creativity among students and the main features of those teachers who engage in such teaching practices. The interview guide was specifically aimed at addressing the first four research questions, focusing on teachers' beliefs about MC, their intentional practices to foster this creativity, and the characteristics of the teachers themselves.

Main Topics and Questions

The interview guide consists of three sections that each focuses on a different aspect of the research questions. The following is a detailed description of the main topics and the questions within.

Section 1. Background and Demographic information

This section covers basic demographic aspects of the participants including location of the school where the participating teacher teaches and its type, teaching experience, educational background and the classes he/she teaches.

Section 2. Teachers’ belief about Mathematical Creativity

This section investigates teachers’ perceptions of MC, their beliefs about their students and their perceptions of the impact of MC on students.

Section 3. Identifying the Characteristics of the Teacher

This section aims to identify the teachers' features and their teaching practices. It explores main features of the teacher (tendency toward PD, flexibility, career commitment and personal beliefs) and their teaching methods in the realm of fostering MC.

Closing Up

The guide concludes with presenting appreciation for the participants' time and valuable contribution to the study.

Data Analysis

The interview transcripts were analyzed using thematic analysis to identify patterns, themes, and insights related to teachers' perceptions, practices, and the fostering of MC. The researcher used constant comparative data analysis as a key method in qualitative research, especially in grounded theory. It consists of a systematic process of categorizing, comparison, inductive and refinement of data.

The coding procedure was initiated as soon as the transcription was finished for the first interview since the coding process is an integral part of the analysis of the transcript. In the coding process, the researcher used a combination of Descriptive Coding, Value Coding and In Vivo Coding.

Descriptive Coding

Descriptive Coding involves the development of coding schemes to standardize text units and reduce errors, and it is useful in analyzing semi-structured interviews to identify categories, patterns and themes (Chowdhury, 2015).

Value Coding

Value Coding involves examining the values, beliefs, or attitudes expressed by participants in their responses in order to identify and categorize the underlying themes and patterns in the data, and hence to identify and prioritize key themes and concepts.

In Vivo Coding

In Vivo Coding uses the participants' own words or phrases in order to capture the nuances and complexities of the data, and it helps in exploring new issues or complex topics, allowing for a more in-depth understanding of participant experiences and perspectives.

Meanwhile, the researcher grouped comparable concepts into subcategories and then group those subcategories into major categories. The coding process starts as soon as each interview is finished and while conducting other interviews in order to pay attention to the thematic saturation, the state at which new interviews add a little or no new information to the researcher, and thus, can decide when to stop conducting new interviews.

Open Coding, Axial Coding, and Selective Coding

The researcher employed open coding, axial coding and selective coding which are key components of grounded theory methodology that clarify detailed perception of the coding process.

Open Coding

This is the initial step in the coding process, it involves breaking down the transcripts into smaller components, inspecting them closely to determine similarities and differences. The significant parts are labeled (coded) as key concepts.

Axial Coding

This phase involves reassembling of the transcript and making connections between codes (categories and subcategories) that were highlighted in the open coding. This process aims to develop more abstract categories and integrate theory.

Selective Coding

This is the final phase in the coding process that involves integrating and refining categories around a core category. This process aims to develop a cohesive theoretical framework that explains that explains phenomena under study. It is used to identify overarching themes and patterns in the transcripts to reduce data complexity into meaningful units.

Integration of Findings

After analyzing both qualitative and quantitative data separately, the findings will be integrated in the discussion section in order to provide a holistic understanding of the research questions. Using the mixed method design would allow for diversity in research tools, and thus a comprehensive and nuanced understanding of the attributes related to MC among Palestinian 8^{th} – 9^{th} grade Mathematics teachers.

Summary

This chapter highlighted the research mixed methods that were used to explore the Palestinian Mathematics teachers' perception of MC as well as their teaching practices. Both qualitative and quantitative methods were employed to conduct an intensive exploration of the research problem in order to have a comprehensive elucidated comprehension of the aspects and factors of the constituents of the research topic, and thus provide rich and strong conclusions.

In the quantitative phase, a structured questionnaire was used among 240 in-service mathematics teachers in all governance of the country. The questionnaire investigates teachers' teaching practices related to the main nine practices believed to promote MC among students. Descriptive and inferential statistical tests were used by SPSS to assess differences in teaching practices relative to main independent factors of teachers' gender, teachers' educational level and teaching experience (seniority).

Semi-structured interviews with 20 teachers from various governance were used in the qualitative phase. The interviews were conducted in order to have a clearer observation of teachers' perception of MC and attitudes toward it, their teaching practices and their complains and challenges. The interviews' transcripts were analyzed using coding procedure of open, axial and selective coding. Main themes tailed to teachers' perceptions, practices, and challenges related to MC were indicated, described and verified by teachers' quotes.

Due to the challenges resulted from the current local political situation of the war, the researcher was unable to conduct classroom observations as part of the qualitative phase. Nevertheless, the mixed methods used were sufficient to supply the researcher with clear picture and rich comprehension framework describing the aspects' components that the researcher aimed to explore concerning the issue of fostering MC in Palestinian classrooms. The results in the next chapter (The Results Chapter) provide fully described information in details, and are presented in a well arranged format addressing each question of the research questions.

Chapter Three

Results

Introduction

The results of this study, which sought to explore the perspectives and practices of eighth and ninth grade Mathematics teachers in fostering MC among Palestinian teachers, and that have been found from the collected data in both, quantitative and qualitative, are presented in details in this chapter. The collected information are reported along with figures, tables and charts as well.

The quantitative part of the research relays on a questionnaire conducted for in-service eighth – ninth grade Palestinian Mathematics teachers. The questionnaire consists of 34 items, synthesized into nine main components that address teaching practices fostering MC among students. The demographic aspects regarded in the study are teachers' gender, teachers' educational qualifications (academic degrees), teachers' teaching experience (seniority) and school affiliation.

Along the quantitative data, qualitative data were also collected through semi-structured interviews with twenty in-service teachers who voluntarily participated in the study. The interviews sought to provide deeper insights into the teachers' perspectives and personal teaching experiences. The qualitative part of the research provide an enrichment to the quantitative findings by elucidating explanation and elaboration to the statistical findings.

Quantitative Results

Initially, Descriptive Statistics of the Demographic variables are presented to give an overview of the sample population in the quantitative approach. This contains frequencies and percentages for categorical variables, such as Gender, Academic degree and Seniority, in addition to means and standard deviation.

Next, the findings from the each of the nine components of the main practices will be presented separately. These findings include Descriptive Statistics for each component as well as inferential statistics in order to determine significant differences based on teachers' gender, academic degree and seniority, in addition to any interaction effects between academic degree and seniority. Moreover, presenting the results of testing an overall composite variable representing Mathematics teachers' practices that foster MC.

Additionally, assessing the reliability of this composite variable, as well as descriptive and inferential statistics to give a more comprehensive view of the differences and interaction effects among the demographic variables. Finally, the chapter presents the key findings, emphasizing the significant results and their reflections on the study's Research questions.

Demographic Characteristics of the Sample for the Quantitative Method

The sample consisted of 240 of eighth and ninth grade Mathematics teachers. The sample included 65 male teachers (27.1%) and 175 female teachers (72.9%). There are 167 teachers (69.6%) holding a Bachelor's degree, 14 teachers (5.8%) had a B.Ed., 54 teachers (22.5%) had M.A., 5 teachers (2.1%) possessed a Ph.D. The demographic characteristics of the participants are presented in Tables A2, A3, A4 and A5 (Appendix A).

Descriptive Statistics

There are nine variables representing the main nine teaching practices that foster MC, these are: Problem solving, Using technology, Guessing and trying, Mathematical Reasoning, Divergent thinking, Problem posing and research, Applying Mathematics to real life problems, Using imagination and Relating to arts and music. Table C1, (Appendix C), provides details of the descriptive statistics of the variables.

Table C1, Appendix C, shows that the mean level of teachers' level of education is 1.57 with a standard deviation of.907, while the education level variable is coded with (1 = B.A., 2 = B.Ed., 3 = M.A. and 4 = PhD), so higher numbers represent higher education levels. Thus a mean of 1.57 assumes that the majority of teachers have B.A., with some having Diploma or higher degrees. According the mean values and standard deviations in Table 4, we have the following results: teaching practices that were indicated to have a high level of usage were Problem solving, Guessing and trying, Mathematical reasoning and Applying to real life problems. While teaching practices that were indicated to have a moderate level of usage were Using technology, Divergent thinking, Problem posing and research, Using imagination and relating to art and music. Whereas the 'overall' comprehensive teaching practices' variable showed a moderate to high level of usage.

Exploring teaching practices by Teachers' Gender

Since descriptive Statistics is an important test that provides a lucid comprehension of the influence of the levels of the independent variables on the dependent variables, then it is important to carry out descriptive statistics tests before running any further analysis.

Therefore, Descriptive Statistics test was conducted after splitting the data by file according to gender in order to have deep insights into the average levels of teachers' involvement in a variety of teaching practices that foster MC with regard to teachers' gender. Table C2, Appendix C, represents the results of the Descriptive Statistics for each teaching practice as well as the 'overall' comprehensive composite variable representing all the practices concerning teachers' gender.

Observing the mean value and the standard deviation for each teaching practice for male and female in Table C2, Appendix C, to interpret the descriptive statistics table. The findings can be summarized as follows:

Male teachers were found to have high level of involvement in Problem solving (μ = 4.13, σ =.70), Mathematical reasoning (μ = 3.90, σ =.64), Applying Mathematics to real life problems (μ = 3.91, σ =.89), while these teachers were found to have an almost high level of engagement in Guessing and trying (μ = 3.87, σ =.81) and a moderate – to high level of engaging Divergent thinking (μ = 3.81, σ =.73). In addition, these teachers were found to have a moderate level of evolvement of Using technology (μ = 3.21, σ =.95), Problem posing and research (μ = 3.61, σ =.82), Using imagination (μ = 3.63, σ =.86) and Relating to Art (μ = 2.99, σ =.92). In general, male teachers were found to have a high level of engaging general 'overall' comprehensive teaching practices into their teaching methods (μ = 3.67, σ =.63).

While female teachers were found to have very high level of involvement of Problem solving (μ = 4.42, σ =.57), of Guessing and trying (μ = 4.21, σ =.69) and of Applying Mathematics to real life problems (μ = 4.26, σ =.80). In addition, these teachers were found to have a high level of engaging in Mathematical reasoning (μ = 4.21, σ =.68), in Divergent thinking (μ = 4.01, σ =.75) and in Using imagination (μ = 4.01, σ =.70). Moreover, these teachers were found to have a moderate to high level of engaging in Problem posing and research (μ = 3.95, σ =.72) and in Relating to Art (μ = 3.65, σ =.90).

In general, female teachers were found to have a very high level of engaging in the 'overall' comprehensive teaching practices (μ = 4.05, σ =.57).

Therefore, the descriptive statistics' results show that female teachers were noticed to have higher mean across most of the teaching practices than male teachers', indicating that female teachers are more likely to engage into MC fostering teaching practices than male teachers do. In spite of this, still both male and female teachers account for high levels of involving in a variety of those teaching practices.

Exploring teaching practices by Teachers' Academic Degree

Similarly, Descriptive Statistics test was conducted after splitting the data by file according to the levels of teachers' academic degree (B.A., B.Ed., M.A. and PhD) in order to have deep insights into the average levels of teachers' involvement in a variety of teaching practices that foster MC with regard to teachers' academic degree. Table C3, Appendix C, presents a summary of the minimum, maximum, mean and standard deviation for the teaching practices and the 'overall' comprehensive teaching practices' variable, within each level of the teachers' academic degree.

Observing Table C3, Appendix C, the mean value and the standard deviation for each teaching practice at the levels of the academic degree to interpret the descriptive statistics table. The findings can be summarized as follows:

For teachers holding B.A., it was found that teachers had high level of involvement in almost half of the teaching practices, which were Problem solving (μ = 4.38, σ =.59), Guessing and trying (μ = 4.13, σ =.71), Mathematical reasoning (μ = 4.11, σ =.70) and Applying Mathematics to real life problems (μ = 4.22, σ =.79). While these teachers had a moderate level of involvement in the rest of the teaching practices, which were Using technology (μ = 3.61, σ =.87), Divergent thinking (μ = 3.9, σ =.74), Problem posing and research (μ = 3.88, σ =.75), Using imagination (μ = 3.93, σ =.73) and Relating to Art (μ = 3.57, σ =.90). Moreover, these teachers have shown a high level of involvement in diverse teaching practices, as for the 'overall' comprehensive teaching practices variable (μ = 3.97, σ =.59).

Teachers with a B.Ed., it was found that teachers had high level of involvement in most of the teaching practices that foster MC, and these were Problem solving (μ = 4.58, σ

=.40), Guessing and trying (μ = 4.40, σ =.62), Mathematical reasoning (μ = 4.36, σ =.44), Divergent thinking (μ = 4.14, σ =.34), Problem Posing and research (μ = 4.16, σ =.45), Applying Mathematics to real life problems (μ = 4.60, σ =.37) and Using imagination (μ = 4.21, σ =.61), While teachers had a moderate to high level of engagement in Relating to Art (μ = 3.76, σ =.81) and a moderate level of engagement in Using technology (μ = 3.55, σ =.61). Moreover, these teachers have shown a very high level of involvement in diverse teaching practices, as for the 'overall' comprehensive teaching practices variable (μ = 4.20, σ =.26).

Teachers with an M.A., it was found that teachers had high level of involvement in Problem solving (μ = 4.34, σ =.70), Guessing and trying (μ = 4.03, σ =.80), Mathematical reasoning (μ = 4.17, σ =.65), Divergent thinking (μ = 4.00, σ =.83) and Applying Mathematics to real life problems (μ = 3.97, σ =.89). While these teachers had a moderate to high level of engagement in Using imagination (μ = 3.81, σ =.86). They had a moderate level of involvement in Using technology (μ = 3.46, σ =.97), Problem posing and research (μ = 3.81, σ =.81) and in Relating to Art (μ = 3.19, σ = 1.04). Moreover, these teachers have shown a high level of involvement in diverse teaching practices, the 'overall' comprehensive variable, (μ = 3.86, σ =.65).

Teachers with a PhD, it was found that teachers had a moderate level of involvement in Problem solving (μ = 3.43, σ =.58), Using technology (μ = 3.13, σ = 1.22), Guessing and trying (μ = 3.60, σ =.86), Mathematical reasoning (μ = 3.50, σ =.79), Divergent thinking (μ = 3.27, σ =.72), Applying Mathematics to real life problems (μ = 3.00, σ =.39) and Using imagination (μ = 3.20, σ =.96). While these teachers had a low level of involvement in Problem posing and research (μ = 2.95, σ =.96) and in Relating to Art (μ = 2.6, σ = 1.12). Moreover, these teachers have shown a moderate level of involvement in diverse teaching practices, as for the 'overall' comprehensive teaching practices variable (μ = 3.19, σ =.82).

Accordingly, the descriptive statistics presented the variation in teachers' engagement in teaching practices with regard to teachers' academic degree. It also revealed that teachers with B.Ed. have, in general, the highest levels of integration of most teaching practices, while those with PhD demonstrate more variability and somehow lower integration of teaching practices.

Exploring teaching practices by Teachers' Seniority levels

Similarly, Descriptive Statistics test was conducted after splitting the data by file according to the levels of teachers' seniority (≤ 5, 6 – 10, > 10) years. In order to have deep insights into the average levels of teachers' involvement in a variety of teaching practices that foster MC with regard to teachers' seniority. Table C4, Appendix C, presents a summary of the minimum, maximum, mean and standard deviation for the teaching practices within each level of the teachers' academic.

Observing the mean value and the standard deviation for each teaching practice for the levels of teachers' teaching experience, the results revealed the following information:

For teacher with (≤ 5 years) of teaching experience, it was found that these teachers were found to have a high level of involving in Problem solving (μ = 4.33, σ =.55), in Guessing and trying (μ = 4.09, σ =.73), in Mathematical reasoning (μ = 4.17, σ =.62) and in Applying Mathematics to real life (μ = 4.16, σ =.79). While they were found to have a moderate to high level of engaging Using imagination (μ = 3.76, σ =.81) and Divergent thinking (μ = 3.83, σ =.76). In addition, they were found to have a moderate level of involving in Using technology (μ = 3.41, σ =.87), in Problem posing and research (μ = 3.74, σ =.82) and in Relating to Art (μ = 3.31, σ =.93). In general, these teachers were also found to have a high level in engaging general, 'overall' comprehensive teaching practices (μ = 3.87, σ =.61).

For those teachers with (6 – 10 years) of teaching experience, it was found that they have a high level of integrating some teaching practices such as Problem solving (μ = 4.19, σ =.69), Guessing and trying (μ = 4.02, σ =.76), Mathematical reasoning (μ = 3.91, σ =.90), Divergent thinking (μ = 3.93, σ =.93) and Applying Mathematics to real life problems (μ = 3.80, σ =.97). While these teachers were found to have a moderate level of engaging in activities with some teaching practices such as Using technology (μ = 3.26, σ =.78), Problem posing and research (μ = 3.63, σ =.81), Using imagination (μ = 3.58, σ =.86) and Relating to Art (μ = 3.27, σ =.85). In general, these teachers were found to have a high level of integrating the 'overall' comprehensive teaching practices (μ = 3.80, σ =.97).

While teachers with more than 10 years of experience were found to have very high level of integrating various teaching practices such as Problem solving (μ = 4.23, σ =.82), Guessing and trying (μ = 4.40, σ =.63), Mathematical reasoning (μ = 4.15, σ =.66) and Applying Mathematics to real life problems (μ = 4.23, σ =.82). They were also found to have a high level of integrating other teaching practices such as Divergent thinking (μ = 4.00, σ =.71), Problem posing and research (μ = 3.95, σ =.72) and Using imagination (μ = 4.02, σ =.71). In addition, they were found to have a moderate to high level of involving in Relating to Art (μ = 3.58, σ =.96) and Using technology (μ = 3.67, σ =.90). In general, these teachers were found to have a very high level of integrating an 'overall' comprehensive teaching practices (μ = 4.01, σ =.59).

The descriptive statistics indicated that more experienced the teachers are more likely to integrate into Creativity fostering teaching practices, and in particular, those with more than ten years of experience had the highest mean scores across most of the practices. These results suggest that teaching experience have a positive impact on the engagement of these teaching practices.

Validity and Reliability

Internal consistency

A reliability analysis was tested on a randomly selected 30 participants from the various governance, as a pilot representative of the population, and calculated the Cronbach's Alpha, which helps determining whether the items in the questionnaire are measuring the same underlying construct consistently. This is presented in Table A6, Appendix A. The selected 30 items lead to a Cronbach's Alpha of.958, indicating excellent internal consistency.

Assumptions Tests

Assessing Normality

Testing for normality via the Kolmogorov-Smirnov test with Lilliefors significance correction and the Shapiro-Wilk test. The results presented in Table C5, Appendix C. The Kolmogorov-Smirnov (K-S) Test results show that all variables have a p-value of.000, indicating significant deviation from normality. Similarly, Shapiro-Wilk (S-W) Test: all variables have a p-value of.000, also indicating significant deviation from normality.

Therefore, both tests suggest that none of the composite variables follow a normal distribution. Consequently, non-parametric tests are conducted for further analysis.

Assessing Homogeneity

For the nonparametric nature of the data of the study, the Brown-Forsythe Test was used. The test was conducted in SPSS through the process mentioned in the Methodology Chapter. It has been analyzed by conducting a One-Way ANOVA on the absolute difference between each dependent variable and its median, the resulting F value is the Brown-Forsythe value. Taking into consideration every combination of the dependent and the independent variables, thus producing a robust analysis of variance homogeneity.

The Brown-Forsythe analysis for teachers' gender

The results of the Brown-Forsythe analysis are presented in Table C6, Appendix C. The Brown-Forsythe analysis results shows that, for gender, significant differences in variance were observed for the 'problem solving' and 'problem posing and research' practices ($F(1, 238) = 5.222$, $p = .023$; $F(1, 238) = 4.432$, $p = .036$ respectively), which implies that there were different variances in responses between male and female teachers. Whereas, no significant differences in variance was observed for the rest of the dependent variables, which were 'Using technology': $F(1, 238) = 1.437$, $p = .232$; 'Guessing and trying': $F(1, 238) = 2.919$, $p = .089$; 'Mathematical reasoning': $F(1, 238) = .036$, $p = .849$; 'Divergent thinking': $F(1, 238) = .035$, $p = .851$; 'Applying Mathematics to real life problems': $F(1, 238) = 1.173$, $p = .280$; 'Using imagination': $F(1, 238) = 1.636$, $p = .202$; 'Relating to Art': $F(1, 238) = 2.776$, $p = .097$). Moreover, for the 'overall' comprehensive teaching practices' variable, there was no significant difference in variance observed as well; $F(1, 238) = 3.670$, $p = .057$.

The Brown-Forsythe analysis for teachers' education qualifications

The results of the Brown-Forsythe analysis for teachers' academic degree, (B.A., B.Ed., MA. and PhD) are presented in Table C7, Appendix C. The Brown-Forsythe analysis results for teachers' 'Academic degree' shows that significant differences in variance were observed in 'Problem solving', in 'Applying Mathematics to real life problems' and in 'Relating Mathematics to Art' ($F(3, 236) = 3.635$, $p = .014$; $F(3, 236) = 3.278$, $p = .022$; $F(3, 236) = 2.950$, $p = .033$ respectively). Whereas, no significant difference in variance was observed for the rest of the dependent variables, which were: 'Using technology': F

(3, 236) = 2.262, p =.082; 3. ‘Guessing and Trying’: F(3, 236) =.687, p =.561; ‘Mathematical Reasoning’: F(3, 236) = 1.259, p =.289; ‘Divergent Thinking’: F(3, 236) = 2.082, p =.103; ‘Problem Posing and Research’: F(3, 236) = 2.480, p =.062 and ‘Using Imagination’: F(3, 236) =.878, p =.453). Nonetheless, for the ‘Comprehensive Teaching Practices’ variable’, there were significant differences in variance observed with teachers’ academic degree (F(3, 236) = 2.843, p =.039).

The Brown-Forsythe analysis for teachers’ Seniority

The results of the Brown-Forsythe test for teachers’ seniority (≤ 5 years, 6–10 years, > 10 years) are presented in Table C8, Appendix C. The Brown-Forsythe analysis results for teachers’ ‘Seniority’ shows that no significant differences in variance were observed for any of the dependent variables, which were ‘Problem solving’: (F(2, 237) =.386, p =.680); ‘Using technology’: (F(2, 237) =.151, p =.860); ‘Guessing and trying’: (F(2, 237) =.121, p =.887); ‘Mathematical reasoning’: (F(2, 237) = 2.731, p =.067); ‘Divergent thinking’: (F(2, 237) = 1.310, p =.272); ‘Problem posing and research’: (F(2, 237) =.658, p =.519); ‘Applying mathematics to real life problems’: (F(2, 237) = 1.345, p =.262); ‘Using imagination’: (F(2, 237) = 1.518, p =.221) and ‘Relating Mathematics to Art’: (F(2, 237) =.314, p =.731). Similarly, no significant differences in variance were observed for the ‘overall’ comprehensive teaching practices’ variable (F(2, 237) =.991, p =.373).

Factor Extraction

An Exploratory Factor Analysis (EFA) were conducted in order to understand the underlying structure of the questionnaire items.

Exploratory Factor Analysis (EFA)

Assumptions, Preliminary Tests, and Data Suitability

Data suitability was measured using the Kaiser-Meyer-Olkin (KMO) and Bartlett’s Test of Sphericity. The results are presented in Table C10, Appendix C. The KMO measure of sampling adequacy was.930, indicating that the sample size was adequate for factor analysis. Bartlett’s Test of Sphericity was significant (Approx. Chi-Square = 5246.759, df = 561, Sig. =.000), suggesting that the correlations between items were sufficiently large for EFA, confirming that the correlation matrix was not an identity matrix and thus suitable for factor analysis.

Communalities for the Exploratory Factor Analysis (EFA)

In order to test whether the extracted factors explain a substantial portion of the variance, communalities were tested and presented in Table C12, Appendix C. and interpreted according to the guideline table, Table C11, Appendix C (Hair, 2010).

The results of the communalities table were interpreted according to the guideline Table C11, Appendix C. the components of Problem solving, the communalities were in the range of.571 –.749, indicating that these variables were moderately – well represented by the factor solution. Similarly, Using technology components had communalities of.611 –.714, indicating that these variables were moderately – well represented by the factor solution as well. Components of Guessing and trying had communalities of.559 –.649, indicating that these variables were moderately represented by the factor solution. While Mathematical reasoning components had communalities of.585 –.769, indicating that these variables were moderately – well represented by the factor solution. For Divergent thinking components, the communalities were.571 –.690, also indicating that these variables were moderately represented by the factor solution. Problem posing and research components had communalities of.615 –.714, indicating that these variables were moderately – well represented by the factor solution. The components of Applying Mathematics to real life problems had communalities of.643 – 6.82l, indicating that these variables were moderately represented by the factor solution. Using imagination components had communalities of.528 –.730, indicating that these variables were moderately – well represented by the factor solution. Finally, Relating to Art components had communalities of.577 –.686, indicating that these variables were moderately represented by the factor solution.

The Total Variance Explained, for the Exploratory Factor Analysis (EFA)

Conducting the analysis for the total variance explained by the extracted factors, six factors were extracted, accounting for 65.210% of the total variance, which indicate that these six factors combined do explain a fundamental part of the variability in the study's data. Consequently, this suggests that the model presents a good fit to the underlying structure of the questionnaire items (Hair, 2010). Table C13, Appendix C, presents the Total variance explained for the exploratory factor analysis (EFA). The first factor alone accounts for 41.575% of the variance, demonstrating its significant contribution. The subsequent factors explain progressively smaller proportions of the variance, indicating that while they are important, their individual contributions are less substantial. Overall, the total variance explained signifies that the factor solution captures the majority of the information contained in the original variables. Therefore, the results indicate that a significant portion of the total variance in the data was effectively captured by the model.

Rotation Sums of Squared Loadings for the Exploratory Factor Analysis (EFA)

Rotation sums of squared loadings, Table C14, Appendix C, illustrates the reflection of variance after the rotation process of the factors. The first to the fifth factors, after rotation, explain 11.123 units, 10.648 units, 7.268 units, 8.916 units and 7.548 units respectively. The sixth factor explains only 1.480 units of the variance after the rotation. Note that the first two factors explain a cumulative percentage 49.276% of variance after rotation (almost half of the variance), indicating the essential explanatory robust of these factors.

Rotated Component Matrix for the Exploratory Factor Analysis (EFA)

In order to determine the factor loadings for each variable on the extracted factors before and after rotation, the rotated component matrix analysis was conducted; Table C15, Appendix C, is a simple guideline criterion for interpreting the component transformation matrix, presented by Table C16, Appendix C.

Factor 1 has moderate correlations with factors 2, 3, 4 and 5 (correlations range.331 – .503), and low correlation (.124) with factor 6. This indicates that factor 1 have some common variance with factors 2, 3, 4 and 5, which means that the underlying construct of factor 1 is related to those of factors 2, 3, 4 and 5 but somehow distinct. Factor 2 has moderate correlations with factors 3 and 4 (.603 and.310, respectively), a low positive correlation with factor 6 (.123), and a moderate negative correlation with factor 1 (-.611). This implies that factor 1 retains its relationships with factors 3 and 4, while it was been adjusted significantly to decrease overlapping with factor 1. Factor 3 has moderate positive correlations with factors 2, 3 and 5 with correlations of.436,.315 and.427 respectively. It has moderate negative correlations with factors 1 and itself (-.450, -.570 respectively) and a low negative correlation with factor 6 (-.027). This implies that factor keeps portions of the variance related to factors 2 and 5 but was restructured. Factor 4 has a strong positive correlation with itself after rotation (.740), a moderate positive correlation with factor 1 (.31), positive low correlations with factors 3 and 5 (.11 and.139

respectively), a low negative correlation with factor 6 (-.172) and a moderate negative correlation with factor 2 (-.634). Therefore, Factor 4 retains its structure and is clearly distinguished from factor 2. Factor 5 shows a strong positive correlation with itself after rotation (.771), moderate correlations with factor 3 (.391) and a low positive correlation with factor 6 (.092). It also has low negative correlations with factors 1 and 2 (-.254 and -.256 respectively) and a negative moderate correlation with factor 4 (-.338). Similarly, factor 5 retains its distinct construct while it shares significant variance with the factors. Factor 6 has a very strong positive correlations with itself (.965), low positive correlations with factors 1 and 4 (.018,.086 respectively), and low negative correlations with factors 2, 3 and 5. Factor 6 has a significant stability and remains distinct by capturing unique variance that is not shared with the rest of the factors.

Conclusively, the component transformation matrix illustrates how the factors been reconstructed by the Variamx rotation in order to have a better interpretability, which ensures that each factor retains a distinct aspect of the data with minimum redundancy.

Correlation Analysis between teachers' teaching practices and teachers demographic variables (gender, academic degree and seniority)

Investigating how teachers' demographical aspects influence their teaching practices via nonparametric analysis, namely Spearmann's rho and Kendll's tau_b coefficients, to explore these relationships. The results of the Correlation analysis (Spearman's rho and Kendall's tau_b coefficients) were interpreted according to several guidelines (Schober et al., 2018), summarized in Table C9, Appendix C.

Correlation Analysis between teaching practices and teachers' Gender

The relationship between teachers' teaching practices and gender is investigated in this section by conducting correlation analysis between teaching practices and teachers' gender using Spearman's rho and Kendall's tau_b coefficients. These correlations are presented in Table C17, Appendix C, describing these relationships, their significance and strength.

A Spearman's rank-order and Kendall's tau_b correlations were conducted to determine the relationship between teachers' practices and teacher's Gender. There was a weak, positive, significant correlation between (almost) every teaching practice and teachers'

Gender ($.1 < r_s < .29, .1 < \tau_b < .29$, p <.05) except for Relating to Art which shows a moderate correlation (r_s =.306, τ_b =.262, p <.01). There was also a weak, positive correlation between the 'overall' comprehensive teaching practices' variable and teachers Gender (r_s =.29, τ_b =.237, p <.01). The results indicate that there significant but weak positive correlations between teachers' gender and teaching practices, with the exception of 'Relating to Art', which had a moderate correlation. This implies that teachers' gender may have an impact on some teaching practices; however, this impact is generally weak.

Correlation Analysis between teaching practices and teachers' degree

To assess the relationships between teaching practices and teachers' educational levels, Spearman's rho and Kendall's Tau_b correlation analysis were employed. The nine teaching practices' variables and the 'overall' comprehensive teaching practices variable were used. The results are presented in Table C18, Appendix C.

The Spearman's rho correlation analysis

There is a very weak, not statistically significant, negative relationships ($r_s < 0$) between teachers' academic degree and almost all the teaching practices' variables, namely Problem solving, Using technology, Guessing and trying, Problem posing and research, Applying Mathematics to real life problems and Using imagination. Moreover, a weak negative significant relationship for Applying Mathematics to real life problems and to Relating Mathematics to Art. Whereas, a slightly negligible positive relationship for Mathematical reasoning is noticed. For the 'overall' comprehensive teaching practices variable, there is a very weak statistically non-significant negative relationship with teachers' academic degree ($r_s = -.087, p = .181$).

Kendall's tau_b Correlation Analysis

There is a very weak negative relationship ($\tau_b < 0$) between teachers' academic degree and almost all the teaching practices' variables, namely Problem solving, Using technology, Guessing and trying, Problem posing and research and Using imagination. These relationships were also not statistically significant. There is also a weak negative relationship for Applying Mathematics to real life problems and to Relating Mathematics to Art which is statistically significant (p =.023, p =.017 respectively). Whereas, there are two relationships that are noticed to be slightly positive (almost negligible, $\tau_b = .004, \tau_b = .026$) for Mathematical reasoning and Divergent thinking, but still not statistically significant relationships. For the ‘overall’ comprehensive teaching practices variable, there is a very weak statistically non-significant negative relationship with teachers’ academic degree ($\tau_b = -.072, p = .162$).

Correlation Analysis between teaching practices and teachers' seniority

Similarly, to assess the relationships between teachers’ teaching practices and their teaching experience (seniority) levels, Spearman’s rho and Kendall’s Tau_b correlation analysis were carried out as well. The nine main teaching practices’ variables and the ‘overall’ comprehensive teaching practices variable were used, the results of the test is presented in Table C19, Appendix C. There are several positive significant relationships between teachers’ Seniority levels and teachers’ teaching practices, such as Using technology with Seniority levels (r_s =.158, p =.014; τ_b =.131, p =.015). Another positive correlation was found between Using imagination and Seniority levels (r_s =.173, p =.007; τ_b =.144, p =.008). There was also positive correlation between Relating to Art and Seniority levels (r_s =.142, p =.027; τ_b =.117, p =.028). Moreover, there is significant positive correlation between the ‘overall’ comprehensive variable (representing all the teaching practices) and Seniority levels (r_s =.138, p =.033; τ_b =.109, p =.033).

These results imply that teachers with more teaching experience are more likely to have gained a variety of rich teaching practices, and thus to implement more effective Creativity fostering teaching practices, in particular integrating technology, using imagination and Art related activities.

Addressing the Last Four Research Questions

This section present the nonparametric methods that were conducted in order to address the last four Research Questions (Q. 5 – Q. 8) by investigating the factors that influence Creativity fostering teachers’ practices.

Research Question 5

“Is there a significant difference in the responses of the in-service Mathematics teachers fostering students' creativity in mathematics with respect to teachers’ gender?”

The Mann-Whitney U Test for Gender Differences in Teaching Practices

To assess the significant differences in the responds of two groups of an independent variable (here, male and female of teachers' gender) on an ordinal dependent variable (teaching practices), the Mann-Whitney U test was employed. Mann-Whitney U Test was carried out to compare the responses of in-service male and female Mathematics teachers regarding their teaching practices that foster MC, the findings are presented as mean ranks and sum of ranks in Table C20, Appendix C, and Mann-Whitney U values in Table 2.

Table 2

Mann-Whitney Test Statistics between male and female teachers (Gender)

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
ProblemSolving	3966.000	6111.000	-3.620	0.000
UsingTechnology	4133.000	6278.000	-3.276	0.001
GuessingAndTrying	4239.500	6384.500	-3.066	0.002
MathematicalReasoning	3978.500	6123.500	-3.605	0.000
DivergentThinking	4662.500	6807.500	-2.168	0.030
ProblemPosingAndResearch	4276.000	6421.000	-2.975	0.003
ApplyingMathToRealLifeProblems	4136.000	6281.000	-3.293	0.001
UsingImagination	4196.500	6341.500	-3.157	0.002
RelatingToArt	3438.500	5583.500	-4.734	0.000
ComprehensiveTeachPractices	3549.500	5694.500	-4.473	.000

The findings in the table of mean ranks and sum of ranks indicate that mean ranks as well as sum of ranks were consistently higher for female teachers' responds compared to their male counterparts in all teaching practices. For example, in 'applying Mathematics to real life problems' component, female teachers, with a Mean Rank of 129.37 versus a lower Mean Rank of 96.63 for male teachers. Similarly, findings for the 'overall' comprehensive teaching practices' variable were also consistent with comparing among the individual teaching practices components, Mean Rank for female teachers (Mean Rank = 132.72) compared to that for male teachers (Mean Rank = 87.61) indicating that female teachers employ a broader range of comprehensive teaching practices that foster MC among their students than male teachers do.

Employing the Mann-Whitney U test, Table 2, the results indicate that there were always significant differences between male and female teachers in their responds on all the practices components, which were: problem solving (U = 3966, p <.005); using technology (U = 4133, p <.005); guessing and trying (U = 4239.5, p <.005); Mathematical reasoning (U = 3978.5, p <.005); divergent thinking (U = 4662.5, p <.005); problem posing and research (U = 4276, p <.005); applying Mathematics to real life problems (U = 4136, p <.005); using imagination (U = 4196.5, p <.005); relating to Art (U = 3438.5, p <.005) and for the 'overall' comprehensive teaching practices (U = 3549.5, p <.005). The findings from the Mann-Whitney U Test indicated that there are significant differences in the main teaching practices that foster MC between male and female Palestinian teachers. Female teachers consistently showed higher level of integrating these teaching practices in their teaching methods than male teachers did. It was noticed that there is also consistency between the results of Mann-Whitney U test for the nine practices individually with regard to gender and to those results of Mann-Whitney U test for the nine practices combined into a comprehensive variable. This consistency between both approaches indicated a significant gender impact on fostering MC among students.

Research Question 6

"Is there a significant difference in the responses of the in-service mathematics teachers fostering students' creativity in mathematics with respect to teachers' academic degree?"

Conducting the Kruskal-Wallis H Test to assess statistical significant differences between the four groups of teachers' educational level (B.A., B.Ed., M.A. and PhD). Table C21, Appendix C, and Table 3, present the results of the mean ranks and the Kruskal-Wallis H test respectively.

Table 3

Test Statistics for the Kruskal-Wallis H test, with respect to Academic degree

	Kruskal-Wallis H	df	Asymp. Sig.
ProblemSolving	10.765	3	0.013
UsingTechnology	1.314	3	0.726
GuessingAndTrying	5.041	3	0.169
MathematicalReasoning	4.915	3	0.178
DivergentThinking	5.545	3	0.136
ProblemPosingAndResearch	7.292	3	0.063
ApplyingMathematicsToRealLife	13.454	3	0.004
UsingImagination	5.438	3	0.142
RelatingToArt	10.180	3	0.017
ComprehensiveTeachPractices	9.081	3	0.028

Note that the mean rank values for teachers with B.A. (118.49 – 126.51), and for those with a B.Ed. (117.21 – 155.79), while for those with a master degree (101.86 – 128.74), and finally for teachers with a PhD (27.80 – 99.30). Therefore, the mean ranks were lowest for teachers with PhD degree and highest for those with a B.Ed.; nevertheless, still for those teachers with a B.A. or with an M.A., the mean ranks were high. These mean rank ranges indicate that teachers with a PhD tend to have lowest scores in engaging in the teaching practices that foster MC than their counterparts, while those teachers with a B.Ed. tend to have higher scores in engaging in the teaching practices that foster MC than their counterparts.

The results in the table show that there were significant differences just for three teaching practices among teachers' educational levels, which are Problem solving ($\chi^2(3)$ = 10.77, p <.05); Applying Mathematics to real life problems ($\chi^2(3)$ = 13.454, p <.05) and for Relating Mathematics to Art ($\chi^2(3)$ = 10.18, p <.05). On the other hand, there were no significant differences among teachers' educational levels for the rest of the teaching practices, which are using technology ($\chi^2(3)$ = 1.31, p =.73), Guessing and trying ($\chi^2(3)$ = 5.04, p =.17), for Mathematical reasoning ($\chi^2(3)$ = 4.92, p =.18), for Divergent thinking $\chi^2(3)$ = 5.55, p =.14, for Problem posing ($\chi^2(3)$ = 7.29, p =.06) and for Using imagination ($\chi^2(3)$ = 5.44, p =.14. In general, for the 'overall' comprehensive teaching practices' variable, there are also significant differences among teachers' educational level with ($\chi^2(3)$ = 9.08, p <.05).

The findings in the Kruskal-Wallis H Test reported that there were significant differences among teachers' educational levels just for three teaching practices, problem solving, applying Mathematics to real life and relating Mathematics to Art, while no significant differences were found for the rest of the teaching practices. In general, there were significant differences found for the 'overall' comprehensive teaching practices variable among teachers' educational levels, indicating that teachers' education influence their implementation of teaching practices that foster MC among their students. Moreover, significant differences in various teaching practices requires further analysis to identify specifically which groups vary.

Post-Hoc Pairwise Comparisons Using Mann-Whitney U Tests with Bonferroni Correction

As a consequence of the results of the Kruskal-Wallis H Test which indicated significant differences in various teaching practices, a post-hoc analysis was carried out in order to assess these differences and make a comparison between groups. A Mann-Whitney U Test was to be conducted in order to carry pairwise comparisons, but in order to avoid the occurrence of Type 1 error; Bonferroni correction was applied.

Mann-Whitney U Tests with Bonferroni Correction across the groups of Academic degree

Accordingly, Mann-Whitney U Test was conducted in order to carry pairwise comparisons among the pairwise comparison groups of teachers' academic degree.

Comparison between teachers with B.A. and those with B.Ed.

Table C22, Appendix C, presents the mean rank and the sum of ranks for pairwise comparison between B.A. and B.Ed. across all teaching practices. The table of ranks indicate that the mean ranks for teachers with B.Ed. was higher than those for teachers with B.A. in almost all the teaching practices except for 'using technology. In addition, the 'overall' comprehensive teaching practices had a higher rank for teachers with B.A. compared to B.Ed. teachers. These findings implies that teachers with B.Ed. had higher scores in engaging in various teaching practices that foster MC than teachers with B.A.

Mann-Whitney U Test between B.A. and B.Ed. teachers, presenting the results in Table 4.

Table 4

The mean rank and sum of ranks between B.A. and B.Ed.. across all teaching practices

	Academic degree	N	Mean Rank	Sum of Ranks
ProblemSolving	B.A.	167	89.57	14959.00
	B.Ed.	14	108.00	1512.00
UsingTechnology	B.A.	167	91.35	15255.50
	B.Ed.	14	86.82	1215.50
GuessingAndTrying	B.A.	167	89.43	14935.00
	B.Ed.	14	109.71	1536.00
MathematicalReasoning	B.A.	167	89.75	14988.50
	B.Ed.	14	105.89	1482.50
DivergentThinking	B.A.	167	89.99	15029.00
	B.Ed.	14	103.00	1442.00
ProblemPosing	B.A.	167	89.43	14934.00
	B.Ed.	14	109.79	1537.00
ApplyingMathToReal	B.A.	167	89.32	14917.00
	B.Ed.	14	111.00	1554.00
UsingImagination	B.A.	167	89.51	14947.50
	B.Ed.	14	108.82	1523.50
RelatingToArt	B.A.	167	90.00	15030.50
	B.Ed.	14	102.89	1440.50
Comprehensive	B.A.	167	89.51	14947.50
	B.Ed.	14	108.82	1523.50

There are four groups in the comparison (B.A., B.Ed., M.A., and PhD), making a total of six comparisons (B.A., B.Ed.), (B.A., M.A.), (B.A., PhD), (B.Ed., M.A.), (B.Ed., PhD), (M.A., PhD). Therefore, applying Bonferroni Correction, the significant p-value is calculated: $p = .05 / 6 = .0083 \approx .008$. The findings in the Table 4 with the Bonferroni-corrected p-value (of.008), indicate that there is no significant differences between both groups (B.A. and B.Ed.) for all the teaching practices, which are: Problem solving ($U = 931$, $p = .204 > .008$); Using technology ($U = 1110.5$, $p = .754 > .008$); Guessing and trying

(U = 907, p =.159 >.008); Mathematical reasoning (U = 960.5, p =.264 >.008); Divergent thinking (U = 1001, p =.367 >.008); Problem posing and research (U = 906, p =.159 >.008); Applying Mathematics to real life problems (U = 889, p =.130 >.008); Using imagination (U = 919.5, p =.180 >.008) and Relating Mathematics to Art (U = 1002.5, p =.373 >.008). Similarly, for the 'overall' Comprehensive teaching practices' variable (U = 919.5, p =.185 >.008).

Comparison between teachers with B.A. and those with M.A.

Table C23, Appendix C, of ranks indicate that the mean ranks for teachers with B.A. were higher than those with an M.A. teachers in Using technology, Guessing and trying, Problem posing and research, Applying Mathematics to real life problems, Using imagination and Relating Mathematics to Art. While the mean ranks were higher for teachers with M.A. than those with a B.A. for Problem solving, Mathematical reasoning and Divergent thinking. In general, the mean ranks and sum of ranks for the 'overall' comprehensive teaching practices' variable was much higher for those teachers with a B.A compared to those with M.A. Conducting the Mann-Whitney U Test between B.A. teachers and B.Ed. teachers, presenting the results in Table 5.

Table 5

The Mann-Whitney U Test comparison between B.A. and M.A. of the Academic degree

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. p
ProblemSolving	4501.500	18529.500	-0.018	0.985
UsingTechnology	4149.000	5634.000	-0.887	0.375
GuessingAndTrying	4193.500	5678.500	-0.782	0.434
MathematicalReasoning	4336.000	18364.000	-0.427	0.669
DivergentThinking	4130.000	18158.000	-0.937	0.349
ProblemPosing	4322.000	5807.000	-0.461	0.645
ApplyingMathToReal	3627.500	5112.500	-2.189	0.029
UsingImagination	4223.500	5708.500	-0.708	0.479
RelatingToArt	3550.500	5035.500	-2.361	0.018
ComprehensivePractices	4055.000	5540.000	-1.112	0.266

The findings from the table with the Bonferroni-corrected p-value (of.008), indicate that there is no significant differences between both groups (B.A. and M.A.) for all the teaching practices, which are: Problem solving (U = 4501.5, p =.985 >.008); Using technology (U = 4149, p =.375 >.008); Guessing and trying (U = 4193.5, p =.434 >.008); Mathematical reasoning (U = 4336, p =.669 >.008); Divergent thinking (U = 4130, p =.349 >.008); Problem posing and research (U = 4322, p =.645 >.008); Applying Mathematics to real life problems (U = 6327.5, p =.029 >.008); Using imagination (U = 4223.5, p =.479 >.008) and Relating Mathematics to Art (U = 3550.5, p =.018 >.008). Similarly, for the 'overall' Comprehensive teaching practices' variable (U = 4055, p =.266 >.008).

Comparison between teachers with B.A. and those with PhD

Table C24, Appendix C, indicate that the mean ranks as well as the sum of ranks were higher for those teachers with B.A. than those with a PhD in all the teaching practices. In addition, the mean rank and the sum of ranks were also higher for teachers with a B.A. than those with a PhD in the 'overall' Comprehensive teaching practices' variable. Conducting the Mann-Whitney U Test across the groups of teachers' Gender, presenting the results in Table 6.

Table 6

The Mann-Whitney U Test comparison between B.A. and PhD of the Academic degree

	Mann-Whitney U	**Wilcoxon W**	**Z**	**Asymp. Sig. p**
ProblemSolving	87.500	102.500	-3.023	0.003
UsingTechnology	330.500	345.500	-0.799	0.424
GuessingAndTrying	254.500	269.500	-1.503	0.133
MathematicalReasoning	224.000	239.000	-1.777	0.076
DivergentThinking	207.000	222.000	-1.938	0.053
ProblemPosingAndResearch	182.000	197.000	-2.161	0.031
ApplyingMathToRealLife	171.000	186.000	-2.286	0.022
UsingImagination	230.500	245.500	-1.724	0.085
RelatingToArt	206.500	221.500	-1.937	0.053
ComprehensivePractices	175.000	190.000	-2.210	0.027

The findings in the Table 6 with the Bonferroni-corrected p-value (of.008), indicate that there is significant differences between teachers with B.A. and those with PhD only in Problem solving (U = 87.5, p =.003 <.008). While there is no significant differences between B.A. and PhD in the rest of the teaching practices, which are: Using technology (U = 330.5, p =.424 >.008); Guessing and trying (U = 254.5, p =.133 >.008); Mathematical reasoning (U = 224, p =.076 >.008); Divergent thinking (U = 207, p =.053 >.008); Problem posing and research (U = 182, p =.031 >.008); Applying Mathematics to real life (U = 171, p =.022 >.008); Using imagination (U = 230.5, p =.085 >.008) and Relating Mathematics to Art (U = 206.5, p =.053 >.008). Similarly, the 'overall' Comprehensive variable (U = 175, p =.027 >.008).

Summing up, the findings from the Kruskal-Wallis H Test highlighted significant differences in various teaching practices among teachers with different educational qualifications, namely, in problem solving, applying Mathematics to real life problems and in relating Mathematics to Art, as well as in the 'overall' comprehensive teaching practices' variable. Afterwards, Post-Hoc pairwise comparisons between groups, using the Mann-Whitney U Test along with Bonferroni correction revealed that teachers with a B.A. had higher significant scores than those with a PhD in problem solving. However, among the other academic degrees there were no significant differences observed. This information implies that the level of teacher's educational qualifications (degree) had an impact on certain teaching practices, specifically problem solving, but not on other teaching practices. This suggests further investigations need to be carried out, especially focusing on how different educational qualifications can influence teaching practices that foster MC among students.

Research Question 7

"Is there a significant difference in the responses of the in-service mathematics teachers fostering students' creativity in mathematics with respect to seniority?"

Kruskal-Wallis H Test was conducted to investigate seniority differences in teaching practices. Table C25, Appendix C, and Table 7 present the results of the mean ranks and the Kruskal-Wallis H test respectively.

Table 7

Test Statistics for the Kruskal-Wallis H test, with respect to Seniority

	Kruskal-Wallis H	df	Asymp. Sig.
ProblemSolving	3.823	2	0.148
UsingTechnology	7.953	2	0.019
GuessingAndTrying	0.704	2	0.703
MathematicalReasoning	1.132	2	0.568
DivergentThinking	2.364	2	0.307
ProblemPosingh	5.152	2	0.076
ApplyingMathToReal	6.003	2	0.050
UsingImagination	9.627	2	0.008
RelatingToArt	5.576	2	0.062
ComprehensivePractices	6.191	2	0.045

Table C25, Appendix C, indicates that the mean ranks were least for those teachers with an experience of 6 – 10 years (92.16 – 124.16), and higher mean ranks for those new teachers with an experience less than five years, whereas the highest ranks were found for long experienced teachers of more than ten years (122.00 – 130.33). These mean rank ranges indicate that teachers with a intermediate experience tend to have lowest scores in engaging in the teaching practices that foster MC than their counterparts, while those teachers who are either starting teachers or well experienced tend to have higher scores in engaging in the teaching practices that foster MC than their counterparts.

The findings from the Kruskal-Wallis H Test, Table 7, show that there are significant differences among the levels of teachers' teaching experience for three teaching practices, namely Using technology ($\chi^2(2)$ = 7.95, p <.05), for Applying Mathematics to real life problems ($\chi^2(2)$ = 6.00, p =.05) and for Using imagination ($\chi^2(2)$ = 9.63, p <.05). While there is no significant differences among the levels of teachers' experience for the rest of the teaching practices, which are: Problem solving ($\chi^2(2)$ = 3.82, p =.15); Guessing and trying ($\chi^2(2)$ =.70, p =.70); Mathematical reasoning ($\chi^2(2)$ = 1.13, p =..57); Divergent thinking ($\chi^2(2)$ = 2.36, p =.31); Problem posing and research ($\chi^2(2)$ = 5.15, p =.07) and Relating Mathematics to Art ($\chi^2(2)$ = 5.58, p =.06). Whereas, there are significant differences found for the 'overall' Comprehensive teaching variable ($\chi^2(2)$ = 6.19, p <.05).

Therefore, the existence of significant differences among the levels of teachers' teaching experience in some of the studied teaching practices as well as in the 'overall' comprehensive teaching practices' variable indicate that teachers' teaching experience influence their implementation of teaching practices that foster MC among their students.

Post-Hoc Pairwise Comparisons Using Mann-Whitney U Tests with Bonferroni Correction

Similarly, since the results from the Kruskal-Wallis H Test indicated significant differences in various teaching practices, then a post-hoc analysis was carried out.

Comparison between teachers with (1 – 5 years) and (6 – 10 years) of experience

Accordingly, Mann-Whitney U Test was conducted in order to carry pairwise comparisons among the pairwise comparison groups of teachers' seniority. Table C26, Appendix C, presents the mean rank and the sum of ranks for pairwise comparison across all teaching practices.

Table C26, Appendix C, indicates that teachers with (1 – 5) years of experience had higher mean ranks and sum of ranks for all teaching practices except for Divergent thinking. Similarly, the mean ranks as well as the sum of ranks were higher for those with (1 – 5) years of experience than those of (6 – 10) years in the 'overall' Comprehensive teaching practices.

Conducting the Mann-Whitney U Test between groups of seniority levels, and applying the Bonferroni correction, there are three groups in the Seniority (≤ 5), (6 – 10), and (> 10) years. Thus, there are three comparisons to be made: (≤ 5, 6 – 10), (≤ 5, > 10) and (6 – 10, > 10). The adjusted p-value is calculated: $p = 0.05/3 = 0.0166 \approx 0.017$.

Comparison between the first couple of seniority levels in Table 8.

Table 8

The Mann-Whitney U Test comparison between (1-5) and (6-10) years' experience across all teaching practices

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig.
ProblemSolving	737.000	1143.000	-0.812	0.417
UsingTechnology	726.500	1132.500	-0.911	0.362
GuessingAndTrying	785.500	1191.500	-0.373	0.709
MathematicalReasoning	724.000	1130.000	-0.934	0.350
DivergentThinking	728.500	2498.500	-0.894	0.371
ProblemPosing	742.000	1148.000	-0.768	0.442
ApplyingMathToReal	634.000	1040.000	-1.764	0.078
UsingImagination	711.000	1117.000	-1.059	0.289
RelatingToArt	780.000	1186.000	-0.421	0.674
ComprehensivePractices	737.000	1143.000	-0.809	0.419

The findings in the Table 8 with the Bonferroni-corrected p-value (of.017), indicate that there is no significant differences between both groups ((1-5 years) and (6-10 years) experience) for all the teaching practices, which are: Problem solving (U = 737, p =.417 >.017); Using technology (U = 726.5, p =.362 >.017); Guessing and trying (U = 785.5, p =.709 >.017); Mathematical reasoning (U = 724, p =.350 >.017); Divergent thinking (U = 728.5, p =.371 >.017); Problem posing and research (U = 742, p =.442 >.017); Applying Mathematics to real life problems (U = 634, p =.078 >.017); Using imagination (U = 711, p =.289 >.017) and Relating Mathematics to Art (U = 780, p =.674 >.017). Similarly, for the 'overall' Comprehensive teaching practices' variable (U = 737, p =.419 >.017).

Comparison between teachers with (1 – 5 years) and (more than 10 years) of experience

Table C27, Appendix C, indicates that teachers with more than ten years of experience had higher mean ranks and sum of ranks for all teaching practices except for Mathematical reasoning. Similarly, in the 'overall' comprehensive teaching practice the mean ranks as well as the sum of ranks were higher for those of more than ten years' experience.

Conducting the Mann-Whitney U Test between (1-5 years) and (more than 10 years) experience, presenting the results in Table 9.

Table 9

The Mann-Whitney U Test comparison between (1-5) and (> 10) years' experience across all teaching practices

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig.
ProblemSolving	4043.500	5813.500	-1.180	0.238
UsingTechnology	3736.500	5506.500	-1.955	0.051
GuessingAndTrying	4336.500	6106.500	-0.448	0.654
MathematicalReasoning	4481.000	16262.000	-0.082	0.935
DivergentThinking	3906.500	5676.500	-1.534	0.125
ProblemPosing	3902.000	5672.000	-1.540	0.124
ApplyingMathToRealLife	4206.000	5976.000	-0.781	0.435
UsingImagination	3673.000	5443.000	-2.126	0.033
RelatingToArt	3770.000	5540.000	-1.869	0.062
ComprehensivePractices	3839.500	5609.500	-1.684	0.092

The findings in the Table 9 with the Bonferroni-corrected p-value (of 0.017), indicate that there is no significant differences between both groups ((1-5 years) and (more than 10 years) experience) for all the teaching practices, which are: Problem solving (U = 4043.5, p =.238 >.017); Using technology (U = 3736.5, p =.051 >.017); Guessing and trying (U = 4336.5, p =.654 >.017); Mathematical reasoning (U = 4481, p =.935 >.017); Divergent thinking (U = 3906.5, p =.125 >.017); Problem posing and research (U = 3902, p =.124 >.017); Applying Mathematics to real life problems (U = 4206, p =.435 >.017); Using imagination (U = 3673, p =.033 >.017) and Relating Mathematics to Art (U = 3770, p =.062 >.017). Similarly, for the 'overall' Comprehensive teaching practices' variable (U = 3839.5, p =.092 >.017).

Comparison between teachers with (6 – 10) years and (> 10) years of experience

The findings from Table C28, Appendix C, show that, for all teaching practices as well as the 'overall' comprehensive teaching practices variable, the rank values and the sum of ranks are higher for teachers with more than ten years of experience than those with (6

– 10) years of experience. Conducting the Mann-Whitney U Test between (1-5 years) and (more than 10 years) experience, presenting the results in Table 10.

Table 10

The Mann-Whitney U Test comparison between (6-10) years and (> 10) years' experience across all teaching practices

	Mann-Whitney U	**Wilcoxon W**	**Z**	**Asymp. Sig.**
ProblemSolving	1694.5	2100.5	-1.766	0.077
UsingTechnology	1540	1946	-2.38	0.017
GuessingAndTrying	1942	2348	-0.794	0.427
MathematicalReasoning	1880.5	2286.5	-1.034	0.301
DivergentThinking	2137	13918	-0.02	0.984
ProblemPosing	1651	2057	-1.941	0.052
ApplyingMathToReal	1540.5	1946.5	-2.395	0.017
UsingImagination	1479	1885	-2.631	0.009
RelatingToArt	1688	2094	-1.792	0.073
Comprehensive	1597.5	2003.5	-2.136	0.033

The findings in the Table 10 with the Bonferroni-corrected p-value (of 0.017), indicate that there is significant differences between the groups (6 – 10 years) and (more than 10 years) only for three practices, namely: Using technology (U = 1540, p =.017); Applying Mathematics to real life problems (U = 1540.5, p =.017) and Using imagination (U = 1479, p =.009 <.017). On the other hand, there is no significant differences for the rest of the teaching practices. These are Problem solving (U = 1694.5, p =.077 >.017); Guessing and trying (U = 1942, p =.427 >.017); Mathematical reasoning (U = 1880.5, p =.301 >.017); Divergent thinking (U = 2137, p =.984 >.017); Problem posing and research (U = 1651, p =.052 >.017); and Relating Mathematics to Art (U = 1688, p =.073 >.017). Similarly, for the 'overall' Comprehensive teaching practices' variable (U = 1597.5, p =.033 >.017).

Summing up, the findings from the Kruskal-Wallis H Test indicated significant differences in various teaching practices among teachers with different length of teaching experience. Particularly, in using technology, applying Mathematics to real life problems, using imagination, as well as in the 'overall' comprehensive teaching practices' variable. As a result, Post-Hoc pairwise comparisons were carried out utilizing Mann-Whitney U

Test along with Bonferroni correction. The findings from the Post-Hoc analysis revealed that teachers with an experience longer than 10 years had significantly higher scores than those teachers with (6-10) years of experience in using technology, applying Mathematics to real life and in using imagination. However, no significant differences were observed, either between teachers with (1-5) years of experience and those with more than 10 years of experience, or between teachers with (1-5) years of experience and those with (6-10) years of experience. This information implies that the length of teaching experience has an impact on certain teaching practices, especially among teachers of longer teaching experience, which emphasizes the crucial role that the length of experience play in promoting MC among students via teaching practices.

Research Question 8

“Are there significant interaction effect between teachers’ academic degree and seniority on the dependent variable of enhancing students' creativity in Mathematics?”

In order to investigate interaction Effects of Academic Degree and Seniority on Teaching Practices by conducting the aligned rank transform (ART). Aligned Rank Transform (Elkin et al., 2021), the researcher had to carry out a comprehensive, thorough analysis using Excel and SPSS. The procedure consisted of transforming the data into adjusted ranked data, then conducting multivariate MANOVA in SPSS on the transformed data, a procedure inspired by the work of (Leys & Schumann, 2010). Conducting a Multivariate Analysis of Variance (MANOVA) on the adjusted rank-transformed data, followed by a post-hoc analysis to assess pairwise differences. The Box’s Test of Equality of Covariance Matrices, shown in Table C29, Appendix C.

The box’s M test shows significant differences in the covariance matrices across groups of teachers’ academic degree and their seniority. Box’s M = 477.45, F = 1.31 and $p < .01$. These findings implies that the assumptions of equality of covariance matrices was violated, and thus, the relationships between the independent groups vary across the groups.

Multivariate analysis of variance (MANOVA) was conducted to assess the main effects of teachers’ academic degree and Seniority along the interaction effect on the teaching practices, presented in Table D1, Appendix D.

The findings indicate that there is no significant main effect observed for either teachers' educational qualifications (Pillai's Trace =.091, F =.696, p =.888) or their seniority (Pillai's Trace =.0102, F = 1.185, p =.263). In addition, neither was there a significant interaction effect between teachers' education and seniority (Pillai's Trace =.258, F = 1.216, p =.147). However, Roy's Largest Root test provides indication for some interaction effects on one or more dependent variables (Roy's Largest Root = 0.114, F = 2.547, p <.01) (Appolus & Okoli, 2022). The results of Levene's Test of Equality of Error Variances is presented by Table C30, Appendix C. The findings from the table of the Levene's Test of Equality of Error Variances show that several teaching practices do not have significant p-values, implying that there is a homogeneity of variance, such as the adjusted rank values for problem solving, using technology, guessing and trying, problem posing, using imagination and relating Mathematics to Art. While the other teaching practices, such as Mathematical reasoning, applying Mathematics to real life and the 'overall' comprehensive teaching practices variable, possess significant p-values indicating heterogeneity of variances among some of their groups.

Assessing the effects of the independent variables, teachers' academic degree and their seniority, along with the interaction effect of both, Education * Seniority, and presenting the results in Table C31, Appendix C. The findings from the Univariate ANOVA's results' table above show that there are no significant main effects or interaction effects for most of the teaching practices (p >.05), while for Applying Mathematics to real life (p =.061) indicating a possible, slight interaction effect.

Since there were some indications for significant effects observed, a Post-Hoc tests were employed using Tukey's HSD test to control for Type I error rates for further investigations. A Post-Hoc analysis helps highlighting the specific group differences within the factors of education and seniority, helps identifying which component of education and seniority differed significantly in affecting the teaching practices, and illustrate comparisons to elucidate the interactions between education and seniority on the teaching practices. The Post-Hoc results are presented in Table C31 in Appendix C. The results revealed that there is no significant pairwise differences between the groups of education or seniority for any of the teaching practices (p > 0.05). This implies that, in spite of the slight differences that were observed between different groups of education and seniority, they still are not considered statistically different. Furthermore, there were no significant pairwise differences between any groups of education (B.A., M.A., PhD) or between any of the seniority groups (1 – 5, 6 – 10 and more than 10) years for the teaching practices.

In summary, investigating the interaction effects between teachers' education and their seniority on adopting teaching practices that foster MC among students have revealed several findings. Though the Multivariate analysis of variance pointed out that there are no significant overall interaction effects, the Roy's Largest Root suggested some possible interaction. Further analysis such as the Univariate ANOVA and Post-Hoc analysis indicated no any significant pairwise differences between the groups of education or seniority for any of the teaching practices. Therefore, there was no detectable evidence that the interaction between academic degree and seniority could have a significant influence on teachers' teaching practices that foster MC.

Qualitative Results

This section presents the main finding from the qualitative method of the study, which consists mainly of semi-structured interviews. The findings from the qualitative data illustrates deeper insights and holistic view of teachers' beliefs and practices in the context of fostering MC among their students in the classroom.

The qualitative method aims to answer the first four research questions:

How do Palestinian 8th – 9th grade mathematics teachers perceive and define mathematical creativity, and how does this perception influence their teaching practices?

In what ways do Palestinian 8th – 9th grade mathematics teachers intentionally design and implement their teaching practices to foster mathematical creativity within the classroom setting?

How do Palestinian 8th – 9th grade mathematics teachers create learning experiences that facilitate the development of students' mathematical creativity?

What are the challenges and the obstacles that Palestinian 8th – 9th grade mathematics teachers face in fostering mathematical creativity in the classroom?

Description of Participants

The twenty participants in the interviews were teachers from public, private, and UNRWA schools. The demographic breakdown is as follows:

Gender: 14 females and 6 males.

Type of School: 11 public, 7 private, 2 UNRWA.

Years of Experience: ranging from 1 to over 10 years.

Description of the participants are given in the Tables C32 and C33, Appendix C.

Coding Analysis

A systematic coding process was conducted in order to analyze the transcripts of the semi-structured interviews. This involved going through sequential stages to affirm a thorough and comprehensive analysis. These stages were, as mentioned in the Methodology Chapter, open (initial) coding, axial coding and selective coding. The analysis was conducted using a qualitative data analysis software, MAXQDA, which helped in organizing the data.

Open Coding

The first coding phase involved an in-depth scrutiny of the interview transcripts, through which segments of text were marked as germane to research questions. Each transcript was perused carefully and codes assigned for specific text pieces that encompassed separate ideas or themes. This phase allowed for the dissection of data into digestible parts and the commencement of pattern recognition and categorization.

Example codes

Each participant described teachers' practices and perceptions about fostering MC. For instance, the participants used codes such as "encourages questions" "integration of digital tools" and "flexibility" This step involved assigning these codes to the teacher's description.

Axial Coding

This phase involved reviewing the initial codes and grouping them into broader categories. The researcher examined the connections between the initial codes to determine how they could be organized around higher order themes. Axial coding is useful for establishing how different codes are connected to each other and to explore their relationship to the main research questions being addressed by the study.

Example of subcategories

The initial codes provided subcategories such as "teaching practices", "challenges" and the "teacher's perception of mathematical creativity". Taking as an example, codes on "integration of digital tools" and "encourages questions" were grouped under the subcategory "teaching practices".

Selective Coding

This is the final phase of the coding analysis in which the main themes were refined and merged into coherent categories that supposed to address the research questions. This stage entailed a careful selection of the core themes that encapsulated the data and clustering them to create an exhaustive narrative.

Example of themes

The author has identified the themes that included "teachers' perceptions of MC", "teaching practices to foster Creativity" "Creating learning experiences" and "strategies and environments". These themes comprised of multiple subthemes that have provided in depth comprehension regarding the research questions.

Using MAXQDA

The data analysis software, MAXQDA was used as part of the data analysis for the coding procedure. It has supported the coding management which involved categorization and organization of codes in a structured manner, allowing for simple visualization with reference to connections between various codes and themes.

The Coding Procedure in MAXQDA

The transcripts of each interview were imported to MAXQDA where the first codes (1st cycle) in a segment-by-segment manner. Its tools for categorization and code-linking facilitated this transition from initial to axial- selective coding through the software. MAXQDA was used to count the frequency of each code and co-occurrence amongst codes, quantifying qualitative data.

Development of Themes

The themes were developed via an iterative cyclic process which involved several coding and literature readings repeatedly to accomplish theme refinement. This continuous procedure was employed to ensure that the refined themes truly emerged from the data and precisely describes the participants' views. Following this coding process, the researcher have thoroughly analyzed the qualitative data from the semi-structured interviews' transcripts in order to produce useful, reliable understanding of the posed research questions. This painstaking procedure ensured that the proposed themes were intact and fully grounded in the data.

Key Themes Identified

The analysis process of the interviews' transcripts has produced key themes that are related to the research questions. The main key themes as well as their subthemes are given below:

Theme 1: Teachers' Perceptions of MC

Teachers have expressed how they perceive MC, especially in their students, and these beliefs were synthesized and categorized in the following subthemes.

Subtheme 1.1: Originality and novelty

All teachers have emphasized that originality and novelty are of the main constituents of MC. Teachers frequently have pointed out that MC is expressed by an original thoughts and ideas as well as unique unfamiliar solution methods. The following are few quotes by participants:

Teacher 2: A female teacher holding an M.A. in Mathematics, with an experience of 6 years and teaches at a public school for girls, expressed her perception of MC as: "It is implementing something new, aaa a new idea, or an innovative way of solving problems, aha, something unfamiliar and out of the ordinary. This is opinion about what Mathematical creativity means".

Here teacher 2 highlighted the originality aspect (implementing something new, new idea) as well as novelty (innovative way of solving problems).

Teacher 8: A female teacher holding a B.Ed., with an experience of 29 years and teaches at a public school for girls, replied:

"Creativity is supposed to be something unfamiliar? More than the usual, for me, I mean, for example, when I ask a question in class, I mean, her answer is something distinguished? In this way, the girl will be creative in her solution, and I will have this creativity. From my point of view, it means something that is not familiar to the girls. I mean, it is not among the usual solution methods presented in the book or I have taught them, for example, but the solution depends on what she took, from my point of view, is creativity."

Here the teacher also emphasizes on originality and on novelty.

Subtheme 1.2 Fluency and flexibility

Only few teachers have mentioned fluency and / or flexibility as a feature or representative of MC. The following are few quotes by participants:

Teacher 3: A male teacher holding a B.Ed., with an experience of 20 years and teaches at a public school for boys responded:

"… It is (MC) that the student responds quickly on the spot and gives a correct answer, eh… you know what, I had few students who sometimes even responds so quickly that I believed they were able to predict what I was going to ask"

Here the teacher emphasizes on fluency (immediate responds and accuracy).

Teacher 4: A female teacher holding a B.A., with an experience of 23 years and teaches at a private school for girls added:

"to me, the Mathematically creative girl is that one who receives the information but doesn't constrain herself to my methods of solution to problems, on the contrary, she always tries to find alternative methods, I had a girl in class nine who always tries to find other methods of shortcuts, her own shortcuts, ehhh, and she usually finds her own correct shortcut. And when I present two methods for the solution, one is from the textbook and the other different, she would comment: I will try to find another way of doing it because there must be another way”

Here the teacher highlighted the flexibility aspect by saying that the student finds or tries to find more than one method of solving problems.

Lack of conception

It is worth noting here that none of the teachers has mentioned ‘elaboration’ and/or ‘communication’ as aspects (components) of MC, in accordance with literature (Agustina et al., 2024).

Misconceptions

Moreover, several teachers have shown misunderstanding or misconception of the term MC, they have mixed it up with diligence, achievement, intelligence and motivation. The following are few examples:

Teacher 1, A male teacher, holding an M.A., with an experience of 11 years and teaches at a public school for boys, expressed his conception of MC as:

“aha, ah… its meaning to me, look! Talking about students, it is mastering the assigned tasks that are set to them, … eh. OK, that’s how I see a mathematically creative student if he mastered the tasks I set for him”

Here, the teacher mixes up with student’s ability to master the learning tasks set for him.

Teacher 10, A female teacher, holding a B.A., with an experience of 23 years and teaches at a mixed (coeducation) private school. She saw that MC as: “when a weak student studies hard and enhances his grades in Mathematics and elevates to an average student level, to me this is mathematical creativity, aha, eh… mathematical creativity is to be able to improve someone’s grades in Mathematics”. Here the teacher perceives learning improvement and achievement with MC.

Theme 2: Teachers’ Practices that Foster Creativity

While describing their teaching practices, teachers have revealed several teaching practices that do foster MC among their students.

Subtheme 2.1 Problem solving and problem posing

Several teachers have mentioned encouraging problem solving and problem posing as part of their teaching practices. The following are some examples of quotes by some teachers:

Teacher 2: A female teacher holding an M.A. in Mathematics, with an experience of 6 years and teaches at a public school for girls. She talked about an experience with one of the students:

"While I was solving a problem, a boy asked me a question, look! I am telling you something that really happened to me. That boy asked me about something that really chocked me, I told him 'how did you think about that, even I haven't thought about it!' He asked about an idea that was very brilliant and I never had thought about it that way, I encourage him and I guided him and his classmates to reach to the solution"

Here the teacher encourages her students to pose strange questions.

Teacher 4: A female teacher holding a B.A., with an experience of 23 years and teaches at a private school for girls, expressed her teaching practices:

"I do feel real excited when the girls ask me questions, especially those questions that make me think hard to answer. I show the girl my appreciation of her innovative question, I transfer the question to the whole class, and all the time I refer to the question as (the girl's name)'s question which makes the girl happy and motivated to learn"

The teacher her highlighted few points, firstly that she allows and encourages posing questions, secondly that she transfer the question to the whole class, creating a class discussion.

Teacher 9: A female teacher, holding an M.A., with an experience of 6 years and teaches at a public school for girls. She describes the type of questions that she poses to her students:

"I like to pose all kind of questions, closed questions and open-ended questions, but as for me I actually like those open-ended questions, no, ah, I mean I really,.. those open-ended questions let you see deeply how students think, different students give different correct answers, and sometimes the same student gives me, not at the same time, different answers, eh, eh you know how much does this way expands their horizons (thinking range)”

She explicitly mentioned how essential to her to ask the students open-ended questions, as a main component of an open-atmosphere environment, to widen their cognitive thinking and thus, foster their Mathematical thinking. Then she added:

“… when I address a problem, I always expose to them (the students) almost every possible way of solving the problem, then I give them the choice to use whichever way they liked most and find it easier when solving problems for homework or on the test”

She uses multiple solution strategies in addressing Mathematical problems to her class.

Subtheme 2.2: Diversity in teaching methods vs. traditional lecturing

Some teachers have expressed their continuous changing in their teaching methods according to the content of the current lesson, some of whom are presented below:

Teacher 2: A female teacher holding an M.A., with an experience of 6 years and teaches at a public school for girls. She explains how she employs diverse teaching methods: “…in addition, eh… and sometimes I use project-based learning method where I partition the class into groups and each group has to work on a project together”. She uses here project-based learning method besides her regular teaching method. Then she added:

“… I love to change my teaching methods, because every lesson in Mathematics needs a different teaching method. I don’t, I don’t use the same pattern of teaching because this would be boring. And when I feel that the students didn’t master the learning tasks I wanted them to, then the first thing I think of is changing my teaching way, and I support my students’ learning by making worksheets to use in the next lesson in which I use another method”

The teacher mentioned that she oscillate between teaching methods according to the need of the learning process.

Teacher 3: A male teacher holding a B.Ed., with an experience of 20 years and teaches at a public school for boys responded. He replied to the question on the teaching methods he uses by saying: “most of the time I teach using several methods, every lesson should have its own special teaching method. But some classes that are weak, I have to use other teaching methods that are appropriate to their levels”, When asked to elaborate, he added:

“I meant that I might use the, you can say same method, eh, of same name of method to two nine grade classes, but I would employ easier, shorter and less tasks for the weak class and harder, longer and more tasks to the stronger class”.

Teacher 3 mentioned that he uses a variety of teaching methods, but he emphasized that any teaching method should take into considerations the students’ level in such a way that the method must include tasks that are appropriate to their abilities.

Teacher 6: A male teacher, holding an M.A., with an experience of 18 years, teaches at a public school for boys. He describes his teaching methods as:

“you see, to me, in order to implement creativity in mathematics among students, it is the teaching strategies. We must look for various teaching methods, not the same method, and not only any methods, but those that bring the boys (students) toward mathematics, I mean attractive methods. I always use games and puzzles, thinking puzzles that are relevant to the content of the lesson in order to attract the boys to the lesson, and you know what? It works just fine with me. The boys are happy, excited to learn the lesson and are active in class. It is true that they don’t all master everything, but everyone accomplish at least half of the tasks I set”

The teacher explains in details a variety of things here, he shed light on the fact of using a variety of teaching methods that he uses, in addition to the quality of these methods to be attractive and interesting to students. Moreover, he mentioned using games and puzzles as well.

Teacher 9: A female teacher, holding an M.A., with an experience of 6 years and teaches at a public school for girls. She expresses her various teaching methods:

“aha, as for teaching strategies, of course I sometimes use the traditional teaching, but I of course use many others, such as project-based learning, the five-hats strategy, peer-learning strategy, collaborative learning, and many other strategies which I can’t remember right now”

She exclusively mentioned the names of the various strategies that she uses in her classes.

Teacher 10, a female teacher, holding a B.A., with an experience of 23 years and teaches at a mixed (coeducation) private school. She explained her teaching methods by saying: “teaching methods, aha, I.. I don’t believe in a fixed teaching method, there must be changing. Every time I must use a different method, I worry a lot about how can I let these girls understand this lesson?”. She keeps thinking about how to have her students learn, which leads her to change her teaching method accordingly.

Traditional lecturing

Few teachers preferred the traditional lecturing rather than diverse teaching method, for example:

Teacher 1, A male teacher, holding an M.A., with an experience of 11 years and teaches at a public school for boys, explains his teaching methods by saying:

“you know, eh… Mathematics content for grades 8 and above is somehow abstract, o..or actually it is totally abstract, and this abstractness requires me as a teacher just to write the rule or formula on the board and explain the conditions of that rule”

Here the teacher implicitly says that he adopts the traditional lecturing method in his teaching, then he added: “yes, not only conditions of the rule, oh, but of course, I also present to them (the students) examples, in other words it is the lecturing method”, mentioning the lecturing method exclusively. Moreover, he justifies the non-diversity in his teaching methods by saying:

“you know it would be possible to use other teaching methods for younger..eh.. lower grades, but not for 8 – 9 graders whose lessons are all abstract”. Then, when asked if he has ever tried using other teaching methods, he replied:

“yes, yes long.. long time ago I tried once teaching by groups, but oh my God, it was chaos, the boys made lots of fuss and it didn’t work at all, you see we have a discipline problem in classes, so I never tried it again. As I have told you before, my method, only method is lecturing, traditional lecturing”

Teacher 8: A female teacher holding a B.Ed., with an experience of 29 years and teaches at a public school for girls, expresses her basic teaching method as:

"Look mister, I have seen several teaching methods in the PD course, long time ago, but look, the most important thing for me is the chock and the board, I don't recognize any other method. Sometimes I present examples and then deduce the final rule and other times I present the final form of the rule and then show them examples"

Here the teacher explicitly mentioned her preference of using traditional lecturing method, moreover, she mentioned that she uses the lecturing inductively (from examples to general rule) and deductively (from general rule to examples). Then, she added:

"I will never give up this method (by lecturing), very rarely that I might use, for once a year, the projector to show the girls a video lesson, but I solve a variety of examples, I don't just stick to the given examples presented in the book, but I add many examples from outside the book"

The teacher insists on sticking to the lecturing method of teaching.

Subtheme 2.3: Integrating Classroom Discussions and Engaging Students

Classroom discussions was mentioned as an inevitable part of every lesson by most of the teachers.

Teacher 4: A female teacher holding a B.A., with an experience of 23 years and teaches at a private school for girls. She explained some of her teaching methods:

"I always insist on having a classroom discussion in every lesson, aha, I, … I love to see the interaction among the girls when one girls suggests a way to solve a problem, and the other would suggest a different way, and sometimes both of their ideas are correct, then I raise the question which way would be simpler, which way is faster, and so on"

The teacher mentioned both, classroom discussion and student engagement as well.

Teacher 7: A male teacher holding a B.A., with an experience of 14 years and teaches at a mixed (coeducation) private school. In expressing his teaching methods, he said:

"it is something very crucial to me to held a classroom discussion in every lesson, you know what, if there weren't a discussion in a lesson then I consider that lesson a failure. If I just lecture, and eh.. there weren't any interaction with students, then this means that I haven't accomplished any of the learning goals that I have set. There must be interactive discussion"

The teacher mentioned exclusively class discussion as an essential part of every lesson, and then he added:

"The discussion doesn't have to be about the core subject of the Mathematical knowledge, but it can be about Mathematics in general, or about the lesson's applications in reality, for example, the other day we had a discussion about the leaning of Pisa tower, its length and its height and how it can be visualized in terms of geometrical planar shapes (right-angle triangle), and then relate it to trigonometry here, and so on.."

Here the teacher emphasized the importance of having a discussion in class, not only as a core subject learning, but also for motivational purposes.

Subtheme 2.4: Integration of Reasoning and Concept-Based Learning

Several teachers emphasized the importance of implementing reasoning and concept-based learning in their lessons, especially when teaching a certain problem-solving skill or derivation of a Mathematical formula.

Teacher 8: A female teacher holding a B.Ed., with an experience of 29 years and teaches at a public school for girls. While explaining her teaching methods, she added:

"While I present a solution for a problem, for example, I emphasize on two things in every step, I emphasize on the Mathematical concept and previous skills that the girls know, so you can say that I merge the skills that the girls already know from previous years or lessons with basic Mathematics concepts and I relate them to the problem we are addressing. This way takes my girls (her students) half way of the solution process and makes the problem more clear (lucid) and of course simpler"

Integration of concept-based learning as well as meaningful learning is obvious in the teacher's teaching practice.

Teacher 15: A male teacher holding an M.A., with an experience of 19 years and teaches at a private school for boys. He explained part of his teaching methods:

"Look mister! Explaining the solution steps and giving reasoning is very important, as I always believe that I must know how students think, I must understand why he think that way. I believe in this, I believe that learning Mathematics is about justification, is about reason, you don't just write something and say I think so, or it is an opinion, no, there is logic and reason, that what makes a small step either right or wrong, no step can be 70% right and 30% wrong"

The teacher emphasized on logical justification and implementation of reasoning in his teaching method.

Subtheme 2.5: Multiple representations

Several teachers have mentioned that they usually try to teach their lessons via different forms and using different demonstration tools, thus implementing 'multiple representations' in their teaching.

Teacher 2: A female teacher holding an M.A. in Mathematics, with an experience of 6 years and teaches at a public school for girls. She described her algebra lesson saying:

"For example, in the Algebra unit, for class 8, I illustrated and explained the difference between two squares formula by cutting out squares, I bring a cardboard square and I draw on one corner another smaller square, I cut off the smaller square and discuss with the girls how to find the remainder area. You know, and step by step, I write on the board the resulting algebraic term for each step, I deduce to them the formula of the difference between two squares"

Integration of technology along the writing on the board is obvious in the teachers' teaching method.

Teacher 9: A female teacher, holding an M.A., with an experience of 6 years and teaches at a public school for girls. She explained how she teaches volumes and surface area of geometrical shapes:

“In the geometry unit for grade 8, I draw the three dimensional shapes on the board, you know, cylinders, cones, prisms, cubes, cuboids, pyramids, etc. and I show the girls the concepts of volume and surface area, then I don’t present to them the general rule for the volume or the surface area, instead of that, I bring with me these 3 dimensional shapes, these are hollow shapes which you can fill up with sand, yes I bring sand with me too to class, and I let several girls demonstrate to class by filling up a cone for example with sand, the girls see how that girl fills up the cone with sand three times with the same amount of sand used to fill up a cylinder of same base (circle). Thus they actually see that the volume of the cone is one-third that of a cylinder of same base, and so forth, etc.”

The teacher uses real tangible tools, which the students observe to represent the general algebraic formula for the volume of three-dimensional shapes, an illustration of multiple representations in her teaching methods.

Teacher 11, A female teacher, holding a B.Ed., with an experience of 16 years of experience, she teaches at a private school for girls. She explained how she makes her lessons more interesting:

“The girls usually are much more active and happy about the lesson content when they understand the purpose of learning that lesson, or its connection to their everyday real life. For example, when I showed them the relationship between the quadratic equation with real life views, before ever talking about the quadratic equation graph, I asked them to bring for the next lesson pictures that contained a U-shape in its form. I brought pictures too, then I demonstrated to the whole class what each girl has brought and I drew on the board sketches of these pictures. They were arcs of churches, arcs of mosques, branches of palm trees, a fountain water flow, a waterfall, a path of a football in the air, a missile, etc. then we concluded the common shape of all these was the U-shape which I told them it is the graph of the quadratic equation. Afterwards, I gave them as an assignment for fun, to make drawings with colors of anything they want but they are allowed to us only U-shapes in every part of their drawing, and they did very beautiful drawings which we posted on the wall of the classroom”

Multiple representation is integrated in the teacher’s method, she used pictures and integrated real life situations, she has engaged her students in bringing these examples, she has integrated art in the lesson by letting the girls draw with colors pictures related to the content of the lesson which made the lesson more exciting and interesting to the girls. Moreover, by requesting that the girls only use U-shape in their drawings, made them use their imagination too. She has acknowledged their drawings by posting them on the wall.

Teacher 14: A female teacher, holding an M.A., with an experience of 11 years, teaches at a mixed (coeducation) private school. She added about her teaching methods:

"I want to share with you a new experiment that I have conducted this year, my colleague at the same school has told me about it, it is that I allow my students to use their smart phones in class, you know it was a risk for me and strange too, especially that it is not allowed to let students use their phones in class, actually they have to pass their phones in the morning to their class teacher. However, I took a special permit from the principle and he let me do it after telling me that I will be responsible for any consequences. So, after spending one period on lecturing and summarizing the rules of graphing the quadratic function the usual traditional way, the next period I guided them to download GegGebra graphing App on their phone, and I taught them how to use it by demonstrating on the smart board, then they used it in class to draw graphs assigned to them by a worksheet. The whole class was active, even the very weak girls and boys they even did it"

Using of digital tools after presenting the concepts and main rules of drawing the quadratic function with its various shifts is a clear illustration of integrating multiple representations in her teachings.

Subtheme 2.6: Outdoor activities

Even though only two teachers have mentioned that they implement outdoor activities sometimes, but they are worth mentioning. Outdoor activities is considered as one of the components of an open-atmosphere environment.

Teacher 5: A female teacher, holding a B.Ed., with an experience of 18 years, teaches at a mixed (coeducation) public school. When describing her methods of teaching, she added:

"Ok, look! A theorem, let me tell you about Pythagoras' theorem, Pythagoras' theorem, I always take them (the students) outside to the playground, we set three points on the ground and we draw triangles, we us a meter (measuring tape) and I let them carry out all the measurements. We also use calculators to apply Pythagoras' theorem to know which triangle is a right-angle one. This is called the opposite of the Pythagoras' theorem, this is the applied activity that we do for that lesson"

The teacher explains in details how she implement an 'open-atmosphere environment' method in her teaching of the Pythagoras' theorem.

Teacher 15: A male teacher holding an M.A., with an experience of 19 years and teaches at a private school for boys. The teacher describes his outdoor activity for the geometry lesson for grade 8:

"ha, aha..aaa I in the Geometry Unit for grade 8 I love to take my students to the yard (playground) few times so that they draw geometrical shapes and measure the sides and calculate the areas. I divide the students into groups of four or five, I give each group a chock and a meter (measuring tape) and I give them tasks to draw and measure geometrical shapes, we make contest among the groups to see which group will come up with best shapes and whose calculations of the areas are correct and like this and all the students interact and participate meaning the activity is exciting"

The teacher describes several methods into one by conducting this activity; he uses an 'open-atmosphere environment' method, with collaborative learning and gamification. A compound out of ordinary strategy.

Exceptions: Teachers' Practices That Do Not Foster MC

There were few teachers whose teaching practices do not foster MC:

Teacher 1, A male teacher, holding an M.A., with an experience of 11 years and teaches at a public school for boys. He expressed his teaching of problem solving strategies and Mathematical skills by saying "I.. I present the solution by writing it on the board, and make sure that the students copy it", and when asked about the details and explanation of the steps of the solution, he added:

"no… no I don't have to, it is not required from us (teachers) to explain the details". Moreover, in talking about how does he relate the lesson with real life problems, he said: "no, no … eh… you see, we are talking about grade 8 and 9, if I were teaching lower grades, say grade 4 or 5 I could make relationship with real life problems, but for grade 8 and 9, the content is abstract and you can’t find connection with real life problems to majority of lessons”

Afterwards, I asked him about digital tools and technology, he commented

“I think students now are in class 8 and 9, they supposed to be and should be learning abstractness, there is no need to use cardboards and pictures, they are not young kids. Also, we don’t have a smart board in the classrooms, but we have a projector and a computer, a laptop, also there is a computer room in the school, but I never used any of these”

Moreover, when asked how he prepares for a lesson that would foster MC among his students, he replied: “To tell you the truth, I have never thought of doing so, I never had in mind fostering creativity when preparing for my lessons. I told you before, my students are weak”

Teacher 17: A male teacher, holding a B.A., with an experience of 4 years, teaches at a public school for boys. When asked about his diversity in teaching problem solving strategies, he replied: “no, as I mentioned before to you, mister, our students are weak, they barely can understand one method and I will be grateful. So I only present one, but the simplest strategy so that they can understand it well”. Thus, explicitly mentioning his belief in the low potential of his students, and accordingly, he teaches them one solution strategy.

Theme 3: Teachers’ Features

The interpretation of the semi-structured interviews’ transcripts has revealed two categories of teachers’ features, each being consistent with these teachers’ practices as fostering or hindering MC among their students.

Subtheme 3.1 Teachers’ features that foster MC

The analysis revealed these teachers’ features which are, according to literature, features of teachers who do foster MC among students. It was noticed that these features were found mostly by those teachers whose teaching practices also foster MC.

Teacher 2: A female teacher holding an M.A. in Mathematics, with an experience of 6 years and teaches at a public school for girls. When asked about how does she set the learning environment in her classes, she said:

"I always tell my girls (students) that they are allowed to use any strategy when solving a problem, even if she has learned it from resources other than me or the book, I tell them that's it is OK to make mistakes, that's how you learn, when you try".

Indicating the safe and encouraging learning environment that she set for her students, in addition to her flexibility in dealing with her students. Moreover, she expresses her willingness to develop and learn: "I always love to consult my colleagues who are of longer teaching experience, this is a good chance for me to learn". She also added, "I love to take advantage of every professional development course that I take, every course that I take I find new useful tools that I can use in my classes". The teacher expressed herself as a learner and her willingness to develop on individual bases and via the PD courses that she attends.

Teacher 4: A female teacher holding a B.A., with an experience of 23 years and teaches at a private school for girls. She described her students as: "I see that creativity is within average girls (of a moderate level) who don't usually study hard but they rely on their understanding and they always come up with their own solution strategies", then she added:

"… most of the girls are creative, but it is that we don't notice it because not all the girls like or can show it, it needs us, the teachers, to help them express it and show it and make use of it".

The teacher has a strong belief in her students' potentials and emphasizes on the role of the teacher to help extracting out that potential and creativity. Afterwards, when asked about her teaching methods, she said: "I always try to change and improve my teaching; I never teach using the same method, every year I change", and she added:

"I always learn and learn more about teaching methods, I always search on the net, looking for new methods, new strategies to solve certain problems, even worksheets and enrichment exercises and tests, I don't copy but I observe several resources and I learn some ideas, then I build my own. I even sometimes watch videos for teachers…. Last year I attended a course on GeoGebra and I learned it very well, and now I use it a lot, it helps me so much”

The teacher expresses herself as a learner, willing to develop her teaching methods as she apply what she learns. Moreover, she expressed her passion for Mathematics by saying:

“I love Mathematics and everything about it, I see Mathematics in everything, I see its beauty, that’s why I love my girls (students) to see eh…to feel to understand it so that they can enjoy it as much as I do… I always tell them this: the moment you understand Mathematics is the moment you feel the excitement and joy of it”

Not only she expresses her passion for Mathematics, but also she wants to reflect this passion onto her students.

Teacher 6: A male teacher, holding an M.A., with an experience of 18 years, teaches at a public school for boys. The teacher expresses his opinion about factors that foster MC among students:

“Most importantly, it is that the students must have a positive attitude toward Mathematics, and this is just a consequence of their positive attitude toward the Mathematics teacher, so, firstly they must like their teacher. And for this to happen, there must be a good relationship between the teacher and his students. Ah… this is to say, back to the first step, it is the teachers role to build a good respectful relationship with his students. That’s why I always try to build this by treating them like my own kids, show care for them, help everyone with many things even outside the classroom, in the playground, the more you show caring and love the more they like you”

The teacher highlights the main basic block for learning in general; it is the good relationship between the teacher and his students. He describes how he approaches his students in building that good relationship, which reflects on students to be more interested in the subject, and thus giving opportunity for the teacher to foster creativity among those students. In addition, he explained this relationship further by saying: “Also when I teach them more than one strategy to solve certain problems, I give them the freedom to choose any way they like in solving homework and test problems”. Indicating the free environment to learn that he sets for his students; and the flexibility in the teaching-learning process that he adopts. These attitudes seem to be formed from his intrinsic belief in learning and developing, as he said: "… many things I learn from various resources, from my own experience, from observations that I made of colleagues' lessons, and even from the net". Then he added: "I love to try to use every method I learn, some methods don't work of course, but then I do some adjustments on that method and it works". The teacher is persistent to develop and promote his teaching methods. Not only he wants to learn some new methods, but also he apply these methods and do the proper adjustments to make good use of his knowledge. Moreover, he added:

"It is true that professional development courses might not be very useful, but there is no course that I took without being benefited from it, I must get out of the course by something new that I learn and use in my classes, and there is always something new to learn".

The teacher shows his positive attitude toward professional development courses, as it is clear in his own words, it is not the courses that were actually useful, but it is the teacher himself.

Teacher 8: A female teacher holding a B.Ed., with an experience of 29 years and teaches at a public school for girls. While talking about the overly comprehensive textbook problem, she said:

"I.. instead of running fast in order to cover all the material in the book, the last unit in grade 8, the Probability unit, usually teachers either teach part of it or just skip it. But I don't, I summarized the unit, and I designed self-explained worksheets with exercises, this saved lots of time and we were able to cover the whole book and the girls didn't lose anything"

The teacher's action reflects her caring toward her students' learning. Finally, she expressed her passion for Mathematics: "I do love Mathematics more than you can ever imagine, since I was in the first grade till today and I love Mathematics, my grade average in Mathematics was always above 90 all my life".

Teacher 13: A female teacher, holding a B.A., with an experience of 7 years, teaches at a public school for girls. She said about how she introduces herself to her students at the beginning of every academic year:

“From the first day of school, in every class that I teach, I introduce myself, then I emphasize to the girls, anything that you don’t understand ask me about it, no matter how small or large it is, ask! I will never put you down, I will always be there for you to show you what and how. There is nothing that you can’t understand or can’t do, I will support you and be beside you step by step until you do. But you must ask me about it, don’t be shy! Eh…. but still you see, there are girls who still are shy to ask”

The teacher shows her caring and full support to her students, especially on the first day of school, which is the first step in the student-teacher relationship.

Teacher 19: A female teacher, holding an M.A., with an experience of 16 years, teaches at an UNRWA school for girls. She expresses how she acts when she feels that the learning goals are not fully accomplished:

“When I notice that the girls don’t understand the lesson, then right away, I switch to a different method, I sometimes unlock my phone and let a girl use it an open on Google, and I ask her to ask for the picture of something relevant to the lesson, she shows her classmates the picture. Sometimes I switch to create a puzzle on the board, sometimes I tell them a story, I am always ready and I have plenty of methods. The flexibility in changing the method always saves the situation”

The teacher speaks proudly of her flexibility in changing her teaching methods upon requirement of the teaching situation.

Subtheme 3.2 Teachers’ features that hinder MC

Teacher 1, A male teacher, holding an M.A., with an experience of 11 years and teaches at a public school for boys. When he was responding to the interview questions, he mentioned several times that his students are very weak:

“eh.eh… you are asking me about creativity, you know what, reality is bitter, my students barely understand low level material, they barely master the given strategies in the book, and they don’t want to, I wish, eh.. I wish I had such students who are able to think of different methods or even who want to know any of them”

"….I told you before, my students are weak", and "my students are of very low achievement, but may be, they may be creative in something else". All these responds indicate the teacher's non-belief in his students' potentials.

In addition, when asked about the professional development courses, he replied:

"To tell you the truth, I … anything called 'Education' I don't like, eh, that's why I have studied a master in pure Mathematics, because I don't like anything related to educational theories. eh, also as for the professional development courses, I participate in these courses, I see that they are, theoretically speaking, they are fine, but not applicable in our context, in real life, that's why I even stopped attending these courses, these courses are based on theories from different cultures, not from ours"

A clear and obvious negative attitude toward professional development courses, and not willing even to try any of the theories he was exposed to.

Teacher 17: A male teacher, holding a B.A., with an experience of 4 years, teaches at a public school for boys. When asked about who is the Mathematically creative student, he replied: "I think only very few students might be mathematically creative, but mostly, no, they are very few who are..". A direct indication of his non-believing in his students' potential.

When asked about his opinion of the professional development courses, he answered: "The professional development courses, as you know, are mandatory, so I have to attend them non-voluntarily, but still I find them useless, not much to learn from, they don't fit within the scope of my teaching methods". He frankly mention his non-interest in professional development courses or from learning any new teaching methods.

Theme 4: Obstacles Hindering MC

Every teacher has mentioned the existence of some obstacles that hinder their implementation of MC among their students.

Subtheme 4.1 Inappropriate textbooks

Most of all the teachers have mentioned that the textbooks are the main obstacle against nurturing MC. They all have mentioned the same hindering features of the textbooks.

Teacher 6: A male teacher, holding an M.A., with an experience of 18 years, teaches at a public school for boys. He complained about the official textbooks saying:

“There are few challenges that we face, aha, a..a.. the textbook, very clustered, too many units to teach, and it is not well structured”. Here the teacher mentioned that the textbook is clustered with lots of material to be taught to students.

Teacher 10, a female teacher, holding a B.A., with an experience of 23 years and teaches at a mixed (coeducation) private school. She commented on the official textbooks:

“School textbooks need lots of modification, I mean, not enough illustrating examples, and the current examples are narrow, superficial questions, there aren’t any creativity fostering questions, or high levels questions, all questions are obvious and direct, where is the creativity in asking: solve the exponential equation: two to the power x equals eight! Where is the creative part here?”

The teacher’s concern is about the shallow level of the content in the school textbook, while having the students exposed to such narrow, superficial questions would limit their creative thinking.

Subtheme 4.2 Short time

Another subtheme that equally mentioned as textbooks by most teachers is the short of time. They mean not enough number of Mathematics lessons per week. Every grade gets five 45-50 minute lessons of Mathematics per week.

Teacher 2: A female teacher holding an M.A. in Mathematics, with an experience of 6 years and teaches at a public school for girls.

She said about challenges she faces: “In addition to that.. every semester, we only have five lessons per week, just five, and this number (of lessons) is not enough for teachers to foster creativity in their students, so the time factor is the biggest factor”. The teacher complains about the number of lessons per week is not enough. This factor is actually a consequence of the first factor, when there is too much content material to cover from the official textbooks, thus, there would be not enough time.

Teacher 15: A male teacher holding an M.A., with an experience of 19 years and teaches at a private school for boys.

"The challenges are actually the number of lessons per week is very little..five lessons. I mean, there are many lessons that require two successive periods directly one after the other in order to be able to elaborate and enrich the lesson and really foster creativity. This would be really very exciting to have"

The teacher here not only mentioned the problem of having not enough number of lessons per week, but also he has added the reason for the need of more lessons, which is to have two successive periods in order to foster creativity.

Subtheme 4.3 Large number of students per class

Most teachers have also mentioned this subtheme as a serious obstacle against fostering creativity in class.

Teacher 9: A female teacher, holding an M.A., with an experience of 6 years and teaches at a public school for girls. She described her class numbers by saying:

"As a serious challenge we have is that the number of girls per class, the classes are clustered here, I am talking about forty to forty-five girls per class, I really feel sorry for these girls, I try, but I really cannot approach every girl among this crowded group. How can I foster creativity in every girl? maybe I succeed with few girls but not all"

The teacher expresses her concern about not being able to foster creativity in every student in her classes. The large number of students is a real barrier.

Subtheme 4.4 Small physical space

Few teachers have mentioned other obstacles such as small classroom space and small school areas that the teachers claim that they cannot move around and cannot employ classroom activities.

Teacher 2: A female teacher holding an M.A. in Mathematics, with an experience of 6 years and teaches at a public school for girls. She complained about the small space in her classrooms by saying: "The classroom, of course, it plays a big role. If I wanted to use a scientific tool, to make a representation or an activity, I really cannot employ it in very narrow space". Her complaint not only represent the small space per class as an obstacle, but also it represents the teacher's awareness that fostering creativity can be accomplished by employing activities in class.

Teacher 6: A male teacher, holding an M.A., with an experience of 18 years, teaches at a public school for boys. The teacher explained that he learned some activities that do foster creativity among students, but he cannot employ these activities due to the small space in school:

"I have learned some excellent activities to employ in Mathematics lessons, for example, in the trigonometry for eighth grade, I would love to conduct them, they are like taking students outside the classroom to the playground, using ropes and protractor, and a pen and a paper, we can measure heights of many things outside, but you see, there is no space, there is only one small playground, and usually it is occupied by another class who are having a sport lesson"

Conclusion

The qualitative analysis sought to explore the diversity in which Palestinian 8^{th} and 9^{th} grade Mathematics teachers perceive MC and their teaching practices within that context. Many teachers have correct vision of some of its aspects, while few have misconceptions. Similarly, many teachers' practices are of those that foster MC and few other teachers' are not. Moreover, teachers' features are an indication of teachers who foster MC among students, while others are not. Finally, obstacles hindering MC were reported, showing common obstacles mentioned by most teachers, namely short time and large number of students. On the other hand, other obstacles that were claimed by very few teachers were also reported for authenticity.

Summary

This chapter provides the results of the quantitative and qualitative research methods, aiming to address the research questions concerning MC through the perceptions and practices of Mathematics teachers in the Palestinian context.

The quantitative method results were the statistical analysis of the 240 questionnaire responds using SPSS. The statistics output tables are reported and analyzed painstakingly to explore the main aspects of the independent factors of teachers' gender, educational level and teaching seniority. The findings from the statistical tests indicate that teaching practices fostering MC are more frequently employed by female teachers compared to male teachers. As for teachers' educational level, there are variations in such a way that teachers with B.Ed. and B.A. are more likely to use problem solving, using technology, guessing and trying. While teachers with an M.A. are more likely to employ problem posing and research, mathematical reasoning and divergent thinking. Teachers with PhD are reported to be the least in employing innovating teaching practices. Additionally, teachers of more than ten years of teaching experience are indicated to be more likely to engage innovating teaching practices in their classroom. The results from the qualitative method were the analysis of the 20 semi-structured interviews using MAXQDA 2020. The interviews highlight deeper insights of the teachers' perceptions and attitudes toward MC through exposing their beliefs and expressing their ideas and thoughts. They describe their teaching practices by rehearsing stories from their own personal experiences. Teachers mentioned few factors hindering the fostering of MC in the classroom included large numbers of students per class, not enough teaching lessons per week and official textbook issues. Nevertheless, teachers shared personal experiences of employing innovating teaching practices such as classroom discussions, divergent thinking, problem solving and posing, relating real life situations to the Mathematics lesson and engaging imagination and technology. Findings from both, quantitative and qualitative methods revealed the relationship between teachers' perceptions of MC and their teaching practices, emphasized the significant impact of the demographic factors and highlighted specific concerns and issues addressing the fostering of MC among students. These findings are analyzed and addressed more closely in the next chapter (Discussion and Conclusion), offering strong-based conclusions that consequently lead to specific practical contributions of three innovating teaching practices: employing extreme-case and paradox problems, pattern problems and most importantly, the 'State Of Rumination Task' for its design of including several innovating practices. Additionally, the findings enabled the researcher to provide a new teaching Methodology (MCM) that is easily applicable and encompasses several factors in the classroom setting (including school principle, the collaboration of the Mathematics staff and the Mathematics teacher).

Chapter Four

Discussion and Conclusion

Introduction

In this chapter, the researcher first presents a proposed MC methodology based on both, literature and the researcher's experience as a Mathematics teacher for 7^{th} – 12^{th} grades and as a college instructor of Mathematics for pre-service teachers. Secondly, the researcher aims to synthesize the study's main findings from both, the qualitative and quantitative methods, and provides the researcher's discussion and conclusion about these findings. The study aimed to explore perceptions and practices of Palestinian Mathematics teachers in the context of fostering MC among their students in the eighth and ninth grade students.

Quantitative and Qualitative Methods

The study was designed to address extensive research questions that, combined, provide a comprehensive insight into the aspects of the research main topic, namely; teachers' perceptions and practices regarding fostering MC.

Quantitative Method

The quantitative method consists of employing a structured, online 5-Likert scale questionnaire, composed of 34 items that was answered by a sample of 240 participants of various demographical aspects, reflecting those of the study's society. The collected wide ranged data sought to address the last four research questions, aiming to reveal if there were significant differences in the responses of in-service Mathematics teachers fostering students' creativity in Mathematics with respect to teachers' gender, to teachers' academic degree, to teachers' seniority as well as the interaction effects between teachers' academic degree and seniority.

Qualitative Method

As a complementary procedure to the quantitative method, the qualitative method was designed by conducting semi-structured interviews with twenty in-service teachers with various demographic aspects fairly representing the society of the study. The qualitative analysis sought to address the first four research questions, aiming to reveal profound understanding of teachers' perceptions, practices and features regarding fostering MC among their students.

Summary of Key Findings

It was observed by the quantitative analysis that there are significant differences in teachers' practices that foster MC among students, influenced by teachers' gender, teachers' academic degree and their seniority. In addition, the analysis also has revealed no interaction effects between teachers' academic degree and their seniority, expressing intricate impacts on teachers' teaching practices.

While the findings from the qualitative analysis has complemented those of the quantitative analysis by revealing deep insights into teachers' perceptions and actual practices, along with teachers' features that were interpreted from the context of the interviews' transcripts. Although many teachers have shown several aspects indicating their fostering MC, still few teachers have shown the opposite.

The following sections combine the findings from both, quantitative and qualitative analysis, to form comprehensive integrated findings. Then, the ramifications of these findings are discussed for educational purposes. Furthermore, the study's limitations will be addressed, as well as suggestions for further research regarding complementary and / or expanding research to the study. Finally, conclusion remarks will be presented.

Discussion of Key Findings

This section presents answers to the research questions by providing discussions of the main findings from the qualitative and the quantitative analysis.

Key findings from the Qualitative Analysis

Addressing Research Question 1

How do Palestinian 8th – 9th grade mathematics teachers perceive and define mathematical creativity, and how does this perception influence their teaching practices?

The qualitative analysis has revealed that many teachers have correct, but partial perception of MC; however, they all agreed on having 'originality' as a common component. These teachers perceived MC as originality, novelty, fluency and flexibility. None of them has mentioned elaboration and/or communication. On the other hand, the analysis has also exposed that few teachers have misconception about MC, being confused up with diligence, achievement, intelligence and motivation. Moreover, the qualitative analysis also has revealed that teachers' perception of MC has a direct influence on their general teaching practices.

Synthesis and interpretation

The findings revealed that Mathematics teachers who do have a correct perception of MC; they do not have a complete perception of MC that embrace all its aspects. The analysis of the findings also revealed that teachers who had a partially correct perception of MC actually implement some teaching strategies that tend to foster creativity in mathematics, and those teachers who had misconception of MC do not value these practices in their teaching methods.

Therefore, designing special PD courses that address elucidating the concept of MC can improve and enrich teachers' potential that would drive them in nurturing their teaching strategies on the track of fostering creativity among students.

Addressing Research Question 2

In what ways do Palestinian 8th – 9th grade mathematics teachers intentionally design and implement their teaching practices to foster MC within the classroom setting?

The qualitative analysis has revealed a variety of teaching methods and strategies that teachers deliberately implement in their teaching practices in order to foster MC among their students. Some of these practices were:

Problem solving and Problem posing

Many teachers have deliberately used multiple solving strategies in order to broaden their students' thinking by exposing them to a variety of thinking tactics. They also implement open-ended questions in the classroom discussions in order to open the way for their students to widen their cognitive spectrum and explore diverse solutions and solving strategies. This method is one of the main components of Open-Atmosphere Classroom, which is considered as an efficient method to stimulate and enrich MC. Some teachers have also engaged their students in constructing their own questions.

Diversity in teaching methods

Various teaching methods were declared and supported by examples form teachers' experiences. These involved using technology, realistic contexts and interdisciplinary, thus assisting the development of the students' interest in Mathematics and stimulating their creative thinking skills. On the other hand, few teachers are still confining themselves to the old style traditional teaching, namely lecturing and summarizing. This rote learning procedure gives no chance for the promotion of creative thinking or even simple thinking skills.

Classroom discussions

Almost all teachers reported classroom discussions as an essential part of every Mathematics lesson. It is the boosting tool that teachers use to drive action into students thinking by explaining their ideas, reasoning, giving examples and counterexamples. Such a method that engages students' thoughts and reasoning in the scenario of the lesson content provokes students' creative thinking.

Integration of reasoning and concept-based learning

Many teachers have reported the significance of integrating logical reasoning in both, the way they address Mathematical problems in class and in encouraging their students to provide it when participating in class discussions. Similarly, teachers have also relied heavily on concept-based learning in their lessons, especially when presenting problem-solving strategies. Both methods of which are essential factors that allow MC to develop among students.

Multiple representations

Several teachers indicated their frequent use of various visual aids, such as pictures, real videos, objects, along the Mathematical symbolic forms of the lesson's content. The integration of technology and digital tools in lessons enriches the lesson content, deepen conceptual understanding, complement any gaps or misconception as well as makes the lesson more exciting and interesting. All these factors reduce many possible barriers between students and their creativity.

Outdoor activities

Outdoor activities is one of the main components of an open-atmosphere environment. Few teachers have reported their integration of outdoor activities in some of their Geometry and Trigonometry lessons. Engaging their students in conducting collaborative tasks that involved using measuring tapes, ropes, protractors and calculators to carry out real measurements and calculations of the school's facilities represents the merging of several innovative teaching methods in an unusual, out of the room's walls environment. In such an environment, students' creativity can rise and develop.

Practices that do not foster Creativity

On the contrary, few teachers have frankly reported their non-integration of any of the previously mentioned teaching methods (methods that foster creativity). Their one method of teaching, one problem solving strategy, no integration of logical reasoning, no implementation of any real life situations, no technology or any multiple representation tools. In addition to their declaration of their non-belief in their students' potential. All these practices do hinder the development of any creativity among students.

Synthesis and interpretation

The findings from the qualitative analysis have revealed a spectrum of teaching practices that foster MC and are actually used by teachers. Moreover, teachers who fall in this category were found to implement most, and for some all, of these practices. Nevertheless, there are still few teachers who persist on using rote-teaching methods that give no chance for creativity. These teachers' practices draw attention for a systemic change by decision makers, including development of teachers' guide textbooks and well-designed professional development courses that walk teachers along the several teaching methods in the realm of fostering MC.

Addressing Research Question 3

How do Palestinian 8th – 9th grade mathematics teachers create learning experiences that facilitate the development of students' mathematical creativity?

The findings from the qualitative analysis have indicated a variety of teaching strategies and practices that teachers use to design learning experiences that facilitate the development of students' MC:

Exploration encouragement and open inquiry

- Open-ended questions: Teachers focus on open-ended questions to expand students' thinking horizon by exploring and comparing diverse solutions to the same problem. This method is a prominent tool that creates creativity and develop thinking skills.
- Multiple solution strategy: Teachers intentionally approach problem solving by presenting several solution methods to the same problem in order to expose to their students various solving tactics; thus empowering their skills and widening their thinking scope.
- Classroom discussions: Teachers emphasize on having classroom discussions as crucial part of their lessons. Students' participation, competition, reasoning and debating stimulate their thinking skills and foster their creativity.
- Encouraging students' curiosity: Teachers encourage their students questioning by appreciating their questions, transferring these questions to the whole class and creating a debate about it; thus creating a curiosity-fostering atmosphere that deepen students' understanding and raising their curiosity about Mathematical concepts.

Interactive activities

Hands-on activities: Teachers engage their students in hands-on activities in which students design their own objects (geometrical 3-D shapes), carry out experiments in measurements of various volumes by using sand in hollow objects, conduct real measurements and carry out calculations. Making students positive participants in the learning process allows them to have deeper understanding of abstract concepts through real, tangible experiments; and thus promoting their creative thinking.

Project-based learning: Some teachers assign to their students project assignments in which they conduct research, collect information, collaborate within groups and interpret their results. Such assignments provoke creative thinking in applying their knowledge. In addition, students' results are to be presented by PowerPoint presentations to the whole class, creating a competitive atmosphere that would drive motivation and creative thinking.

Collaborative learning environment

Teachers integrate collaborative learning in their lessons either by having it as part of another teaching method as mentioned earlier, or by having it the main teaching method such as group-based learning in class. This gives students the chance to participate, share ideas, discuss, assess and learn from each other.

Applying Mathematics to real world situations

Many teachers have emphasized the necessity of applying Mathematical knowledge to real life situations in order to make the lesson connected to students' life and thus making the lesson more interesting to learn. Not only that this approach answers students' question: "Why do I have to study this?", makes the lesson relevant and shows its usefulness, but also it deepen the understanding of Mathematical concepts.

Integrating technology and digital tools

Teachers make use of technology frequently for several reasons, such as demonstration purposes, making connections, explanatory and reasoning. While the usage of digital tools is an inevitable since digital devices are in every part of students' life. Teachers present online software programs (especially GeoGebra) as well as train their students how to use them in their Mathematics learning. This approach enriches students' Mathematical knowledge as well as equips them with a self-learner digital skill.

Synthesis and interpretation

Therefore, the findings from the qualitative analysis imply that creating learning experiences that foster MC combines more than one approach at once. These approaches include open inquiry, interactive activities, collaborative learning, applying Mathematics to real world situations and integration of technology and digital tools. Even though, those teachers who declared that they do not use any of these approaches have claimed that it is due to persistent obstacles such as large number of students, short time vs. large curriculum textbook, small classroom size and students' discipline problems.

Consequently, this suggests that special PD courses as well as textbook modifications or complementation by a teachers' guide to support teachers in implementing these strategies. Not to ignore the concern about school buildings and classrooms sizes (physical size and number of students as well).

Addressing Research Question 4

What are the challenges and the obstacles that Palestinian 8th – 9th grade mathematics teachers face in fostering mathematical creativity in the classroom?

The findings from the qualitative analysis revealed several challenges and obstacles that prohibit the implementation of strategies that foster MC among students. Teachers, especially those who declared that they do not make use of strategies and methods fostering creativity, have reported many of these factors. Other factors were interpreted by the researcher from the context of the analysis.

Official textbooks

Densely packed: Most teachers have complained about the excessive amount of content matter in the official textbooks mandated by the MOE. Teachers are supposed to cover the whole material with their students, which makes the teachers more concern about the quantity rather than the quality of learning. As a result, employing less activities and few methods that foster creative thinking.

Inappropriate: Some teachers have highlighted that these textbooks are narrow and superficial. The textbooks neither present creative ideas nor address deep thinking problems. As a consequence, teachers (especially new ones) design their teaching methods accordingly and students focus on the level of their textbook when studying.

Short time

As a direct consequence of having densely packed textbooks, teachers emphasized on not having enough time, represented by the number of lessons per week. Implementation of innovative strategies, according to teachers, will consume lots of the lesson’s time. Moreover, some teachers have even highlighted that integrating certain methods that foster creativity requires two successive periods on the schedule.

Large class sizes

Teachers mentioned that large number of students per class several times as a big challenge for fostering creativity among students. Teachers find it difficult to employ certain teaching methods that foster creativity in such a large class. In addition to the difficulty in providing sufficient guidance and proper feedback on an individual bases.

Small space

Some teachers complained from having small space in classrooms as well as in school. Small classrooms makes class seem packed and clustered, and hinders the mobility of teachers as well as students; which makes it challenging to employ creativity fostering activities either in classroom or outside.

Teachers doubt their students' potential

This intrinsic obstacle was interpreted from teachers' description and intension implementation of teaching methods that foster creativity. Teachers, who declared that they only use the rote-learning, traditional lecturing method, have justified this attitude to their doubt in students' potentials. This inner thought belief is the origin source that prohibit teachers from altering their teaching methods and trying new ones. Therefore, it is essential to have special psychological PD courses that bring this issue on the table and work on replacing this negative attitude toward students' potential by a strong positive one in teachers.

Synthesis and interpretation

These findings emphasize the main obstacles that Palestinian Mathematics teachers encounter when trying to integrate teaching methods that foster creativity in their lessons. One main issue is the official textbook that dictate the flow of the teaching across the academic year, hindering teachers from paying attention to anything but to finish the assigned material in the textbook by the end of the academic year. Another big challenge was the number of students per class and the small classroom size, a problem that needs attention from decision makers in the government, especially the ministry of finance, to provide sufficient aid for building new schools of large classroom sizes. Alongside, is the systemic structure of the education system, concerning the number of lessons per week to be balance by the amount of content matter in the curriculum syllabus.

Key findings from the Quantitative Analysis

Addressing Research Question 5

Is there a significant difference in the responses of the in-service mathematics teachers fostering students' creativity in mathematics with respect to teachers' gender?

The findings from the quantitative analysis indicated that there is a statistically significant difference in the responses based on teachers' gender. The female teachers have been observed to have higher level of integrating teaching practices that foster MC than male teachers. These findings imply that female teachers maybe more tending to implement teaching methods that foster creativity among their students. However, other aspects could influence this difference, such as various educational history, certain PD courses and special personal skills. Consequently, closer research into these aspects could reveal deeper understanding of how teachers' gender affects their teaching methods.

These findings align with the 'Gender Schema Theory (GST), by Sandra Bem (Bem, 1983), which explores how gender influence teachers' teaching strategies in promoting and encouraging Creativity. according to GST; female teachers are more likely to use innovative teaching practices due to their influence by social norms to prioritize teamwork, caring and student-centered strategies. Additionally, from Constructivist Learning Theory, female teachers are more likely to use more student-centered pedagogical approaches and are more likely to implement constructivist practices in the classroom (Solomon, 2011).

Addressing Research Question 6

Is there a significant difference in the responses of the in-service mathematics teachers fostering students' creativity in mathematics with respect to teachers' academic degree?

The findings from the quantitative analysis indicated that there are statistically significant differences in the responses based on teachers' academic degree. Teachers with B.A were observed to be more likely tending to integrate most of the teaching practices that foster MC in their teaching methods, while those with an M.A. were observed to be more likely to integrate Problem solving, Mathematical reasoning and Divergent thinking. This maybe due to the fact that teachers with B.A. still have fresh knowledge of the teaching methods and skills that they have accomplished recently, while teachers with an M.A. have deeper knowledge in the content matter of Mathematical reasoning and problem solving techniques. Moreover, teachers with B.A were observed to be more likely to implement some teaching practices than those teachers with PhD. These teaching practices are problem solving, applying Mathematics to real life problems and relating Mathematics to Art. Similarly, this may be explained due to teachers with B.A. have more recent teaching methods' learning and training than those with a PhD. In addition to the fact that teachers with PhD usually are more sophisticated in their knowledge and communicate at high cognitive levels. Special researches need to be conducted more closely as to highlight specific needs for teachers with B.A. and those with M.A. in order to design proper PD courses to address these two samples separately.

These findings can be explained through some Educational theories. Pedagogical Content Knowledge (PCK), conceptualized by Lee Shulman, is especially important for comprehending these variations. PCK stresses the importance of teachers not only comprehending the subject matter they are teaching, but also being able to effectively instruct that material in ways that are interesting and inclusive for students (Van Driel & Berry, 2017). Educators who hold a B.A. degree could be more inclined to incorporate a wider variety of teaching methods that enhance creativity. This is because their up-to-date education typically covers a significant focus on teaching strategies, allowing them to be more familiar with various instructional approaches that stimulate creative involvement from students. Teachers with M.A. or Ph.D. focus on problem-solving and mathematical reasoning, prioritizing advanced concepts over teaching methods as they specialize. Cognitive Load Theory suggests experts prioritize complex cognitive tasks over general teaching strategies.

Experiential Learning Theory can explain differences in teaching approaches (Garlick, 2014). Teachers with recent training and B.A. degrees may focus on innovative techniques, while those with advanced degrees prioritize enhancing student understanding, potentially limiting creativity.

Customized professional development options are needed for teachers at different stages, focusing on their unique strengths and requirements. Advanced degrees may emphasize innovative teaching methods, while undergraduate degrees may focus on enhancing teaching strategies.

Addressing Research Question 7

Is there a significant difference in the responses of the in-service mathematics teachers fostering students' creativity in mathematics with respect to seniority?

The findings indicated significant differences in the responses based on teachers' seniority. In particular, more experienced teachers were found to be more tending to integrate certain teaching practices that foster creativity in their teaching. These are using technology, applying Mathematics to real life and implementing imagination. This may be explained due to the richness in teaching methodologies that experienced teachers have gained over the years, and thus are able to implement these methods in their lessons creatively. Moreover, experienced teachers are well equipped with classroom management strategies that enable them to overcome any discipline problem and smoothly conduct their lessons, which make their integration of interactive, creativity fostering, teaching methods applicable. This suggests that there ought to be special training courses for experienced teachers to qualify them train new teachers and pass their teaching experience to them effectively.

These results are related to the Experiential Learning Theory (Kolb), which suggests that knowledge is formed by converting experiences (Kolb & Kolb, 2009). Experienced teachers leverage practical insights to create innovative learning environments, adapting teaching methods efficiently by integrating technology and nurturing creativity. Moreover, Social Learning Theory (Bandura) demonstrates how experienced teachers can inspire creativity in newer colleagues by serving as examples and sharing successful strategies. This highlights the collaborative nature of learning and the importance of sharing expertise for ongoing teaching progress (Legg, 2023). PD programs using experienced teachers can enhance PD for new teachers. This fosters creativity and knowledge-sharing among teachers of different experience levels.

Addressing Research Question 8

Are there significant interaction effect between teachers' academic degree and seniority on the dependent variable of enhancing students' creativity in mathematics?

The quantitative analysis into the interaction effects between teachers' academic degree and their seniority on adopting teaching practices that foster MC indicated the following findings:

Multivariate Analysis of Variance (MANOVA): The findings highlighted that there were no significant overall interaction effects between teachers' academic degree and their experience upon the dependent variables, represented by various teaching practices that foster MC.

Roy's Largest Root analysis: The findings from Roy's Largest Root analysis revealed a possible potential interaction effect.

Univariate ANOVA and Post-Hoc Analysis: Further analysis, using Univariate ANOVA and Post-Hoc tests revealed that there was no significant pairwise differences between the groups (levels) based on academic degree or seniority for any of the prescribed teaching practices. Therefore, there is no significant influence on the adoption of the teaching practices due to either the academic degree, teachers' seniority or their interaction.

Consequently, no significant interaction effects were observed indicates that the influence of teachers' academic degree and teachers' experience functions separately rather than being combined together. Which implies that teachers with certain academic degree or having more experience does not improve or reduce the possibility of integrating teaching practices that foster MC when combined with each other. Hence, it is important to approach both, teachers' academic degree and their experience in the teachers' training and PD courses separately. In addition, there might be aspects other than teachers' academic degree or experience that actually influence teachers to integrate the specified teaching practices that foster creativity. Thus, further research need to be conducted to investigate these aspects in order to have deeper insights into the main predictors that might influence teachers' adoption of teaching practices that foster creativity in Mathematics.

The interaction between teachers' academic degree and experience does not significantly impact the adoption of teaching practices promoting creativity. These findings can be understood by examining Differentiated Professional Development and Andragogy theories by Knowles. Andragogy emphasizes that adult learners and teachers bring diverse experiences and motivations to professional development (Terehoff, 2002). Customized PD focusing on educational credentials and work experience is essential. Teachers at different career stages and with varying academic knowledge may face specific challenges when integrating creativity into their teaching. Tailored professional development programs are necessary to support both new and experienced teachers in promoting creativity in math, regardless of their educational background. Moreover, these findings can also be connected to Pedagogical Content Knowledge (PCK) by Shulman, which shows that teaching goes beyond content and experience (Van Driel & Berry, 2017); effective teaching requires ability to engage individual students with meaningful subject matter; hence, targeted interventions needed for PCK development.

Future research should explore various factors that influence the use of creativity in math teaching, such as teachers' beliefs, school environment, resources, and mentoring. This can help improve acceptance of innovative teaching methods.

Teaching Practices Developed by the Researcher

Based on the analysis of the findings from the research, the qualitative study in particular, combined with the previous literature and studies, the researcher has developed three teaching practices that foster MC. These are illustrated below with a thorough description of each, along with practical examples.

Extreme-Case problems and Paradox problems

Although some people might think that this is just part of 'Problem-Solving' or 'Problem-Posing' practices; however, extreme-case problems is different. Problem Solving requires students to apply their conceptual understandings and knowledge to solve a traditional routine problem. Problem posing allows students to construct their own problems based on certain situations or conditions. However, extreme-case problems and paradox problems escort students beyond familiar situations, utilizing multiple dimensional thinking and employing imagination.

Concept: Cognitive Disequilibrium is grounded in Constructivist Learning Theory. According to this theory, students' learning is mostly achieved by encountering contrasting or uncertainties opposing previous knowledge, thus provoking creative thinking.

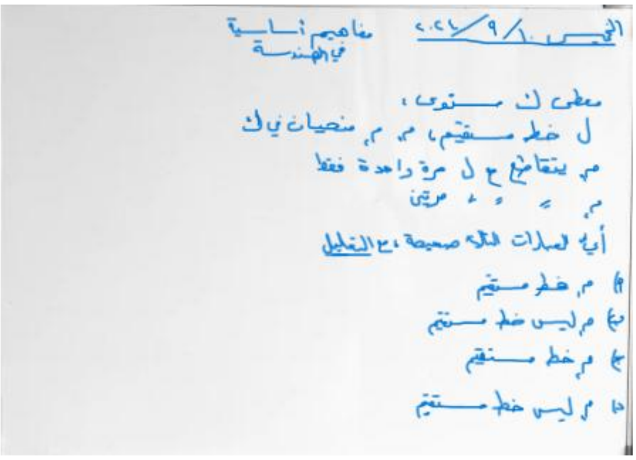
Employment: Integrating extreme-case questions (there is either a strange unexpected answer or no answer) and paradox problems leads to cognitive disequilibrium, where students face absurdness.

Practical Examples for The Extreme-Case problems and Paradox problems

Teacher 1, a female teacher from Jerusalem Governance. In the lesson of basic Geometry for grade 7, the teacher introduced line, curve, surfaces and plane. She has stated the following problem on the board (this is a translation of what she has written, as shown in the figure 1):

Figure 1

A geometry problem presented to the seventh graders



Given P a plane, l a line in P, C_1, C_2 two curves in P as well. Given that C_1 intersects l in only one point. C_2 intersects l in two points. Which of the following is definitely true, and why?

A: C_1 is a line.

B: C_1 is a not a line.

C: C_2 is a line.

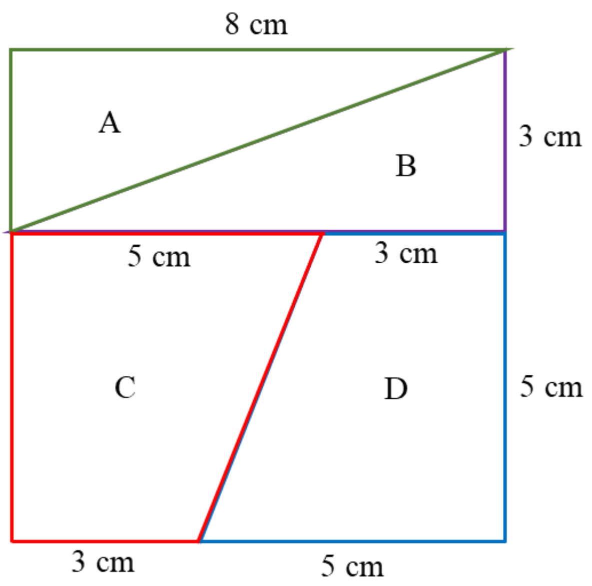
D; C_2 is not a line.

The teacher noted that the students participated with a variety of solutions, but the teacher did not give an acknowledgement of the correct answer, but she asked for justification of the answer and asked the whole class to judge if that justification was correct or not. The students who gave wrong answer, when trying to justify their answer have noted that their answer was incorrect. Some of those who gave correct answer (D) were not able to give full justification. Three students were able to give correct justification for their correct answer in different terminology. Saeed said that two lines can intercept each other in only one point (as a principle stated earlier). Jamil said that since C_2 intercept the line in two points then it must be either a broken line or a C shaped curve. Radi said that if C_2 were a line and it intercept l in two points then l cannot be a line (it must be a curve) which is not the case. Then the teacher raised the question of: Why the other choices cannot be definitely true? Many other students participated (along with the same three students) and mentioned reasonable justifications. In other words, the teacher noted that this question has not only accomplished a correct answer from three students, but has also has changed the way students think. In addition, it has provoked their thinking to not only answer and justify their correct answer, but also to make them think and justify why the wrong answers were wrong and cannot be true. The teacher expressed her admiring of this type of questions and noted that it does really promote creative thinking among students.

Example 2. This following question may be addressed to grades 7, 8 and 9. The question can be posted on the screen of the classroom via the projector (or on can be drawn on the board). The problem: Consider the following 8 cm by 8 cm square.

Figure 2

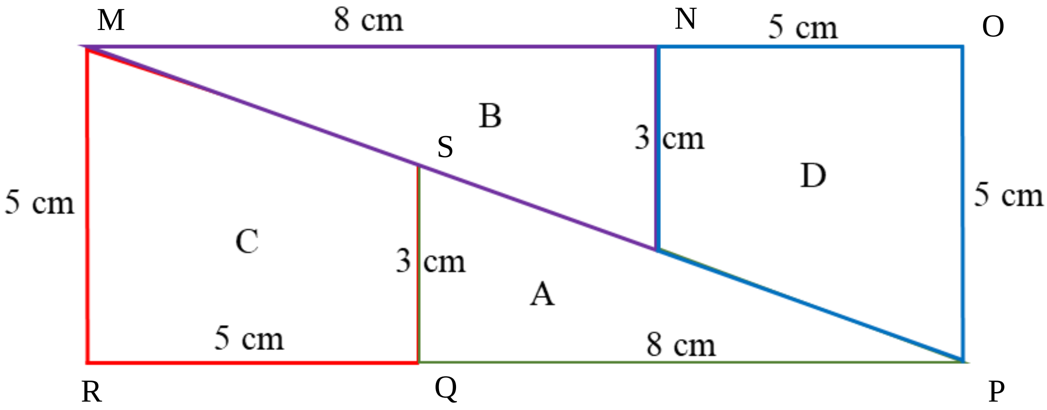
An 8 by 8 square has an area $= \mathbf{8^2 = 64\ cm^2}$



Rearranging the components we get a 5 cm by 13 cm rectangle, whose area = 65 cm^2.

Figure 3

After rearranging the square components, a 13 cm by 5 cm rectangle, area $= \mathbf{13 \times 5 = 65\ cm^2}$



This question may be addressed to grade 7, 8 and 9. Student can approach the problem by observing that the new formed rectangle is not a proper rectangle. Using triangle similarities between the triangles ΔMPR and ΔSPQ: Computing the proportions of similar triangles, we should get: $(MR \div SQ = RP \div QP)$; however:

$$\frac{MR}{SQ} = \frac{5}{3} \neq \frac{RP}{QP} = \frac{13}{8}$$

Therefore, since triangle similarities is not fulfilled, implying that the shape formed by combining shape C and A does not result in a proper triangle. Therefore, there would be a very slight gap accumulating the extra 1 cm^2. Another approach to the problem could be using analytic geometry. Drawing the formed rectangle in the Cartesian plane, with the segment MR on the y-axis and RP on the x-axis. Then the coordinates of the points: R(0, 0); M(0, 5), S(5, 3); P(13, 0). The line segments MS, SP and MP are supposed to be collinear and thus having same slope, students will find that the slopes of MS, SP and MP are, respectively:

$$m(MS) = -0.4; m(SP) = -0.375; m(MP) \approx -0.385$$

Implying that these lines are not collinear, indicating the gap in the formed rectangle.

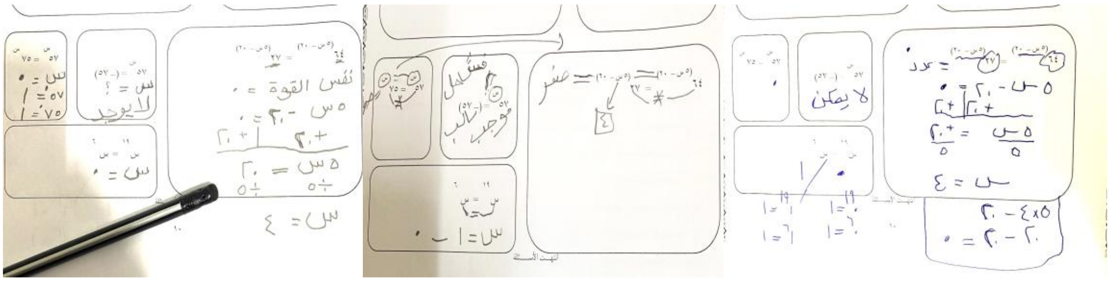
Teacher 2: a male teacher in Jerusalem governance. Introducing the indices lesson to his nine grade students, he spread a worksheet on solving simple exponential equations. The six – tenth questions were the following:

$$64^{(5x-20)} = 27^{(5x-20)} \; 57^{x} = (-57) \; 57^{x} = 75^{x} \; x^{19} = x^{6}$$

The following figure presents three students' solutions.

Figure 4

Solutions of three different students



For the first equation, the three students noted the exponents were the same for different bases, implying that the exponent can only be zero. The first and third students solved the exponent equation setting it to zero, while the second student pointed out that the exponent is zero, then he guessed the answer to the equation (x = 4). The second and third equations were extreme case problems which the three students have noticed that the second equation has no possible solution (positive number raised to any power will only be positive). The third equation similar to the first (as indicated by the arrow that the second student has drawn). The last equation has similar sense however, as the teacher has told me that some students thought that x = – 1 is one of the answers, but these three students have noticed that x = 0 and x = 1 are the only solutions (x = - 1 is not, since the powers were of different parity, one even and the other is odd).

Pattern Problems

Concept: Pattern problems grounded in Constructivist Theory by constructing knowledge while solving problems and exploration. Pattern Problems, in particular, are aligned with Algebraic Thinking and Inductive reasoning.

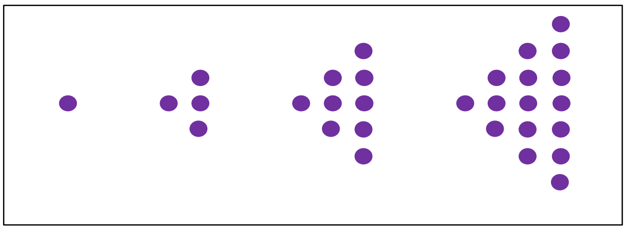
Employment: Integrating Pattern problems either continue the pattern or find the algebraic formula generating the pattern, would provoke students' creativity by letting them employ their conceptual knowledge and utilize their Mathematical skills to find the pattern.

Example on Employing Pattern Problems

The researcher carried out the following practice in the ninth grade. The following problem was posted on the board. The problem stated: Observe the following arrangement of spots:

Figure 5

The pattern problem as presented to students

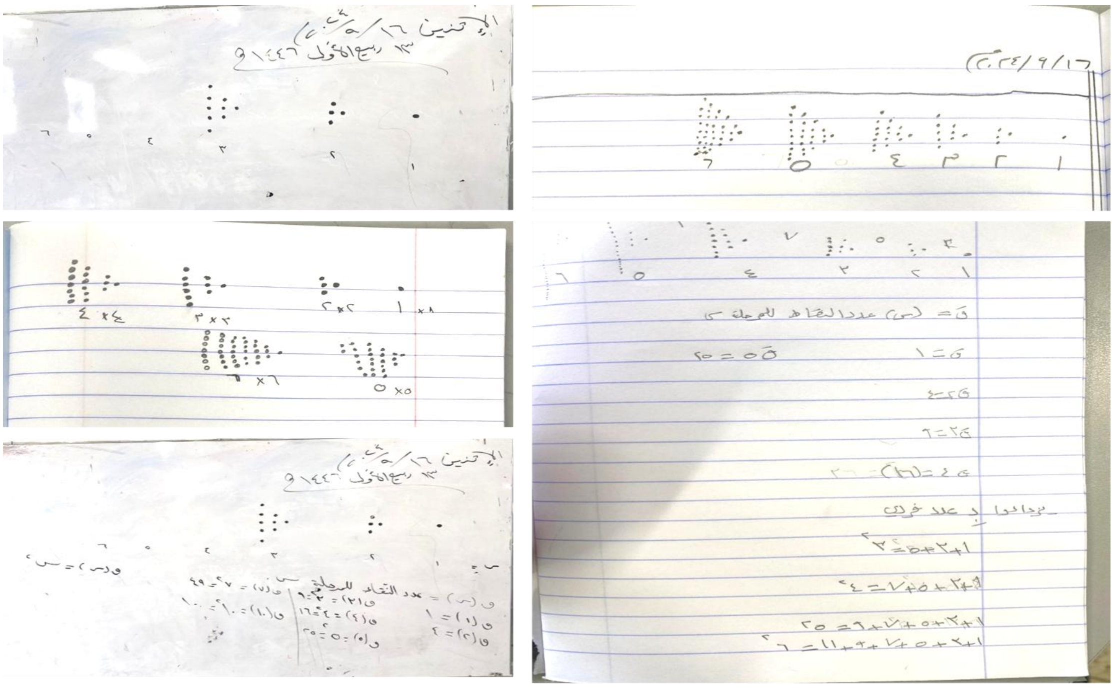


Draw three more arrangements that follow. How many spots are there in each level? Can you find a relationship between the number of spots in each level and the level number?

The following photos were taken of the board and of four students' notebooks.

Figure 6

The pattern problem presented on the board, along with students' solutions



The first image on the top right shows that the student has drawn the next two levels, the middle image on the left side shows that the second student has written the numeric relationship between the number of spots in each level and the level number to be:

$$1 \times 1, 2 \times 2, 3 \times 3, 4 \times 4, 5 \times 5, 6 \times 6$$

The third student on bottom left side has written an algebraic expression for the same result of the second student as:

$$f(1) = 1, f(2) = 4, So, f(3) = 3^2 = 9, f(4) = 4^2 = 16,$$

$$f(5) = 5^2 = 25, f(7) = 7^2 = 49, f(10) = 10^2 = 100,$$

Finally, he wrote: $f(x) = x^2$.

The last student, bottom right, in addition to deducing the same result, he has noticed that an odd number of spots is added to each successive level, writing: “adding an odd number”

$$1 + 3 + 5 = 3^2$$

$$1 + 3 + 5 + 7 = 4^2$$

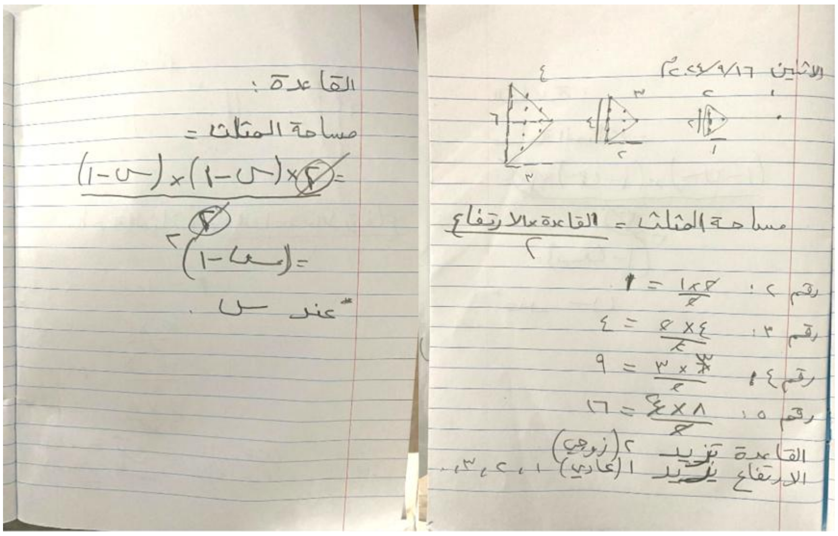
$$1 + 3 + 5 + 7 + 9 = 5^2$$

$$1 + 3 + 5 + 7 + 9 + 11 = 6^2$$

These answers show evidently the creative thinking of these students, since they have never been exposed to such relationship of series of numbers or formulas for the sum of odd numbers. Moreover, there is a student who even surprised me with his solution, shown in the following figure.

Figure 7

Solutions of two students for the pattern problem, each of different approache



The student has imagined the formulation of a triangle by the spots, and then he considered measuring the area of each triangle (starting from the second level), writing:

“$number1\text{:}\ \frac{2\times1}{2}=1,\ number2\text{:}\ \frac{4\times2}{2}=4,\ number3\text{:}\ \frac{6\times3}{2}=9,\ number4\text{:}\ \frac{8\times4}{2}=16$

The base increases by 2 (an even number), the height increases by 1 (a regular number): 1, 2, 3, etc. The rule:

The area of the triangle $= \frac{2\times(x-1)\times(x-1)}{2} = (x-1)^2, for\ the\ level\ x$”.

This was really a creative way of thinking, using imagination of forming triangles from the spots, combining geometry (area of triangles) with numbers and deducing an original formula (relatively speaking).

Employing a State of Rumination Task (SORT) after School

Analyzing the findings from the results of both the quantitative as well as the qualitative research, it was evident that teachers vary in employing teaching practices that foster MC, based on their educational background, their seniority and maybe personal interest. This lack of utilizing certain teaching practices is due to lack of knowledge of how to do it or lack of experience in doing it. Thus, the researcher has developed this teaching method, which would be ‘two birds with one stone’ method. A method that would let students engage in several innovating practices including observing, relating to real life problems, thinking, creating and posing problems, solving problems, taking photos and drawing, searching on the web and collecting information, presenting to class and discussion as well as using imagination. The researcher called this method 'a state of rumination task – SORT', for it lets students enter a state of rumination and thinking on their way home, rehearsing what they have learned in class, connecting and reasoning.

Concept: This teaching practice is grounded in a combination of several Educational Learning Theories, such as Constructivist learning theory (which emphasizes on the involvement of students in their learning), Cognitive theory of learning (emphasizing on activating students' mental processes, such as thinking, remembering, manipulating and designing) and Metacognitive theory of learning (emphasizing on students' monitor their learning process, assess their progress by comparing and choosing, then deciding).

Employment: The timing of integrating this learning practice is during the last five minutes of the class lesson. The teacher assigns to students the following take-home task: the teacher asks the students to carry out the following experiment: on their way home, as soon as they exit the school's gate, they need to observe closely everything they see on the way home, people, buildings, vehicles, street roads, etc. and to find a connection between an observed object (or situation) and anything that is related to the Mathematics lesson in class. They may also take a photo of that observant by their smartphone. At home, students are to draw a sketch of that thing with its relationship to the lesson in class, give its parts estimated values (they may use the internet to find approximate values of a average measurement, such as peoples' height, electric pole height or radius, something's speed or weight, etc.). Then students may design a Mathematical situation (problem) with the approximate values they have assigned, solve it and address it to class for discussion. In addition, students may work in pairs or groups, allowing for collaborative learning.

Having students enter into a state of rumination about the lesson that they have learned in class, making the lesson a dilemma that occupies students' thinking process for a while, and while watching and revising their memory of their lesson would carry their conception to deeper parts of their brains and to a higher level of perception through interconnection processes with brain memories, brain images and understanding. Noting that this type of teaching practice consists of several innovating teaching practices. First of all, it is an open task, students can pick anything they see as related to the content of the lesson, students are directly involved, utilizing technology and digital tools, relating Mathematical concepts to real world problems, researching (by gathering data from the internet), problem posing (by constructing their own problems), problem solving (by solving the problem), and classroom discussion when presenting their experiment and findings to class.

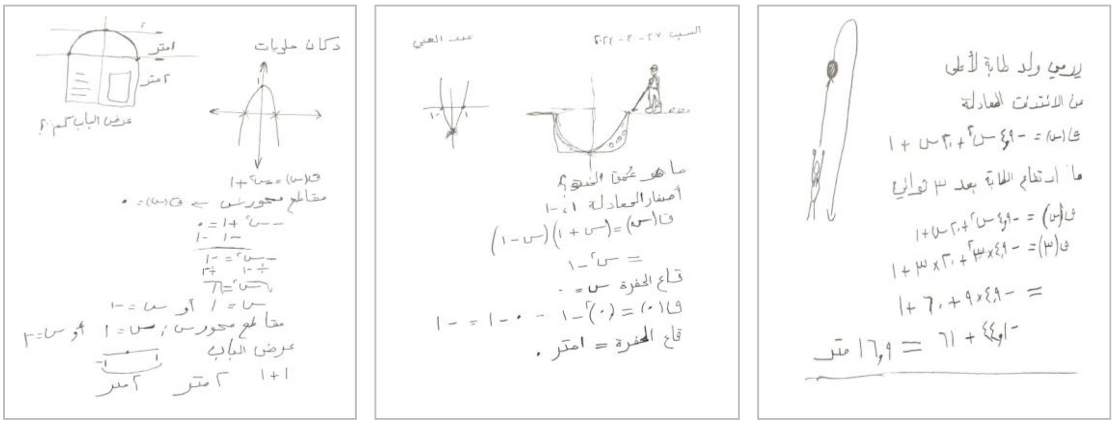
Example on Employing a State of Rumination Task (SORT) after School

Introducing the lesson of ‘The quadratic function’. The researcher employed the SORT method to the ninth grade in April, 2024.

After the researcher introduced the concept of the quadratic equations with it general algebraic and geometric sketch of a U or ∩ shape (Parabola), its components (coordinates of the y-intercept, of the vertex and the x-intercepts if existed). The researcher assigned the following task to his students. Every student had to observe everything he sees on his way home after school and choose an observant that has the Parabola shape, to take a photo of that shape and/or to draw a sketch at home or a drawing. He could use the internet search engine to find approximate values of the heights and/or width of that object (a man, a pole, a building, a rope, an electric cable, etc.). Students were also informed that those who come back the next day with the completion of the task will be offered extra credits. On the next day, several students came back with a variety of problems, whose pictures in Figure 8.

Figure 8

Three different SORT activities by students



The first student on the left, came back with his sketch of a sweet shop that has a domelike door. He sketched a ∩ shape parabola describing the door, and he wrote that the height of the lower door is 2 m while its upper part (dome shape) is 1 m. His problem was to find the width of the door. He approximated the quadratic equation by: $f(x) = -x^2 + 1$. Then he solved the equation $-x^2 + 1 = 0 \Rightarrow x = \pm 1$. Thus, the width to be 1+1 = 2 m.

The second student sketched a worker standing at a hole dug in the ground. He wrote that the width of the hole is 2 m. He drew a sketch of a U shape parabola. Using the width of 2 m to give the two zeros of the quadratic equation of 1 and – 1. He then wrote the quadratic function: $f(x) = (x + 1)(x - 1) = x^2 - 1$. To find the depth, which is the vertex point at the y-axis, he set $x = 0$, $f(0) = (0)^2 - 1 = 0 - 1 = -1$. Therefore, the depth is 1 m.

The third student (on the left), sketched the graph of a boy throwing a ball upward, he used the internet to find the quadratic equation describing an upward thrown ball, finding that: $f(x) = -4.9x^2 + 20x + 1$. He wanted to know what the height was at the third second. So, $f(3) = -4.9(3)^2 + 20 \times (3) + 1 = -4.9 \times 9 + 60 + 1 = -44.1 + 61 = 16.9$ m.

Noting that these three responds were evidently creative. For students to be able to imagine the suitability of fitting the quadratic parabola into the observed objects (dome shape shop door, the hole in the ground, and the path of an upward thrown ball) was creative thinking. Approximating values of the heights and width, using the internet to look for the quadratic equation describing the path of an upward thrown ball was also creative work. Implementing the given information and solving these problems (even though they were simple) was also creative. The collective process that these students carried out in relating the content of the lesson to real life situations was creative. The students' self-confident and pride that they came back to class with, in carrying out these tasks, explaining them to class was motivating to these students and inspiring to others.

Mathematical Creativity Methodology (MCM)

State of the art for the MCM

Teaching methodologies are systematic approaches used by educators to organize and implement educational activities to achieve specific learning goals. These methods are rooted in learning theories and reflect the success of the learning process and teacher competencies (Al Khadhim, 2023).

Teaching methodologies that aim to foster MC among students focus on involving students in problem solving by driving their talents to produce original and useful solutions, presenting flexibility in various approaches and applying their Mathematical knowledge to real life situations

In the recent decades, many researchers have explored teaching strategies that foster MC, including inquiry-based learning, collaborative learning models, and problem-solving strategies (Bicer, 2021b). However, these methodologies may be hindered by special educational contexts, such as those characterized by large class sizes, rigid curricula, or limited resources, such as a constrained socio-political context as in Palestine. Moreover, these methodologies do not take into considerations their feasibility and multifacetedly. The need for such 'feasible' and 'multifaceted' methods arises from the findings in the current research, as teachers vary in their implementations of innovating teaching practices due to their lack of knowledge of the other methods or of how to apply them. As a result, the Mathematical Creativity Methodology (MCM) emerges within this landscape and for those specific reasons as to be an applicable, feasible and multifaceted methodology.

Introduction

The researcher suggests a design of an MCM consisting of three modules; the first is addressed to school principals to conduct a preparatory workshop for the Mathematics staff. The second is addressed to the whole Mathematics staff (under the management of school principals, as well) to design a collaborated teaching plan. The third module is an in-class teaching activities and practices. Combining the three modules leading to a well-designed teaching milieu that would foster MC among students. The methodology is emanated from basic, inevitable Educational Theories, from the findings of this PhD research as well as from personal teaching experience as an instructor of Mathematics for school students and for pre-service Mathematics teachers.

Purpose and Rationale

Based on the findings from the study, several obstacles, challenges and barriers were identified to hinder teachers' fostering MC in the Mathematics classroom. These hindrances are not all under teachers' control or responsibility; but some are of the school principals', not to mention of course policymakers as well. Thus, the methodology presented here, has a small part of which is designed to address school principals while the other (larger tasks) addresses the Mathematics staff. Moreover, combining my personal long experience of teaching Mathematics for school students, 7th – 12th grades, and for pre-service teachers at a local College of Education with the findings from the researches of this study, I have noticed significant influence of certain teaching practices on the promotion of MC among students. Students who are taught and addressed in schools in a special manner are more likely to improve their comprehension and to promote their MC.

This methodology is constructed to link theoretical concepts with the findings from the current PhD research as well as the researcher's practical experience. It is grounded in Pedagogical Content Knowledge (PCK), Constructivist, Meaningful Learning, Humanistic Education Theory, Social Constructivism and Professional Learning Communities (PLCs).

Conceptual Ground

The current MCM is rooted in basic educational theories that focus on the significance of integrating and motivating students, student-centered approaches and employment of deep thinking provoking strategies. These are among educational theories that maintain a cornerstone for the teaching strategies that are pointed out to in the current methodology, confirming that these strategies are well derived from basic educational theories along being potent in fostering MC.

The first Educational theory utilized in the methodology is the Humanistic Education Theory, which sees students as engaged, aware individuals with the ability for self-motivated development and realization (Tasnim & Ahmed, 2022). It highlights the significance of students' feelings and individual significance during their learning (Habsy et al., 2023; Tasnim & Ahmed, 2022).

Secondly, Meaningful Learning Theory, of David Ausubel, emphasizes that learning occurs when new knowledge is related and connected to existing (previous) knowledge.

Then, the Pedagogical Content Knowledge (PCK), which combines pedagogy and content to enhance teaching effectiveness (Rollnick & Mavhunga, 2017), enabling skilled teachers to tailor material for diverse learners. It involves organizing, presenting, and adapting topics to engage students effectively.

Social Constructivism is a learning theory that emphasizes the role of social processes in knowledge creation and understanding. As a practical manifestation of Social Constructivism is the ‘Professional Learning Communities (PLCs). (PLCs) are collaborative structures in schools that promote ongoing professional development and enhancement for teachers. Teachers share vision and values and practical activities.

Constructivist Learning Theory is a learning theory that emphasizes active knowledge construction by learners based on their experiences and interactions. This is manifested in Mathematics Education in terms of nurturing learning milieu that allows students to explore, integrate, try and discover, thus promoting their MC potentials.

Grounded in Constructivist learning theory are Cognitive Disequilibrium and Problem-Posing Theory. Cognitive disequilibrium theory states that learning occurs when students encounter a state of cognitive imbalance due to certain contradictions or uncertainty during the learning process. Problem-Posing Theory of Learning posits that students learning occurs better when they generate their own new problems and solve them. Both theories are integrated in the current methodology as demonstrated hereafter.

Core Components of the MCM

The core components of the MCM are managed to offer teachers with practical teaching practices that foster MC. These components are designed based on Educational Theories, findings from this PhD research and from the author’s personal rich experience as a Mathematics instructor for school students and pre-service Mathematics teachers.

The First Module, for School Principals

Confirming Teachers' Conception of MC

Concept: this component of the MCM emphasizes on confirming teachers' proper conception of MC, its aspects, how to identify students' creative potentials and how to nurture it among students.

Employment: Teachers' PD programs: school principals are urged to incorporate special PD workshop in the preparatory phase of the school year (few days before the academic year is recommended) and a PD course throughout the academic semester. This workshop should focus on providing teachers with theoretical background containing definitions, examples in the workshop, while the PD course to include teaching strategies as well as educational videos. Senior teachers from same school could conduct these PD courses.

The Second Module, for the Mathematics Staff (and the School Principals)

Professional Learning Communities (PLCs)

Concept: These are pragmatic application of the 'Collaborative Learning through Social Constructivism' employed on teachers. The emphasis is upon teacher collaboration and shared learning among the staff members.

Employment: At the same preparatory phase, during or after the PD workshop mentioned in the previous section; in the preparation meeting, the school Mathematics staff should set a general teaching plan whose design is based on collaboration and back-to-back teamwork. Part of this plan is to assign a day of every week for the weekly periodic staff meetings. Throughout the weekly periodic Mathematics staff meetings, teachers are encouraged to share and exchange teaching strategies and teaching tools such as technological material and specific worksheets.

The Third Module, for Mathematics Teachers in Class

General learning milieu basis

Teachers having two styles of communications with students, one is their general teacher-student talking. The other is their special teaching-learning approach; which could also be part of the first style. Teachers should adopt the Humanistic Learning in their general teacher-student approach, while they must implement the Meaningful Learning approach in their teaching practices.

Humanistic Learning Milieu

Concept: The MCM highlights the essence of promoting humanistic learning milieu from the Humanistic Learning Theory principles. In order to achieve strong, well-developed communication with students, they must be addressed with respect, caring and love, recognizing their needs, emotions, and feelings. This will not only motivates students' participation but also will promote their creative potentials.

Employment: Another type of PD courses that school principals should provide for the school staff (in general) are those that emphasize on the communication skills between teachers and students. Building positive teacher-student relationships through communication skills is important for improving student academic outcomes and motivation (Scarlett et al., 2009). As a basic Teachers should address students with respectful statements, such as sir and mam; they should understand students' complaints, accept their excuses, give them another chance, support and encourage them.

Meaningful learning

Concept: The MCM strongly emphasizes on incorporating meaningful learning as an essential foundation for every Mathematical lesson. It relates new learning concepts and skills to previously existing knowledge; this connection would make learning easier to comprehend and conceptualize.

Employment: Teachers are encouraged to make connections between new learning contents with students' existing knowledge. There are several ways to approach Meaningful learning, varies according to the level of complexity of the connections between the new material and its pre-requisite components.

Integrating MC Innovating Teaching Practices

Concept: The MCM encourages teachers to integrate the teaching practices that foster MC (those mentioned in this study as synthesized from previous studies as well as those practices developed by the researcher, mentioned in the previous section).

Employment: Teachers are encourage to start their lesson by employing one of the teaching practices developed by the researcher (Extreme-Case, Paradox or Pattern problems), for they serve an excellent starting point of brain storming as well as grasping the attention of students. Following up, teachers should vary in integrating other teaching practices (out of the nine practices mentioned in the study). Some practices would be more appropriate and more effective in some lessons than in others would. For example, in teaching geometrical objects features, it would be better to use cardboards and let students cut, construct objects, measure lengths and conduct calculations, while for teaching graphs of algebraic equations (lines, quadratic equations or polynomials), it would be more effective to use graphing digital tools (either laptops, IPads or personal smartphones). Nonetheless, there are teaching practices that should be implemented in every Mathematics lesson; these include brainstorming, class discussions and posing questions.

Integrating the SORT method

At the end of the lesson, teachers are encouraged to utilize the SORT method, beside the usual everyday lesson homework of solving certain problems. The SORT method keeps students connected to the lesson, thinking about the lesson and the task on the way home, trying to make connections between the observed and the lesson would set students' imagination free to create their own links and express how they see things. In addition to collecting information from the internet, taking photos that they can share with class the next day or they may draw that photo in their notebooks. They design their own problem and solve it, present it to class and discuss their solutions. We can see how this method integrate several innovating teaching practices combined, and most importantly, is that it is at the heart of student-centered learning.

Practical Implementation of the MCM

The presented MCM consists of three modules, and in order to be adopted properly in schools, the school principal and the Mathematics staff have to value the importance of the impact of each module.

PD workshop for Confirming Teachers' Conception of MC

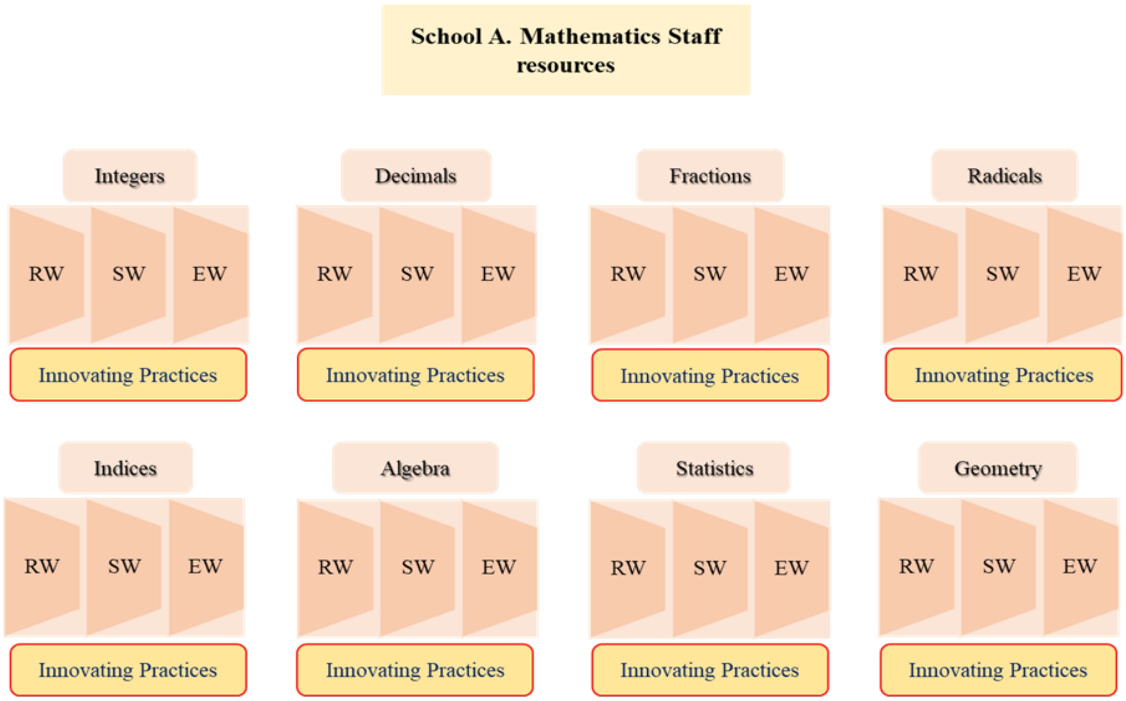
The first module is Confirming Teachers' Conception of MC; addressed for school principals to accomplish. It is composed of two phases, the first being a preparatory PD workshop before the beginning of the school academic year. This workshop is to introduce Mathematics teachers to the proper conceptions of MC, its aspects, differentiating between MC and any other Educational concepts, and how to identify mathematically creative student. In order for the workshop to be most efficient, it should not be of a lecturing nature, but it should be of an interactive nature. Teachers receive written and visual material via emails or any other digital tool, and they should be assigned (before the workshop day) tasks such as giving their feedback on the material they have received, choosing two – three concepts and preparing examples. Then during the workshop, teachers share and discuss their work with facilitating and guidance of the workshop instructor. In addition, the instructor could be very well a senior active teacher from the same school.

The second phase is a PD course throughout the academic year (semester). This PD course is to provide teachers with teaching skills of how to implement those identified innovating teaching practices. In order for the meetings of these PD courses to be efficient, it is recommended that they should be instructed by senior teachers from same school on one hand. On the other hand, the meetings should be interactive where every teacher has to contribute to the meeting. This can be done via conducting implementing 'flipped-classroom' strategy among the teachers, where they receive written and visual (video) description of the teaching practice(s) to be discussed in the coming meeting. Each teacher design a lesson plan (for the current lessons he/she teaches) in which the teaching practice(s) is integrated. During the meeting, each teacher demonstrates a lesson in simulated classroom settings. Getting feedback from the group, pinpointing the teacher's strengths as well as the stages that need improvements. This guarantees the efficiency of these PD courses.

The second module, addressed for the Mathematics staff as well as school principals to accomplish; consisting of two parts: Professional Learning Communities (PLCs) and creating a Humanistic Learning Milieu. PLCs; emphasize that school Mathematics staff ought to work as a whole body, with the same spirit in the PD course, supporting each other. Their initial step is to construct an Online Mathematics Staff Dropbox (OMSD), such as an interactive open Google folder with subfolders labeled by titles of Mathematics content matter. Each subfolder to have subfolders of Video lessons' links, Regular Worksheets (RW) (worksheets of an average level), Scaffolding Worksheets (SW) (worksheets that address certain weakness, fill in the learning gaps and gradually leveraging the level), and Enrichment Worksheets (EW) (of high level) without specifying grade level. The staff members are to contribute to the subfolders each at his/her own pace. The OMSD to be shared with the staff members as well as the school administration. Every teacher can enter to the OMSD and use any of these resources according to the needs of his/her students. For example, Mr. A. of grade 9 and Miss B. of grade 7 found that class 9 and class 7 have difficulties in operations on fractions, they can enter to the SW subfolder of the fractions folder and use the scaffolding worksheets (may be the same worksheets), while Miss C. of grade 8 found that class 8 are at an advance level in Algebra, then she can enter to the EW subfolder and use the enrichment resources there. Moreover, under each topic to have a subfolder containing 'Innovating Practices' in which teachers contribute with their own designed teaching practices that foster MC. This would include suggesting technological materials, open questions, multiple solution problems, real world problems, artistic relevance, etc. as well as personal experiences. Figure 1 illustrates a sample of constructing the OMSD. Then teachers have to share and discuss their experiences of success and / or challenges during their weekly staff meeting, in order to modify, strengthen and develop teaching practices.

Figure 9

A sample of an OMSD



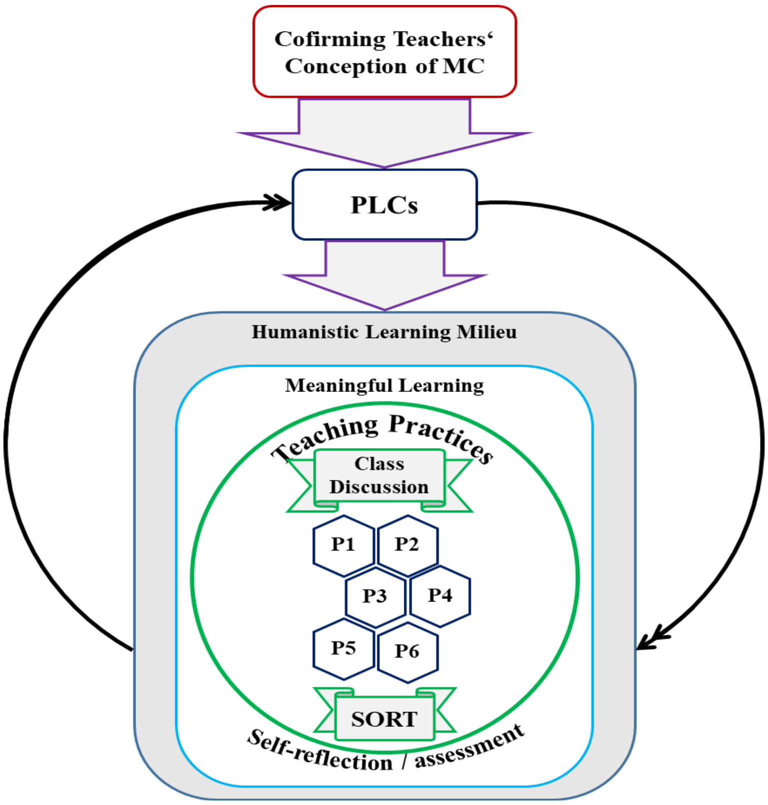
Additionally, the OMSD will help in dealing with the issues mentioned by teachers (in the interviews) concerning the official textbooks. Gaps, lack of enrichment exercises and innovative tasks can be treated by the contribution of the staff members.

The second part is creating a Humanistic Learning Milieu. This can be accomplished by participating in a PD special course that is designed to provide teachers with communication skills that aim to create a positive student-teacher relationship. Humanistic aspects that teachers usually do not pay attention to. Some of the general practices are: Addressing students by name, greeting students on their birthdays, wishing a good health for a student coming back to school after recovery. Talking to students in private to discuss certain personal issues (never giving students negative feedback in the publicity of the whole class, which is not constructive). Giving students another chance and provide them with the appropriate help they might need. The more caring and affectionate the teacher is to his/her students the more influencing on students he/she would be. In addition, such an environment allows students to be more likely to integrate in the learning process, collaborate more and complete assigned tasks.

The third module, for Mathematics teachers to accomplish in class; consisting of two parts. Firstly, the general part is to have meaningful learning as a baseline; for its necessity in progressing in any kind of learning. Teachers must identify students' previous knowledge and mastered skills before proceeding to a higher level of learning. This would confirm a proper learning lacking possible gaps which, if exist, would gradually increase creating an unbridgeable fissure. The second part is integrating innovating teaching practices in class. Innovating teaching practices to choose from; are those identified in the literature as well as those new teaching methods proposed be the researcher in this study. Additionally, teachers should be able to decide which teaching practice is more appropriate for certain topic. However, classroom discussion, including brainstorming, is an essential tool for every lesson. Moreover, I strongly suggest that teachers employ SORT practice, since it combines most of the innovating teaching practices. Teachers who are not even aware of how to implement certain teaching practice, then by employing SORT it would cover most of these practice, namely: student engagement, experimenting, relating to real life problems, problem posing (designing the problem), open problems (the students choose their example and construct their problem), problem solving, research (gathering information from the internet), relating to art (by sketching the observant and taking photos), divergent thinking (by choosing which object to relate to the lesson), Mathematical reasoning (by presenting, explaining the problem and demonstrating the solution to the class), class discussion (by discussing the solution and answering the classmates questions), using imagination (the whole process is about using imagination by recalling the class lesson and trying to connect the lesson's components with what the student sees on the way home). In addition to activating the students brain by setting the student in a rumination state of continuous thinking about the class lesson, trying to make connections and looking for relevancies, which would make the student connected to the lesson, increasing his/her motivation and involvement, not to mention increasing students potential in observing the world around him/her differently, since this task is given to students almost every lesson with variation in the level of the task (it could be a very simple introductory task or more advanced one), and their field of search is the same way back to their residence, thus promoting their cognitive skills as well as their metacognitive skills. Throughout the time setting for covering a certain Mathematics chapter (3 week3 – a month), repeating the process. Sharing the staff with teacher's feedback and discussing. An illustrating diagram of employing MCM in the classroom is shown in Figure 10.

Figure 10

An illustration of employing MCM in the classroom



Reviewing the MCM

The researcher approached four official supervisors of Mathematics teachers from various governorates (Jerusalem, Ramallah, Nablus and Salfit) to review the MCM and to provide a feedback. The supervisors' feedback and comments were aiming about the same points, though expressed in different ways. These comments are summarized as follows:

Positive Points

The supervisors expressed their acknowledgement and admiring of the value of the MCM as a promising methodology that would foster MC among students, especially for combining the humanistic theory along with the cognitive learning theory (Meaningful learning). Moreover, the distribution of duties among the school principals and teachers was also highlighted as a proper management of the methodology. The supervisors have also expressed their commendation for the school's Mathematics teachers' periodic collaborative work and the PLC.

Negative Points

The supervisors have indicated that the MCM lacks assessment methods for both, teachers and school principals. According to them, assessment methods should be clearly stated and explained.

Special Concerns

They all have expressed their concern about the following points:

The lack of internet and/or digital tools in certain areas in the country, which would make constructing the OMSD impossible. In addition to employing certain digital tools in the learning process.

The availability of well-prepared PD courses to address the innovating teaching practices, as well as those PD courses for promoting the humanistic learning practices and highlighting meaningful learning lessons.

One of the supervisors expressed his concern about the desired objectives of the MCM, are they for fostering creativity only or improving students' achievement or both.

The author's comments on the feedback of the supervisors

Reflecting on the supervisors special concerns

The lack of internet and/or digital tools would not be an obstacle for employing the methodology. The OMSD can easily be substituted by having a Mathematics shelf in the teachers' room with labeled folders carrying the same titles and same categories as those in the OMSD. As for the well-prepared designed PD courses, there are rich human resources in the ministry of education and they are available upon request by school principals. There are plenty of very well qualified educators in the local universities and colleges who can also help in designing such courses for the ministry of education. Finally, for the clarity of objectives, in the context of the Research, the main objective is to promote students' MC in their thinking and in their approaching mathematical problems. On the long run, this would definitely promote achievement as well. However, the main researcher's concern in this research is to promote, provoke and enrich students' creative thinking, producing students who can generate new ideas and original solutions to big existing problems, becoming new inventors and explorers, rather than making others think for them. To stop employing others' ideas and thoughts and using foreigner machineries by the aid of the translated catalogue.

The Assessment Methods That May Be Used For the MCM

Assessment methods to be used by school principals

School principals should have a well-planned follow up procedure, such as attending some of the PLC meetings, and getting individual feedback from each teacher on their progress in class as well as their feedback about their PLC meetings.

School principals should guide/or request from the instructor of the PD courses to have the course assignments as real implementations of what they have learned in each meeting.

Assessment methods to be used by the teachers

Teachers can utilize several assessment methods in class such as a checklist. A checklist of the components or indicators of creative thinking of the students, such as new ideas, multiple solution methods, better communication skills, providing reasoning, fluency and flexibility. Another assessment method is having a portfolio for students to keep their creative work. Moreover, teachers may also request the aid of a colleague to run an observation of his/her class and use the checklist mentioned above. Finally, if possible, the teacher may video record some of his/her lessons and watch them later on, and write a reflection, in addition to sharing and discussing these lessons with other colleagues.

Implications for Theory and Practice

Theoretical implications

The findings from the study contribute to the theoretical understanding of MC in the following aspects:

Broadening the conceptual model for MC

The findings of the analysis have revealed that teachers express a variety of ways of how they perceive MC and nurture it in their teachings. Their implementation of problem-solving, problem-posing and open inquiry, essential class discussions, applying Mathematics to real world situations, and embracing collaborative learning environment. These realms imply that MC is more than finding correct solutions, it comprises composing new problems, applying knowledge to real experiences, and contributing in a group-based task activities, these all provoke students' creativity (Elgrably & Leikin, 2021). This conception agrees with current theories that observe Creativity as a sophisticated, multifaceted concept in Education (Hanson, 2015; Shymanovska-Dianych & Ishcheikin, 2021).

Variations in Influences of Teachers' Characteristics

The findings from this study have revealed that characteristics such as gender, academic degree and experience vary in their impact on teachers' teaching practices. Which imply that these various effects of teachers' characteristics should be considered meticulously by theoretical models of creativity in Education.

Non-Interaction Effects

The absence of significant interaction effects between teachers' academic degree and their seniority on their teaching practices questions the assumptions of some current theories on the combined influence of teachers' education and experience (Liu et al., 2010; Suárez & Jiménez, 2016). Thus, the findings call for further research and deep theoretical investigations into the interaction influence of various predictors of teaching practices.

Practical Implications

The study highlights several practical implications for teachers, school principals and, decision makers in PMOE.

Curriculum design (official textbooks)

The frequently highlighted aspects concerning the official textbooks ought to be taken into serious considerations through an overhaul reform of the curriculum. Firstly, an urgent need for reduction of the amount of content matter. Including open-ended examples and exercises, integrating exploratory and research group-based tasks and encouraging high thinking skills via bonus problems. In addition, a well-designed teachers' guidebook should assist teachers along every lesson, especially new onboarding teachers.

Professional development

The findings from the study emphasize the desideratum for well-designed PD courses that aim to equip teachers with the proper tools to enable them implement teaching practices that foster MC. However, PD courses ought to be of various types. Firstly, differentiating between PD courses that address teachers with B.A. and those with M.A. in order to focus on each groups' needs. Teachers with B.A. need to be trained more on how to integrate open-ended, innovative questions, how to emphasize on reasoning and deep thinking and how to encourage out of the box thinking, while teachers with M.A. need to be trained on how to employ technological tools, digital tools and relate Mathematical knowledge to real life situations. Secondly, another type of PD courses that teachers need are of theoretical and psychological nature that impart clear description and differentiation of certain educational concepts such as creativity, achievement, distinguished, students' potential, motivation, etc. Distinguishing between achievement and potential as characteristics of students, for example, would urge teachers to approach their students differently.

Moreover, as was mentioned in an earlier section, employing highly experienced teachers to conduct some to PD courses to pass their own rich experiences to younger teachers.

Supportive environment for teachers

The analysis of the study also indicated the need for a supportive environment for teachers. This would include sufficient classroom equipment for presentational purposes, appropriate class sizes, proper schedule arrangement (including additional periods per week for Mathematics lessons). In addition to proper schedule management to allow for some Mathematics lessons to be conducted in the computer lab (if applicable, having a big room as a Mathematics lab, to be equipped with proper tools, objects, measuring taps, ropes, etc. where students can conduct relevant experiments). Finally, a caring supportive, wise administration policy, this would include acknowledging teachers' concerns, fulfil their needs of special equipment. In addition to frequently conducting teachers' workshops for teachers within the same school as well as participating in workshops for several schools in the school district; thus exchanging teaching methods and innovative ideas. Considering these aspects would stimulate teachers effectively to integrate teaching practices aiming to foster MC.

Concluding, this study highlights the main factors that have significant impact on teachers' practices that foster MC. By approaching both theoretical and practical implications, the findings from the analysis declare the need for the promotion of more productive teaching practices, efficient curriculum designs and supportive policies. Accordingly, these factors, if nurtured well, would provide practical routes for enhancing the educational system to embrace in creative learning.

Conclusion

The current study made significant contributions to the understanding of teachers' perception and practices in the context of MC in Palestinian 8^{th} – 9^{th} grade Mathematics education. The study employed a mixed-method research, whose analysis has highlighted an overall view of how teachers perceive MC, how they aim to foster creativity through their teaching practices and how they describe hindering obstacles against their innovative practices. Combining both quantitative and qualitative data enabled the research to carry out a meticulous analysis, emphasizing the sophistication of factors that play crucial roles in employing teaching practices that foster MC in class.

Comparison with Other Studies

1. (Ayele, 2016): “Mathematics Teachers’ Perceptions on Enhancing Students’ Creativity in Mathematics”

Methodology

This is a quantitative research that examined how teachers' practices influence students' MC in schools. The independent variables included teachers' teaching level, years of service, and academic degree. The study found no significant relationship between these variables and enhancing creativity in Mathematics. However, there was a small significant interaction effect between teachers' academic degree and teaching level, seniority, and between teaching level and seniority. Interestingly, teachers with a B.Ed. had greater mean responses at preparatory and high schools, while those with a Master's degree had greater mean responses at primary and secondary schools.

Comparison between the findings from the results of current study with Ayle’s:

The influence of teachers’ academic degree

Similar to Ayle’s findings, there were statistically significant differences in the responses based on teachers’ academic degree. However, more precisely, the current study pinpoints those significant differences based on academic degree for specific teaching practices. Teachers with B.A. were observed to be more tending to integrate most of the tested teaching practices than those with M.A., while those with an M.A. were found to be more tending to integrate Problem solving, Mathematical reasoning and Divergent thinking.

The influence of teachers’ gender

Moreover, Ayle’s study did not address teachers’ gender as a factor influencing their teaching practices, whereas the current study highlights that female teachers are more tending to integrate teaching practices aiming at fostering creativity than male teachers.

The influence of teachers’ seniority

As for seniority, contrast to Ayle’s findings, there were significant differences in the responses based on teachers’ seniority, more experienced teachers are more tending to integrate certain teaching practices aiming at fostering creativity.

Suggestions and recommendations

Both studies suggest that further research should be carried out in order to have deeper understanding of the influence of the addressed factors along other factors that may be unobserved. Moreover, both studies pinpointed at the need for continuous PD courses, with the emphasizing of the current study on specifying the types of these PD courses as well as their instructors (experienced in-service teachers).

Therefore, both studies investigated the influence of several aspects of teachers on their teaching practices that foster MC, both studies found some influences of some of these factors with the current study being more meticulous which was reflected in the precise findings among the levels of the addressed factors on one hand, as well as in enabling the researcher to discern the types of needed PD courses for teachers.

2. (Bicer, 2021b): "A systematic literature review: Discipline-specific and general instructional practices fostering the mathematical creativity of students"

This is a systematic review of teaching practices that foster creativity among school students. Synthesizing and analyzing the results of 58 articles on the subject. MC was defined as the ability to produce ideas, strategies or products that are genuine to the student. The authors identifies teaching practices that are essentials for fostering MC among students, these practices include problem solving and posing, 'model-eliciting activities'. Moreover, cognitive flexibility that surpasses regular style of solving problems and integrating innovative methods has a crucial role in fostering creativity.

Comparison between the findings from the current study with Bicer's:

Teaching practices

Although Bicer has mentioned all (MC fostering) teaching practices that were found in the 58 studies that it has covered explicitly, so does the current study. However, some these teaching practices were mentioned in the current study implicitly, such as multiple solution tasks, model-eliciting activities, extendable tasks, and emphasizing the abstract nature of mathematics. On the other hand, the current study exclusively highlights other teaching practices such as applying Mathematical knowledge to real world situations, cultivating imagination and collaborative learning.

General Practices

Bicer had also highlighted general practices that could foster creativity among students, such as Judgment-Free And Collaborative Environment where students are allowed to participate and share their opinions freely in class without being threatened by judgment (verbally or by grades), and Sufficient Time: Offering students enough time to think, try, and participate. While the current study has not mention these factors explicitly. Both studies emphasize on the significance of the setting of the learning milieu to be supportive, safe and risk-free, encouraging, sharing and exciting.

Factors affecting teaching practices aiming at fostering creativity

Bicer's review did not consider the impact of teachers' characteristics such as gender, academic degree or seniority. It discussed comprehensively teachers' preparation and PD. While the current study conduct a thorough analysis of the influence of teachers' characteristics: gender, academic degree and seniority, on their (creativity fostering) teaching practices. In addition, the current study has considered teachers' features as well, their willing to develop and learn, believing in their students' potentials, etc.

Challenges and obstacles

Bicer has identified key challenges such as not enough teacher training and PD courses, curricula's issues and the pressure of standardized exams. Suggestions were made concerning systemic alterations to provide sufficient support for teachers, reforming curricula as well as more efficient PD courses. While the current study has identified same challenges (except for standardized exams, since the study focus only on 8^{th} and 9^{th} grade teachers), in addition to other obstacles such as large class sizes, small classrooms, time problem (insufficient number of periods per week for each class).

Suggestions and recommendations

Similarly, suggestions included systemic changes to support teachers including the refining of the mandated textbooks, decreasing the number of students per class, building more schools of larger spaces and offering more periods for each class weekly.

Therefore, there is a pretty closeness in the findings of the current study with that of a comprehensive systematic literature review. However, the current study identifies more factors and investigating more aspects encompassing the topic of fostering MC.

3. (Joklitschke et al., 2022): **"**Notions of creativity in mathematics education research: A systematic literature review"

Anther systematic literature review about various notions of creativity in Mathematics education. It is a comprehensive overview of the notion of Creativity in Mathematical education by synthesizing and analyzing 51 articles. The study identified several prevailing ideas (notions) about Creativity in Mathematics education, namely: MC as Flexibility, Fluency and other characteristics, MC as Divergent Thinking, MC as a sequence of stages, MC based on 'Person-Product-Process-Behavior notion, MC in the Sense of Creative Mathematical Reasoning (CMR) including novelty, plausibility, and mathematical foundation which were developed afterwards into creativity, plausibility, and anchoring.

Comparison between the findings from the current study with Joklitschke's:

The literature review of Joklitschke synthesized the Notion of MC into the various categories that were just mentioned in the last paragraph. The Joklitschke's study does not consider the influence either of teaching practices or of teachers' characteristics as the current study does. While the current study align with the frameworks mentioned in Joklitschke's, specifically in highlighting the significance of divergent thinking and the ability to create multiple solution strategy. Additionally, the current study also emphasizes on implementation of applying Mathematical knowledge and collaborative learning, as practical teaching methods, in fostering these notions of MC. As for the impact of teaching practices at fostering creativity, Joklitschke's study does not consider the influence of teachers' characteristics (gender, academic degree or seniority) on teachers' practices aiming at fostering MC, as the current study does.

Therefore, both studies provide rich conceptions into the comprehension and the development of MC in schools. Whilst Joklitschke's study concerns more with the notion of MC, the current study focuses more on practical applications, especially teachers' perceptions, features and their teaching practices as well as dwelling into influencing factors on teachers' practices in order to come out with beneficial suggestions aiming at enhancing MC among students in schools.

4. (Leikin & Sriraman, 2022): "Empirical research on creativity in mathematics (education): From the wastelands of psychology to the current state of the art"

This is another systematic review that studied empirical researches on Creativity in Mathematics education. The study investigated 49 papers that described empirical studies on creativity in mathematics education. Out of these 49 studies, some studies examined the relationships between creativity in Mathematics and other characteristics, some were on creativity related to instructional practices and Mathematical tasks, others investigated teachers' creativity-related conceptions and competencies The paper focused on the progress of research on Creativity starting with psychological theories up to its integration in Mathematical Education. The same prevailing ideas about Creativity were identified. The study highlights the essence of understanding these various ideas in order to enhance teaching practices aiming to better foster MC. Additionally, the study also indicate the necessity of integrating Creativity into Mathematics curricula (textbooks).

Comparison between the findings from the current study with (Leikin & Sriraman)'s

The review study of Leikin & Sriraman highlights the various aspects of the MC, exposing its several conceptual frameworks, such as problems (solving and posing), implementation of divergent and convergent thinking, in addition to the significant role of learning processes that are both, individual and collaborative based in creative Mathematics.

Similarly, the current study's findings identifies the sophistication of MC, emphasizing on practical facets including applying Mathematical knowledge to real life situations and collaborative learning to improve MC. Beside aligning with the more comprehensive conceptual frameworks considered by Leikin & Sriraman, the current study incorporates special insights into the obstacles and barriers in the face of teachers, hindering their integrating of these teaching practices in their lessons. As for the teaching practices,

The review study of Leikin & Sriraman discusses several teaching practices aiming at fostering MC, such as integrating open-ended problems, open-tasks and nurturing multiple solutions strategies. Additionally, the review study emphasizes the crucial role of constrain-free curricula and teachers' free will (independence) in improving MC. Similarly, the current study highlights the discussed teaching practices with the emphasis on open-ended questions and applying Mathematical knowledge. Moreover, the current study identifies certain challenges and obstacles, in particular, issues related to official textbooks, large class size in students' number, small classrooms and insufficient number of periods per week (these challenges were not pointed to in Leikin's review.

Other related studies

5. (Raba' & Harzallah, 2018): "Palestinian Teachers' Views on the Factors That Limit Students' Creativity and Some Possible Strategies to Overcome Them"

This is a mixed method study that used the researchers used a 20-item questionnaire and a 5-question interviews. The study investigates the degree of enhancing creative thinking skills in the English for Palestine and Mathematics curricula from the teachers of English and Mathematics perspectives. The study found that the degree of using creative

Research results revealed that the level of creative thinking implementation in educational institutions and curriculums is insufficient and minimal. Based on the results, the researchers suggested various teaching approaches, proper instruction for teachers and learners on various strategies, and the integration of activities in the syllabus to boost students' creativity. according to the study, teachers believe that schools hinder innovation due to class size and strict management. Students lack opportunities for creative thinking as they are tied to mandated course materials. teachers are pressured to cover overwhelming curriculum, leaving little room for activities like role-play and problem-solving that enhance cognitive abilities. To address this, schools can incorporate real-life scenarios and relevant homework to bridge the gap between academics and real world skills. Critical and creative thinking should be integrated into all areas of learning to develop students' cognitive abilities for future success. Some of these findings align with the findings from my study (class size, overwhelming curriculum).

6. Abdul-Muhsen (2015): "The Effectiveness of a Program Based On Some Self-Organized Learning Strategies in Teaching Mathematics to Develop Creativity Skills for Preparatory Stage Students".

The article discusses the effectiveness of a program based on some self-regulated learning strategies in teaching mathematics to develop the creative skills of preparatory stage students. The study aimed to:1. Identify the level of creative mathematics skills among second-grade preparatory students.2. Develop a program based on some self-regulated learning strategies to develop the creative mathematics skills of second-grade preparatory students.

The researcher discussed the effectiveness of a designed teaching program that is based on self-regulated learning strategy in the Mathematics classroom on the development of MC on upper elementary grades (middle school). The researcher aimed to identify the level of MC among students and to develop the proposed program. The researcher used experimental method using two groups of students, one is an experimental group that undergone the self-regulated learning program and the other is a control group that was taught by traditional methods. The study revealed the effectiveness of the program in developing all the MC skills of the experimental group.

7. Al-Malky (2021): "The Effectiveness of Using Instruction Activities based on the Reality Theory in Developing Creativity Achievement in Mathematics among Gifted Students".

The study's findings indicate that teaching activities based on Reality Mathematics Theory are effective in fostering creativity among gifted students. These activities encourage students to engage with real-world issues and collaborate in chat rooms, shifting them from passive learners to active participants. By solving real-life math problems and sharing ideas, students develop flexible thinking and linguistic abilities. The safe, supportive environment created by these activities boosts confidence and creativity, allowing students to express new ideas without fear of judgment. Overall, the realistic mathematics approach enhances cognitive frameworks, social interactions, and problem-solving skills while promoting a deeper understanding and enjoyment of math concepts.

Main Contribution to the Field of Mathematical Education

Advancing the Concept for MC

The study has extended the theoretical (conceptual) foundation for MC, by highlighting that it comprises more than just finding correct solutions; it also includes composing original problems, employing real-world applications and contributing in a group-based task activities. This advancement and broadening of the conception contribute to current researches' investigations as well as highlighting the pathways for further studies.

Understanding the Teacher's Role

By analyzing the effects of teachers' gender, academic degree and experiences, the study provides important observations of how these aspects affect teachers' integration of certain teaching methods aiming to foster MC. The study's findings urge for serious interventions from policy and decision makers in the PMOE, especially for refinement of the official textbooks and for designing appropriate PD courses.

Highlighting Main Challenges

The study pinpoints major obstacles to fostering MC in class. Some of which are the design and constituents of the official textbooks, large number of students, not enough lessons per week for each class. These challenges call for the attention of decision makers for a dramatic alternation in vital issues in the educational system, for the sake of enabling teachers to foster creativity and accomplish a profound learning.

Suggesting an MC Methodology

The researcher suggests a methodology to be effective and applicable in schools to foster MC. The methodology addresses the role of school principals, the whole Mathematics school staff as well as the individual role of each Mathematics teacher in class. The methodology is grounded strongly on basic, well-established persistent Educational theories such as constructivist theory, cognitive theory, humanistic theory and meaningful learning theory. In addition, the methodology was designed to fulfill the needs and obstacles hindering MC in schools according to the analysis of the findings from the study's research results. The methodology provides a well-designed hierarchy for teachers to follow systematically. I believe that the structure of the methodology will be very beneficiary for fostering MC among students in schools because it is constructed based on scientific theories, because it addresses issues and problems mentioned by teachers in this study, and because it doesn't address big issues (such as official textbooks) that need the interference of policymakers and the PMOE, but requires simple planning, staff collaboration and little principal support.

Suggesting New Innovating Teaching Practices that Foster MC

The researcher suggested the implementation of few teaching practices to foster MC in the Mathematics class. These are Extreme-Case problems and Paradox problems, Pattern

Problems and employing a State of Rumination Task (SORT). These practices involve students in deep thinking and provoke students' creative potentials. Moreover, the SORT practice is, in my opinion, the most important for its encompassing most of the innovating teaching practices mentioned in the literature, in addition to its nature of promoting metacognitive thinking process as well as it open-nature that allows students to observe objects that they like. For instance, students who are interested in football would try to investigate football related objects, and those who are interested in cars would try to observe shapes of car designs and integrate it to fit in the content of the lesson material, while those who are interested in buildings or plants would involve those objects. Most importantly, is that the SORT practice would change the way students observe things around them, making a scientific interpretation of everything they observe.

Significance of the Study and Its Findings

The study has indicated the essential role of teachers in fostering creativity, thus lies the necessity to support and assist them. The findings are critical for decision makers and educators to take actions on the track of fostering MC in classes. Nonetheless, the findings led the researcher to develop an Educational MC methodology designed in such an applicable way that does not need essential interventions from policymakers or the Ministry of Education. The methodology is easy to follow and employ in schools even with possible recruiting of staff members. Moreover, the methodology helps soothing and/or eliminating certain hindering issues, such as accumulated official textbooks. Additionally, new teaching practices were also developed as well.

Limitations of the study

Although the study highlights important perspectives on fostering MC among students by mathematics teachers, this study still has various limitations that ought to be presented.

Sample size

The sample of the study was quite small and focused only on certain areas of Palestine. Moreover, because of the political situation that caused closure of main roads between Palestinian cities and villages, the researcher was not able to conduct classroom observations. Moreover, the results of the study may not apply to all teachers in Palestine or to those of different cultural backgrounds. In addition, that the findings focus on

Mathematics teachers for 8th and 9th grades, which suggest that these findings may not be applicable to teachers of other subjects or at other grade levels.

Methodological restrictions

The data of the study was collected through a questionnaire and semi-structured interviews, both of which considered as self-reported data which might lead to distortions such as social desirability bias, where participants might portray themselves more positively.

Dramatic political situations

The data collection took place in a politically unstable academic year that included hybrid learning, sudden closure of roads and villages, sudden strikes and school closures. All these factors have affected the whole Palestinian educational system, affecting several factors that might not been observed in the analysis. In spite of all these limitations, the study offers comprehensive insights of the obstacles, opportunities and role players in fostering MC among Palestinian students.

Recommendations

According to the findings, discussions and conclusions of the study, the researcher suggest various recommendations to improve and develop the fostering of MC among Palestinian students. These recommendations target teachers, school principals, policymakers in the PMOE, in addition to researchers.

For Teachers

Believing in students' potential

Teachers should believe more in their students' potential. Students are not fixed, unchangeable blocks, neither are incapable to learn. Every student has special skills and personal interests. Distinguishing these abilities and acknowledging them would increase their self-esteem and stimulate their motivation to collaborate and participate in class activities. Teachers' belief in their students is the first step toward integrating teaching methods aiming to foster creativity.

Teamwork and collaborative teaching mission

Teachers are strongly advised to engage in a collaborative teaching teamwork. They can make use of each other's skills and knowledge. They can share and exchange their work during the PLCs meetings and by contributing to the OMSD. By employing the proposed MC methodology, in addition to implementation of the newly developed teaching practices (especially the SORT practice), they can orient their potential in a focusing direction whose influence would be very efficient and effective in fostering MC among students.

Implementation of the Proposed MC Methodology and Teaching Methods

Teachers are advised to employ the proposed MC Methodology since it encounters Educational basis, hierarchy teaching stages as well as implementation of teaching practice. In addition to its cyclic nature of self-assessment via contemplation and feedback. A crucial component of the methodology is to frequently integrate innovative teaching practices, that boost the level of suspense among students' expectations of what the lesson's activity will be like today! Pose more open-ended problems, apply Mathematical knowledge to real life scenarios to make it relevant, employ project-based learning and involve students in demonstrations and actual measurements. Additionally, integrating the three developed teaching practices is also encouraged, especially the SORT practice. These practices improve students' creative thinking as well as deepen their understanding of sophisticated, abstract Mathematical concepts.

Using Technology and Digital Tools

Teachers are encouraged to use technological tools for demonstrational purposes, especially in Geometry and Trigonometry lessons. Holding a prism, toughing it, observing its sides, bases, height, etc. have a much deeper conception than looking at a 3-D graph on the board. In addition, digital tools that are part of the student's everyday life experience, especially their smart phones. Teachers can make use of this small but efficient device by assisting students download some applications, such as GeoGebra and Desmos. Teachers can easily train their students on how to use either app and can give them tasks to conduct either in class or at home. Students love to use their phones that would make the learning task a favorable one. The more students are engaged in the learning process the more they promote their thinking skills.

Professional Development

Teachers are encouraged to pursue their professional development continuously. They should look for other teaching methods, new methods. They should participate in PD courses that they think that these courses focus on creative teaching strategies. Alternatively, they can watch online videos of other teachers, locally or internationally, to see how some lessons are being taught. Moreover, more experienced teachers are encouraged to carry out their own personal workshops at their school or in the school district and to train new teachers and pass to them the rich experience.

For School principals

School principals should maintain a supportive teaching environment that allows for fostering creativity. This includes acknowledging teachers' concerns and interests, providing them with teaching tools they request. Offering teachers space and freedom to conduct outdoor activities. Designing appropriate lesson schedule according to teachers' request (maybe of having successive lessons on same class). Conducting workshops for teachers. These actions would encourage teachers and help them integrate teaching practices aiming at fostering creativity.

For Policymakers

Refinement of official textbooks

Official textbooks need to be refined by organizing less number of units of the content matter, demonstrating higher thinking examples as well as adding problems at such level. Employing open-ended problems and applying Mathematical knowledge to real world problems. In addition to integrating project-based and research-based problems.

Designing special PD

Policymakers should provide schools with well-designed PD courses that aim at fostering innovative teaching methods, in addition to those theoretical-foundational based courses that would enlighten teachers by the exact meaning of certain educational concepts. Moreover, they should appreciate well experienced teachers by assisting them to conduct PD courses for new teachers. Exchanging experiences and observing each other would boost teachers to integrate creative teaching practices.

Infrastructural development

Policymakers should encourage investors to build new large schools with large classrooms, enough number of rooms to allow for having computer labs, Mathematics lab, large playground, etc. Making the physical space convenient for both, teachers and students would allow for engaging into teaching activities that foster creativity.

For Researchers

Investigating other factors

Further research ought to be conducted to investigate other factors that could impact the fostering of MC, such as teachers' attitude, cultural diversity (living in cities or villages), parents and family factors. Having a deeper insight into these factors can help in understanding of obstacles and supporting points in fostering creativity.

Assessing the MC Methodology

Given the MC methodology with its theoretical grounding, its well-illustrated stages and components and applicability suggest for further research to be conducted in order to assess and verify its efficient impact on fostering MC among students.

Conducting comparative research

Comparative research in various educational settings, both in and out of Palestine, can pinpoint best teaching practices that foster creativity as well as factors affecting these practices. These researches can offer important standards and perspectives to enhance educational methods worldwide.

Conclusion

These suggestions are intended to help improve MC in the classroom by meeting the immediate needs of teachers and implementing necessary systemic changes. Teachers, school principals and policymakers can collaborate to establish a more vibrant and encouraging educational setting for promoting creativity and innovation in Mathematics education by following these suggestions.

List of Abbreviations

Abbreviation	Meaning
DIA	the German Abitur
EJ	East Jerusalem
GCSE	General Certificate of Secondary Education
GML	General Linear Models
IB	the prestigious International Baccalaureate Organization
MC	Mathematical Creativity
MEAs	Model-Eliciting Activities
MOE	Ministry of Education
MRs	Multiple Representations
NCTM	National Council of Teachers of Mathematics
SAT	American Scholastic Aptitude Test
SORT	State of Rumination Task
STS	Science-technology-society
UNRWA	United Nations Relief and Works Agency
WB	West Bank

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Appendices

Appendix A

Quantitative Survey Instruments and Participant Demographics

Table A1

Number of eighth and ninth grades Palestinian Mathematics teachers according to type of school and gender

Type of school	Public schools		Private schools		UNRWA schools	
Gender	M	F	M	F	M	F
Total	996	1394	98	316	54	106
Total	2390		414		160	
Male teachers			1148			
Female teachers			1816			
Total			1447			
Total			2964			

Table A2

The Main three Palestinian Regions of the Population Sample

Southern Governorates	Middle Governorates	Northern Governorates
Hebron and surroundings	Jerusalem, Jericho, Ramallah and al-Bireh	Jenin, Tubas, Nablus, Tulkarm, Salfit and Qalqilya

Table A3

Data of Teachers' Gender

Gender	Frequency	Percent
Male	65	27.1
Female	175	72.9
Total	240	100.0

Table A4 Table A5

Data of Teachers' Education *Experience Data of Teachers' Teaching experience*

Academic Degree	Frequency	Percent
B.A.	167	69.6
B.Ed..	14	5.8
M.A.	54	22.5
PhD	5	2.1
Total	240	100.0

Teaching experience	Frequency	Percent
1 - 5 years	59	24.6
6 - 10 years	28	11.7
More than 10 years	153	63.7
Total	240	100.0

Table A6

The Cronbach's Alpha for the subsample of 30 participants

Case Processing Summary			Reliability Statistics	
	N	%	Cronbach's Alpha	N of Items
Cases	30	100.0	.958	35

Table A7

The Questionnaire's Main Questions Concerning Teachers' Teaching Practices

1. Problem Solving
I expose the characteristics of concepts and relate them to the solution of the problem.
I direct students to link their Mathematical thinking to basic concepts.
I encourage students to explore several ways of solving mathematical problems.
I direct students to use the skills that they have acquired to solve Mathematical problems.
I employ several teaching strategies to develop mathematical creativity, such as brainstorming.
I encourage students to participate in class discussions.
I encourage students to share and justify their ideas about mathematical knowledge in class discussions.
I use class discussions to reach to Mathematical generalizations and/or Mathematical knowledge.
2. Using of technology in teaching and learning
I employ appropriate explanatory tools in classroom teaching.
I employ the use of computerized programs in teaching mathematics (computer programs and/or phone applications) in the Mathematics' teaching-learning process in the classroom.
I assign to students computer-based learning tasks (computer programs and/or phone applications).
3. Guessing and trying
I pay attention to and shed interest on students' answers based on guesswork and/or approximate answers.
I allow mistakes in students' class interactions and responses.
I direct students to learn from their mistakes.
4. Mathematical Reasoning
I give logical explanation for each step of the solution while displaying Mathematical knowledge.
I instruct students to explain their answers and explain their thinking rout in a Mathematical Discussions.
I use 'teaching by groups' method in my teaching in order for students to evaluate each other's solutions, thus enhancing their logical-mathematical thinking and collaborative problem-solving skills.

I use active learning methods to stimulate class discussion and apply logical thinking in approaching solutions to the proposed questions.

5. Divergent Thinking

I address to students open-ended questions (which have several solutions).

I encourage students to explore unusual approaches in solving Mathematical problems.

inquire students to think of other ways to solve a problem, which they have just solved.

6. Problem posing and research

I allow students to ask questions (whether they are directly related to the topic of the lesson or not).

I direct students to think about questions asked by other students.

I direct the students to search for the answer to some of the posed questions through digital sources (the Internet) as a homework.

I assign students to do specific research tasks on Mathematical Knowledge either in the classroom and/or as homework.

7. Applying Mathematics to real life problems

I link Mathematical Knowledge (of the lesson topic) to life applications.

I present examples of Mathematical problems from the students' environment.

I ask students to bring practical examples of the Mathematical topic (such as a tangible object, a picture, or written information).

8. Using imagination

I use imagination to present some Mathematical examples of the lesson topic.

I try to represent the information through multiple representations (showing pictures, showing a movie, using computer programs, etc.).

Whenever it is possible, I relate the topic of the lesson to geometric shapes.

9. Relating to Art and/or Music

Whenever it is possible, I make a connection between the architecture (buildings, decoration, domes, etc.) and the mathematical topic in the classroom instruction.

I assign artistic assignments (drawing, coloring, cutting, decoration, embroidery, etc.) that are directly related to the subject of the Mathematics lesson.

I organize competitions related to Mathematical topics among students.

Appendix B

Qualitative Interview Protocols and Participant Profiles Framework

Table B1

Demographics of Participants in the Semi-Structured Interviews

Teacher ID	Gender	Experience (years)	Education Level	School Type	Governance
Teacher1	M	11	M.A.	Public	Jerusalem
Teacher2	F	6	M.A.	Public	Hebron
Teacher3	M	20	B.Ed.	Public	Ramallah
Teacher4	F	23	B.A.	Private	Ramallah
Teacher5	F	18	B.Ed.	Public	Ramallah
Teacher6	M	18	M.A.	Public	Jerusalem
Teacher7	M	14	B.A.	Private	Jerusalem
Teacher8	F	29	B.Ed.	Public	Northern
Teacher9	F	6	M.A.	Public	Hebron
Teacher10	F	23	B.A.	Private	Jerusalem
Teacher11	F	16	B.Ed.	Private	Jerusalem
Teacher12	F	6	B.A.	Public	Ramallah
Teacher13	F	7	B.A.	Public	Northern
Teacher14	F	11	M.A.	Private	Ramallah
Teacher15	M	19	M.A.	Private	Jerusalem
Teacher16	F	8	M.A.	UNRWA	Jerusalem
Teacher17	M	4	B.A.	Public	Ramallah
Teacher18	F	6	M.A.	Public	Hebron
Teacher19	F	16	M.A.	UNRWA	Northern
Teacher20	F	4	B.A.	Public	Hebron

Table B2

Interview Guide

Introduction

Identification of the interviewer and the interview

Defining the interviewer and explaining the purpose of the interview.

Informing the estimated time duration of the meeting.

Confidentiality

Ensuring confidentiality and not revealing the identity of the participants.

Asking for consent to record the interview, and explaining that the recordings will only be accessed by the researcher and will be stored securely.

Confirming that any quotes used will not be linked to any individual, (No individuals will be identified in the reporting of the research).

Informing the interviewee that he/she will be notified by the findings and outcome of the research after it is completed.

SECTION 1: BACKGROUND AND DEMOGRAPHICS

General basic questions

How long have you been teaching mathematics?

Which classes do you teach?

Can you briefly describe your educational background?

SECTION 2: BELIEFS ABOUT MATHEMATICAL CREATIVITY

1. Definition of Mathematical Creativity

As a mathematics teacher, what does "Mathematical Creativity" mean to you?

2. Benefits of Mathematical Creativity

How do you think that Mathematical Creativity can benefit students' learning in Mathematics and their mathematical skills?

3. Characteristics of a Mathematically Creative Student

In your opinion, who is a mathematically creative student?

Follow-up: So, do you think that these features, that you have just mentioned, are limited to certain students? Or could it be present among other students but maybe it needs some external stimulus?

4. Creating a Learning Environment

How do you create a learning milieu that helps develop mathematical creativity in your students?

Follow-up: Could you elaborate more by describing particular teaching methods that you use in that context?

SECTION 3: IDENTIFYING THE CHARACTERISTICS OF THE TEACHER

5. Description of Students' Mathematical Abilities

How do you describe the Mathematical abilities of your students?

Follow-up: How do you support and stimulate that potential?

6. Adaptation of Teaching Methods

Can you describe instances where you decided to change some teaching methods, why did you try new methods then, and how?

Follow-up: Suppose that you are using teaching methods that you find to be (and may be) very successful and effective teaching methods, would you consider exploring other (new) teaching methods? Why? How can you explore it, what are your resources?

7. Introducing the Beauty of Mathematics

How do you introduce your students to the beauty of mathematics?

Follow-up: Is it possible to do this in every lesson?

8. Participation in Professional Development

What is your rate of participation in professional development programs or courses?

Follow-up: What courses or programs do you enjoy most?

9. Additional Thoughts

Would you like to add anything that you think is important for students' Mathematical Creativity in learning Mathematics?

CONCLUSION

Thanking the Participant for the time, collaboration and valuable contribution to the study.

Table B3

A guideline criterion for interpreting communalities

Communalities	Criteria	Interpretation
≤ 0.4	Low	The variable is not well represented by the factor solution.
0.4 – 0.7	Moderate	The variable is moderately represented by the factor solution.
≥ 0.7	High	The variable is well represented by the factor solution.

Appendix C

Quantitative Statistical Analysis Outputs

Table C1

Descriptive Statistics of the Variables

	Mean	Std. Deviation	N
Level of teacher's education	1.57	.907	240
ProblemSolving	4.3594	.62129	240
UsingTechnology	3.5597	.88804	240
GuessingAndTrying	4.1139	.73372	240
MathematicalReasoning	4.1271	.68417	240
DivergentThinking	3.9528	.74915	240
ProblemPosingAndResearch	3.8604	.76317	240
ApplyingMathematicsToRealLife	4.1611	.83784	240
UsingImagination	3.9069	.76666	240
RelatingToArt	3.4736	.94932	240

Table C2

Descriptive Statistics for teaching practices by levels of gender

Gender of teacher		N	Min	Max	Mean	Std. Deviation
Male	ProblemSolving	65	1.00	5.00	4.1346	.69888
	UsingTechnology	65	1.00	5.00	3.2051	.94958
	GuessingAndTrying	65	1.00	5.00	3.8667	.80536
	MathematicalReasoning	65	2.25	5.00	3.9000	.64317
	DivergentThinking	65	1.67	5.00	3.8051	.73336
	ProblemPosingAndResearch	65	1.50	5.00	3.6115	.82210
	ApplyingMathematicsToRealLife	65	1.00	5.00	3.9077	.88095
	UsingImagination	65	1.00	5.00	3.6256	.86303
	RelatingToArt	65	1.00	4.67	2.9949	.92326
	ComprehensiveTeachPractices	65	1.89	4.72	3.6724	.63138
Female	ProblemSolving	175	1.13	5.00	4.4429	.56979
	UsingTechnology	175	1.00	5.00	3.6914	.82893
	GuessingAndTrying	175	1.33	5.00	4.2057	.68525
	MathematicalReasoning	175	1.50	5.00	4.2114	.68145
	DivergentThinking	175	1.00	5.00	4.0076	.74959
	ProblemPosingAndResearch	175	1.00	5.00	3.9529	.72089
	ApplyingMathematicsToRealLife	175	1.00	5.00	4.2552	.80365
	UsingImagination	175	1.67	5.00	4.0114	.70203
	RelatingToArt	175	1.00	5.00	3.6514	.89829
	ComprehensiveTeachPractices	175	1.60	5.00	4.0478	.57141

Table C3

Descriptive Statistics for teaching practices by levels of teachers' academic degree

	Level of teacher's education	N	Min	Max	Mean	Std. Deviation
B.A.	ProblemSolving	167	1.13	5.00	4.3750	.59078
	UsingTechnology	167	1.00	5.00	3.6068	.87223
	GuessingAndTrying	167	1.33	5.00	4.1317	.71037
	MathematicalReasoning	167	1.50	5.00	4.1138	.70107
	DivergentThinking	167	1.00	5.00	3.9401	.74203
	ProblemPosingAndResearch	167	1.00	5.00	3.8772	.74591
	ApplyingMathematicsToRealLife	167	1.33	5.00	4.2216	.79373
	UsingImagination	167	1.67	5.00	3.9341	.72831
	RelatingToArt	167	1.00	5.00	3.5689	.89720
	ComprehensiveTeachPractices	167	1.60	5.00	3.9744	.59348
B.Ed.	ProblemSolving	14	3.88	5.00	4.5804	.40014
	UsingTechnology	14	2.00	4.33	3.5476	.60774
	GuessingAndTrying	14	3.33	5.00	4.4048	.61573
	MathematicalReasoning	14	3.50	5.00	4.3571	.43539
	DivergentThinking	14	3.67	4.67	4.1429	.33878
	ProblemPosingAndResearch	14	3.25	5.00	4.1607	.44514
	ApplyingMathematicsToRealLife	14	3.67	5.00	4.5952	.37390
	UsingImagination	14	3.33	5.00	4.2143	.60774
	RelatingToArt	14	1.67	5.00	3.7619	.81049
	ComprehensiveTeachPractices	14	3.51	4.64	4.1961	.26246
M.A.	ProblemSolving	54	1.00	5.00	4.3403	.69720
	UsingTechnology	54	1.00	5.00	3.4568	.96760
	GuessingAndTrying	54	1.00	5.00	4.0309	.80165
	MathematicalReasoning	54	2.75	5.00	4.1667	.65156
	DivergentThinking	54	1.67	5.00	4.0062	.82541
	ProblemPosingAndResearch	54	1.50	5.00	3.8148	.81290
	ApplyingMathematicsToRealLife	54	1.00	5.00	3.9691	.88611
	UsingImagination	54	1.00	5.00	3.8086	.86294
	RelatingToArt	54	1.00	5.00	3.1852	1.03941
	ComprehensiveTeachPractices	54	1.89	5.00	3.8643	.65428
PhD	ProblemSolving	5	2.75	4.25	3.4250	.58363
	UsingTechnology	5	1.67	4.33	3.1333	1.21564
	GuessingAndTrying	5	2.33	4.67	3.6000	.86281
	MathematicalReasoning	5	2.25	4.25	3.5000	.79057
	DivergentThinking	5	2.33	4.00	3.2667	.72265
	ProblemPosingAndResearch	5	1.75	4.00	2.9500	.95851
	ApplyingMathematicsToRealLife	5	1.33	4.33	3.0000	1.39443
	UsingImagination	5	2.00	4.33	3.2000	.96032
	RelatingToArt	5	1.33	4.00	2.6000	1.11555
	ComprehensiveTeachPractices	5	2.18	4.00	3.1861	.82083

Table C4

Descriptive Statistics for teaching practices by levels of teachers' seniority

Teaching experience		N	Min	Max	Mean	Std. Deviation
1-5 years	ProblemSolving	59	2.63	5.00	4.3347	.54508
	UsingTechnology	59	1.33	5.00	3.4124	.87393
	GuessingAndTrying	59	1.67	5.00	4.0904	.72933
	MathematicalReasoning	59	2.50	5.00	4.1737	.61981
	DivergentThinking	59	1.67	5.00	3.8305	.75651
	ProblemPosingAndResearch	59	1.00	5.00	3.7415	.82128
	ApplyingMathToRealLife	59	1.67	5.00	4.1638	.78631
	UsingImagination	59	1.33	5.00	3.7627	.81427
	RelatingToArt	59	1.00	5.00	3.3051	.93113
	ComprehensiveTeachPractices	59	1.95	4.78	3.8683	.60820
6-10 years	ProblemSolving	28	2.00	5.00	4.1920	.68927
	GuessingAndTrying	28	1.33	5.00	4.0238	.76405
	MathematicalReasoning	28	2.00	5.00	3.9107	.89808
	DivergentThinking	28	1.00	5.00	3.9286	.92677
	ProblemPosingAndResearch	28	1.75	5.00	3.6339	.81218
	ApplyingMathToRealLife	28	1.33	5.00	3.7976	.97432
	UsingImagination	28	2.00	5.00	3.5833	.85887
	RelatingToArt	28	1.67	5.00	3.2738	.85131
	ComprehensiveTeachPractices	28	1.97	4.85	3.7340	.67097
> 10 years	ProblemSolving	153	1.00	5.00	4.3995	.63415
	UsingTechnology	153	1.00	5.00	3.6710	.89589
	GuessingAndTrying	153	1.00	5.00	4.1394	.73311
	MathematicalReasoning	153	1.50	5.00	4.1487	.66047
	DivergentThinking	153	2.00	5.00	4.0044	.70916
	ProblemPosingAndResearch	153	1.75	5.00	3.9477	.72016
	ApplyingMathToRealLife	153	1.00	5.00	4.2266	.81887
	UsingImagination	153	1.00	5.00	4.0218	.70677
	RelatingToArt	153	1.00	5.00	3.5752	.96369
	ComprehensiveTeachPractices	153	1.60	5.00	4.0149	.59080

Table C5

Tests of Normality

	Kolmogorov-Smirnov		Shapiro-Wilk	
	Statistic	Sig.	Statistic	Sig.
ProblemSolving	.151	.000	.825	.000
UsingTechnology	.115	.000	.963	.000
GuessingAndTrying	.138	.000	.906	.000
MathematicalReasoning	.126	.000	.930	.000
DivergentThinking	.142	.000	.939	.000
ProblemPosingAndResearch	.139	.000	.947	.000
ApplyingMathematicsToRealLife	.165	.000	.851	.000
UsingImagination	.165	.000	.937	.000
RelatingToArt	.126	.000	.959	.000

Table C6

Brown-Forsythe by One Way ANOVA of Medians of Dependent Variables across Levels of Gender

		Sum of Squares	df	Mean Square	F	Sig.
ProblemSolving	Between Groups	1.087	1	1.087	5.222	.023
	Within Groups	49.537	238	.208		
UsingTechnology	Between Groups	.445	1	.445	1.437	.232
	Within Groups	73.644	238	.309		
GuessingAndTry	Between Groups	.756	1	.756	2.919	.089
	Within Groups	61.642	238	.259		
MathReasoning	Between Groups	.007	1	.007	.036	.849
	Within Groups	47.226	238	.198		
DivergentThink	Between Groups	.008	1	.008	.035	.851
	Within Groups	55.308	238	.232		
ProblemPosing	Between Groups	1.190	1	1.190	4.432	.036
	Within Groups	63.909	238	.269		
ApplyMathTReal	Between Groups	.414	1	.414	1.173	.280
	Within Groups	84.028	238	.353		
UsingImagination	Between Groups	.439	1	.439	1.636	.202
	Within Groups	63.912	238	.269		
RelatMathTArt	Between Groups	1.036	1	1.036	2.776	.097
	Within Groups	88.797	238	.373		

Table C7

Brown-Forsythe by One Way ANOVA of medians of dependent variables across levels of Academic degree

		Sum of Squares	df	Mean Square	F	Sig.
ProblemSolv	Between Groups	2.236	3	.745	3.635	.014
	Within Groups	48.388	236	.205		
UsingTechgy	Between Groups	2.071	3	.690	2.262	.082
	Within Groups	72.018	236	.305		
GuessAndTry	Between Groups	.541	3	.180	.687	.561
	Within Groups	61.858	236	.262		
MathReason	Between Groups	.744	3	.248	1.259	.289
	Within Groups	46.490	236	.197		
DivergentThink	Between Groups	1.426	3	.475	2.082	.103
	Within Groups	53.890	236	.228		
ProblemPosing	Between Groups	1.989	3	.663	2.480	.062
	Within Groups	63.110	236	.267		
ApplMathTReal	Between Groups	3.378	3	1.126	3.278	.022
	Within Groups	81.064	236	.343		
UsingImagin	Between Groups	.710	3	.237	.878	.453
	Within Groups	63.641	236	.270		
RelatMathToArt	Between Groups	3.247	3	1.082	2.950	.033
	Within Groups	86.586	236	.367		
Comprehensive	Between Groups	1.452	3	.484	2.843	.039
	Within Groups	40.192	236	.170		

Table C8

Brown-Forsythe by One Way ANOVA of medians of dependent variables across Seniority' levels.

		Sum of Squares	df	Mean Square	F	Sig.
ProblemSolv	Between Groups	.160	2	.080	.386	.680
	Within Groups	49.210	237	.208		
UsingTechgy	Between Groups	.090	2	.045	.151	.860
	Within Groups	70.484	237	.297		
GuessAndTry	Between Groups	.063	2	.032	.121	.887
	Within Groups	62.335	237	.263		
MathReason	Between Groups	1.064	2	.532	2.731	.067
	Within Groups	46.169	237	.195		
DivergentThink	Between Groups	.621	2	.310	1.310	.272
	Within Groups	56.140	237	.237		
ProblemPosing	Between Groups	.347	2	.174	.658	.519
	Within Groups	62.518	237	.264		
ApplMathTReal	Between Groups	.876	2	.438	1.345	.262
	Within Groups	77.196	237	.326		
UsingImagin	Between Groups	.765	2	.382	1.518	.221
	Within Groups	59.679	237	.252		
RelatMathToArt	Between Groups	.212	2	.106	.314	.731
	Within Groups	80.215	237	.338		
Comprehensive	Between Groups	.339	2	.170	.991	.373
	Within Groups	40.579	237	.171		

Table C9

Interpretation guideline for Spearman's rho and Kendall's tau_b coefficients

	Spearman's rho & Kendall's tau_b	
Strength of relationship between variables	Negative	Positive
Very weak	0 to –.10	0 to.10
Weak	–.10 to –.29	.10 to.29
Moderate	–.30 to –.49	.30 to.49
Strong	–.50 to –.69	.50 to.69
Very strong	–.70 to – 1	.70 to 1

Table C10

KMO and Bartlett's Test for the Exploratory Factor Analysis (EFA)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.930
Bartlett's Test of Sphericity	Approx. Chi-Square	5246.759
	df	561
	Sig.	.000

Table C11

A guideline criterion for interpreting communalities

Communalities	Criteria	Interpretation
≤ 0.4	Low	The variable is not well represented by the factor solution.
0.4 – 0.7	Moderate	The variable is moderately represented by the factor solution.
≥ 0.7	High	The variable is well represented by the factor solution.

Table C12

Communalities for the Exploratory Factor Analysis (EFA)

	Initial	Extraction
Problem Solving1	1.000	.706
Problem Solving2	1.000	.749
Problem Solving3	1.000	.571
Problem Solving4	1.000	.692
Problem Solving5	1.000	.637
Problem Solving6	1.000	.607
Problem Solving7	1.000	.588
Problem Solving8	1.000	.665
Using Technology1	1.000	.611
Using Technology2	1.000	.714
Using Technology3	1.000	.656
Guessing and trying1	1.000	.649
Guessing and trying2	1.000	.559
Guessing and trying3	1.000	.616
Mathematical Reasoning1	1.000	.683
Mathematical Reasoning2	1.000	.585
Mathematical Reasoning3	1.000	.693
Mathematical Reasoning4	1.000	.769
Divergent Thinking1	1.000	.690
Divergent Thinking 2	1.000	.571
Divergent Thinking 3	1.000	.654
Problem posing and research1	1.000	.615
Problem posing and research2	1.000	.665
Problem posing and research3	1.000	.684
Problem posing and research4	1.000	.714
Applying Mathematics to real life problems1	1.000	.682
Applying Mathematics to real life problems2	1.000	.696
Applying Mathematics to real life problems3	1.000	.643
Using imagination1	1.000	.528
Using imagination2	1.000	.687
Using imagination3	1.000	.730
Relating to Art and/or Music1	1.000	.686
Relating to Art and/or Music2	1.000	.577
Relating to Art and/or Music3	1.000	.598

Table C13

Total Variance Explained for the Exploratory Factor Analysis (EFA)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Var	Cum %	Total	% of Var	Cum %
1	14.135	41.575	41.575	14.135	41.575	41.575
2	2.618	7.701	49.276	2.618	7.701	49.276
3	1.627	4.786	54.061	1.627	4.786	54.061
4	1.535	4.515	58.577	1.535	4.515	58.577
5	1.194	3.513	62.090	1.194	3.513	62.090
6	1.061	3.120	65.210	1.061	3.120	65.210
7	.967	2.843	68.053			
8	.862	2.536	70.589			
9	.781	2.296	72.885			
10	.732	2.152	75.037			
11	.642	1.889	76.926			
12	.605	1.780	78.706			
13	.564	1.660	80.366			
14	.529	1.557	81.923			
15	.520	1.529	83.452			
16	.501	1.474	84.926			
17	.458	1.347	86.273			
18	.421	1.237	87.510			
19	.402	1.181	88.692			
20	.364	1.071	89.763			
21	.350	1.031	90.794			
22	.349	1.026	91.820			
23	.333	.979	92.799			
24	.306	.900	93.699			
25	.293	.862	94.562			
26	.279	.820	95.381			
27	.254	.748	96.129			
28	.237	.697	96.826			
29	.224	.659	97.485			
30	.205	.603	98.088			
31	.186	.546	98.634			
32	.173	.510	99.144			
33	.163	.479	99.623			
34	.128	.377	100.000			

Table C14

Rotation Sums of Squared Loadings for the Exploratory Factor Analysis (EFA)

	Rotation Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total
1	14.135	41.575	41.575	11.123
2	2.618	7.701	49.276	10.648
3	1.627	4.786	54.061	7.268
4	1.535	4.515	58.577	8.916
5	1.194	3.513	62.090	7.548
6	1.061	3.120	65.210	1.480

Table C15

Guideline criterion for interpreting the component transformation matrix (Table 33)

Correlation	Criterion	Interpretation
.70 – 1.0	High	The factor is stable and distinct (no changes in the factor structure after rotation).
.30 –.69	Moderate	The factor was moderately transformed by rotation (some redistribution of variance among factors to have simpler, more interpretable structure.
.00 –.29	Low	The factor was significantly changed by rotation (significant redistribution of variance, which makes the factor more distinct).

Table C16

The Component Transformation Matrix

Component	1	2	3	4	5	6
1	.599	.503	.357	.368	.331	.124
2	-.611	.242	.603	.310	-.306	.123
3	-.450	.436	-.570	.315	.427	-.027
4	.031	-.634	.011	.740	.139	-.172
5	-.254	-.256	.391	-.338	.771	.092
6	.018	-.173	-.174	.086	-.040	.965

Table C17

Nonparametric Correlations between teaching practices and teachers' Gender.

	Spearman rho		Kendall's tau_b	
	Corrl. Cff	Sig. (p-value)	Corrl. Cff	Sig. (p-value)
ProblemSolving	.234	0.000	.199	0.000
UsingTechnology	.212	0.001	.182	0.001
GuessingAndTrying	.198	0.002	.173	0.002
MathematicalReasoning	.233	0.000	.201	0.000
DivergentThinking	.140	0.030	.122	0.030
ProblemPosing	.192	0.003	.165	0.003
ApplyingMathToReal	.213	0.001	.186	0.001
UsingImagination	.204	0.001	.178	0.002
RelatingToArt	.306	0.000	.262	0.000
ComprehensivePractices	.290	0.000	.237	0.000

Table C18

Nonparametric Correlations between teaching practices and teachers' academic degree

	Spearman rho		Kendall's tau_b	
	Corrl. Cff	Sig.	Corrl. Cff	Sig.
ProblemSolving	-0.039	0.551	-0.031	0.561
UsingTechnology	-0.070	0.281	-0.058	0.283
GuessingAndTrying	-0.051	0.433	-0.042	0.440
MathematicalReasoning	0.006	0.931	0.004	0.934
DivergentThinking	0.028	0.663	0.026	0.639
ProblemPosing	-0.047	0.471	-0.039	0.467
ApplyMathToReal	-.144	0.025	-.125	0.023
UsingImagination	-0.052	0.420	-0.043	0.427
RelatingToArt	-.156	0.016	-.129	0.017
ComprehensivePractices	-0.087	0.181	-0.072	0.162

Table C19

Nonparametric Correlations for teaching practices with teachers' Seniority levels

	Spearman rho		Kendall's tau_b	
	Corrl. Cff	Sig.	Corrl. Cff	Sig.
ProblemSolving	0.102	0.115	0.084	0.115
UsingTechnology	.158	0.014	.131	0.015
GuessingAndTrying	0.041	0.524	0.035	0.519
MathematicalReasoning	0.015	0.814	0.013	0.809
DivergentThinking	0.088	0.175	0.073	0.181
ProblemPosing	0.126	0.051	0.104	0.052
ApplyingMathToReal	0.090	0.163	0.075	0.169
UsingImagination	.173	0.007	.144	0.008
RelatingToArt	.142	0.027	.117	0.028
ComprehensivePractices	.138	0.033	.109	0.033

Table C20

Mann-Whitney Ranks (Gender)

	Gender of teacher	N	Mean Rank	Sum of Ranks
ProblemSolving	Male	65	94.02	6111.00
	Female	175	130.34	22809.00
UsingTechnology	Male	65	96.58	6278.00
	Female	175	129.38	22642.00
GuessingAndTrying	Male	65	98.22	6384.50
	Female	175	128.77	22535.50
MathematicalReasoning	Male	65	94.21	6123.50
	Female	175	130.27	22796.50
DivergentThinking	Male	65	104.73	6807.50
	Female	175	126.36	22112.50
ProblemPosingAndResearch	Male	65	98.78	6421.00
	Female	175	128.57	22499.00
ApplyMathToRealLife	Male	65	96.63	6281.00
	Female	175	129.37	22639.00
UsingImagination	Male	65	97.56	6341.50
	Female	175	129.02	22578.50
RelatingToArt	Male	65	85.90	5583.50
	Female	175	133.35	23336.50
ComprehensivePractices	Male	65	87.61	5694.50
	Female	175	132.72	23225.50

Table C21

educational levels of teachers

	Gender of teacher	N	Mean Rank
ProblemSolving	B.A.	167	121.01
	B.Ed.	14	144.89
	M.A.	54	121.19
	PhD	5	27.80
UsingTechnology	B.A.	167	123.53
	B.Ed.	14	117.21
	M.A.	54	113.95
	PhD	5	99.30
GuessingAndTrying	B.A.	167	121.80
	B.Ed.	14	147.79
	M.A.	54	113.66
	PhD	5	74.70
MathematicalReasoning	B.A.	167	119.37
	B.Ed.	14	140.93
	M.A.	54	124.02
	PhD	5	62.90
DivergentThinking	B.A.	167	118.49
	B.Ed.	14	134.75
	M.A.	54	128.74
	PhD	5	58.90
ProblemPosing AndResearch	B.A.	167	121.46
	B.Ed.	14	148.64
	M.A.	54	116.46
	PhD	5	53.40
ApplyingMathematics ToRealLifeProblems	B.A.	167	125.58
	B.Ed.	14	155.79
	M.A.	54	101.86
	PhD	5	53.40
UsingImagination	B.A.	167	121.84
	B.Ed.	14	147.07
	M.A.	54	114.26
	PhD	5	68.90
RelatingToArt	B.A.	167	126.51
	B.Ed.	14	143.11
	M.A.	54	101.15
	PhD	5	65.60
ComprehensiveTeachPractices	B.A.	167	123.18
	B.Ed.	14	151.18
	M.A.	54	110.71
	PhD	5	50.90

Table C22

The Mann-Whitney U Test comparison between B.A. and B.Ed. of the Academic degree

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig.
ProblemSolving	931.000	14959.000	-1.271	0.204
UsingTechnology	1110.500	1215.500	-0.313	0.754
GuessingAndTrying	907.000	14935.000	-1.409	0.159
MathematicalReasoning	960.500	14988.500	-1.116	0.264
DivergentThinking	1001.000	15029.000	-0.902	0.367
ProblemPosing	906.000	14934.000	-1.407	0.159
ApplyingMathToReal	889.000	14917.000	-1.515	0.130
UsingImagination	919.500	14947.500	-1.340	0.180
RelatingToArt	1002.500	15030.500	-0.891	0.373
Comprehensive	919.500	14947.500	-1.325	0.185

Table C23

The mean rank and sum of ranks between B.A. and M.A. across all teaching practices

	Academic degree	N	Mean Rank	Sum of Ranks
ProblemSolving	B.A.	167	110.96	18529.50
	M.A.	54	111.14	6001.50
UsingTechnology	B.A.	167	113.16	18897.00
	M.A.	54	104.33	5634.00
GuessingAndTrying	B.A.	167	112.89	18852.50
	M.A.	54	105.16	5678.50
MathematicalReason	B.A.	167	109.96	18364.00
	M.A.	54	114.20	6167.00
DivergentThinking	B.A.	167	108.73	18158.00
	M.A.	54	118.02	6373.00
ProblemPosing	B.A.	167	112.12	18724.00
	M.A.	54	107.54	5807.00
ApplyingMathToReal	B.A.	167	116.28	19418.50
	M.A.	54	94.68	5112.50
UsingImagination	B.A.	167	112.71	18822.50
	M.A.	54	105.71	5708.50
RelatingToArt	B.A.	167	116.74	19495.50
	M.A.	54	93.25	5035.50
Comprehensive	B.A.	167	113.72	18991.00
	M.A.	54	102.59	5540.00

Table C24

The mean rank and sum of ranks between B.A. and PhD across all teaching practices

	Academic degree	N	Mean Rank	Sum of Ranks
ProblemSolving	B.A.	167	88.48	14775.50
	PhD	5	20.50	102.50
UsingTechnology	B.A.	167	87.02	14532.50
	PhD	5	69.10	345.50
GuessingAndTrying	B.A.	167	87.48	14608.50
	PhD	5	53.90	269.50
MathReasoning	B.A.	167	87.66	14639.00
	PhD	5	47.80	239.00
DivergentThinking	B.A.	167	87.76	14656.00
	PhD	5	44.40	222.00
ProblemPosing	B.A.	167	87.91	14681.00
	PhD	5	39.40	197.00
ApplyingMathToReal	B.A.	167	87.98	14692.00
	PhD	5	37.20	186.00
UsingImagination	B.A.	167	87.62	14632.50
	PhD	5	49.10	245.50
RelatingToArt	B.A.	167	87.76	14656.50
	PhD	5	44.30	221.50
Comprehensive	B.A.	167	87.95	14688.00
	PhD	5	38.00	190.00

Table C25

Table of ranks among the teaching experience levels of teachers

	Seniority (years)	N	Mean Rank
ProblemSolving	1 - 5	59	114.04
	6 - 10	28	101.34
	More than 10	153	126.50
UsingTechnology	1 - 5	59	109.02
	6 - 10	28	95.45
	More than 10	153	129.51
GuessingAndTrying	1 - 5	59	118.19
	6 - 10	28	111.91
	More than 10	153	122.96
MathematicalReasoning	1 - 5	59	122.78
	6 - 10	28	107.52
	More than 10	153	122.00
DivergentThinking	1 - 5	59	108.56
	6 - 10	28	124.16
	More than 10	153	124.43
ProblemPosing	1 - 5	59	111.56
	6 - 10	28	99.96
	More than 10	153	127.71
ApplyingMathematicsToReal	1 - 5	59	118.54
	6 - 10	28	92.16
	More than 10	153	126.44
UsingImagination	1 - 5	59	108.20
	6 - 10	28	92.71
	More than 10	153	130.33
RelatingToArt	1 - 5	59	108.68
	6 - 10	28	102.64
	More than 10	153	128.33
ComprehensivePractices	1 - 5	59	110.58
	6 - 10	28	97.88
	More than 10	153	128.46

Table C26

The mean rank and sum of ranks between (1-5) and (6-10) years' experience teaching practices

Seniority	Seniority (years)	N	Mean Rank	Sum of Ranks
ProblemSolving	1 - 5	59	45.51	2685.00
	6 - 10	28	40.82	1143.00
UsingTechnology	1 - 5	59	45.69	2695.50
	6 - 10	28	40.45	1132.50
GuessingAndTrying	1 - 5	59	44.69	2636.50
	6 - 10	28	42.55	1191.50
MathematicalReasoning	1 - 5	59	45.73	2698.00
	6 - 10	28	40.36	1130.00
DivergentThinking	1 - 5	59	42.35	2498.50
	6 - 10	28	47.48	1329.50
ProblemPosing	1 - 5	59	45.42	2680.00
	6 - 10	28	41.00	1148.00
ApplyingMathToRea	1 - 5	59	47.25	2788.00
	6 - 10	28	37.14	1040.00
UsingImagination	1 - 5	59	45.95	2711.00
	6 - 10	28	39.89	1117.00
RelatingToArt	1 - 5	59	44.78	2642.00
	6 - 10	28	42.36	1186.00
Comprehensive	1 - 5	59	45.51	2685.00
	6 - 10	28	40.82	1143.00

Table C27

Mean rank, sum of ranks between (1-5) and (>10) years' experience across teaching practices

	Seniority (years)	N	Mean Rank	Sum of Ranks
ProblemSolving	1 - 5	59	98.53	5813.50
	More than 10	153	109.57	16764.50
UsingTechnology	1 - 5	59	93.33	5506.50
	More than 10	153	111.58	17071.50
GuessingAndTrying	1 - 5	59	103.50	6106.50
	More than 10	153	107.66	16471.50
MathematicalReasoning	1 - 5	59	107.05	6316.00
	More than 10	153	106.29	16262.00
DivergentThinking	1 - 5	59	96.21	5676.50
	More than 10	153	110.47	16901.50
ProblemPosing	1 - 5	59	96.14	5672.00
	More than 10	153	110.50	16906.00
ApplyingMathToReal	1 - 5	59	101.29	5976.00
	More than 10	153	108.51	16602.00
UsingImagination	1 - 5	59	92.25	5443.00
	More than 10	153	111.99	17135.00
RelatingToArt	1 - 5	59	93.90	5540.00
	More than 10	153	111.36	17038.00
Comprehensive	1 - 5	59	95.08	5609.50
	More than 10	153	110.91	16968.50

Table C28

The mean rank and sum of ranks between (6-5 years) and (more than 10 years) experience across all teaching practices

	Seniority (years)	N	Mean Rank	Sum of Ranks
ProblemSolving	6 - 10	28	75.02	2100.50
	More than 10	153	93.92	14370.50
UsingTechnology	6 - 10	28	69.50	1946.00
	More than 10	153	94.93	14525.00
GuessingAndTrying	6 - 10	28	83.86	2348.00
	More than 10	153	92.31	14123.00
MathematicalReasoning	6 - 10	28	81.66	2286.50
	More than 10	153	92.71	14184.50
DivergentThinking	6 - 10	28	91.18	2553.00
	More than 10	153	90.97	13918.00
ProblemPosing	6 - 10	28	73.46	2057.00
	More than 10	153	94.21	14414.00
ApplyingMathToRealLife	6 - 10	28	69.52	1946.50
	More than 10	153	94.93	14524.50
UsingImagination	6 - 10	28	67.32	1885.00
	More than 10	153	95.33	14586.00
RelatingToArt	6 - 10	28	74.79	2094.00
	More than 10	153	93.97	14377.00
Comprehensive	6 - 10	28	71.55	2003.50
	More than 10	153	94.56	14467.50

Table C29

The Box's Test of Equality of Covariance Matrices

Box's M	F	df1	df2	Sig.
477.454	1.314	275	8193.22	0

Table C30

Levene's Test of Equality of Error Variances

		Levene Statistic	df1	df2	Sig.
FinalAdjustedRank_ProblemSolving	Based on Mean	.897	9	229	.529
	Based on Median	.816	9	229	.602
	Based on Median and with adjusted df	.816	9	212.295	.602
	Based on trimmed mean	.894	9	229	.531
FinalAdjustedRank_UsingTechnology	Based on Mean	1.631	9	229	.108
	Based on Median	1.676	9	229	.096
	Based on Median and with adjusted df	1.676	9	210.235	.096
	Based on trimmed mean	1.655	9	229	.101
FinalAdjustedRank_ GuessingAndTrying	Based on Mean	1.209	9	229	.290
	Based on Median	1.115	9	229	.353
	Based on Median and with adjusted df	1.115	9	220.725	.353
	Based on trimmed mean	1.197	9	229	.298
FinalAdjustedRank_ MathematicalReasoning	Based on Mean	2.250	9	229	.020
	Based on Median	1.806	9	229	.068
	Based on Median and with adjusted df	1.806	9	173.983	.070
	Based on trimmed mean	2.222	9	229	.022
FinalAdjustedRank_ DivergentThinking	Based on Mean	1.557	9	229	.129
	Based on Median	1.416	9	229	.182
	Based on Median and with adjusted df	1.416	9	218.791	.182
	Based on trimmed mean	1.546	9	229	.133
FinalAdjustedRank_ ProblemPosingAndResearch	Based on Mean	.945	9	229	.487
	Based on Median	.813	9	229	.604
	Based on Median and with adjusted df	.813	9	217.617	.605
	Based on trimmed mean	.935	9	229	.496
FinalAdjustedRank_ ApplyingMathematicsToRealLifeProblems	Based on Mean	3.137	9	229	.001
	Based on Median	2.537	9	229	.009
	Based on Median and with adjusted df	2.537	9	215.903	.009
	Based on trimmed mean	3.272	9	229	.001
FinalAdjustedRank_ UsingImagination	Based on Mean	.442	9	229	.911
	Based on Median	.296	9	229	.975
	Based on Median and with adjusted df	.296	9	213.443	.975
	Based on trimmed mean	.431	9	229	.918
FinalAdjustedRank_ RelatingToArt	Based on Mean	1.192	9	229	.301
	Based on Median	.991	9	229	.448
	Based on Median and with adjusted df	.991	9	216.698	.448
	Based on trimmed mean	1.195	9	229	.299
FinalAdjustedRank_ ComprehensiveTeachPractices	Based on Mean	2.201	9	229	.023
	Based on Median	2.106	9	229	.030
	Based on Median and with adjusted df	2.106	9	218.310	.030
	Based on trimmed mean	2.220	9	229	.022

Table C31

Tests of Between-subject effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial η^2
Corrected Model	FinalAdjustedRank_1	66005.91	10	6600.59	0.812	0.617	0.034
	FinalAdjustedRank_2	78232.45	10	7823.25	1.020	0.427	0.043
	FinalAdjustedRank_3	85547.32	10	8554.73	1.142	0.332	0.047
	FinalAdjustedRank_4	97197.53	10	9719.75	1.192	0.297	0.049
	FinalAdjustedRank_5	57202.00	10	5720.20	0.622	0.795	0.026
	FinalAdjustedRank_6	21948.54	10	2194.85	0.473	0.907	0.020
	FinalAdjustedRank_7	58569.53	10	5856.95	1.362	0.199	0.056
	FinalAdjustedRank_8	22460.16	10	2246.02	0.589	0.822	0.025
	FinalAdjustedRank_9	23251.62	10	2325.16	0.505	0.886	0.022
	FinalAdjustedRank_10	39554.21	10	3955.42	0.855	0.576	0.036
Intercept	FinalAdjustedRank_1	469567.47	1	469567.47	57.786	0.000	0.201
	FinalAdjustedRank_2	486735.13	1	486735.13	63.442	0.000	0.217
	FinalAdjustedRank_3	436091.073	1	436091.07	58.214	0.000	0.203
	FinalAdjustedRank_4	538270.78	1	538270.78	66.037	0.000	0.224
	FinalAdjustedRank_5	449076.29	1	449076.29	48.806	0.000	0.176
	FinalAdjustedRank_6	481995.89	1	481995.89	103.807	0.000	0.312
	FinalAdjustedRank_7	519112.54	1	519112.54	120.701	0.000	0.345
	FinalAdjustedRank_8	488621.14	1	488621.14	128.077	0.000	0.359
	FinalAdjustedRank_9	485570.93	1	485570.93	105.362	0.000	0.315
	FinalAdjustedRank_10	481426.87	1	481426.87	104.113	0.000	0.313
Education	FinalAdjustedRank_1	4433.97	3	1477.99	0.182	0.909	0.002
	FinalAdjustedRank_2	15428.95	3	5142.98	0.670	0.571	0.009
	FinalAdjustedRank_3	3930.80	3	1310.27	0.175	0.913	0.002
	FinalAdjustedRank_4	13464.53	3	4488.18	0.551	0.648	0.007
	FinalAdjustedRank_5	3360.54	3	1120.18	0.122	0.947	0.002
	FinalAdjustedRank_6	2157.65	3	719.22	0.155	0.926	0.002
	FinalAdjustedRank_7	6007.67	3	2002.56	0.466	0.707	0.006
	FinalAdjustedRank_8	4548.40	3	1516.13	0.397	0.755	0.005
	FinalAdjustedRank_9	3550.64	3	1183.55	0.257	0.856	0.003
	FinalAdjustedRank_10	3691.89	3	1230.63	0.266	0.850	0.003
Seniority	FinalAdjustedRank_1	1016.47	2	508.23	0.063	0.939	0.001
	FinalAdjustedRank_2	7324.97	2	3662.48	0.477	0.621	0.004
	FinalAdjustedRank_3	26798.08	2	13399.04	1.789	0.170	0.015
	FinalAdjustedRank_4	8385.55	2	4192.77	0.514	0.599	0.004
	FinalAdjustedRank_5	8001.45	2	4000.73	0.435	0.648	0.004

	FinalAdjustedRank_6	1217.54	2	608.77	0.131	0.877	0.001
	FinalAdjustedRank_7	6255.69	2	3127.84	0.727	0.484	0.006
	FinalAdjustedRank_8	1299.73	2	649.86	0.170	0.843	0.001
	FinalAdjustedRank_9	34.88	2	17.44	0.004	0.996	0.000
	FinalAdjustedRank_10	2290.33	2	1145.16	0.248	0.781	0.002
Education * Seniority	FinalAdjustedRank_1	38994.82	5	7798.96	0.960	0.443	0.021
	FinalAdjustedRank_2	38009.21	5	7601.84	0.991	0.424	0.021
	FinalAdjustedRank_3	64879.41	5	12975.88	1.732	0.128	0.036
	FinalAdjustedRank_4	75293.84	5	15058.77	1.847	0.105	0.039
	FinalAdjustedRank_5	36988.97	5	7397.79	0.804	0.548	0.017
	FinalAdjustedRank_6	15805.01	5	3161.00	0.681	0.638	0.015
	FinalAdjustedRank_7	46096.45	5	9219.29	2.144	0.061	0.045
	FinalAdjustedRank_8	10963.52	5	2192.70	0.575	0.719	0.012
	FinalAdjustedRank_9	14539.60	5	2907.92	0.631	0.676	0.014
	FinalAdjustedRank_10	24665.18	5	4933.04	1.067	0.380	0.023
Error	FinalAdjustedRank_1	1860839.41	229	8125.94			
	FinalAdjustedRank_2	1756905.93	229	7672.08			
	FinalAdjustedRank_3	1715464.01	229	7491.11			
	FinalAdjustedRank_4	1866584.91	229	8151.03			
	FinalAdjustedRank_5	2107101.76	229	9201.32			
	FinalAdjustedRank_6	1063289.50	229	4643.19			
	FinalAdjustedRank_7	984887.37	229	4300.82			
	FinalAdjustedRank_8	873648.57	229	3815.06			
	FinalAdjustedRank_9	1055369.23	229	4608.60			
	FinalAdjustedRank_10	1058918.03	229	4624.10			
Total	FinalAdjustedRank_1	5411705.32	240				
	FinalAdjustedRank_2	5319998.39	240				
	FinalAdjustedRank_3	5285871.32	240				
	FinalAdjustedRank_4	5448642.44	240				
	FinalAdjustedRank_5	5649163.76	240				
	FinalAdjustedRank_6	4570098.04	240				
	FinalAdjustedRank_7	4528316.89	240				
	FinalAdjustedRank_8	4380968.72	240				
	FinalAdjustedRank_9	4563480.85	240				
	FinalAdjustedRank_10	4583332.25	240				
Corrected Total	FinalAdjustedRank_1	1926845.32	239				
	FinalAdjustedRank_2	1835138.39	239				
	FinalAdjustedRank_3	1801011.32	239				
	FinalAdjustedRank_4	1963782.44	239				

FinalAdjustedRank_5	2164303.76	239
FinalAdjustedRank_6	1085238.04	239
FinalAdjustedRank_7	1043456.89	239
FinalAdjustedRank_8	896108.72	239
FinalAdjustedRank_9	1078620.85	239
FinalAdjustedRank_10	1098472.25	239

Table C32

The demographical description of the participant teachers in the interviews

	8th and 9th grade Mathematics teachers					
Type of school	Public schools		Private schools		UNRWA schools	
Gender	M	F	M	F	M	F
	3	8	3	4	0	2
Total per type	11		7		2	
Male teachers	6					
Female teachers	14					
Total	20					

Table C33

Detailed description of the participating teachers in the interviews

Teacher ID	Gender	Experience (years)	Education Level	School Type	Governance
Teacher1	M	11	M.A.	Public	Jerusalem
Teacher2	F	6	M.A.	Public	Hebron
Teacher3	M	20	B.Ed.	Public	Ramallah
Teacher4	F	23	B.A.	Private	Ramallah
Teacher5	F	18	B.Ed.	Public	Ramallah
Teacher6	M	18	M.A.	Public	Jerusalem
Teacher7	M	14	B.A.	Private	Jerusalem
Teacher8	F	29	B.Ed.	Public	Northern
Teacher9	F	6	M.A.	Public	Hebron
Teacher10	F	23	B.A.	Private	Jerusalem
Teacher11	F	16	B.Ed.	Private	Jerusalem
Teacher12	F	6	B.A.	Public	Ramallah
Teacher13	F	7	B.A.	Public	Northern
Teacher14	F	11	M.A.	Private	Ramallah
Teacher15	M	19	M.A.	Private	Jerusalem
Teacher16	F	8	M.A.	UNRWA	Jerusalem
Teacher17	M	4	B.A.	Public	Ramallah
Teacher18	F	6	M.A.	Public	Hebron
Teacher19	F	16	M.A.	UNRWA	Northern
Teacher20	F	4	B.A.	Public	Hebron

Appendix D

Multivariate Test Results

Table D1

Multivariate Tests

Effect		Value	F	Hypthsis df	Error df	Sig.	Partial η^2
Intercept	Pillai's Trace	.463	18.937	10.00	220.00	.000	.463
	Wilks' Lambda	.537	18.937	10.00	220.00	.000	.463
	Hotelling's Trace	.861	18.937	10.00	220.00	.000	.463
	Roy's Largest Root	.861	18.937	10.00	220.00	.000	.463
Education	Pillai's Trace	.091	.696	30.00	666.00	.888	.030
	Wilks' Lambda	.911	.694	30.00	646.42	.890	.031
	Hotelling's Trace	.095	.693	30.00	656.00	.891	.031
	Roy's Largest Root	.058	1.282	10.00	222.00	.242	.055
Seniority	Pillai's Trace	.102	1.185	20.00	442.00	.263	.051
	Wilks' Lambda	.901	1.182	20.00	440.00	.265	.051
	Hotelling's Trace	.108	1.180	20.00	438.00	.267	.051
	Roy's Largest Root	.072	1.584	10.00	221.00	.113	.067
Education * Seniority	Pillai's Trace	.258	1.216	50.00	1120.00	.147	.052
	Wilks' Lambda	.765	1.217	50.00	1006.72	.147	.052
	Hotelling's Trace	.278	1.216	50.00	1092.00	.148	.053
	Roy's Largest Root	.114	2.547	10.00	224.00	.006	.102

APPENDIX E

A Scientific Questionnaire

Directed to Mathematics teachers for the eighth and ninth grades in Palestinian schools.

On the topic of creativity in teaching and learning Mathematics

Dear Teachers:

I am a student at An-Najah National University, College of Graduate Studies, Doctoral Program in Teaching and Learning. I am conducting scientific research for my doctoral thesis entitled:

"*Exploring eight – ninth grade Mathematics teachers' perspectives, and practices: a comprehensive study on Creativity in Palestinian classrooms*."

This questionnaire aims to explore your understanding of creativity as the ability to think and how this can be manifested in students' learning behavior. Here I am particularly interested in learning about creativity in Mathematics, and how you test it as a teacher in the learning behaviors of your students. Your answers will be used for research purposes only and will remain strictly confidential. There are no right or wrong answers. Your answers should reflect your beliefs, experiences, and practices as a Mathematics teacher. Your participation in answering the survey is greatly appreciated.

The researcher

Sultan Kowkas

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Section 1 - Demographic information

The Governorate in which the school I work at is located:

Jerusalem	Bethlehem	Hebron	Ramallah & al-Bireh	Nablus	Jenin
☐	☐	☐	☐	☐	☐
	Jericho	Tubas	Tulkarm	Qalqilya	Salfit
	☐	☐	☐	☐	☐

Type of School that I work at is:

An UNRWA School	private school	Public School
☐	☐	☐
Co-ed School	School for girls	School for boys
☐	☐	☐

Gender

M		F	
	☐		☒

Teachers' Education		**Teaching Experience**	
Diploma	☐	1 – 5 years	☐
B.A. in Mathematics	☐	6 – 10 years	☐
M.A. in Mathematics	☐	11 – 15 years	☐
M.A. in Education	☐	More than 15 years	☐
PhD in any area	☐		

Section 2 – My practices as a Mathematics teacher in the Mathematics classroom

1. I present solutions to problems by exposing the characteristics of concepts and relating their relationship to the solution method..

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

2. I direct students to link their Mathematical thinking to basic concepts.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

3. I encourage students to explore several methods of solving Mathematical problems.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

4. I direct students to use the skills that they have acquired to solve Mathematical problems.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

5. I encourage students to engage in class discussions.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

6. I encourage students to share and justify their ideas in class discussions.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

☐	☐	☐	☐	☐

7. I use class discussions to reach to Mathematical generalizations.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

8. I pay attention to and shed interest on students' answers based on guesswork and/or approximate answers.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

9. I allow mistakes in students' class interactions and responses, and I direct students to learn from their mistakes.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

10. I direct students to explain their answers and explain their thinking rout in a Mathematical Discussions.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

11. I have the students evaluate each other's work and discuss that evaluation among themselves.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

12. I address to students open-ended questions (which have several solutions).

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

☐ ☐ ☐ ☐ ☐

13. I encourage students to explore unusual approaches in solving Mathematical problems.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

14. I allow students to ask questions (whether they are directly related to the topic of the lesson or not).

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

15. I direct students to think about questions asked by other students and to think about the solution and to research it at home as a homework.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

16. I explain the real-life applications of the Mathematics lesson topic.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

17. I present examples of Mathematical problems from the students' environment.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

18. I ask students to bring practical examples of the Mathematical topic (such as a tangible object, a picture, or written information).

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

☐	☐	☐	☐	☐

19. I use imagination to present some Mathematical examples of the lesson topic.

Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
☐	☐	☐	☐	☐

20. I direct students to use visualization in Mathematical thinking.

Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
☐	☐	☐	☐	☐

21. I relate the topic of the lesson to geometric shapes.

Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
☐	☐	☐	☐	☐

22. I combine Art and Mathematics in classroom instruction.

Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
☐	☐	☐	☐	☐

23. I assign artistic assignments (drawing, coloring, cutting, decoration, embroidery, etc.) that are directly related to the subject of the Mathematics lesson.

Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
☐	☐	☐	☐	☐

24. I organize art competitions related to a Mathematics topic among students.

Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

☐ ☐ ☐ ☐ ☐

Section 3 – My features as a Mathematics teacher in the Mathematics classroom

25. I believe in the potential of all students, and therefore I support and encourage all students in the Mathematics class.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

26. I try various teaching strategies when I feel that the previous method was not effective.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

27. I use new teaching methods and techniques that I learn in professional development programs and courses.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

28. I incorporate imagination and unusual situations into my Mathematics classes.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

29. I do not present new theories to students as to be taken for granted, but rather I direct students through gradual steps to derive those theories.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

30. I break down complex topics/theories into simple, gradual parts and link them together to reach their final form.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

31. I emphasize the importance of the lesson and its application in real life.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

32. Whenever possible, I express the beauty of Mathematics by connecting the content to Art and nature.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

Thank You

Your Participation Is Highly Appreciated

Appendix F

Certificate of acceptance of the research extracted from the dissertation

Research title: The Impact of Teachers' Gender, Education, and Experience on Fostering Mathematical Creativity: A Quantitative Study

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OFFICIAL NOTICE

The editorial team of the journal "Mathematics and Informatic" issues this document in certification that the article by Sultan Kowkas "The Impact of Teachers' Gender, Education, and Experience on Fostering Mathematical Creativity: A Quantitative Study" will be published in the journal "Mathematics and Informatics" No. 3, 2025.

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جامعة النجاح الوطنية
كلية الدراسات العليا

استكشاف وجهات نظر وممارسات معلمي الرياضيات لصفوف الثامن–التاسع: دراسة شاملة حول الإبداع والتحديات والتطوير المهني في الفصول الدراسية الفلسطينية

إعداد
سلطان أمين عيسى قوقاس

إشراف
أ. د. سائدة عفونة
أ. د. دانييل بورغوس

قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الدكتوراه في التعلم والتعليم، بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس – فلسطين.

2024

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الملخص

المقدمة: إن مفهوم الإبداع متعدد الأوجه ويتطور باســـتمرار حيث يتم تفســـيره بشـــكل مختلف عبر مختلف التخ صـ صات والثقافات، مما يؤدي إلى مجموعة متنوعة من وجهات النظر، من مفهوم الإلهام الإلهي الذي تبناه الفلا سفة الأوائل إلى الأفكار الحديثة للأ صالة والقدرة على حل الم شكلات. من خلال هذه الأطروحة، يخوض الباحث في تحقيق شامل للإبداع في مجال تعليم الريا ضيّات، وَبالتحديد فحص وجهات نظر وأ ساليب معلمي الريا ضيات الفل سطينيين في الف صول الدرا سية لل صف الثامن والتا سع. في سياق الريا ضيات، يتجلى الإبداع بطريقة مميزة عن تلك الموجودة في الفن والأدب، حيث يمزج بين الحداثة والعملية ويظهر المرونة والقدرة على التكيف والإبداع في الفكر. هناك استنتاج لا مفر منه مفاده أنَّ الإبداع الرياضي يستلزم اندماج الأصالة والأهمية. يتألف هذا من ثلاث صفات أ سا سية: الطلاقة والمرونة والأ صالة. ومن الجدير بالذكر أن الذكاء الريا ضي والإبداع يرتبطان بعلاقة تكاملية، حيث يعزز كل منهما الآخر.

الأهداف: يهدف هذا البحث إلى التعمق في ت صورات وأ ساليب معلمي الريا ضيات الفل سطينيين الذين يعلمونَ طلاب ال صف الثامن والتا سع، مع التركيز على تنمية الإبداع الريا ضي. كما ي سعى الباحث إلى التحقيق في العوامل التي تؤثر على ممارسات التدريس هذه.

المنهجية: تم ا ستخدام نهج مختلط الأ ساليب، ي شتمل على تقنيات جمع البيانات الكمية والنّوعية. ومن أجل تقييم آرائهم وتوجهاتهم نحو الإبداع الريا ضي ب شكل كمي، تم توزيع ا ستبيان على معلمي الريا ضيات. علاوة على ذلك، تم إجراء مقابلات شاملة للحصول على فهم نوعي عميق لتجاربهم وأساليب التدريس الخاصة بهم.

النتائج الرئيسية: اكتشف البحث أن المعلمات والمعلمين الحاصلين على درجة البكالوريوس والمعلمين ذوي الخبرة الأكبر كانوا أكثر ميلاً لاستخدام أساليب التدريس الإبداعية. وتمثلت الصعوبات الرئيسية في الكتب المدرسية غير المرنة، وضيق الوقت، والفصول الدراسية المكتظة. حتى مع هذه التحديات، صرح معلمين ومعلمات بالأســـاليب الناجحة مثل طرح المشـــكلات والتطبيقات العملية. ومع ذلك، لم تكن هناك علاقة تفاعلية ملحوظة بين التّأهيل العلمي للمعلمين وسنوات الخبرة، مما يؤكد على أهمية توفير فرص التدريب الشخصية (كلاً حسبَ احتياجه منَ المعلمين).

المساهمة: اقترح الباحث ثلاث ممارسات تعليم لترافق الممارسات التدريسية المعروفة لتعزيز الإبداع الرياضي، بالإضافة إلى منهجية تدريسية جديدة تم مراجعتها من قبل مشرفين رسميين لمعلمي الرياضيات.

الخُلاصـــة: يؤَكد هذا البحث على أهمية تعزيز التعلم التعاوني في المدارس من خلال التدريب المتخصـــص والمناهج القابلة للتكيف. يمكن أن يؤدي التحســن في هذه المجالات إلى تعزيز أســاليب التدريس الإبداعية، مما يؤدي في النهاية إلى خلق جو تعليمي أكثر ابداعاً وجاذبيّةً للطّلبة.

الكلمات المفتاحية: الإبداع الرياضي، ممارسات المعلمين، تعزيز الإبداع، معلمو الرياضيات الفلسطينيون، طلاب الصف الثامن والتاسع الفلسطينيون.