

# Investigating Mathematics Teachers' Role to Improve Students' Creative Thinking

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**Abstract** Successful Teacher enhances, encourages and helps to develop the students' creative thinking, methods of teaching and democratic environment increase the students ability of creative thinking, as what previous several studies which showed that the moderate school environment leads to the availability characteristics of creativeness, such as extroversion, enthusiasm, emotional equilibrium of the instructor, and the ability to enhance creative thinking among students. The study aimed to investigate the roles of mathematics teachers in improving creative thinking, and it is restricted to a high school math teachers' role of creative thinking abilities associated with fluency, originality, flexibility, explanations And their ability to support those skills in the classroom, researchers suggested a list of themes improving creative thinking abilities, the following main three themes; Asking questions, Teacher's response, and Building an exciting environment. To achieve these goals for the current study, the researcher limited the study on develop methods of evaluating, a suggested methods of teaching for in service teachers' to improve their performance and their creative thinking abilities by the diversity of teaching methods such as using open-end divergent questions, motivational questions, and brainstorming.

**Keywords:** *creative thinking in mathematics, verbal fluency, flexibility, originality explanations*

**Cite This Article:** Salwa Mrayyan, "Investigating Mathematics Teachers' Role to Improve Students' Creative Thinking." *American Journal of Educational Research*, vol. 4, no. 1 (2016): 82-90. doi: 10.12691/education-4-1-13.

## 1. Introduction

Creative thinking has become an essential objective to function in developed educational systems, by developing plans, programs, alternatives, good curricula, contribution of method of teaching specialist in curriculum, and creative thinking development, challenging their creativity, raise their motivation to innovate, and implement methods of teaching based on scientific approach, respect students' ideas, and provide the opportunity for innovation, and productivity.

[18] Study shows that the main three teacher point view out of the fifteen major factor mentioned by education staff for the gifted and talented students was, building the curriculum, financial resources, teachers' attitudes while teaching, are what cause the reaction, and affect the students' attitudes, understanding of themselves, and give students the opportunity to make a good decisions. The teacher is responsible for creating good atmosphere to support the educational programs success for the gifted students; through workshops. The content that works on the development of students' thinking. The teacher can help in merges conceptual understanding through dialog with students to complete the mental processes with little direct support; base-through specific subjects the teacher can exercise cognitive processes such as: the organization of conceptual facts in a systematic, linking ideas together, make inferences and reach generalizations.

[2] The teacher can develop students creative thinking by avoiding traditional methods in teaching which based on memorization, remembering, and authoritarian style, he should use instead modern methods in treating the subject in teaching matter which is based on learner, and works to establish democratic relations and encourage students' questions, different ideas, meet the learner forms a reasonable challenges and excitement, encourage dialogue and discussion, problem solving, cooperative learning, The teacher can play an important and essential role in the students development of creative thinking, developing new methods of teaching without relying on one way, and use exciting means in teaching, respect students' mentality care about them and encourage them to display their own abilities in solving mathematical prob [16]" Analysed the daily records of five qualified teachers activities found out that about 36% of the overall performance distinguished by creative thinking and a low level of skills to facilitate the creative thinking process, the main obstacles to innovation in the school was teaching methods, where traditional methods of evaluation based on the conservation, remembering of information and authoritarian teacher.

Studies by "[8] and [4]"found out that the lack of creativity in teaching skills, continued reliance on traditional methods in teaching, based on teacher belief that he knows Everything for classroom discipline, which hinders creativity of the students and the emergence of talented ideas,

[10] Found out that the lack of sufficient knowledge of the techniques and parameters of creative thinking is the

main obstacles to use these parameters in creative thinking development methods. It is important to develop and maintain programs for mathematics teachers to enhance creative thinking development, and these changes require evaluation of teachers in the field, and to determine strengths and weaknesses in their classroom, access scientific basis can contribute to improve the programs preparation content and mathematics teachers training, this requires defining the role of mathematics teachers in creative thinking enhancement, what is the current study try to investigate.

### 1.1. Problem of the Study

The study aimed to identify the problem by answering the following question: What are mathematics teachers' role in improving creative thinking?

### 1.2. Study Importance

Thus study investigate the role of mathematics teachers in the field by evaluating their performance, as well as colleges of education officials, directing their attention in building and preparation programs for teacher training and writing textbooks, to help In-service mathematics teacher for self-evaluation and support their role creative thinking the role of mathematics' teacher to improve students' creativity is the primary academic goals of the 21<sup>st</sup> century require many special sets of skills in order to succeed in work and life. Therefore, educational systems must transform their objectives, to creativity, fluency in information and communication technologies, and the ability to solve complex problems (National Council of Teachers of Mathematics, NCTM, 2008; creativity plays a vital role in the full cycle of advanced mathematical thinking. It contributes in the first stages of development of mathematical theory when possible conjectures are framed as a result of the individual's experience of mathematical context; it also plays a part in the formulation of final mathematical evidence as deductive system with clearly defined axioms and formally constructed proofs

### 1.3. Study Objective

This study aims to investigate the roles of mathematics teachers in supporting students creative thinking.

### 1.4. Study Limitations

This study was limited to investigate the roles of high school math teacher of creative thinking abilities associated with: fluency, originality, flexibility, explanations',

## 2. Study Terms

- **Verbal fluency:** Fluency The ability to generate a number of ideas so that there is an increase of possible solutions or related problem that the student's ability to mention the largest possible number of mathematical concepts and terminology in a specific time and according to certain conditions.
- **Flexibility:** Intended to expand the student's ability to answer the unusual exercises, so that increasing the degree of flexibility and the ability to produce different categories or perceptions whereby there are a variety of different ideas about the same problem
- **Originality:** Means the student's ability on the speed of perception and production of new mathematical ideas, and the ability to create fresh, unique, unusual, totally new, or extremely different ideas, complex or complicated ideas from one idea or from simple ideas. Traditionally the eight elements below are ones commonly thought of as inherent elements of creative production, as well as attributes associated with creative problem solving abilities.
  - a) **Complexity :**The ability to conceptualize difficult, intricate, many layered or multifaceted ideas or products.
  - b) **Risk-taking :**The willingness to be courageous, adventurer, daring — trying new things or taking risks in order to stand apart.
  - c) **Imagination :** The ability to dream up, invent, or to see, to think, to conceptualize new ideas or products – to be ingenious.
  - d) **Curiosity :**The trait of exhibiting probing behaviours, asking and posing questions, searching, being able to look deeper into ideas, and the wanting to know more about something.
- **Explanations:** Means the ability to add new explanations and a variety of idea, or solution to a problem, or graphing that will help to develop or implement them.
- **Math teacher roles in support of creative thinking:** The set of behaviours, verbal and non-verbal acts which is shown by a mathematics teacher during his interaction with his students in a classroom, which works to support the students creative thinking
- **Convergent and divergent thinking:** Two necessary types of thinking for being creative in defining creative problem-solving In this category one of the more common definitions of creativity has to do with separating creative thought into a process of dual exchanges through the blending two types of thinking convergent and divergent thinking, to go through a series of steps first diverging (expanding ideas) and then converging (narrowing possibilities) until a solution is found. Divergent thinking usually include the ability to think of diverse original ideas with fluency and speed. Ideating and brainstorming are premiere examples of exercises using this type of thinking. What if. . . ? How about. . . ? Could we try this or that idea. . . ? Are types of questions that can lead to divergent thought patterns. A convergent thinking is defined as the ability to use logical and evaluative thinking to critique and narrow ideas to ones best suited for a given situations, or set criteria. We use this type of thinking when we make crucial and well-formed decisions after appraising an array of ideas, information, or alternatives. Creative

- **Creative thinking in mathematics:** Mental activity is directed towards the formation of a new mathematical relationships beyond the known relations for students in math, and these new relationships reflect the ability of two types of verbal fluency and intellectual ability, flexibility, originality, and the ability of explanations, which are defined as follows:

production is often characterized by the divergent nature of human thought and action. Divergence is usually indicated by the ability to generate

Robert Sternberg and Wendy M. Williams (1996, ASCD) wrote a valuable little scheme that can help teachers and parents to understand creativity "How to develop student creativity" Below the researcher summarized their ideas and added a few of his own., According to Sternberg and Williams creative work consists of the application and melding of three types of thinking, all of which they contend can be learned or improved. They think that creativity is a balance between these three metacomponents:

- Analytical ability :Includes the ability to think convergently, it requires critical thinking as one analyzes and evaluates thoughts, ideas, and possible solutions. This type of thinking is key in creative work because not all ideas are good ones, some need to be removed. Creative people use this type of thinking to consider implications and project possible responses, problems, and outcomes. this ability known as "critical thinking".
- Synthetic (creative) ability: Includes divergent thinking as it is the ability to think of or generate new, original, and interesting ideas. But it is also the ability to spontaneously make connections between ideas, or groups of ideas that often go unnoticed, or discovered by others.
- Practical ability: The world is full of people who have good ideas, as well as ones who can pick ideas apart. However, the basic key to creative work must include the ability to use practical thinking. This is the ability to translate abstractions and theories into realistic applications. It is the skill to sell or communicate one's ideas to others, to make others believe that ideas, works, or products are valuable, different, useful, innovative, unusual, or worthy of consideration. This type of thinking is prized in the context of being creative because it is how one finds a potential audience for one's creative work. An innovation or invention needs an audience, a consumer, a user, and implementer. Indeed, ideas are just ideas if no one knows about them or no one uses them.

### 3. Methodology

A descriptive approach used, aimed to describe and investigate and attempt to derive number of mathematics teaching tools and methods to improve teachers' roles in supporting students' creative thinking.

## 4. Literature Review

### 4.1. Mathematic Teacher's Role in Improving Creative Thinking

The teacher role is the most important stimuli that work to create effective climate of teaching and learning within the classroom, encouraging student to think unique and original, which is creative personality characters, what teacher says and does affects student learning, Researches

that has been done in the past twenty years studied the impact of the teacher behaviour, not student achievement alone, self-concept, social relations, thinking abilities, teaching methods dealing with the students in the classroom, their behaviour, as well as the expressed view, opinions, suggestions, ideas, and its impact on creative thinking, motivation and creativity, as those capabilities can be developed if there is specific measurable educational attitudes, which would fit self-learning and teaching in the appropriate educational environment.

The relationship between the teacher behaviour and the student learning, powers the students' learning, and achievement of certain features in teaching, such as verbal dialogue between the teacher and students, classroom management, clarity of purpose, organization of the subject, strategies, asking questions, method to answer the students' questions, the course-planning method, so the teacher who does not have the required competencies for the development of creativity, can not do anything about the development of creative thinking.

The educational situations, which traditionally planned and implemented required attitudes for relocating what is in the book into the students minds, without any ability to recruit, think or applied, those subjects in new situations to work towards the development of students' creativity.

(Cropley,2001)Confirm that, teachers support for creativity must work to urge students to look for genuine solutions, conscious attention to students with questions and suggestions. do not judge the speed of ideas provided by students, develop students self-assessment [9] suggest in his study, the teacher should support creative students, by using discussion method and dialogue in the classroom, encourage students to cooperative learning taking into account an individual differences, follow an interesting approach at the beginning of the lesson, has a great deal of flexibility, keen on the use of humour in the class so students do not get tired and improve their performance.

"Creative thinking is much more than using your imagination to crank out lots of new ideas. Creative thinking is a lifestyle, a personality trait, a way of perceiving the world, a way of interacting with other people, and a way of living and growing". Gary Davis, Since the 1950s cognitive psychologists and researchers have been trying to explain the differences in diverse types of thinking. In 1956 Benjamin Bloom with others developed a hierarchical listing, or taxonomy, annotating the complexity of the differences in varied levels of cognition. Most teachers are generally familiar with this work, known as Bloom's Taxonomy, and it starts from simplest forms of thinking progressing to those that are more complex as: knowledge, comprehension, application, analysis, synthesis, and lastly evaluation.

Use and combine the 3 levels of thinking created by Robert Sternberg and Wendy Williams to create diverse activities in order to help students explore aspects of intelligence and creativity, Analytical Thinking, Creative Thinking, Practical Thinking, Analyze, Critique, Judge, Compare/contrast, Evaluate, Assess, Create, Invent, Discover, Imagine if . . . , Suppose that . . . , Predict, Apply, Use, Put into practice, Implement, Employ, Render practical.

**Creativity;** creativity is the ability to imagine or invent something new, creativity is not the ability to create out of nothing, but the ability to generate new ideas by

combining, changing, or reapplying existing ideas. Some creative ideas are astonishing and brilliant, while others are just simple, good, practical ideas that no one seems to have thought of yet. Everyone has substantial creative ability. Just look at how creative children are. Creativity has too often been suppressed through education. Creativity is also an attitude which is the ability to accept change and newness, a willingness to play with ideas and possibilities, a flexibility of viewpoint, the practice of enjoying the good, while looking for ways to improve it. Creative people work hard and continually to improve ideas and solutions, by making gradual alterations and refinements to their works. Contrary to the mythology surrounding creativity, very few works of creative excellence are produced with a single stroke of brilliance or in a frenzy of rapid activity the creative person knows that there is always room for improvement.

**Creative Methods:** Several methods have been identified for producing creative results. Here are the five classic ones:

- **Evolution.** This is the method of incremental improvement, new ideas stem from other ideas, new solutions from previous ones, the new ones slightly improved over the old ones, many of the very sophisticated things we enjoy today developed through a long period of constant incrimination, making something a little better here, a little better there gradually makes it something a lot better even entirely different from the original. The evolutionary method of creativity also reminds us of that critical principle: Every problem that has been solved can be solved again in a better way, creative thinkers do not subscribe to the idea that once a problem has been solved, it can be forgotten, or to the notion that "if it ain't broke, don't fix it." A creative thinker's philosophy is that "there is no such thing as an insignificant improvement."
- **Synthesis.** Two or more existing ideas are combined into a third, new idea.
- **Revolution.** The best new idea is a completely different from the previous ones. While an evolutionary improvement philosophy might cause a professor to ask, "How can I make my lectures better and better?" a revolutionary idea might be, "Why not stop lecturing and have the students teach each other, working as teams or presenting reports?"
- **Re-application.** Look at something old in a new way, go beyond labels, remove prejudgments, expectations, assumptions and discover how something can be applied again in better way
- **Changing Direction.** Many creative breakthroughs occur when attention is shifted from one angle of a problem to another. This is sometimes called creative insight.
- **Creative Thinking and Problem Solving obstacles.**
  - a) Every problem has only one solution (or one right answer).
  - b) The best answer/solution/method has already been found.
  - c) Creative answers are complex technologically.
  - d) Ideas either come or they don't. Nothing will help.

**Mental blocks to creative thinking and problem solving.**

Prejudice, Functional fixation, Learned helplessness, Psychological blocks.

#### **Positive attitudes help creativity**

Curiosity, challenge, constructive discontent, believe that most problems can be solved, the ability to suspend judgment and criticism, seeing the good in the bad, problems lead to improvements, a problem can also be a solution, problems are interesting and emotionally acceptable, perseverance, flexible imagination, that mistakes are welcome.

#### **Characteristics of the Creative Person**

Curious, seeks problems, enjoys challenge, optimistic, able to suspend judgment, comfortable with imagination, sees problems as opportunities, sees problems as interesting, problems are emotionally acceptable, challenges assumptions, doesn't give up easily, perseveres, works hard.

#### **Types of the question types that helps creativity**

- **Classroom questions:** Questions during the interaction of education position in the classroom is the most important skills that contribute to the development of students creative thinking, especially if the teacher give students the opportunity to take part in answering and collecting the questions data, give them a meaning, show and link the relationships by formulating the given questions by the teacher to his students and the type of this formulation has an undeniable impact with the students, it is so may lead them to think and use reasoning skills, knowledge employment in dealing with the tasks given to them, or may turn to the conservation and memorization by heart [13]. The skill of asking questions or accountability is to give students more knowledge, data, information that is examined, create students' knowledge, determine what they want to discover, determine how much they have already learned through the different educational stages, and asked questions to help them to expand their knowledge and their understanding in different concepts.

## **4.2. Questions Classification**

The importance of the classroom questions in the educational process has found great interest from educators, to the list classifications of the classroom questions, [7]. Discussing the classroom questions classification as proposed by Gallagher based on Guilford theory of to build mentality, that if the goal of education is to develop students' creativity, the ability of composition of correct and good logical assessment governance on things; the percentages according to Gallagher on the whole is not appropriate, especially with regard to identifying, remembering, thinking and evaluation, also states that education needs more urgent to think of objective evaluation, and therefore the teacher has to be for the students' creative thinking development goes beyond converging thinking, researchers see that there are three types of questions that help the classroom teacher in developing students creative thinking, divergent questions, higher - order questions, and, analytical questions.

A **divergent question:** is a question with no specific answer, but rather exercises one's ability to think broadly about a certain topic in education, divergent questions allow students to explore different avenues and create



many different variations and alternative answers or scenarios. Correctness may be based on logical projections, may be contextual, or reached through basic knowledge, conjecture, inference, projection, creation, intuition, or imagination. These types of questions often require students to analyze, synthesize, or evaluate a knowledge and then project or predict different outcomes.

**Divergent Questions:** The use of divergent questions during the educational interaction has a positive impact on improving the student's creative thinking ability,

Divergent questions open-ended can not predict the answer to be provided by the student, forcing the student to think creatively, and stems to the maximum to enable his imaginative and thinking capabilities,

**Higher-Order Questions:** Higher-order questions require answers that go beyond simple information and both the language and thinking behind them is more complex. They take learners into more abstract language functions, such as giving and justifying opinions, speculation, and hypothesizing. Questions the student in a higher mental levels of knowledge is to answer the teacher activity, aims to expand students' thinking and access more thinking to the answers, and these questions belong to the level of analysis, synthesis and evaluation, according to Bloom's Taxonomy, (Abdel-Mageed, 1998) some studies found that effective use of the teacher cognitive questions High in the development of student creativity, such as (Ruman1997), (Abdel-Mageed,1998). Questions the level of analysis such as identification and reasoning, conclusion (What are the components), Comparison: Compare the (two ideas - two forms - two ways ... etc), and to identify similarities and differences between them.

**Identify main ideas,** Aimed at enabling students to identify main ideas and list them all, through the students training to conceptual construction, summarizing ideas verbally, identifying Errors,, whether logical or arithmetic or knowledge, determine the reasons for these errors, correct them, or change thinking style that cause these errors.

**Flow Chart level of questions:** This level includes a students' ability to make value judgments about the data, ideas, opinions, theories, shown by the student and his views on issues, views, values, and to judge the problems solutions' feasibility

**Level of creativity:** The level of creativity training directly on the innovation, producing answers that are characterized by originality, the questions in this level require the learner to collect parts form whole to build new style, at this level is organizing the information component into a whole to expresses the meaning, connection, imposition of assumptions, this level also requires the student to organize particular ideas to problem solution and this kind of thinking requires the teacher to challenge his students' innovative questions ability. This level includes the following operations, predictability through data Predicting which means the ability to understand the available data to the student and the inference from which there is more than that either in time or in the subject, and can predict either the completion of incomplete data in some problems, or tendencies that characterize the available data, as the questions that measure skill of the prediction of the reality of evidence or information available, lead to the identification of the

ability to overcome the limits of what is known or to go beyond that in a way or another, Therefore, training students to predict from what is available data helps to develop the originality of the learner, which is one of the most important capabilities of creative thinking, which can estimate the originality and unseen by thinking about the sequences of future events to generate ideas or expectations arising from, and we see that issue of Statistics in Mathematics is a fertile ground can be used in students training on the skill of prediction, and linking several ideas in one statement

**Analytical Questions:** The questions that the teacher builds on the student's answer, in order to help him reconsidered for improvement or development to be more accurate and detailed, or the questions put by the teacher when the student can not answer, or when answer is incorrect answer.

**Direct questions:** where the teacher helps the student to reconsider his answer if it is not appropriate.

**Converted questions:** where the teacher directs a question to another student rather than go by the follow-up to the first student.

**Buzz questions:** it is determine a specific idea, and asks students to answer them, the student initial responses acceptable then the teacher ask students to explore the answers and build on it, which helps to develop the capacity of completion, which is considered as one of the basic rules for brainstorming method,

**Creative environment:** When we considering creativity as a process, this process must go through several stages until it reaches resulting creative individual, these stages require the appropriate conditions for creative environment to stimulate the learner towards innovation at every stage, where that creativity is the only outcome of the good interaction among higher mental processes in humans as well as personality characters are the best types of friendly environmental conditions for creativity Therefore, the classroom components of the educational materials, and methods of learning, educational tasks, positive attitudes toward learning, manifestations of physical components, means of certain works to provide what might be called environmental infrastructure; to learn and to think in an organized, ongoing, therefore the classroom environment is one of the important elements of education programs of thinking success, and creative environment is a good atmosphere for the development of innovation and prosperity, interesting, appropriate mentally and emotionally to the creative student.

[17], Many studies pointed out the behaviour influence of the teacher in the classroom on the students' creativity.

Mccormick [22] stated that open classroom develop students' creativity and confidence, it became clear that creative characteristics availability in the school environment within the moderate classroom, led to the high creative capabilities of students, a positive relationship between the parameters ( extroversion, enthusiasm, emotional stability), and the ability to think creatively with the students, math teacher that encourages dialogue and freedom of expression, what is right for us it is right for others, to accept the others mistakes and, working on its response to the right, without intolerance or yield to anger and excitement, accept and convinced alternative views if it is right.

[13] The teacher can create an environment that encourages creative thinking as a method of interaction between teacher and student, which provides trust, risk the level of thinking, the warmth of the relationship, openness, a sense of security in classroom, style response. Provides a set of guidelines that can be guided by the teacher during the training process of creativity in the classroom, including; accept and encourage divergent thinking, boost attempts to find solutions to unusual problems, even if the final result were not ideal, holds views contrary to your opinion, make sure that students receive the same thing of the classroom teacher privileges, encourage students to trust their ideas and answers, give some answers from time to time, stress that each student has the ability to be creative in some way, characterized the work of creative efforts in the work of each student, and do not have a classification of originality in some of the duties, be a promoter for creative thinking, developed a model to resolve the issue through creative solutions to guess rare issues of class, encourage the students to postpone the provisions speculation the on specific question, to be taken all possibilities into account [2].

**Thinking time:** Period waiting for the teacher after giving the question and before determining a student to answer or repeat the question, or say anything, and knew at the time thinking about the period of time that following the student response to the question and before suspending out, or move to explanation or asking the question to another.

[15], 3-4 seconds after hearing a question give the student them a chance to think about the answer and the content of the question, also give the student an opportunity, so that goes on, or modify his answer or re-considered, and leads to an expanded response, and to use methods of a new intellectual existence, that means the teacher is expected student answer, and he was confident that he can answer this but he needs some time. (Southpaw, 1998).

[23], showed that when the goal of the learning process to improve students' thinking we need to increase the time of thinking,

(Rochester, 1983), found that there is evidence of increased mental activity to increase the time to think, the time of thinking can be between 3-5 seconds after asking the question in the time, except that this time does not give a great opportunity for students to go deeper in addressing the skills involved, which requires the teacher prolonging the thinking commensurate with the nature of the educational situation, and the number of students and classroom period, if the period of silence after his question short, it means that we encourage short answer that rely on memory, or shallow thinking, but if the period of silence is relatively long, This encourages the answer in complete sentences, also give students the opportunity to choose the type of thinking and to complete the process of thinking about the answer, the existence of differences in student responses related to the teacher's period of silence, students short answer ; If the silence of the teacher for a short - one or two seconds - pause the student, but if the silence of a minute or more goes on to provide a full answer and additional good ideas which encourages creativity, the teacher increasing time of waiting after his question, and before allowing a student to answer,

increases flexibility, and lead the student to provide a greater number of alternative solutions,

**The originality of thinking.** When thinking in solving mathematical problems and the rule application, encouraging the learner to, a careful and deep thought in the solution, that he can get many of the alternatives to solve the problem which requires a mental effort to overcome the tendencies of traditional solution and access to different solutions, some of which may be characterized by originality and uniqueness and, therefore, the teacher encourage students to overcome the first idea and search for other different solutions, multiple issues and Mathematical rule during the proposals presentation for the development of mathematical skills in students, that "should encourage originality of thought, and by encouraging students to submit and propose new solutions to the problem or the application of mathematical rule. " Can also develop students' originality to give different solutions and a variety of mathematical situations, by giving students the opportunity to solve the exercise in more than one way, and give them mathematical problem that they come out to several different solutions can be innovative ideas and far from normal, some teachers insist that their students solve the questions and exercises in ways that he used, and does not encourage them to think of new solutions and invent ways of their own, and that obscure the originality and creativity of learners.

From the above it is clear that math teacher he is a role model for students to provide new solutions while solving exercises, and application of mathematical rule in the textbook, and it should encourage students to shortcut solutions or make some additions to solutions development, the students are asked to identify the steps which are used to reach to the answer, and the reasons for the alternatives selection, which helps in strengthening the knowledge of the given data (Meta Cognition, awareness of thinking, thinking about thinking), so the students are expected to benefit from the methods of their colleagues in thinking, and can use other methods and plans different from their colleagues, issue new ideas may be characterized by originality as it is. when teacher asks students to describe what is going on in their minds, it helps them to develop awareness of the cognitive processes undertaken by them, and when listening to describe the what they heard or learned from their colleagues that they do grow up to have the flexibility of thinking, accept the diversity of methods addressed to the same problem, find the largest possible number of alternatives for a solution, and to identify steps of the solution to determine the reasons for students' selecting for these alternatives, and not to insist on one correct answer, sanction issues and math problems to the limited steps, and develop new solutions to the exercises, or shortened, changes, and thinking out loud to their colleagues, teach students a skill that takes into account the originality requires the teacher to encourage students not to re-formulate the idea of others, encouraging students to produce new ideas before determining the final answers.

**Problem Solving:** Teaching problem solving is an effective way for the development of scientific skills, and cognitive processes, and scientific creativity, these strategies working on the development of creativity, and consistent with the nature of mathematics, because its use

puts students in a positions close to them at all stages of the creative process, as they work to accustom the student to the problems that face them in life, and to find alternatives to multiple solutions to one problem which is the essence of the creative process.

[16], many studies results on the effectiveness of problem solving use in the development of innovative thinking for students, on the effectiveness of dealing with math problems, and the entrance to the general problems, the development of students' creative thinking in mathematics at high school level, more than a way to solve problems on in both academic achievement in geometry and innovation for high achievement students, solve problems compared with other teaching methods in the development of creative thinking, according to the results of previous studies, and literature that dealt with problems solving, the teacher who seeks to develop creative thinking, present the subject of learning in the form of mathematical problems, solving, and trains students to various strategies to solve problems where there is no one specific strategy in problem-solving, but a number of researchers had to identify some general steps that can be used to solve problems in an orderly manner, and different style applied as the nature of the problem to be solved. The role of the teacher in learning based on problems solving directed initiatives of students and verification, strengthened, stay away from the lecture, or give instructions, or providing students with ready information, the teacher decision based on class size, cognitive maturity of students', and educational goals of the material, when teachers use a method of learning based on problem solving, they give their students the opportunity to self-reliance and responsibility in the learning process, it is assumed that in this type of learning that the teacher is an expert in the subject and has a good skills of learning resources which can guide the students to a variety of sources in searching, such as books, journals, websites, experts and specialists

**Explanation:** The use of specific terms for verbal interaction in the classroom, anyone who looks to the nature of the educational process, it is noted that learning often is through a process of verbal interaction between teacher and learner in the classroom, so the lack of clarity of semantics used in the verbal communication of any of the parties - the teacher and the learner -, a barrier to access to the desired goals of the learning process, and if the goals of educational communication in the classroom position in students development of creative thinking, it would require to develop a teacher-defined strategy for words related to thinking, so that helps students to understand the semantics used in organizing thinking process, It may be the cause of the failure of the student's thinking, may be he does not understand the meaning, and that he does not know how to hire the cognitive function required of it, so the teacher uses the concept to be specified, and to train students to do these specific cognitive skill

Clear from the all previous studies that the teacher uses specific terms which associated with specific skills need to be implemented in specific actions of the students, for example: instead of the teacher saying to look at these two forms, to compare the two forms, and then train the students to find similarities and differences between forms, so no example contains a comparison, the student will

identify similarities and differences, because the use of words and expressions related to thinking skills and processes, established scientific methodology in general communication and discussion, problem solving, decision-making. [5], further clarification of the example to mention some of the specific words that the teacher can use in classroom setting,

specific words related to thinking, which can be use by the teacher in classroom situations focus on the skills of comparison, prediction, classification, analysis, imposing assumptions, interpretation, and all of the skills of working to stimulate creative thinking among students, and while hearing of these terms from their teachers or their parents or their peers in their daily lives, they are involved in knowledge associated with these terms, so that they entered into their dictionary of language; to become part of their special language, and the teacher to explain the cognitive processes, so that there is a meaning agreed upon between the student and the teacher about the cognitive skills involved, in the sense that students learn what is going on in their minds when they are comparing and what are the steps that will help them to make a decision? or how active they can become creative?.

[13] students acceptable behaviour in the classroom and the teacher who seeks to develop creative thinking for students, and set organization of definite critical words of students' behaviour, used by the teacher to modify the behaviour of his students in the classroom, so that the work of these terms to modify the behaviour of students, and in the same time does not impede students' psychological freedom the classroom, which is one of the basics of classroom exciting environment to think creatively, and avoids the use of blunt language lead to rein the student either to continue to answer or question, or create a descriptive environment, authoritarian hinder creative thinking, so we seek to make dialogue with students about the behaviour most appropriate, which must act on his teachings, as well as on what is applied in the classroom and outside of the rules and regulations, observance of morality, social behaviour of the best and this is essential to develop alternative solutions,.

### 4.3. Educational Technology

Technology education is an area concerned with facilitating the individual's learning through innovation and development, organization and systematization of the use of learning resources of various types, and through the management of these processes and organization. The previous definition of the most comprehensive is inserted literature in defining the concept of educational technology; as it is not limited only to the production and use of the tools and the provision of learning resources, but also to focus on one of the components of the educational system, the different ways of thinking, with its focus on innovation, development and management learning processes.

Educational technologies and their impact in the development of ways of thinking as in [19] study which referred to the effective use of educational technologies (monitor images - painting hairy - programmed learning - optical Blackboard) in teaching mathematics to develop the ability to think creatively, many other found possibility of developing the students' creative ability,

using various educational techniques, including the study of. (Alsayed 1999) According to the researchers that the use of educational technologies in the classroom works to stimulate students' ideas and fantasies, by offering many of different stimuli, which is a key element in the development of fluency, flexibility, originality, teacher's optimum use of education technology, while providing different sources of the educational process in classroom, allowing students to deal direct with them, and refer to additional sources learning all commensurate with the level of maturity of the students, and attention to the development of abstract thinking, which should be promote high school students', and the teacher's opportunity to use different educational models for students outside the classroom for further learning, the provision of different sources to obtain data and information about the learning subject. Exposing students to appropriate stimuli to make the student trying to reach the answer, and by thought-provoking questions, such as: divergent questions and the opportunity for students to long term think, which is essential to them to be confident in ways of thinking and solutions. Building descriptive environment creative, provoking thought, and encourages students to curiosity, intellectual exploration risks, the generation of multiple ideas and the opportunity to express their feelings characterized by respect for the views and ideas of students. A positive response from the teacher to help maintain thinking, and open the various ways of thinking. Operational model emulated the students in dealing with the different thinking skills, the behaviour of the teacher during the subject learning process in the classroom. Here we will discuss many of the roles assigned to a teacher of mathematics, which contribute to support students' creative thinking in the classroom in the form of a list containing (32) a descriptive conduct, divided into three main themes as follows:

I - Classroom questions to support creative thinking, contains (9) sub-skill, For the teacher:

1. Follow-up questions such, silence for some time after posing questions to students to give them the opportunity for further reflection and meditation,
2. Open-ended questions (divergent),
3. Higher cognitive levels of questions (analysis, synthesis, creativity).
4. Ask questions directly after the completion of each educational paragraph,
5. Use words are characterized as questions (related to the specific thinking),
6. formulate questions in a manner calls students to go towards the recovery of the relationship between cause and effect to determine the (similarities, contrast, comparison),
7. Questions require the use of the subject of learning "concepts circulars" that were reached in the new situations,
8. Teacher asks a summary has not been said (from another colleague) to activate the positive listening, show the students' questions by reformulation or ask questions to help,
9. Questions used to determine the sounding data and information available to the students about the learning subject.

II - Teacher Responses in support of creative thinking,

1. Avoids the use of words to think and ballasts that prevent more in-depth treatment of the cognitive tasks such as: Well done, excellent, wrong, Irresponsible idea,
2. Silence for some time after hearing the students answer to get of them more of the answer,
3. Aske the students for largest possible number of alternatives for the answer,
- Students are to be asked to
4. indicate what steps used to reach to the problem solution,
5. to develop hypotheses according to the available data,
6. to compare between the ideas,
7. to suggest some practical applications of the laws, rules and theories they studied.
8. Interpretations of the available data and the results have been reached, to predict from the data and the data available.

III - Building descriptive exciting environment for creative thinking,

The teacher should:

1. Provides an opportunity for students to use educational models during and after classes,
2. Refers to different sources to obtain additional information about the subject,
3. Avoid focusing on the grades in the classroom,
4. Welcomes all ideas from the students no matter what kind and at what level,
5. Provides an opportunity for students to change places and the pattern of sitting in the classroom,
6. Urge students to exchange ideas, avoid monetary judgments on ideas provided by the students until the students finish the debate,
7. Enhance students sense of the problems during class,
8. Urges students to use specific words related to thinking and verbal communication,
9. Avoid the comparison between the level of the students with each other,
10. Use educational technologies to provide the subject learning,
11. Avoid excitement, rigor and gloom in the responses to the students behaviour
12. Give enough time for students to express their ideas,
13. Analyse some of the key concepts to concepts of a subsidiary,
14. Thinking out loud to students during the problem-solving and the application of the laws,
15. the relational structures of the subject learning.

## 5. Recommendations

1. Rewrite text books to serve initiating the creative thinking
2. Develop methods of evaluating of the in-service teachers' performance;
3. Develop colleges of education programs and curriculum activities and skills that underlie creative thinking, to ensure that the teachers get the behaviours and skills of supporting of creative thinking.
4. Diversity in the teaching methods used by faculty members of college Education; including creative



approaches, such as divergent open-ended questions, stimulus questions, and brainstorming.

5. Hold aperiodic workshops and conferences about creative thinking and mathematical thinking in general
  - The researcher Comment The researcher experience in teaching math at college level for more than 30 years creativity can be enhanced if it's there originally, but cannot be created from none.

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