



The effectiveness of a proposed teaching strategy based on the theory of successful intelligence in developing creativity skills in mathematics for students of primary stage

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Abstract

The aim of the paper is to measure the effectiveness of a proposed teaching strategy based on the theory of successful intelligence in developing creativity skills in mathematics among primary school students. To achieve this aim, the researcher employs a semi-experimental approach and designs one group of pre and post-test. The researcher carries out the test of creative thinking in mathematics. He also builds a teaching strategy based on successful intelligence to develop creative skills in mathematics among primary school students. This strategy was applied to the research sample students, which numbered 35 male and female students from the fifth grade of primary school. To measure the effectiveness of the strategy, the test was applied remotely to the research sample. The results showed that there is a statistically significant difference at the level of significance (0.05) between the mean scores of the experimental group students in the pre and post-tests to test creativity skills in mathematics after successful intelligence-based teaching in favour of the post-test.

Keywords: Successful Intelligence, Creativity in Mathematics

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1. Introduction

Mathematics plays an important role in all fields of life. It is an abstract science of creativity of the mind. It is also described as the queen of sciences because it does not need any other science to grow and expand. Mathematics is a science harnessed to serve many applied fields in various sciences. It has received great attention from thinkers and scholars due to its accuracy [3]

Mathematics focused on developing the creative aspects of students, and called for the development of creative thinking abilities. This is evident through the educational objectives of teaching mathematics. Mathematics is one of the subjects that contribute significantly to improving and developing creative thinking. This is due to the cumulative nature of the material where many logical results are deduced from the same data. Mathematics is also rich in multiple solutions to the same situation [14]

The development of creative thinking among students is the focus of educational institutions' attention, as providing students with creative thinking skills helps them face the problems and challenges of contemporary life [2]

The creativity is a process that can be learned, trained and developed. It is also known as a process that produces something new that is useful and novel. It is one of the most important kinds of thinking that aims at finding solutions for different issues and problems to arrive at new and unfamiliar results. It is also characterized by its comprehension and complexity.

The creative thinking is an important aspect of student learning. It makes him take a positive attitude towards learning, and feel enjoyable at the time of learning. Through creativity, the student can modify the wrong information and turn it into a creative production because they acquire creative thinking at early stages. In so doing, they can solve their problems easily. This in turn enables them to be more productive at maturity. This is one aim of the effective learning. Therefore, creative thinking skills must be developed and taught to students at an early stage and leave room for them to express their ideas freely and discover and produce knowledge in new, unconventional ways [16].

In light of the development that has followed man in all walks of life and what these developments have brought about tremendous progress in all Arab and foreign countries, it has become necessary to shed light on those methods and means that make us approach this growth and creativity that many advanced countries have reached. As we take a step to apply these theories in education, it is a good step, which opens the way for researchers to develop programs and strategies based on the latest theories. These theories prove their effectiveness and success in many countries. They are put into action in different educational stages and levels [24].

Among the theories that concerned with the development of students' creative abilities is the successful intelligence theory of the American scientist Robert Sternberg. The history of this theory has been extensively documented in two previous articles: one in *The Behavioral and Brain Sciences*, and the other in *The Review of General Psychology* [33]. The Successful intelligence means that type of intelligence that concerns everyone in reaching important goals in life which is based on thinking through three different ways (analytical, creative, and practical), and knowing how to use the three aspects of thinking [21].

Based on the definition of successful intelligence, there are three components to this theory:

1. Analytical intelligence: It refers to the student's ability to analyze, make judgments, compare, think critically, find differences, evaluate ideas, and clarify [31]
2. Creative Intelligence: It refers to the student's ability to be creative, discover, imagine, and make assumptions [31], and [20].

3. Practical Intelligence: “It means the student’s ability to apply, employ, and put things into practice, and this is evident in daily life” [31].

This theory is considered one of the few theories that combined theoretical and applied thought at the same time. This fact facilitated the educational use of it. Sternberg and his colleagues presented the educational applications of the theory based on their vision that education is based on the two dimensions of memory and analytical abilities, and there is no equilibrium with the other dimensions. As a result, many researches focused on the successful application of intelligence with its three abilities in education for the sake of improving school achievement [5].

Sternberg also confirmed that teaching using successful intelligence has succeeded. More importantly, the students in the case of successful intelligence are more effective than the other students [30].

2. Problem of the Study

Based on the previous studies that called for the need to develop creativity skills in mathematics among students, especially primary school students, such as the study [13], which aimed to identify the effectiveness of mathematics teaching based on the components of concept-rich teaching in developing creative thinking skills for basic stage students and the study of [27], which aimed to identify the impact of using the iPad in developing mathematics among fourth-grade students in private schools in the capital governorate, Amman, the researcher made sure of the need to develop creativity skills in mathematics, especially among students. As mentioned before, the researcher identified the problem of the current research in “weakness of creativity skills in mathematics among primary school students”, and to address this problem, this research tried to answer the following questions:

- What are the skills of developing creativity in mathematics appropriate for primary school students?
- How to build a teaching strategy based on the theory of successful intelligence in developing students’ mathematical creativity?
- What is the effectiveness of the teaching strategy based on successful intelligence in developing creativity skills in mathematics for primary school students?

Hypothesis of the Study

There is a statistically significant difference at the level of significance (0.05) between the mean scores of the experimental group students in the pre and post tests to test creativity skills in mathematics after successful intelligence-based teaching in favor of the post test

Aims of the Study

The paper aims at: Developing creativity skills in mathematics among primary school students

Importance of the Study

1. Theoretically, the present paper can be benefited in:
 - (a) Determine the skills of creativity, which must be developed for students at primary stage.
 - (b) Develop a teaching strategy derived from successful intelligence that can be applied in mathematics lessons at the primary stage.
2. Practically, the present paper may benefit the following categories:
 - (a) Primary school pupils in: Helping them develop their creativity in mathematics.
 - (b) Mathematics teachers in:
 - The possibility of using a teaching strategy based on successful intelligence that may help them develop their teaching.
 - The possibility of being guided by a questionnaire for the appropriate mathematical creativity skills for students.
 - (c) Curriculum planners:
 - Using the teaching strategy based on successful intelligence in building mathematics curricula at all different stages.
 - Paying attention to include creativity in mathematics through textbook exercises.
 - (d) Researchers: The current research opens the way for other research in the field of mathematics using successful intelligence.

Limitation of the Study

The present paper is limited to :

1. Human limits: primary school students (a sample of fifth grade students).
2. Spatial boundaries: one of the primary schools in the governorate of ...
3. Time limits.
4. Objective limits :
 - (a) Mathematics lessons for primary school students.
 - (b) Develop appropriate mathematical creativity skills for students.

Terms of the Study

- Successful intelligence theory

The Successful intelligence is defined as “the use of an integrated set of abilities necessary to achieve success in life. It is determined by the individual according to his social and cultural situation by recognizing strengths and making maximum use of them. At the same time, he realizes the weaknesses, and looks for ways to correct or compensate for them. The smart individuals succeed in adapting to, shaping and choosing the environment by finding a balance in their use of analytical, creative and practical abilities” [29].

Procedurally, it is defined as a set of analytical, creative and practical activities designed to develop creativity skills in mathematics among primary school students.

- Creativity in mathematics

It refers to a set of performance methods in mathematics characterized by originality, flexibility, fluency and a sense of problems. The criterion for creativity in mathematics is that the response is essentially uneducated and based on educated experiences [26].

It is defined procedurally as the score obtained by the student in the test of creativity skills in mathematics.

3. Creativity in mathematics

It is defined as a mental activity directed to the production and discovery of original solutions to mathematical problems, in addition to the formation of new relationships that go beyond the relationships known to the student in an atypical mathematical situation and at a specific time [14].

It means that the process in which the student becomes sensitive to problems, shortcomings, dissonance, identifying difficulties and missing elements, searching for solutions, making guesses, formulating and testing hypotheses, re-testing them, and then arriving at the results [3].

The Creative thinking is a purposeful mental activity of the highest types of thinking. It includes a new and original addition to the collection of several components in a new construction. So, the creative thinking is characterized by its ability to form connections between the main elements of a problem to reach a creative solution [8].

Torrance in [9] identified the abilities associated with creative thinking. They are as follows

Originality: It means the student's ability to produce rare solutions compared to the ideas presented. In the field of mathematics, it means giving students the opportunity to solve exercises in more than an innovative way and far from ordinary ideas.

Fluency: It means expressing the largest number of ideas in a specific period of time through a specific stimulus. In the field of mathematics, it means giving students the opportunity to innovate, think and summon various ideas through exposure to the subject of the lesson.

Flexibility: It refers to the production of the largest number of ideas. The student is placed in an educational situation that requires him to think from his mental point of view with the development of various possibilities and the selection of each of them until he reaches the possibility that enables him to solve the correct one.

Elaboration Details: It refers to the student's ability to add particles to an idea, and to see problems in tools or social systems that others do not see in them.

The Creative thinking skills combine positivity and strength to put the creative student in an advanced position in terms of his ability to see things, deal with various problems and address situations in a perceptive manner. This is to lead to a unique, innovative and unique solution [7].

The role of the mathematics teacher in developing creativity [4]:

- The mathematics teacher helps to create an effective climate for learning in the classroom in a way that encourages the student to have distinguished and original thought, which is one of the characteristics of the creative personality.
- He does not leave the development of students' abilities to chance, but rather develops them by following the appropriate method and way to address their issues and behaviors.
- The teacher's point of view towards their opinions, suggestions and ideas has a significant impact on arousing their motives towards creativity and thinking.

- Encourages students to play the role of a researcher in learning and teaching mathematics, relying on himself in accessing, analyzing and criticizing information, as well as reaching new relationships [10]:

The Creativity is part of mathematics, fused with mathematics in different ways, including three important ways: (Ali, 2018, 91)[10].

-Abstraction: This method is related to creating models that reflect the real world and life problems which can be solved with mathematical tools known to the student.

- Connection: It means the application of known mathematical tools to new problems. This allows seeing problems from a new perspective which means the occurrence of a connection between mathematical knowledge and other knowledge to understand and solve problems.

-Research: It refers to the discovery of new mathematical tools that correspond to problems that have not been analyzed.

Stages of creative thinking: Graham Wallas [34] identified four stages that the creative process passes through:

1. Preparation stage: Through this stage, the problem or situation is identified, all its aspects are known, compared with similar problems, and the methods of their solutions are reached to benefit from them in producing innovative solutions to the current problem.
2. Incubation stage: in which the student leaves the problem and turns to another activity in order to leave room for ideas to brew in his mind.
3. Illumination stage: It refers to the sudden drop of the idea inside the mind, during which the student gets the solution.
4. Verification stage: It refers to verifying the validity of the production reached by the student in the light of logical facts.

4. The theory of successful intelligence

Among the considerations that contributed to the emergence of successful intelligence, [30, 25]:

- Seeking to get out of the narrow range, on which traditional intelligence theories were built. These theories focus on a small group with high abilities, which qualifies them to obtain higher grades when performing traditional intelligence tests.
- identification of priority processes to shape the intelligence which leads success in life.
- There are no people who are good at everything, or complete failures in their lives, but their diversity in the way they set goals, and try to strive in different ways to reach success is the key.

The structure of the theory of successful intelligence:

Sternberg explained the internal components of the theory of successful intelligence through three aspects of intelligence: intelligence and its relationship to the inner world of the individual, intelligence and the individual's experience, intelligence and the outer world of the individual. He defined these relations in three theories:

A- Synthetic Theory: Componential Sub-theory

The theory considers that intelligence is linked to the internal aspect of the person in the areas of mental processes that lead to intelligent behavior to a lesser or more degree, and the goals are translated into motor outputs. This theory is based on a set of components:

- Beyond Ingredients: Metacomponents

It is a higher control process used to implement monitoring and planning, and it is assumed that the processes beyond the ten most important components of the intelligence function are [17]:

- Acknowledging that there is a problem.
- Knowing the nature of the problem.
- Choosing the minimum set of items to perform the task.
- Defining the strategy for performing the tasks, including the minimum elements.
- Identify mental representations of information.
- Deciding to identify sources of attention.
- Track the occurrence of task performance.
- Evaluate the solution.
- Knowing how to behave in the feedback he receives.
- Completion of work as a result of feedback.
- Performance Components: Performance Components are mental processes lower than the first component and used in implementing various strategies in performing a specific task [5].
- Knowledge Acquisition Components, identified by Sternberg, namely: selective coding, selective aggregation, and selective comparison [5, 25].

B- Experiential Sub theory:

This theory combines experience and intelligence. The best way to measure intelligence depends on the availability of both Novelty, which means: the individual's ability to deal with the new task, and Automatization which means the individual's ability to self-process information (Sternberg & Grigorenko, 2004, 17)[32].

C- Contextual Sub-theory:

Components of intelligence are applied to various levels of experience in order to serve three functions in the everyday context of adaptation, modulation, and selection [17].

5. Components of successful intelligence: [30]

Successful intelligence has three components which are:

A- Analytical Intelligence

It is considered the first component of successful intelligence. It includes conscious guidance of mental processes to find a solution to the problem. It is used for various goals in solving problems aimed at moving from the problem situation to the solution and removing the obstacles facing the person [19].

Some teachers who apply successful intelligence in pedagogy do not use memorization-based instruction alone; Many students may have the desire to learn, but their inability to recall and recall information makes them feel like a failure [12].

However, the skill of analysis is not sufficient. We often need to use our creative skills to find innovative solutions to a problem, and practical skills to identify realistic solutions. Analytical intelligence appears when information processing components are applied to analysis, comparison, evaluation, or judgment. Components that are applied to types of problems which are relatively common are dealt with. relatively common where the judgments that are issued are merely abstract judgments [30].

B- Creative Intelligence

The Creative intelligence is required to formulate good problems and solutions, and is important to think of innovative solutions to seemingly impossible problems [18].

One of the most important capabilities of creative intelligence is the ability of a person to be fluent, that is, to produce the largest number of ideas on a particular topic. Originality means producing new, unconventional solutions and ideas characterized by novelty, uniqueness, and details. This in turn means developing and improving the idea by adding clarifications to it that help to highlight it, and sensitivity to problems. It also means the ability to sense the weaknesses, feel the problems and find creative solutions to them [18].

The Creative abilities are considered a bridge between practical and analytical capabilities. A balance between the three capabilities must be achieved. The individual combines creative ideas, distinguishing scalable ideas from non-developable ideas, evaluating them, and applying creative ideas. The individual may possess analytical and practical capabilities. However, these ideas are far from renewal, so their impact is limited. The Creativity here is related to the individual's ability to move efficiently from traditional ways to non-traditional ways of thinking, and this transition requires a decision or a subjective desire for him [15].

C- Practical Intelligence

It is the daily intelligence in life that depends on the latent knowledge that we acquire through unstructured contact with others. Sternberg identifies three main aspects of this type of intelligence: The first aspect is: adaptation to the environment, which means the individual's attempt to match his abilities and needs with the requirements and characteristics of the environment in which he lives in a particular socio-cultural context. The second aspect is the formation of the environment, i.e. the individual making a change in all or some of the elements of the environment around him instead of submitting to the characteristics and needs of the environment. The third aspect is choice, meaning that the individual chooses a completely new environment [20].

D- Practical abilities and tacit knowledge:

Tacit knowledge is a form of practical intelligence. The student is able to choose, adapt and modify the environment, which reflects his practical ability to learn from experiences close to his position, and apply them to knowledge continuously to achieve goals. Practical intelligence is the individual's ability to perceive tacit knowledge in the environment; and work on translating it into problem solving. This in turn is reflected in the atmosphere surrounding the individual in his dealings with others [30].

General principles on the application of educationally successful intelligence and the role of the teacher and their application in the classroom:

A- Principles of Successful Intelligence Theory [28, 31]:

- Requires a set of competitions that encourage students to participate in analytical, creative and hands-on learning activities.
- The teacher should help all the students to make the best use of their skills by addressing all the students for some time. The teacher must balance the teaching strategies.

- Teaching should include components of knowledge acquisition (selective comparison, selective coding, and selective aggregation).
- Teaching and assessment using successful intelligence help students to know their abilities and work to develop them.

B- The role of the teacher in the teaching process [31].

- Provide numerous examples of concepts covering a wide range of applications.
- Giving students multiple and varied choices in assessment, such as worksheets, projects, and applying what they have learned in daily life.
- Treat students in a way that maintains the integrity of the seminar.
- Helping students take advantage of their strengths and helping them correct weaknesses.
- Students need to learn how to balance adaptation with the formation and selection of environments.
- Students should be encouraged to accept the challenge of risk in order to learn from their mistakes.
- Pupils need to learn how to overcome obstacles.
- The teacher takes into account the individual differences of the students.
- Teaching and assessment must balance the use of creative, analytical and practical thinking.

The student's role in teaching [21]. The role of the pupil is illustrated by some of the characteristics that distinguish students with successful intelligence, which are:

- Intelligent students successfully control their impulses, impulse control, and problem-solving ability.
- They know the time of perseverance: Students with successful intelligence know very well that success comes after frustration and failure.
- Balances practical, analytical and creative intelligence, they know the right time to use analytical, creative and practical thinking.
- Able to focus on achieving goals and working towards achieving them.
Translate thought into action.
- Initiative owners:
- Deferring Reward: Pupils with successful intelligence refuse to reward themselves for small results, but put their abilities and time into great life-changing achievements.

Previous Studies:

Studies dealing with creativity in mathematics:

The study of [6] aimed to identify the level of teaching practices of primary school teachers to develop creativity and learning skills in mathematics. The study used a note card for learning and creativity skills. The sample consisted of 36 teachers. The results of the study reveal that the teaching performance of teachers is of a middle degree in the fields of critical thinking and problems solving skills. While in the axis of communication and cooperation, it was at a low degree. In the axis of creativity and innovation skills, the level of teaching practices was at a low degree. The study concluded that there are no differences between the average scores of mathematics teachers in their teaching practices for the development of learning skills and creativity.

Studies dealing with successful intelligence:

- A study of [1] in the Arabic language, which indicated the effectiveness of the educational program based on successful intelligence in developing the creative, analytical and practical abilities of outstanding students. The study sample consisted of 98 students. The researcher developed the Sternberg test, prepared an educational program and then applied it, then applied Post-testing. The results revealed a significant effect of the educational program in developing creative, analytical and practical skills of the outstanding students for the benefit of the study group.

- The Study of [22] based on successful intelligence. This study found teaching paraphrasing as a complementary skill to the three skills of successful intelligence by reproducing knowledge or formulating it after being well represented. Its results indicated that the application of practical intelligence education came first. Then analytical intelligence, then creative intelligence, followed by teaching paraphrasing or reproduction.

The study [23] aimed to identify the effectiveness of a cognitive acceleration program in developing critical thinking and successful intelligence among fifth grade students. The study sample consisted of 128 students. They were divided into two experimental and control groups. The critical thinking test was applied before. The experimental program was applied to the study sample, then the post application of the test. The results revealed the effectiveness of the training program.

The results of the study of [11] demonstrated the effectiveness of a successful intelligence program based on the Sternberg model, and metacognitive thinking skills in the degree of critical thinking practice among sixth graders.

6. Questionnaire

A questionnaire for creativity skills in mathematics appropriate for primary school students

The skill	The target skill	The extent of the skill's affiliation	The extent of the suitability of the skill
	Suggested modification	Affiliated	Not Affiliated
		Suitable	Inappropriate

Fluency

- 1- Solving non-routine problems.
- 2-Find new ideas that fit the concept of the lesson.
- 3-He remembers some concepts and links them together.
- 4-Produces new, unconventional ideas.
- 5-He comes up with many ideas at a specific time.
- 6-It raises a variety of questions that attract attention.
- 7-He thinks about solving problems in depth and in new and innovative ways.

Authenticity

- 8- Discovering and correcting fallacies
- 9-Discover patterns that relate to what you have learned.

- 10-Reaching a solution to problems in more than one way.
- 11-Reaching mathematical generalizations quickly.
- 12-The ability to divide general problems into sub-problems.
- 13-Understand the problem
- 14-Understand the available alternatives to the solution.
- 15-Choosing the appropriate alternative for the solution.
- 16-He plans well during the conversation and is not random.
- 17-Generates innovative ideas that revolve around the lesson.
- 18-Devise new ideas and information related to the topic.

Flexibility

- 19- The concept is formulated in a new way.
- 20-Solve problems
- 21-Produces new ways to reach the solution.
- 22-Apply what he has learned from knowledge.
- 23-He presents various examples of new concepts in his own style.
- 24-The student diversifies his ideas flexibly.
- 25-Solve exercises and problems freely and flexibly.

Procedures:

Research Methodology: The research followed the quasi-experimental study method (one-group design)

Search tools:

The following tools were used in the research procedures:

1- Experimental processing tools, including:

- Identifying creativity skills in mathematics that are appropriate for students.
- Teacher's guide for teaching mathematics lessons according to the proposed teaching strategy based on successful intelligence to develop students' creativity in mathematics.
- Student's book for teaching mathematics according to the proposed teaching strategy based on successful intelligence to develop students' creativity in mathematics skills.

2-Measuring tools:

A test of students' creativity in mathematics.

Search procedures:

In order to answer the aforementioned questions, the research proceeds with the following procedures:

To answer the first question:

1-What creativity skills in mathematics are appropriate for students?

The researcher followed the following steps:

1-Preparing a questionnaire on creativity skills in mathematics appropriate for students, by reviewing previous studies and research that dealt with creativity in mathematics, and benefiting from their results.

2-Presenting the questionnaire in its initial form to a group of arbitrators who are professors of curricula and methods of teaching mathematics.

To answer the second question:

3-How can a teaching strategy based on successful intelligence be built to develop students' creativity in mathematics skills?

- The researcher prepared a student's book and a teacher's guide prepared according to successful intelligence to develop creativity skills in mathematics for primary school students.

To answer the third question:

4-What is the effectiveness of the teaching strategy based on successful intelligence in developing creativity skills in mathematics for primary school students?

The researcher took the following steps:

- Choosing the research sample (fifth grade primary) that will be studied using the teaching strategy based on the theory of successful intelligence.
- Preparing the creativity test in mathematics.
- Pre-application of the test on the research sample.

Teaching the proposed teaching strategy based on successful intelligence on the research sample.

Applying the test remotely to the research sample.

Data collection and statistical processing.

- Providing recommendations and suggestions in light of the research results.

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