

Using 4MAT Model to Develop First Primary Pupils' Creative Thinking Skills in science

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Abstract

The present study aimed at tackle this problem by investigating the effectiveness of using 4MAT model for developing the preparatory stage pupils' creative thinking skills in science. A test of creative thinking skills in science) was developed. The participants consisted of 89 first-grade preparatory stage pupils who were divided into 49 for the experimental group and 40 for the control group. Two instructional units entitled "Material and its structure as well as energy" included in the first-grade preparatory stage pupils' science book were modified and taught to the experimental group pupils according to 4MAT model. The control group received regular instruction. The findings showed that: There are statistically significant differences at 0.01 between the experimental group pupils mean scores and those of the control group in the post-administration of the creative thinking test as a whole and at each one of its skills, in favour of the experimental group.

Key Words: 4MAT Model – Creative thinking skills- Science instruction, Preparatory School Pupils, Egypt

Introduction and background:

An important aim of education is to develop the pupils' and/or students' thinking skills. They are important as they help pupils in the various educational situations. They enable learners to evaluate others' viewpoints and judging them in an accurate manner. They also enhance the learning process and free their minds from the constraints

of answering difficult questions. Furthermore, they develop the learners' awareness of cooperative learning and its importance (Saada,2011,77).

AL-Demerdash(1997,4) pointed out that developing thinking skills is one of the aims of teaching science in the preparatory stage. This takes place through training pupils on some mental skills such as the ability to make hypotheses, analyze logically, extract information from tables and drawings and conduct some experiments and basic processes; there by contributing to developing their scientific thinking skills as well as creative thinking skills.

According to Ibrahim(2015) and Sener&Tas (2017), developing creative thinking skills among science teachers helps in preparing creative and productive learners who are capable of connecting sciences and daily life, facing the requirements of the current situation and the ability to analyze and interpret information. It also helps in producing several and varied ideas that reflect what goes on in the surrounding environment, increasing their motivation to learn and the ability of understanding the various dimensions of problems, formulating hypotheses and looking for possible solutions.

Taylor(2017) also focused on the importance of developing the learners' creative thinking skills, this is represented in preparing learners to the 21st century skills and motivation them to inquiry and meaningful learning. That is why developing creative thinking skills is considered prerequisite and integral part in any instructional curriculum.

There are several studies conducted on developing creative thinking skills among preparatory stage pupils, Al-

Fadly(2014), for instance, revealed that the environmental inquiry- based activities proved to be effective in developing eighth intermediate pupils` achievement and creative thinking skills. Yehia(2014) revealed that e-science fiction proved to be effective in developing first intermediate pupils` creative thinking skills and motivation to achievement.

Tolba et. Al(2015)proved that SCAMPER strategy is effective in developing preparatory stage pupils` creative thinking skills. Also AL-Hashem (2019) revealed that concept mapping is effective in developing secondary school pupils` creative thinking skills in science . Finally, Salama et.al(2020) proved that e-mind mapping is effective in developing basic ninth grade female students` creative thinking skills in science.

It is evident that the various new strategies used to develop creative thinking skills focused on the learners` active in self acquisition of knowledge. 4MAT model is one of these models that are student- centered. It was introduced by Bernice McCarthy(1987) in light of human development theories of John Dewy, Karl Gang, David Kolb and jan Biaget. It focuses on 4- Mode Application Techniques.

McCarthy depended on David Kolp`s lerning theory of Experimention and identified 4 learning styles. These include the innovative learner, analytic learner, common sense learnerand dynamic learner(McCarthy,1990 and Scott,1994) .

McCarthy identified four stages each of which has two inter- related steps to the right and the left hemispheres and the learners` styles of learning. These four stages include

reflective observation, concept making, active experimentation and concrete experiences (Creative applications).

Several researchers paid more attention to the use of 4MAT model in teaching science in the preparatory stage (e.g. Aktas and Bilgin, 2015; Abdo, 2016; Kashtan, 2016; EL- Adily, 2017; EL- harbi, 2017; Hamam, 2018). This reflects the importance of 4MAT model in teaching science.

However, the status-quo of teaching in the preparatory stage still focuses on the cognitive domain only. Lecturing is still the dominant method in teaching science and the use of non- functional teaching aids. This, in turn, does not contribute to developing thinking skills in general and creative thinking skills in particular, this is supported by El- Fadly, 2014; Tolba et.al, 2015 and Hammam, 20118 that revealed the preparatory stage pupils' poor level in creative thinking skills.

Also, the researcher conducted a pilot study where she administered Torrance's creative test (verbal form A) to 32 1st preparatory pupils at Katamia prep. School for boys and girls, EL- Bagour Administration, Menofia Governorate. The findings revealed that the overall mean score of the test was 16.5 and consequently the standard mean score of the test was 0.8. This reflects the pupils' poor level in creative thinking skills.

Based on what is mentioned above, the current study aimed at developing first year preparatory pupils' creative thinking skills through using 4MAT model.

Statement of the problem

The problem of the study is represented in the weak level of first preparatory pupils in creative thinking skills. That is why the current study investigated the effectiveness of 4MAT model in developing 1st preparatory pupils' creative thinking skills in science.

Significance of the study

The study might be significant to:

- Teachers of science as it provides them with a teachers' guide that's helps teach science according to the 4MAT model.
- Pupils and/ or students studying science as it provides them with worksheets and handouts that help them develop their creative thinking skills via 4MAT model.
- Researchers as it provides them with various of new areas of research in the field of teaching science.

Delimitations of the study

- A group of 89 prep. School pupils selected at random from AL- Katamia and EL- Shaheed Mohammed Samy prep. Schools, EL-Bagour Administration, Menofia Governorate.
- Two units (Material and its structure – Energy) from the prescribed science textbook during the first semester of the academic year 2019/2020.
- Some creative thinking skills including fluency, flexibility and originality.

Instruments and Material

- A test on creative thinking skills in science (prepared by the researcher)
- Pupils' worksheets on the two units.

Hypothesis of the study

The study attempted to verify the following hypothesis

There is a statistically significant difference at 0.01 level between the experimental and the control groups mean scores on the creative thinking post test in favor of the experimental group.

4MAT model and its theoretical underpinings

According to Seker and Ovez (2018), 4MAT model is introduced by Bernice McCarthy(1987) and is based on the blend between Kolb`s model of learning styles and the findings of the two hemispheres researches (Ambosaidi, 2018, 247). It is also based on several teaching strategies that are consistent with learners` characteristics.

The philosophy of 4MAT model is based on the blend between the basic principles of several theories in human development and the human brain functions.so, the main assumption of 4MAT is that" humans learn and develop through the continuous personal modifications and adaptations as they form meaning in their lives, such an assumption is derived from John Dewy,Karl Gang and Kolb`s theories" (McCarthy, German, Lippit,2002,1)

Learning styles according to 4MAT model

McCarthy divided learning styles into 4 according to the methods learners perceive and process information where most learners are engaged using all learning methods where as some prefer one specific method (scott,1994,4) .

According to McCarthy(1990) and Elci,Kilic and Akan(2012), these 4 modes /styles are as follows:

- Imaginative learner: who receives information in a realistic manner and processes it through direct

experience and observation using his/her senses. Such a learner learns better through listening, participation and discussion groups.

- Analytic learner: who receives information in an abstract manner and processes it through reflection, thinking and intensive reading. Such a learner integrates his/her observation and experiences with what he/she wants to learn.
- Common sense learner: who receives information in an abstract manner and processes it in a logical manner. Such a learner connects facts and theories to application and practice
- Dynamic learner: who receives information in a realistic manner and processes it in an active manner through integrating experience with application and employing new knowledge in new situations. Such a learner learns through self- inquiry.

Learning Cycle in 4MAT model

According to McCarthy (2000,1-9), there are eight steps which are as follows:

1- Connect

It aims to make pupils engaged in the learning process and encourage them to connect between knowledge and their personal meaning. The teacher's role is represented in motivating learners and helping them build on their prior knowledge. The teaching method appropriate to learners is discussion.

2- Attend

The teacher's role is represented in monitoring, observing and helping learners to analyze, predict and participate in the various classroom activities.

3- Imagine

It is the step in which the learners moves from mere observation to the abstract concept. The teacher`s role is to teach and build experience through providing knowledge and integrating personal experience in an attempt to help learners acquire concepts and connect what they already know to what is presented by the teacher.

4- Inform

It is the step of forming facts and theories, teaching takes place through the regular and direct methods, the appropriate activities are represented in categorization, comparison, planning and acquiring knowledge.

5- Practice

It is the step in which concepts and new knowledge are applied and practiced, the appropriate activities to be used include exercises, worksheets and practical ones and the teacher has to guide and counsel.

6- Extend

It is the step of integrating experience with self, the learner acts as a discoverer who concentrates on acquiring knowledge by himself/ herself and adding new experiences whereas the teacher`s role in to guide and encourage learners to learn

7- Refine

The learner has to make the responsibility for learning widening and assessing his/her knowledge, the learner has to be able to identify the points of strength (to be enhanced) and points of weaknesses to be remedied.

8- Reform

The learner adapts himself / herself with the new experiences and participates what is learnt with peers, the appropriate activities are represented in creating models and assessing them and the teacher supports the learners' learning and providing them the opportunities to create applications and experiment knowledge in various contexts.

Studies related to using 4MAT model in science

Aiash and Zahran(2013) investigated the effectiveness of 4MAT in developing 6 elementary female pupils' (Girls') achievement and attitudes, the findings revealed that 4MAT is effective in achieving its aim.

In (2016), AL-Kashtan(2016) study aimed at investigating the effectiveness of 4MAT and Generative learning models in the problem solving of science verbal problems among 9th elementary girls, , the findings revealed that there are statistically significant differences between the two experimental groups` (1,2) and the control group in favor of the two experimental groups.

Finally, Hammam(2018) investigated the effectiveness of McCarthy's model in developing 2nd year prep. Pupils' scientific concepts and reflective thinking, the findings revealed that McCarthy's model proved to be effective in achieving the aim of the study.

Creative thinking: definition and skills

Creativity is one of the 21st century skills. Also, it is one of higher- order thinking skills(HOTS). Creative thinking is one of the skills ought to be developed by learners in general, and preparatory school pupils in particular.

Creative thinking is the type of thinking that is concerned with generating ideas and products characterized by novelty, originality, flexibility, fluency, sensitivity to problems and providing genuine solutions to problems (Zaiton, 2006).

He identified some skills of creative thinking that include fluency, flexibility, originality and problem sensitivity. They are as follows:

- Fluency: which refers to the ability of producing a great number of creative ideas at a specific time provided that such ideas should be appropriate to the subject under thinking.
- Flexibility: which refers to 'generating various ideas for solving a certain problem or changing the viewpoint concerning that problem and viewing it from several perspectives' (Awing and Ramly, 2008, 336).
- Originality: which according to (Awing and Ramly, 2008, 336), refers to "the ability to produce new, unexpected and unfamiliar ideas, and the more the idea is not common and less used the more original it is."

Teaching science and developing creative thinking skills

Al-Baaly (2010, 178) pointed out that curricula of science can effectively contribute to developing the learners' creative thinking skills. This can take place through using some strategies and creative activities in the form of scientific problems that challenge the learners' mental potentials providing them the opportunities to propose the appropriate solutions. They can also practice inquiry and discovery and develop their abilities of observation and introducing new ideas and viewpoints.

To help learners develop creative thinking skills, Ramadan(2010) and Ahmed(2012) proposed that teachers should:

- Use various methods of teaching that arouse pupils` thinking.
- Encourage pupils` divergent thinking that makes them view a certain topic from several perespectives.
- Ask questions that stimulate pupils` thinking about a certain topic.
- Encourage pupils to find out new solutions or alternative ideas through asking open- ended questions.
- Connect between previous and new information.
- Encourage good thinking through group work and cooperative learning.
- Teach courses that develop learners` discovery, imagination, research and experimentation.

Studies related to developing creative thinking skills in science

AL-Wesimi(2013) investigated the effectiveness of Marzano`s learning dimensions model in developing first prep. Pupils` achievement, creative thinking skills and motivation to learn. The findings revealed that the experimental group pupils outperformed the control group ones in achievement, creative thinking skills and motivation.

Also, Centinkaya(2014) investigated that effect of creative problem solving on developing talented prep. Pupils` creative thinking. The findings revealed that there are statistically significant differences between the experimental and the control groups` mean scores on

Torrance's creative thinking test in favor of the experimental

Furthermore, Al-Hashem(2019) revealed that concept maps proved to be effective in developing secondary school pupils' creative thinking skills. In 2020, Salama, Barghouth and Darwish proved that mind mapping is effective in developing ninth grade female students' creative thinking skills.

Procedures of the study

- Preparing worksheets on "Matter and its structure " and "Energy" units.

The worksheets on such two units were adapted and prepared according to 4MAT model where they were divided into 14 topics taught to pupils throughout 17 classes(periods), the same as scheduled by MOE plan. The worksheets included the following:

- Inquisitive scientific activities to help pupils acquire knowledge and apply it to subsequent situations.
 - Questions, thought- provoking queries and brainstorming.
 - Questions and situations that aim at training pupils on creative thinking skills.
 - Using varied assessment techniques that include MCQs, open-ended Questions and life-related problems.
 - While preparing such worksheets, clarity, appropriateness and variety of Questions were all considered.
- Preparing the teacher's guide according to 4MAT model. It was prepared to guide teachers and help them

teach such two units effectively. It contained an introduction, general directives for teachers, time plan, general aims of the two units and references.

- Preparing a creative thinking skills test
- The test was prepared according to the following:
 - Aim of the test was to develop 1st prep. Pupils' creative thinking skills through using 4MAT model.
 - Constructing the test in the form of open-ended questions considering clarity, simple language that is understandable, language accuracy and comprehensiveness.

The following table(1) shows the specifications of the creative thinking skills test in science.

Table(1) specifications of the creative thinking skills test in science.

Skill	Questions	Score	No.	Overall score
Fluency	1,2,3,4,5	5	5	25
Flexibility	6,7,8,9,10	5	5	25
Originality	11,12,13,14,15	5	5	25
Total	_____	_____	15	75

Validity of the test

The validity of the test was established by a panel of jury members and experts in science teaching who provided some modifications. Having done such modifications, the test became valid. Also, content validity was calculated through computing the correlation co-efficient between the score of each item(in each skill) and the overall score of the skill each item belongs to. Correlation coefficient was significant at 0.01 level.

In addition, discriminative validity was calculated there were statistically significant differences at 0.01 level between the high level group and the low level one reflecting that the test had a high degree of discriminative validity.

Reliability of the test

The reliability of the test was established by using ALpha Cronbach and pearson correlation coefficients (Test- Retest). The value of pearson correlation co-efficient was significant at 0.05 level. This reflects that the test was highly reliable.

Piloting the test

Piloting the test aimed at ensuring clarity, readability and computing test time. Using EL-Sayed's equation (2014,476), it was estimated that the test time is 45, in addition to 5 minutes for reading test directives. So, the allocated time is 50 minutes.

Treatment

a- Participants of the study

The participants of the study included 89 first preparatory pupils in AL-Kamia school, AL-Bagour, Menofia governorate. They were divided into an experimental group (n= 49) taught through 4MAT model and a control group (n=40) who received regular instruction.

b- Pre- testing

Both groups were pretested with the aim of establishing equivalence in their entry level before treatment. Using Spss program revealed that there were no statistically

significant level between the two groups before treatment where t was 1,10

c- Post testing

By the end of treatment, both groups were posttested to reveal the effect of 4MAT on developing first prep. Pupils' creative thinking skills. Data were treated statistically and the findings were interpreted.

Results and Discussion

To verify the study hypothesis, t was calculated to reveal the differences between the two groups' mean scores before and after treatment. See table (2)

Table(2) t value of the differences between both groups on creative thinking skills test

Skill	Group	N.	M.	S.D.	t	sig	D.F.	η^2
Fluency	Exp.	49	4,76	4,01	13,024	0,01	87	0,661
	Control	40	5,96	1,62				
Flexibility	Exp.	49	6,31	4,17	7,162	0,01	87	0,371
	Control	40	1,48	0,99				
Originality	Exp.	49	8,02	5,14	5,942	0,01	87	0,289
	Control	40	2,53	3,08				
Overall	Exp.	49	29,08	12,33	9,311	0,01	87	0,499
	Control	40	9,96	4,49				

Table (2) reveals that there is a statistically significant difference at 0.01 level between the exp. And the control groups` mean scores on creative thinking skills posttest in favor of the experimental group; therefore, the study hypothesis was supported.

- Eta- squared (η^2) ranged between 0,289 and 0,661 reflecting that there is high effect(0,289 – 0,661) of 4MAT model on developing 1st prep. Pupils` creative thinking skills.
- Effect size ($=0,661$) was high reflecting the fact that teaching through 4MAT model had a very high effect on developing 1st year prep. Pupils` creative thinking skills.

Such a finding is due to the following:

- Providing the opportunities for learners to learn and think. 4MAT model helps learners to be responsible for their learning and are the center and at the heart of the learning process.
- 4MAT model focuses on encouraging discussion, accepting others` ideas and viewpoints and practicing activities.
- Continuous encouragement to the learners` ideas and questions and practicing activities increased their motivation and confidence.
- The worksheets and the various activities practiced by pupils helped them connect ideas and meaningfully learn concepts and use them in real- life like situations.

Recommendations:

- Paying more attention to the recent methods of teaching that are student- centered where students are active

participants not passive ones relying on conventional methods.

- Reconsidering science curricula in which thinking skills should be integrated.
- Paying more attention to the pupils` learning styles and using activities that rely on the two hemispheres.

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