

Using the thinking stations strategy for developing Faculty of Education female students' creativity and scientific concepts

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Abstract

The study aimed to identify the effectiveness of the thinking stations strategy in the development of creativity and scientific concepts for faculty of Education female students and Disclosure of the relationship between creativity and the scientific concepts. In order to achieve the objectives of the study, the working papers were prepared according to the strategy of thinking stations and the test of creativity and the test of scientific concepts related to the energy unit of the Integrated Science course was built. The study sample consisted of 33 female students from the 3rd level of the faculty of Education/Children's Department /Menoufia University. The one group pre-test and post-test research design was used .The results show that thinking stations strategy has a positive effect on the development of creativity and scientific concepts of the female students and there is no correlation between creativity and the development of scientific concepts

Keywords: thinking stations strategy, creativity, scientific concepts.

1. Introduction

Creativity has become increasingly important, as one of the most important and notable skills for success in the 21st century (Henriksen, Mishra &Fisser, 2016). All sciences, arts and human civilizations are products of creativity (Aiamy&Haghani, 2012).

Previous studies proved the positive effects of creativity on achieving some educational goals (Al-Bau'l, 2012; Mokhtar, 2016; Matroni, 2018).

Torrance describes creativity as sensing difficulties, problems, gaps in information, missing elements, something askew; making guesses and formulating hypothesis; possibly revising and retesting them; and finally communicating the results” (Torrance, 1988).

Plucker, Beghetto& Dow (2004) have defined creativity as the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social group.

Creativity, in general, has been defined as the skill of generating new ideas or creating original and valued products (Rábanos & Torres, 2012)

The main creativity abilities can be illustrated as follows: Fluency refers to the ability to produce a large number of ideas at a specific time; flexibility is the ability to generate various ideas or thinking indifferent directions; originality refers to the ability to generate a novel and unique or statistically infrequent ideas; elaboration is the ability to add details to ideas.

Due to the importance of creativity, many studies have been concerned with its development through various strategies such as study of Aiamy & Haghani (2012). It showed the effectiveness of synectics and brainstorming for development of creative thinking. Nurdin & Setiawan (2015)

improved students' cognitive abilities and creative thinking skills on temperature and heat concepts through an Exelearning-Assisted Problem Based Learning. Malik et al (2017) concludes that application of HOT Lab design is effective to increase creative thinking skills for pre-service physics teachers in the lesson of electric circuit. Sandika &Fitrihidajati (2018) found positively remarkable effects of web-based creative thinking teaching on creativity. Supriyanti & Halimatul (2018) indicated that guided inquiry supplemented with material local-based experiment (LMBE) approach support students to acquire scientific inquiry skills and fosters creative thinking skill by innovating the local material chemicals. Al-Zahrani &Al Arabi (2018) demonstrated the positive impact of the cloud computing environment on the development of creative thinking .Al- Ghashm & Al Hammadi (2018) showed the positive effect of virtual labs technology in the development of creative thinking.

Although the development of creativity is important, traditional educational practices do not reflect this and focus on the preservation of information which hinders the development of creativity. So, the researcher proposes a new strategy that can contribute to the development of creativity, called thinking stations, in which students are allowed to roam on several stations: reflection station, analysis station, imagination station, critical station, and finally the innovative station.

Every station is provided with educational materials and student working papers to solve some tasks. that may contribute to the development of creativity.

Teaching strategies should not focus on a particular type of thinking, as each type contributes in solving problems and forming integrative thought. This highlights the importance of strategy of the thinking stations that promote different types of thinking.

The strategy of the thinking stations is based on the constructivism theory; on the following principles:

- Diversity in tasks raises different types of thinking.
- Learners construct their own learning experiences by thinking.
- Previous experiences are necessary to explain new experiences.
- Collaboration increases the production of ideas.
- Preferably presented tasks challenge the abilities of students to stimulate their thinking.
- Providing the opportunity for imagination is necessary to develop thinking and creativity.
- Attention should be given to the processes of thinking not the result of thinking.

Teaching using the thinking stations strategy goes through the following steps:

- The teacher uses warm-up activities and clarifies the lesson objectives
- The teacher Divides learners into five groups. each group includes (5-7) learners.
- The teacher Determines the time each group takes to perform the required task from each station.
- The teacher invites groups to roam on several stations alternately.
- The learners perform the tasks of each station and solve the work papers.
- Learners in each group discuss after performing the task at each station.
- The teacher starts to discuss the learners after roaming all groups on all stations.
- The teacher evaluates learners and providing feedback.

The researcher believes that the strategy of thinking stations can contribute to:

- Emphasizing the active role of the learner.
- Giving an atmosphere of pleasure and change in learning experiences.
- Developing the different types of thinking.
- Diversification of educational experiences.
- Improving students 'social skills.

- Promoting positive trends towards science.
- Overcoming the disadvantages of traditional methods of teaching.
- Increasing student motivation to learn.
- Overcoming the problem of lack of materials and tools.

Creativity should be promoted in the university, and scientific concepts should be also improved during the learning process.

Some of the previous studies focused on the development of scientific concepts using different strategies among students of faculty of education (Al-Bazzaz, 2003; Mohammed, 2018)

Scientific concepts are necessary for creativity, where the students can rephrase them, produce new and unique ideas, and recognize the missing elements from it. So the current study seeks to development these concepts among female students of faculty of education.

Female students are the future teachers responsible for the development of creativity and scientific concepts among their pupils.

2. Study Problem

Creativity is necessary for science, technology, and art that encompass everyday life (Runco, 2014). Despite the importance of creativity, educational systems, at all levels, are still lacking in sufficient development of their skills and depend on traditional teaching methods that are concerned with memorizing information without understanding.

The researcher noticed the weakness of the ability of creativity among female students of the faculty of education when teaching the integrated science course. The stereotype of the response and the inability to generate new responses were noted, too. To confirm these observations, the researcher conducted a pilot study aimed at determining the level of creativity for female students of the 3rd level of the faculty of education/children's department. The results indicated their low level.

Some studies indicated that the level of creative abilities were in low or medium level among students (Awamleh, Al Farah& El-Zraigat 2012; Turkey, 2018)

The researcher also conducted another pilot study aimed at determining the level of scientific concepts of the energy unit of the same female students, and the results indicated their low level

In light of the above, the problem of study is determined by the low level of creativity and scientific concepts among female students of the faculty of education and the inadequacy of traditional teaching methods in their development. To address this problem, the current study tries to use the thinking stations strategy to enable their development. The problem of this study is to answer the following questions:

1. What is the effectiveness of the thinking stations strategy in the development of creativity among female students in the faculty of education?
2. What is the effectiveness of the thinking stations strategy in the development of scientific concepts among female students of the faculty of education?
3. Is there a relationship between the creativity and the scientific concepts of the faculty of education female students?

3. Study hypothesis

The hypotheses of study could be listed as follows:

H1: Thinking stations strategy would positively affect development of creativity.

H2: Thinking stations strategy would positively affect development of scientific concepts.

H3: There is a positive correlation between creativity and scientific concepts.

4. Study objectives

The objectives of the study are as follows:

1. Determining the effectiveness of the thinking stations strategy in the development of creativity of the students of the Faculty of Education.
2. Determining the effectiveness of the thinking stations strategy in the development of scientific concepts among the students of the Faculty of Education
3. Disclosure of the relationship between creativity and the scientific concepts of the Faculty of Education students

5. Study Importance

The study is expected to:

- Present a new strategy that can be used to develop creativity and promote the scientific concepts.
- Direct the attention of those responsible for university education to the importance of developing the creative skills of the students of the Faculty of Education.
- Provide procedural lessons from the integrated science course using the thinking stations strategy.
- Open the field for other research aimed at developing the thinking stations strategy.

6. Method

6.1 Research Design

This study has used one group pre-test and post-test research design.

6.2 Participants

The study participants were undergraduate female students (N = 33) of the 3rd level of the faculty of Education/Children's Department /Menoufia University, Egypt during the second semester of 2019. The mean age of the female students was 21.2 ranging from 20 to 23.

6.3 Materials and tools

6.3.1 Working papers

The working papers were constructed to help female students to study the energy unit using the thinking stations strategy. To confirm validity and suitability, the working papers were presented to a group of experts. Then, a pilot study was conducted on 18 female students of 3rd Division of the Faculty of Education, Menoufia University/ children's department. In a final form each lesson had five working papers as follows:

1) *The working paper of the Imagination station*

It includes a number of tasks that require each female student to unleash their imagination and go beyond the reality of imagining themselves a part of a tool, or imagining the implications that can occur based on the occurrence of a hypothetical situation, etc. Thus, the female student can access new relationships, composing images and giving new interpretations and perceptions of old things.

2) *Working paper for the analysis station*

It contains some tasks that require analysis of the text to key and sub-ideas, or understanding the relationship between the part and all, determining the cause, the result, the comparison and other tasks in which the female student exercises analytical skills.

3) *Working paper for the reflection station*

It includes tasks that require reflection, careful observation and insight, disclosure of inaccuracies and the suggestion of some solutions and other tasks in which the student exercises reflection thinking skills.

4) *Critical station working paper*

It focuses on tasks such as correcting attitudes and things, identifying strengths and weaknesses, developing assumptions, scrutinizing evidence and reasoning, and other tasks in which female students exercise the skills of critical thinking.

5) *Innovative station working paper*

It depends on a number of tasks, such as merging tools, reversing ideas, and connecting different things to reach all new things.

6.3.2 Creativity Test

The abilities measured by the test were defined in fluency, flexibility and originality. The test was built from five parts: Consequences, Unusual Uses, and Improvement, Asking questions and Proposals, each of which included three open-ended questions. Then, the researcher presented the test to a group of experts whose suggestions have been taken. The pilot study was conducted on 18 female students. The reliability of the test was calculated using the equation of Kuder & Richardson, and the persistence coefficient was 0.71. This indicated that the test had reasonable reliability. Also, the internal consistency coefficients were calculated by finding the Pearson coefficient between the scores for each ability of creativity and the total scores. Coefficients ranged from 0.59 to 0.74, and all coefficients were statistically significant at the level 0.01 indicating that the test is valid and applicable.

6.3.3 Scientific Concepts Test

The researcher constructed the test in energy unit of 35 items to measure the levels of knowledge, understanding and application. Then, many experts seek validity of the test, while the pilot study was conducted on 18 female students. The discrimination coefficient was calculated for each item and ranged from 0.27-0.82. Also, the coefficient of difficulty was calculated and ranged from 0.31-0.80. The reliability of the test was calculated using the equation of Cranach's Alpha, and the persistence coefficient was 0.79.

6.4 Procedures

First, the researcher clarified a purpose of the study and procedures of applying the thinking stations strategy to participants. Pretest was conducted. Then, female students were allowed to study energy unit using the strategy with the supervision and guidance of the researcher for 8 weeks. Finally, post-test was conducted. Data of creativity test and scientific concepts test were analyzed by T-Test, and the value of effect size was calculated

7. Results

7.1 Results related to Hypothesis 1

To test Hypothesis 1, the researcher analyzed the data of female students' performance in the pre-post creativity test using T test, and calculated the Value of ETA squared (η^2) to determine the value of effect size. The following Table 1 summarizes the results:

Table 1

T-test means scores between pre-post creativity test and value of effect size

Measurement	N	Mean	S.D.	T	Level	(η^2)	size effect
Pre-test	33	68.57	23.98	14.96	Sig. at level 0.01	0.87	5.17
Post-test		157.45	32.67				

Table 1 show that the value "T" equals 14.69 and is statistically significance at level 0.01. The value of effect size equals 5.17 (more than 0. 8). This shows that the effect size of the thinking stations strategy is large on creativity. Therefore, Hypothesis 1 was accepted.

7.2 Results related to Hypothesis 2

To test Hypothesis 2, the researcher analyzed the data of female students' performance in the pre-post Scientific Concepts test using T test, and calculated the Value of ETA squared (η^2) to determine the value of effect size. The following Table 2 summarizes the results:

Table2

T-test Means scores between pre-post Scientific Concepts test, and value of effect size

Measurement	N	Mean	S.D.	T	Level	(η^2)	size effect
Pre-test	33	16.79	2.90	5.87	Sig. at level 0.01	0.27	1.22
Post-test		21.00	2.00				

Table 2 shows that the value "T" equals 5.87 and is statistically significant at level 0.01. The value of effect size equals 1.22 (more than 0. 8) showing that the effect size of the thinking stations strategy is large on scientific concepts. Therefore, Hypothesis 2 was accepted.

7.3 Results related to Hypothesis 3

To test Hypothesis 3 the researcher calculated the Spearman coefficient between the score of the participants post creativity test and post scientific concepts test. The correlation coefficient is 0, 31 which were not statistically significant, these show no correlation between creativity and scientific concepts. Therefore, Hypothesis 3 was rejected.

8. Discussion

- The results indicate that thinking stations strategy has a positive effect on the development of creativity, may be due to the contribution of the different stations in the development of creativity as follows:
 - The Imagination station is designed to encourage the student to practice imaginative thinking skills such as: the skill of organizing new relationships of previous components and configuring mental images. It can be useful in rebuilding previous experiences and mental images in a new format, giving new interpretations and perceptions of old things, and helping in the multiplicity and diversity of visions. Ibrahim & Osama (2016) confirm the effectiveness of imagination on understanding scientific concepts and developing the creative thinking skills among the educational sciences and faculty of arts students.

- The analysis station requires the practice of analytical thinking skills such as: understanding the relationship of all to the part, defining the cause and the result, comparison, guessing, leading to the development of the ability to perceive the problem and the clairvoyance of different dimensions, increasing sensitivity to it. These are necessary conditions for creativity to begin, and help to develop the skill of improvement. Amer (2007) pointed to the importance of analytical thinking for the creative solution of the problem in all its types, where it is considered the fundamental phase of its stages.
- Reflection station provides the opportunity to practice reflection thinking skills such as visual vision, disclosure of inaccuracies and the development of proposed solutions. This leads to developing the abilities of female students to observe accurately, reorganize the familiar elements, generate new solutions to problem, add novel meanings and attention to detail. In this regard Abu Sbeih's study (2014) showed the positive impact of training using reflection thinking in developing the skills of the solution creative problems
- The critical station, in which the female student is trained in critical thinking skills; such as evaluation, interpretation, knowledge of assumptions, helps the student to assess the current situation and realize deficiencies and defects. This is an essential step so that creativity starts, and critical thinking is necessary to assess and improve on innovative product. Ulger's study (2016) proved the significant positive correlation between creative thinking and critical thinking skills of university students. This is an indication of the importance of the critical station in the development of creativity.
- In innovative station, the female student depends on the skills of divergent thinking in proposing the new ideas to develop the current things and think about different directions to improve them. AL-Tarawneh's study (2011) indicates the importance of training on divergent thinking in developing creativity.

In addition, the female students also collaborate in solving the tasks of the stations, leading to multiple visions and the generation of diverse and new ideas. Results of previous studies reinforce the results of this study. Kashmer (2018) showed the positive impact of the use of the cooperative learning strategy in the development of creative thinking

- Results indicate that thinking station strategy has a positive effect on the development of scientific concepts. This may be due to the following factors:
 - The thinking stations strategy is based on the Constructivism theory, so all the tasks of the stations are concentrating on the learners and their activity in the acquisition of concepts correctly. This theory affirms that the experiences should be meaningful for the learners, which will help them to interpret the concepts and scientific phenomena. Many studies have shown the effectiveness of instructional strategies based on Constructivism theory in the development of scientific concepts like Daoud(2011),AL-Dololy (2013),
 - The collaboration of students in solving station tasks may lead to the integration of experiences, the availability of sufficient information about phenomena and the perception of the different dimensions of the concepts.
 - Some stations, such as the analysis station, can help in understanding complex concepts and increase the ability of female students to categorize and compare.
 - Innovative and imagination stations may increase the ability of learners to apply concepts in new situations.
 - The diversity of stations may contribute to a multiplicity of experiences and thus a better understanding of concepts.

- The strategy of thinking stations increases the student motivation to learning. It changes the study routine and makes learning more enjoyable.
- Students discover and construct their own concepts. This helps in remembering scientific concepts, and understanding them more deeply.
- The results show that there is no correlation between creativity and the development of scientific concepts, which can be explained as follows:
 - The learner who cares about the achievement of scientific concepts does not have enough time for creativity, as all his time is spent remembering and memorizing concepts.
 - The creative person looks at things in a new way that may not conform to the realistic view. Therefore, he or she misses the answer to the achievement tests.
 - The creative student may not have the ability to remember. Therefore, he achieves less in tests.
 - The creative person is interested more about the originality of the idea than being scientifically correct. Therefore, he fails in achievement tests.

This finding agrees with many studies like Balgiu & Adîr (2014), Bilal (2015), Faisal (2018)

9. Conclusion

Results reveal that thinking stations strategy promotes creativity and scientific concepts development. Teaching strategies should not focus on a particular type of thinking, as each type contributes, in some way, to enabling the individual to succeed in his life. The university should play an essential role in supporting students' development of creativity.

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