

## **The divergent thinking skills of secondary school students**

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### **Abstract**

The current research aims to know the extent to which secondary school students possess divergent thinking skills in chemistry, and to achieve the goal of the research, the descriptive approach was used. Divergent thinking consisting of (24) objective items, the validity and reliability of the tool were verified. The research was applied to the basic sample in the first semester of the year (2020-2021), and the results showed using the t-test for one sample and two independent samples and the Pearson correlation coefficient the following:

- 1- There is a significant decrease in the divergent thinking skills of fifth grade students in biological sciences in chemistry, except for the skill of improvements.
- 2- The existence of a difference in favor of the students in the divergent thinking skills.

In light of the findings of the research, a set of conclusions, recommendations and suggestions were presented, including:

- 1- Preparing training programs to develop teachers' divergent thinking abilities through the use of some strategies and asking questions that develop this type of skills, which helps achieve positive results.
- 2- Benefiting from research tests in future studies to reveal the level of divergent thinking among learners.
- 3- Interest in developing divergent thinking skills through science and chemistry curricula at all stages by including some activities and tasks that develop those skills.

**Keywords:** divergent thinking skills, secondary school students.

### **Research problem:**

There is no doubt that we live today in a world full of challenges and rapid developments, which imposes on those in charge of the educational process a great

responsibility in how to help learners adapt to those challenges and developments. An inspiring teacher in the way he teaches and the way he teaches, education in general is no longer just transferring scientific knowledge from the teacher to the students, but the main task is to teach students how to think, not how to memorize the study material without understanding and realizing it, which requires the student to possess thinking skills, but The current indicators indicate that our students still suffer from the problem of understanding chemistry and linking its components. Among its components, in addition, each student has a specific style of thinking and a special style in dealing with the information provided to them, and based on that, in order for the two researchers to verify the extent to which High school students (fifth grade bioscience) demonstrated divergent thinking skills from chemistry, and directed a questionnaire to teachers of chemistry, which included the following two questions:

Q1/ Do secondary school students use divergent thinking skills during the lesson?

Q2/ Do students have divergent thinking skills when studying chemistry?

In light of the teachers' responses and their analysis, it was found that:

1- 56% of the answers of chemistry teachers confirm that their students use divergent thinking skills during the lesson.

2- 68% of the chemistry teachers' answers that they raise questions that contribute to stimulating thinking skills in general, and that each student has a specific style of thinking.

Accordingly, the two researchers decided to conduct a research to verify the extent to which students possess divergent thinking skills, so the problem of the current research is determined by answering the following question:

Do secondary school students have divergent thinking skills in chemistry? Is there a difference between (males and females) in their possession of these skills?

### **The importance of research**

The importance of the research is manifested in the following:

1- The research is a modest addition to Iraqi and Arab studies in the field of methods of teaching science in general and in the specialization of methods of teaching chemistry in particular, as it aims to know the extent to which high school

students possess a form of thinking, which is the branched thinking that has a great importance in solving problems.

2- Directing the attention of chemistry teachers to the importance of achieving goals, including developing divergent thinking skills through teaching chemistry.

3- It provides a test in divergent thinking, which helps those in charge of chemistry curricula to benefit from it.

4- The research is consistent with modern educational trends that call for attention to thinking patterns and skills.

**Research Objectives: The current research aims to:**

To identify the extent to which secondary school students possess divergent thinking skills?

To achieve the aim of the research, the following questions were formulated:

1- Do fifth-grade biological science students possess divergent thinking skills?

2- Is there a difference between male and female students in their possession of divergent thinking skills?

**Research limits:** The current research is limited to:

1- A sample of secondary school students for the fifth grade of biological sciences in the Rusafa Education Directorates (1, 2, 3) in government schools (morning) in Baghdad governorate.

2- The first semester of the academic year (2020-2021).

3- The first four chapters of the chemistry textbook for the fifth grade of biological sciences (for the year 2019-2020/ the ninth year) Ministry of Education Republic of Iraq

4- Divergent thinking skills, including (synthesis and composition, realization of new relationships, reclassification, the skill of making improvements and providing new visions).

**Research Hypotheses:** To achieve the research objectives, the following null hypotheses were formulated:

1- There is no statistically significant difference at the level of significance (0.05) between the average real and hypothetical performance of secondary school students in the divergent thinking skills test.

2- There is no statistically significant difference at the significance level (0.05) between the mean scores of male and female students in divergent thinking skills.

### **Define terms. It includes all of the following:**

1. Divergent thinking skills: define them:

Al-Amoudi (2016) defines it as: “That style of thinking that is based on mental processes that help the student’s mind to launch in manifold directions and is inferred by the ability to synthesize, compose, perceive relationships, multiply different visions, produce more than one solution to scientific problems and issues, and issue divergent answers in course topics. Chemistry, and it can be measured in the student’s score in the divergent thinking test prepared for this”

(Al-Amoudi, 2016: 524).

The two researchers adopted the theoretical definition (Al-Amoudi, 2016) as it is consistent with the requirements of the current research.

### **Divergent thinking is defined operationally:**

It is that skill that makes students practice mental operations, which helps them to launch in several manifold directions, and this is evidenced by their ability to (structure, compose, realize relationships, multiple visions, and suggest improvements) in the topics of the chemistry course for the fifth grade of biological sciences, and it can be measured by the degree that he obtains. The student in the divergent thinking test that I prepared for that.

2. Secondary stage students: They are the fifth grade biological science students, which are included in the secondary stage.

### **Theoretical framework and previous studies**

First, the theoretical framework

#### **1- Divergent thinking:**

Divergent thinking helps to create new connections between neurons that allow it to walk through new paths that it was not taking before and in a way that helps the mind in providing a new possibility to create more brain work and what leads it to

work in a better possibility, faster and with higher efficiency, and it is also a cognitive process. It allows a number of responses to one question, which leads to the production of unfamiliar ideas for a problem, and the production of these responses increases the possibility of arriving at a new and original idea, so a process that opens the individual's imagination to many possible research, connections and efforts, as the greater the individual's ability to reach a wider range of connections and connections the greater his ability to solve problems (Omran, 2005: 8–9).

(Ali, 2009) said that divergent thinking is one of the patterns of thinking that makes the task of teaching and learning an open, dynamic, constantly changing and forming system that links new information with the student's previous cognitive structures so that it leads to meaningful learning (Ali, 2009: 71).

### **1-1- The importance of divergent thinking in teaching**

When the learner pursues divergent thinking, he deals with problems in a way that is different from other types of thinking in order to find a solution to the problem that requires more than one solution, since the owner of this type of thinking has the ability to generate the largest possible number of creative and non-typical responses and solutions to any problem he faces, and this requires providing a safe environment rich in stimuli and activities that stimulate thought so that the learner can release his potential energies (Jad Al-Haq, 2017: 72), and divergent thinking helps lead the mind to create new connections and convergences between nerve cells, and thus their ability to perceive the relationships between different ideas and develop a lot will increase. Of the mental skills they have, such as the ability to synthesize, compose, reclassify, make improvements and provide new insights, which increases their motivation towards learning and enriches the potential of their human mind (Shehata, 2013: 188).

Therefore, the development of divergent thinking is of great importance in teaching as it helps students to do research and discovery to overcome the problems they face and helps them to form a comprehensive vision of the dimensions of the problem (Al-Marwani, 2020:40).

### **1-2- Objectives of divergent thinking:**

- Records the student's ability to perceive and discover multiple solutions to any of the questions.

Recording the teacher's ability to perceive to formulate or design questions.

- Reaching a level of conviction and reassurance by addressing unconventional responses.

Developing the ability to perceive the direction of focusing the activity and finding possible variables within the topic.

- Develop the student's ability to verify solutions and organize them for special purposes.

(Al-Hilfi, 2020 : 95)

### **1-3- Divergent thinking skills used in the research:**

The educators emphasized that training students to use divergent thinking skills and educational applications of the human brain has become a necessity and a major goal for the success of the learning process and the creation of a new generation of thinking students who are able to deal with a high degree of success with a high-tech society, and this requires providing them with different learning skills and the inclusion of different curricula With a lot of divergent thinking skills in various academic subjects, and in science in particular, and for different educational stages (Al-Anzi and Sahlouli, 2016: 548)

**Table (1)**  
**Divergent thinking skills used in research**

Skill	the definition
Composition and authoring	It means the student's ability to assemble the elements and parts and link them together to form a new pattern or structure that did not exist in the past.
Realizing new relationships	It means the student's ability to find new relationships between objects or elements.
Reclassification	It means the student's ability to regroup things that have the same properties in one group.
Make improvements and provide new insights	It means the student's ability to introduce modifications, additions, or suggestions by presenting new creative visions and ideas that contribute to solving the problems at hand.

(Marwani, 2020: 39)

### **Second: Previous studies dealing with divergent thinking:**

1- Rabari's study (2011): It aimed to "discover the correlation between divergent thinking, project work, creative attitudes, critical thinking, originality, and interaction with games and scientific materials. The results showed a significant correlation between students' scores in divergent thinking, creative attitudes,

critical thinking and interaction. With games, scientific materials and originality, the study was conducted in (Indonesia).

2- Hendawy's study, Imad Muhammad (2018): It aimed to "know the effectiveness of the scamper strategy in developing divergent thinking and science fiction skills in science for middle school students." The results of the study resulted in the effectiveness of the scamper strategy in developing divergent thinking and science fiction skills. in Egypt).

### **Research Methodology and Procedures:**

The descriptive research approach has been adopted because it represents one of the appropriate scientific research methods, as this method describes and identifies the facts related to the phenomenon under study or the current situation, and it does not stop at describing the phenomenon only, but rather explains and analyzes that phenomenon to reach meaningful evaluations, and it is one of the most The most widely used and widely used curricula (Awda and Fathi, 1987: 99).

### **Research community:**

The current research community consists of fifth-grade bioscientific students in secondary and preparatory schools affiliated with the Baghdad Education Directorates, Al-Rusafa/first, second and third, whose number is 16034, except for secondary school students (evening studies), whose number is (4000) male and female students.

### **Research sample: The research samples include the following:**

1- Primary exploratory sample: The initial exploratory sample consisted of 40 male and female students (20) males and (20) females from Abdullah bin Rawahah High School for Boys and Al-Kawthar High School for Girls affiliated to the Baghdad Education Directorate Rusafa First. This sample was used to determine the clarity of the paragraphs and the time taken to answer the questions. test items.

2- The sample of statistical analysis: It consisted of (200) male and female students. The sample was calculated according to the opinion of (Nunnally)\* at the rate of (7) individuals for each paragraph. The sample was taken from (6 schools) middle and high schools for boys and girls affiliated with the Directorate of Education of Rusafa First. This sample was used to know the psychometric properties for the tests.

3- The main research sample: The basic research sample was chosen in a random manner with a proportional distribution from 3 directorates of education in Baghdad / Al-Rusafa, first, second and third, as it was calculated according to (Steven\* Thompson) equation and it amounted to (372) male and female students distributed over (8 schools) for males and females.

Search tools:

To achieve the goal of the research, it is necessary to have a tool to measure the research variables, which prompted the two researchers to review the literature and previous studies related to the research variables, and due to the lack of a ready test to measure this variable, the following test was prepared:

### **Divergent thinking skills test.**

#### **Here is an explanation of those steps:**

1-1- Determine the objective of the test:

The objective of the current test is to determine the extent to which students in the fifth grade of biological sciences possess divergent thinking skills in chemistry.

1-2- Identifying divergent thinking skills:

After reviewing the educational literature and benefiting from the theoretical background of this research, the divergent thinking skills were identified, which are four skills that include (the skill of composition and composition, realizing new relationships, reclassification, making improvements and providing new visions).

1-3- Presenting skills to a number of specialists:

After identifying the divergent thinking skills, they were presented to a number of specialists in the field of chemistry and its teaching methods, to express their opinions about their suitability for the research sample and in light of their opinions and the agreement percentage of 80% and above. The two researchers identified the divergent thinking skills appropriate for their research.

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\*(Nunnally)indicated that the size of the statistical analysis sample should be no less than five individuals for each test item and to calculate the sample size according to this trend (the number of the statistical analysis sample = the number of test items x 5).Nunnally,1978:200).



\* Steven Thompson's equation was used to calculate the basic research sample and it was mentioned in the statistical methods.

#### 1-4- Determining the scientific material:

The scientific material was determined by looking at the content of the scientific material for the secondary stage represented in the chemistry book for the fifth grade of the biological sciences. It included the first four chapters of the book, which represent the material of the first chapter, which will build the test paragraphs on the basis of the scientific material

#### 1-5- Drafting the test items:

The paragraphs of the divergent thinking skills test were formulated from the type of objective paragraphs, where (24) paragraphs of the multiple-choice type were formulated, in front of each paragraph four only one correct answers, and the objective paragraphs were prepared according to their suitability for the skills. Table (2) shows the item number that measures the skill and its number for each of the divergent thinking skills.

**Table (2)**  
**The item number that measures the skill and its number for each of the divergent thinking skills**

T	Skill	Item number that measures skill	number of paragraphs
1	Skill composition and authoring	1,2,3,4,5,6	6
2	The ability to perceive new relationships	7,8,9,10,11,12	6
3	Reclassification skill	13,14,15,16,17,18	6
4	Make improvements and provide new insights	19,20,21,22,23,24	6

#### 1-6- Drafting the instructions for the test:

The instructions for testing divergent thinking skills were formulated, and included the following:

- 1- The purpose of the test.
- 2- How to answer the questions.
- 3- The time allotted to answer.

The two researchers took into account that the instructions be clear and understandable for the students, and also explained to them that their score on the

test is for the purposes of scientific research, and that the student must answer all the paragraphs.

#### 1-7- Apparent honesty:

The test in its initial form was presented to a number of specialists in the field of chemistry and its teaching methods to verify the suitability and representation of the paragraphs for the field you measure and for the test as a whole. Some specialists.

1-8- **Test correction instructions:** Exemplary answers have been developed for the paragraphs of the divergent thinking skills test to ensure that they are typical solutions to be relied upon in the correction. Four alternatives are placed in front of each paragraph, one of which is correct only, giving one point for the correct answer and zero for the wrong answer and thus The total score of the test became (24 degrees) with a hypothetical average of (12).

#### 9-1- Applying the test to a reconnaissance sample:

##### a) Application to sample information (first reconnaissance):

The test was applied in its initial form on a sample of secondary school students, represented by the fifth biological science students, who numbered (40) male and female students, distributed (20) male and (20) female students. The aim of this was to know the possibility of students answering its paragraphs, determining their inquiries and determining the time to answer For the test, it was found that the collection of its paragraphs and instructions were clear, as the average time was (45) minutes.

##### B) Application to the statistical analysis sample (second reconnaissance)::

After verifying the possibility of applying the test and the clarity of its instructions and determining the time through the initial exploratory sample, it was applied to a sample of statistical analysis of secondary school students, represented by students of the biological sciences fifth grade in (3 schools for males) and (3 schools for females), which consisted of (200). Male and female students divided into (100) male and (100) female students.

#### **Statistical analysis of test items:**

The test was applied to a survey sample consisting of 200 male and female students, and after the answers were corrected, the final scores were arranged in

descending order, then the highest percentage of 27% of the scores was taken, representing the upper group, and the lowest 27% of the scores representing the lower group, where the number of students in each group was (54). male and female students, the following are the statistical analyzes:

### **Paragraph difficulty factor:**

The difficulty coefficient was calculated for each paragraph. It was found that the difficulty coefficients ranged between (0.44 - 0.58), which are acceptable coefficients, as the sources indicate that it lies between (0.20 - 0.80), which is the acceptance period, except for paragraph No. (23) characterized by a high difficulty coefficient, Therefore it was deleted.

### **The strength of paragraph recognition**

The discriminatory power was calculated for each of the test items, and it turned out to range between (0.54 - 0.80), and the item is considered acceptable if the percentage of its discrimination coefficient is (20%) or above. As for the paragraph whose discrimination coefficient is less than this percentage, it is recommended to delete it as in Paragraph No. ( 23) which was deleted due to its weak discriminatory power.

### **Effectiveness of alternatives:**

The effectiveness of the alternatives for the test items was found and it was found that the wrong alternatives attracted the students of the lower group more than the upper group with a percentage of no less than (5%) of the total students, and thus all the paragraphs are camouflaged except for paragraph No. (23) due to the difficulty of the paragraph we referred to earlier.

### **Construction veracity:**

This is what is called the validity of the concept. The validity of the construction of this test was verified by the following methods:

1- The correlation coefficient of the degree of each paragraph with the degrees of its domain:

The Point Pacerial correlation coefficient has been adopted in order to find the correlation coefficient between the degree of each paragraph and the degree of its range, and the results ranged between (0.35 - 0.46), that is, it indicates the internal consistency in the test items in addition to calculating the T-value to know the

significance of the correlation and it was found that it ranges Between (5.28 - 10.61), while the tabular value is (1.96), which indicates the statistical significance of the paragraphs, except for paragraph No. (6) it was omitted due to the weak correlation between it and the paragraph to which it belongs, where the T-value reached (0.16), which indicates weakness The paragraph relates to the domain to which it belongs.

## **2-The correlation factor between the grades of each paragraph and the degree of total testing:**

The Point Pacerial correlation coefficient was adopted to find the correlation coefficient for each paragraph with the overall test score, as it ranged between (0.3 - 0.53), in addition to calculating the T-value to find out the significance of the correlation and it was found that it is equal to (4.12 - 8.84), while the tabular value is (1.96), which It indicates the statistical significance of the items and their relationship to the overall test score, except for items (6, 9, 14, 23) that were omitted due to the weak correlation between them and the test as a whole, where the t-value reached (1.42, 1.71, 1.71, 1.28) respectively. These values are less than the tabular value of (1.96) and are therefore omitted.

## **3- The correlation coefficient of the scores of each domain and the scores of the overall test:**

The Pearson correlation coefficient was used to find the correlation coefficient between the scores of each domain and the overall test score, as it ranged between (0.4 - 0.53), in addition to calculating the T-value of the correlation significance, and it was found that it ranged between (5.11 -8.84), which indicates its statistical significance and the table (2) explains it.

## **4- The correlation coefficient of the scores of the domains among themselves:**

The correlation coefficients for the fields among them were found by adopting the Pearson correlation coefficient in addition to calculating the T value of the correlation significance, and it was found that it ranges between (6.54-10.61), which indicates that it is a statistical function.

## **Test stability:**

The stability of the test was calculated in two ways. The first was the Cronbach's alpha equation applied to the scores of the statistical analysis sample, and the test reliability coefficient was (0.87), which is a good indicator of the test reliability

(Al-Kubaisi, 2010:297), and the test stability was calculated using the retest method, and the value of the test was Test reliability coefficient (0.85), which is a good indicator of test reliability (Al-Assaf, 2003: 237).

Thus, the test in its final form consists of (20) paragraphs of the type of multiple choice, ready for application.

### **Final application of the test:**

The test was applied to the basic research sample consisting of (372) male and female students during the period from 28/2/2021 to 11/3/2021, and the students' answers were corrected.

### **Statistical means**

The statistical package (SPSS) version V24 and Microsoft Excel, in addition to the following statistical methods, were used to analyze the following research data:

### **Presentation and interpretation of results:**

Verification of the first objective: Do secondary school students possess divergent thinking skills?

The following null hypothesis was derived from it: There is no statistically significant difference at the level of significance (0.05) between the mean of the real and hypothetical performance of secondary school students in the fifth grade of biology in the test of divergent thinking skills.

In order to achieve the goal of the research, the t-test equation for one sample was used to compare the arithmetic means with the hypothetical means and extract the calculated t-values to compare them with the tabular value of (1.96) at the significance level (0.05) and the degree of freedom (371) and Table (3) shows the calculated t-value and the hypothesis to indicate the difference between the mean The real and hypothetical performance of the research sample students.

### **Table (3)**

**It shows the calculated and hypothesized T value to indicate the difference between the average real performance**

**The hypothesis for the students of the research sample**

the field	the nber	Arithmetic mean	standard deviation	hypothe cal mean	Calculated T	indication
Installation	37	2.31	0.89	2.5	-4.1	0.0
realization		1.12	0.89		-29.8	0.0
Rating		1.93	1.12		-9.9	0.0
improvements		2.42	0.90		-1.7	0.4
divergent thinking		7.78	2.01	10	-21.3	0.0

It was shown in Table (3) above that there was a significant decrease in the skills of synthesis, cognition, classification and divergent thinking in general in the research sample, except for the improvement skill, whose results indicated that there was no significant difference between the hypothetical and arithmetic mean, which means that the research sample possessed the skill of improvements. The results of this study agree with the results of the Rabari study, which indicated a low level of divergent thinking as a result of the low level of creativity, which is the basis of divergent thinking.

**The second objective: Is there a difference between male and female students in their possession of divergent thinking skills?**

The following null hypothesis was derived from it: There is no statistically significant difference at the significance level (0.05) between the mean scores of male and female students in divergent thinking skills.

To achieve the goal, the two researchers used the t-test for two independent samples for the purpose of comparing the arithmetic means among them and extracting the calculated t-value for the purpose of comparing it with the tabular value of (1.96) at the significance level (0.05) and the degree of freedom (370), and table (4) shows that.

**table(4)**

**T-test of two independent samples of divergent thinking skills**

the field	sex	the	Arithmetic	standard	Calculated	Indication	Interpreted
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		number	mean	deviation	T		
Installation	Mention	162	2.42	0.79	2.07	0.04	male superiority
	female	210	2.23	0.95			
realization	Mention	162	1.07	0.88	-1.06	0.29	not significant
	female	210	1.17	0.90			
rating	Mention	162	1.68	1.16	-3.83	0.00	superiority of females
	Female	210	2.12	1.05			
Improvements	Mention	162	2.10	1.04	-6.21	0.00	superiority of females
	female	210	2.66	0.69			
divergent thinking	Mention	162	7.27	1.96	-4.41	0.00	superiority of females
	female	210	8.18	1.96			

Through table (4) above that there was a difference in favor of the students in the composition skills, while the female students excelled in the skills of classification, improvements, and divergent thinking in its general form, while in the cognitive skills there was no significant difference between male and female students.

### Conclusions:

In light of the current research results, the following can be concluded:

- 1- There is a significant decrease in the divergent thinking skills of secondary school students in chemistry except for the improvement skill.
- 2- The existence of a difference in favor of the students in the divergent thinking skills.

### Recommendations:

Based on the findings of the research, the two researchers recommend the following:

- 1- Preparing training programs to develop the divergent thinking abilities of teachers through the use of some strategies and asking questions that develop this type of skills, which helps to achieve positive results.

2- Taking advantage of the divergent thinking test in future studies to reveal the level of learners in this style of thinking.

3- Interest in developing divergent thinking skills through science and chemistry curricula at all stages by including some activities and tasks that develop those skills.

### **The suggestion:**

In light of the current research results, the following suggestions were made:

1- Conducting empirical studies examining the effect of different strategies on the development of divergent thinking and at different stages of study.

2- Conducting similar studies to the current research in other disciplines such as physics and biology.

3- Conducting studies investigating the effect of integrating divergent thinking skills within the academic content of secondary and intermediate stages.

### **References**

1. Al-Amoudi, HalaSaeed (2016): The effectiveness of a proposed strategy based on e-learning blogs in teaching chemistry, developing divergent thinking and social skills towards studying chemistry among female special education students, College of Education, Umm Al-Qura University, Volume IX, Issue III, Journal of Educational and Psychological SciencesQassim University, Saudi Arabia.
2. Al-Anazi, Mazrouq bin Hammoud and Sahlouli, Yahya bin Ahmed, (2016): Analysis of the content of science courses for the upper grades of the primary stage in the light of divergent thinking skills, Faculty of Education,Assiut University, Volume Thirty-second, Issue Three, July.
3. Al-Assaf, Saleh bin Muhammad, (2003): "The Introduction to Research in Behavioral Sciences", 3rd Edition, Al-Obaikan Library, Riyadh.
4. Al-Halfi, Intisar Odeh Musa, (2020): Holistic Thinking, 1st Edition, Al-Amir Office for Printing and Reproduction, Baghdad - Bab Al-Moadham
5. Ali, Wael Abdullah Muhammad (2009): The Effectiveness of Using Divergent Thinking Strategies in Raising the Level of Achievement in Mathematics and Developing Some Habits of Mind among Fourth Grade Students, Studies in Curricula and Teaching Methods, Issue (153), The



- Egyptian Association of Curriculum and Instruction, Faculty of Education, Ain Shams University.
6. Al-Kubaisi, WahibMajeed (2010): "Applied Statistics in Social Sciences", 1st Edition, Dar Al-Alameya, Beirut, Lebanon.
  7. Al-Marwani, Dhaif Allah Masoud, (2020): "The effectiveness of using the White and Jenston model (PEOE) to teach science in developing divergent thinking and deep understanding among middle school students with different levels of information processing, PhD thesis, College of Education, Umm Al-Qura University.
  8. Gad Al-Haq, Nahla Abdel-Moati, (2017): "The Experimental Dialectical Approach to the Development of Divergent Thinking and Scientific Skills in Science for Preparatory School Students", Journal of Scientific Education, Volume Twenty, Issue Four, April, Egypt.
  9. Hendawy, Emad Mohamed (2018): "The Effectiveness of the Scamper Strategy in Developing Divergent Thinking and Science Imagination Skills in Science for Preparatory Stage Students," The Egyptian Journal of Scientific Education, Volume Twenty-first, Issue Six, June.
  10. Newton, (2000) Tea Ching For under sanding what it is and how to do it, new york; RoutedgeFalmer.
  11. Nunnally, J.c. (1978), **psychometric Theory**, Newyork: McGraw Hill company.
  12. Odeh, Ahmed Suleiman and Fathi Hassan Malkawi (1987): "The basics of scientific research in education and human sciences, its elements, curricula, and statistical analysis of its data", 1st Edition, Al-Manar Library for Publishing, Amman, Jordan.
  13. Omran, Taghreed (2005): Towards New Horizons in Our Learning Reality - Teaching and the Development of Divergent Thinking - Teaching and Activating Nerve Cells in the Brain - Fifth Educational Series, Cairo Publishing House, Egypt.
  14. Rabari, J. Indoshi, F&Okwach T, (2011). Correlates of Divergent Thinking among Secondary School Physics Students Educational Reserch2(3). 982-996.
  15. Shehata, Mohamed Abdel Moneim, (2013): "The Effectiveness of a Suggested Program Based on Some Divergent Thinking Strategies in Developing Mathematical Communication Skills for Primary School

Students”, Arab Studies in Education and Psychology, Volume Three, Issue 39, July.

16. Thompson, Steven K. (2002), sampling, second Edition, John Wiley & sons.