Research Article

The Effect of Kagan's Structures on Divergent Thinking among Fourth-Grade Middle School Students in Biology

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Abstract

The research aims to identify the effect of kagan structures on divergent thinking among fourth-grade middle school students in biology. The two researchers chose Al Zuhur Prep for Boys affiliated to the General Directorate of Education in Nineveh Governorate intentionally, division (A3) was chosen to represent the experimental group, and Division (B1) represented the control group, by (21) students per division, and the two researchers conducted parity between students of the two groups of research in The following variables: (previous biology information, divergent thinking (previous information), intelligence, previous achievement in biology), The two researchers identified the five chapters of the biology textbook for the fourth scientific grade and formulated the behavioral goals for the topics that he will study, so they were (157) behavioral goals in Bloom's six levels, and the researchers prepared a research tool, represented by the divergent thinking test. It may consist of six domains with two paragraphs for each field, and the following statistical methods were used: (the T-test for two independent samples, the Pearson correlation coefficient, and the equation (Cooper agreement, strength of distinction, Alpha - Cronbach, Aita square), in addition to the statistical bag of the social sciences. (Spss) and (Microsoft Excel)), and after analyzing the statistical results, it reached the superiority of the experimental group students in the divergent thinking test.

Keywords: Kagan structures, divergent thinking

Chapter One
The Definition of the Research
The problem of the rsearch

many students at different school levels suffer from the problem of teaching them in ways that are inconsistent with the learning models appropriate to their abilities, and this leads to poor learning or obtaining it with lower grades, and some students and their teachers may reach the conclusion that they have a problem in their ability to learn, and many of them may have amazing learning abilities if they are taught in a way or strategy that matches their true mental models of learning (Abu Jadu & Al-Sayyad, p. 159, 2017).

Although the results of educational studies and research have added new dimensions to learning outcomes in the educational field to find solutions to educational problems, there is a clear weakness in students 'levels of knowledge acquisition and its application in their daily life. The situation indicates that the teacher is still captive to the traditional method of teaching, which works to provide students with the largest amount of information without taking into account the scientific benefit from it, because the information acquired in this way does not affect them greatly in their lives and does not solve their problems for them, Often their relationship with it ends after she performs its function, and students 'achievement is measured by the amount they have memorized from scientific facts and information without having a tangible impact on their reality. Consequently, the learner will find himself unable to use this information in managing his daily life affairs or adopting it in new situations that require him to practice thinking processes and his skills, that the traditional methods do not develop thinking but are based on memorization and indoctrination, and this has been confirmed by many studies conducted in Iraq as a study (Madi, 2011). The study (Al-Dulaimi, 2012). the study (Mansour, 2013).

From this reality, the research problem stems from the researcher's feeling of the continuation of the circumstances and problems that led to the lack of development of thinking skills in general and divergent thinking, especially among students. This requires presenting modern teaching strategies that help raise the level of thinking among students, and due to the lack of studies at the Arab and local

levels that dealt with Kagan structures in the teaching of sciences in general and biology in particular, so the researcher decided to identify the effect of using (Kagan structures) on divergent thinking among fourth-graders of science.

The researcher identified the research problem with the following question:

What is the effect of Keegan's structures on divergent thinking among fourth-grade middle school students in biology?

The importance of the research

In light of this scientific and technological development, education in general and scientific education, in particular, has an important responsibility, which is to prepare human cadres capable of keeping pace with this scientific progress. Accelerated technology in various areas of life and this is achieved by working on developing individuals' experiences, modifying them, refining their talents, stimulating their motivation, exploding their energies, and enriching their ideas. It also aims to prepare individuals in a comprehensive, integrated, and parallel preparation in all spiritual, mental, physical, and social aspects so that one side does not overwhelm the other. And so that they are useful members of their society. (Al-Mousawi, p. 82, 2005).

Due to the intertwining of information and its rapid increase in information, education and its development have become inevitable, because it is the tool that develops and develops the capabilities of the learner, transfers knowledge to him in an orderly manner, and gives him mental capabilities that focus on knowledge in all its aspects and take the most effective to achieve the aspiration of society. (Meri & Mohammed, p. 75, 2002).

Education is considered the means and tools of education in achieving the goals and a source for meeting the demands of society for effective human capacity, as a field that reflects the functions and objectives of education through its educational institutions represented by education. (Attia, p. 17, 2009).

Educators and specialists in science curricula and methods of teaching them emphasize that science teaching are no longer just a transfer of scientific knowledge to the learner as it is prevalent in traditional methods of teaching, but science teaching has become a process that means activating the student's previous knowledge and building new knowledge, acquiring, understanding, preserving and using it in different life situations. (Zaiton, p. 20, 2007).

Kagan structures for cooperative learning are one of the recent trends in the field of education that aims to link learning with action and the positive participation of learners. (Al-Deeb, p. 16, 2011).

The study of biology has a role in the development of teaching thinking, as biology and its many scientific and practical activities are considered one of the fertile sciences that contribute to developing various thinking skills when making possible efforts and planning well for the lesson. (Abd Al-Salam, 2006: 20).

Divergent thinking is one of the types of thinking that has received clear attention from contemporary researchers. Guilford referred to divergent thinking as the focus of thinking processes that refer to creativity. (Khalifa, p. 193, 1994).

Based on the above, the importance of research is determined by the following:

1- An attempt to research and experiment with new strategies based on constructivism theory in teaching science curricula in general and biology in particular, and this is the prevailing modern trend to develop teaching these subjects in the field of education.

2- This research is considered the first study dealing with teaching biology using Kagan structures and their effect on divergent thinking in Iraq (to the best of the researcher's knowledge).

3- Teaching divergent thinking as a skill through different subjects leads to improving students' performance.

The research goal and its hypothesis

The current research aims to find out the effect of (Kagan structures) on divergent thinking among fourth-grade middle school students in biology.

The goal is achieved through the validity of the following null hypothesis:

- There is no statistically significant difference at the level of significance (0.05) between the mean scores of the experimental group students who studied according to Kagan structures and the average scores of the control group who studied according to the usual method of divergent thinking test.

The limits of the research

The current research is limited to fourth-grade scientific students in Al-Zuhour Prep for Boys affiliated to the General Directorate of Education in Nineveh Governorate, the first semester of the academic year (2020/2021), the textbook for the tenth edition of Biology 2019.

Defining terms:

Kajan structures was defined by (Al-Deeb, 2011). as a modern method of cooperative learning based on organized activity in the classroom, which provides greater opportunity for students to learn and participate positively, and works to reduce the role of the teacher, and leads to an increase in students 'achievement." (Al-Deeb, p. 23, 2011).

Divergent thinking

Divergent thinking is defined by (Al-Kubaisi, 1989). as the ability of the individual to generate many ideas (familiar and unfamiliar) for the uses of several things (Al-Kubaisi, p. 46, 1989). The researcher defines it procedurally: as the student's ability to give correct solutions and answers (familiar, unfamiliar) to the items included in the test prepared by the researcher and consisting of my skills (fluency and flexibility).

Chapter two
The theoretical framework and previous studies

Theoretical framework
First - Kagan structures
Kagan structures for cooperative learning

Dr. Spencer Kagan developed structures to be used in teaching to help students during the teaching process to achieve the lesson objectives easily and attractively as well as the accuracy in implementing what is required of the individual after determining the role of each person in it. , As it includes practical steps based on movement, representation, and love for the student to reach the achievement of the goals for which they were set, which include social skills such as - the love of cooperation, participation, dialogue management, tolerance, the statement of the other opinion, and leadership, The practical application of skills during the implementation of the structures is evidence of learning practically more than just listening, as these structures develop the student's love of self-learning, as well as aiming, by applying them to other goals such as implanting values in students' hearts, to create the right, useful and desirable directions in society. (Ariq, p. 13, 2009).

The reason for the name

Kagan initially called the term strategies on his models, but he noticed as the work continued on them that they differed from cooperative learning strategies, in their freedom from content, and their distinction in forming learners' interaction with any content, And in his attempt to search for a word more eloquent than the term "strategy", he was able in a moment of clairvoyance to borrow the term "Structures" from his early field of work as "an armed blacksmith" designing the steel structures of buildings during their construction, as his structures are similar (his structures) that are not related to the content with steel structures after being filled with reinforced concrete any finishes can be changed on them at will while the structures remain stable. (Abu Ghanima, p. 297-298, 2017).

The Seven Keys of Kagan's Structures

The first key: the structures themselves, "Structures", as more than (200) combinations were designed to enhance achievement, participation in different thinking skills, and social skills. It depicts the way the teacher organizes interaction in the semester.

The second key: "Teams", and "Kagan" recommends the use of heterogeneous teams, as they include different levels, interests, and trends that contribute to the exchange of experiences and enrich the work of the teams, and the team should consist of two pairs of participants to increase the rate of communication.

The third key: "Classroom Management", as it is essential to the success of the work, and it focuses on agreeing on silent signals, working rules inside the classroom, organizing teams, and clarity of instructions and instructions.
Fourth key: Class Building.
Fifth Key: Teams Building.
Sixth key: social skills.
The keys conclude with the four basic principles of "Kagan cooperative structures" coded "P, I, E, S" (Abu Ghanima, p. 295, 2002).

Basic principles of "Kagan structures"
1- "Positive Interdependence".
2- Individual Accountability
3- "Equal Participation".
4- "Simulation Interaction" (Soleimani & Khosravi, p. 22, 2018).
In this study, the two formulations will be relied upon (the heads are numbered together, find out the error).

Numbered Heads Together (Think Together): The formula of "Numbered Heads Together (Think Together)" belongs to a teacher named "Russ, Frank" who works at the first school to open its doors to "Spencer Kagan" to train teachers to use his structures, Where the headmaster of the school "Kagan" was invited to follow his training and look at the behavior of this teacher who called him crazy, describing him as creating chaos in the classroom, and despite that, the learners love him and learn better, and "Kagan" recorded a complete lesson for the teacher, and Kagan was not aware of what he did at the beginning The teacher, when he and his assistant noticed the video, they noticed that it was a new formula, and then he developed its steps in light of the four basic principles of "PIES" and gave it the name "Numbered Heads Together." (Abu Ghanima, p. 298, 2017).
The steps for combining the numbered heads are:
The teacher divides the class into foursome teams. Each student of the team is given a number from 1 to 4 and distributes cards with questions between the teams.
Steps:
1- The teacher poses the question or problem and sets a time to think about answers to the question.
2- Specifies a time for members to write their answers.
3- Students stand to put their heads together and discuss their answers.
4- Students sit down at the end of discussing their answers or at the end of the discussion time.
5- The teacher calls the number of the student whom he wishes to assign to answer from each team.
6- After discussing the answers of all the teams, each team celebrates their achievement (Langworthy, p. 24, 2015).

Find the error
The teacher gives a question or an item with the wrong information and asks each team to discover the error. This combination can be done between every two of the team.
Steps:
1- Determine the content from the teacher.
2- Distribution of working papers among the team.
3- Discovering the error from one of the team members and correcting it.
4- Review the answers.
Recommendations for administering this composition:
A- The content must allow for multiple answers.
B - The need to correct the information from the team.
C- Diversify the uses of the formula (a question can be given that includes options one of which is wrong, and they are asked to discover the error and correct it). (Al-Deeb, p. 90-92, 2011).

Second: Divergent thinking

Divergent thinking is that type of thinking that includes the production of multiple solutions or multiple assumptions in the sense that the individual who uses it can reach more than one solution to the problem or situation and that these solutions are characterized by creativity and the term divergent has been used synonymously. The term innovative or creative is widely used among educators, the individual who thinks with this type of thinking offers multiple solutions to the problem or situation that are serious, as he knows that it is a way to produce the largest number of ideas possible by examining the problem or situation from multiple angles in proportion to the individual's capabilities and experiences. (Attieh, p. 127-128, 2015).

Guilford is often credited with distinguishing between convergent and divergent thinking. But some scholars knew the value of this perception before "Guilford". The individual, for example, developed the first test of intelligence at the beginning of the twentieth century and included an open-ended task that does not differ from the divergent thinking tests which are common today. (RNCO, p. 10, 2011).

Some indicated that (Spearman) was the first to distinguish between divergent thinking and convergent thinking through measurement methods. Divergent thinking (free or absolute) is measured using its tests that require the teste to be independent in thinking and uniqueness in choosing creative answers with originality and distinction while thinking Asymptotic (limited or narrow) is measured by using traditional general intelligence tests that require the teste to specify specific and correct answers to direct and limited questions or items. (Razuki & Latif, p. 21, 2018).

The concept of divergent thinking

Some many scientists and researchers defined divergent thinking like (Al-Sheikh, 2014): he defined it as "the flexible thinking that moves in multiple directions and is characterized by the production of new information and the creation of various solutions to problems, and it is represented in situations that allow several correct answers". (Al- Sheikh, p. 181, 2014).

(Zayer, 2020). "as thinking that includes the production of many different solutions or responses without restricting the individual's thinking by predetermined rules, and it is an approach to creative thinking". (Zayer & others, p. 34, 2020).

Principles of divergent thinking

Divergent thinking is based on several principles:

The first principle: Postpone judgment on things

This principle means delaying judgment and evaluation until a large number of possibilities and alternatives are provided. (Al-Jebali, p. 38, 2012).

The second principle: seeking the largest amount of ideas

Researchers in this field are interested in the number of ideas put forward, believing that this quantity leads to a diversity of ideas, and then to their novelty and originality. Meaning that the more ideas are generated, the greater the probability of having original and distinct ideas, and this principle directs the learner towards seeking to generate the largest number of ideas and alternatives and helps to achieve the goal by expressing ideas with the fewest words. (Razuki & Latif, p. 36 -37, 2018).

The third principle: starting

This principle emphasizes recording all incoming ideas while not being preoccupied with whether the idea is useful or not, as non-traditional ideas are often the way to find new alternatives, as finding a new relationship between ideas may be the result of ideas that seem illogical or unhelpful. let the imagination go beyond the ordinary. (Khalil, p. 22, 2007).

The fourth principle: Relax a little while the thoughts are brewing

This principle is intended to set aside the problem for some time and engage in an activity or hobby that has nothing to do with the problem. This principle reflects the idea of "incubation" as one of the stages of the creative process. Original ideas may spring to mind during this period, and it is useful for the person to carry a pocket notebook with him to record these thoughts.

The fifth principle: try to incorporate ideas - be intrusive

This principle is intended for the individual to be alert all the time to the ideas presented by others during the "creative problem solving" process, and he may be able to arrive at an original idea by linking various ideas from here and there, and there is nothing to prevent that. (Groane, p.284, 2002).

The basic components of divergent thinking

First: Fluency: means the ability to generate a large number of alternatives, synonyms, ideas, problems, or uses when responding to a specific stimulus, and the speed and ease of generating them, which in essence is a process of recalling and summoning optional information, experiences, or concepts previously learned. It takes one of the following forms:

a - fluency of shapes.
b - fluency of symbols or words.
c - fluency of meanings and ideas, "intellectual fluency"
d - expressive fluency
e - fluency of association or relational fluency. (Al- Hila, p. 48-49).

Second: Flexibility

It is seeing things through different areas or angles to do those things using various strategies. This ability is represented in the mental processes that would distinguish between the individual who can change the direction of his thinking from another angle, from the individual who freezes his thinking in one direction. Flexibility includes A- Automatic flexibility, B- Adaptive flexibility of meanings (Nawfal & Abu Awad, p. 68, 2010).

Previous studies

1- Al-Awadi study (2019) Jordan: It aims to identify the effect of using a cooperative learning strategy based on Kagan structures on creative thinking in mathematics for sixth-grade students, the study sample was 60 students, the researcher adopted the quasi-experimental approach, and the study tool was a test of creative thinking. , The following statistical methods were used, the arithmetic means, standard deviation and standard error, the associated Anova analysis of variance, and the study found statistically significant differences between the mean scores of the creative thinking test in favor of the experimental group students.

Chapter Three

Research Methodology and Procedures

First: Research methodology and experimental design: The two researchers adopted the experimental research approach because it is more appropriate for his research, as experimental research represents the most accurate types of scientific research that can affect the relationship between the independent variable and the dependent variable in the experiment. (Melhem, p. 374, 2010).

The two researchers have adopted an experimental design with partial control for the experimental and control groups, one of which controls the other and the one with the post-test. The design includes two groups, the experimental group that is studied according to the Kagan structures, and the second group that is studied according to the usual method, as shown in the figure below:

The experimental design used in the research

Group	parity	independent variable	dependent variable
Experimental	-previous information test.	Kagan divergent	Divergent thinking.

Control	Divergent thinking. Intelligence. Previous achievement	The usual way	Divergent thinking.

Second: The research community and its sample

The current research community is represented by all fourth-grade scientific students in Al-Zuhur Preparatory School for Boys, which was intentionally chosen from one of the day preparatory schools of the General Directorate of Education in Nineveh Governorate for the academic year (2020-2021), of which there are 208) students of ten classes (A1…. A5) include (21) students in each class and (B1…. B5) and include (21, 21, 21, 20, 20) respectively. The researcher selected the research sample by random assignment method, where Division (A3) represented the experimental group and Division (B1) represented the control group, the sample students consisted of (42) students by (21) students for the experimental group and (21) students for the control group.

Third: Control Procedures

1- Internal Safety of Experimental Design

To verify the internal integrity of the experimental design, the following factors were addressed:

The Equivalence of the two research groups: Before experimenting, the two researchers checked the parity of the students of the two research groups, and statistical equivalence was made in the variables that may affect the results of the research, which are as follows:

a- The previous information of Biology.

b- Divergent thinking test (previous information).

c- IQ test.

d- Previous achievement in biology.

2- External safety of the experimental design

In addition to the aforementioned statistical parity procedures among the members of the research sample, some extraneous variables have been controlled that the researchers believe may affect the safety of the experiment. As for, some of these variables are presented:

measuring tool, sample selection, time, experimental extinction, subject matter, teaching Confidentiality regarding experience, physical conditions, weekly classes.

Fourth: Research requirements

1- Determining the subject of the study

The two researchers relied on the subjects decided on biology for the fourth scientific-grade for the year (2020-2021) that included the first five chapters of the book.

2- Preparation of behavioral objectives: The two researchers formulated several behavioral objectives depending on the content of the scientific material. The number reached (157) behavioral objectives according to Bloom's classification in the cognitive domain of the six levels.

3- Preparing the teaching plans: The researchers prepared (9) teaching plans for each group, teaching plans according to the structure of the two components of the experimental group, and plans according to the (normal) method of the control group.

Fifth: The research tool: The research tool is a means of collecting data through which research questions are answered or hypotheses are tested (Al-Shayeb, p. 69, 2009).

To achieve the objectives of the research, this required the preparation of a tool, namely:

First: The Divergent Thinking Test: The following is an explanation of the preparation stages:

A- Determining the purpose of the test

B- Preparing the test: The two researchers viewed and studied many tests to build a test that meets the objectives of the current research. Among these tests are:

1- The Divergent Thinking Test that was prepared by (Al-Tamimi, 1996).

2- The divergent thinking test that was prepared by (Al-Rikabi, 2010).

C - Determine the skills of divergent thinking:

First: Fluency:

It means the ability to generate a large number of alternatives, synonyms, ideas, problems, or uses when responding to a specific stimulus, and the speed and ease in generating them, which is, in essence, an optional recall and recall of information, experiences, or concepts previously learned.

There are types of fluency: Relational fluency, fluency of meanings and ideas, fluency of shapes, fluency of symbols, expressive fluency. (Al-Hila, p. 48-49, 2002).

Second: Flexibility

It means the ability to generate various ideas that are not of the type of ideas normally expected, and direct or transform the course of thinking with a change in the stimulus or the requirements of the situation, and flexibility is the opposite of mental inertia, which means adopting predetermined mental patterns that are not subject to change as needed (Thaer, p. 48, 2009).

Types of Flexibility: automatic elasticity, adaptive elasticity of meanings.

D- Formulating the test items: The two researchers formulated the test items following the purpose for which they were prepared to measure the divergent thinking ability of fourth-grade scientific students in the subject of biology.

E - Correction of the test: for each correct answer in all items (1) is given and the wrong answer is given (zero).

F- Test validity:

1- Apparent validity: To verify the apparent validity of the test, the test was presented to a group of experts specializing in methods of teaching science, measurement, and evaluation.

G - The exploratory application of the test: The divergent thinking test was applied to two survey samples to find out the clarity of the test instructions and the clarity of its paragraphs, and to extract the psychometric properties of the test.

2 - Validity of construction (internal consistency): The correlation coefficient was calculated between each paragraph and the field to which it belongs, and the values ranged between (0,60 - 0,79), as well as between the score of each item and the total score of the test (0,21 - 0.39), And also between the field score and the total score of the test, as it ranged from (0,34 - 0.48), and all the values of the correlation coefficients were statistically significant, noting that the tabular value of (r) is equal to (0.19) at the level of significance (0.05) and the degree of freedom (98).

Distinguishing Power: The two researchers used the T-test for two independent samples, and the results showed that the calculated T-test values ranged between (2.36 - 5.09), which are all greater than the tabular value of (2,01) and the degree of freedom (52), so the test items are all good.

The Stability of the divergent thinking test: The test reliability was calculated using the internal consistency method by adopting the formula (Alpha Cronbach), as the stability coefficient according to the aforementioned equation reached (0,83) and this indicates that it is a good and acceptable reliability coefficient.

The final formula for the divergent thinking test: It consists of (12) items that measure six of the divergent thinking skills: (relational fluency, intellectual fluency, fluency of shapes, verbal fluency, automatic flexibility, and adaptive flexibility of meanings).

Sixth: The Procedures for applying the experiment

Seventh: The statistical tools:

The researchers used the following statistical methods: The Statistical Portfolio for Social Sciences (Spss) and the (Microsoft Excel) program.

Chapter Four

Presentation, interpretation, and discussion of the results

Results of the Divergent Thinking Test

To verify the validity of the null hypothesis which stated that (there is no statistically significant difference at the level of significance (0.05) between the mean scores of the experimental group students who studied according to Kagan structures and the average scores of the control group who studied according to the usual method in the divergent thinking test).

The two researchers extracted the arithmetic mean and standard deviation of the divergent thinking test among students of the two groups (experimental and control), then applied the t-test (t-test) to two independent samples, and the results were listed in the table below as follows:

Table (1) shows the results of the (T. test) test for two independent samples of the two research groups in the Divergent Thinking Test.

Group	Number of students	Arithmetic mean	standard deviation	degree of freedom	T-value		Statistical significance at a level (0,05)
					Computed	tabular	
experimental	21	55,23	12,12	40	2,88	2,02	function
control	21	45,95	8,40				

The results in the above table indicate that there is a statistically significant difference in favor of the experimental group in the divergent thinking test, thus rejecting the null hypothesis and accepting the alternative hypothesis, and to find out the size of the effect, the researchers adopted the eta-squared equation (η 2).

Table (2) shows the values of the t-test, (η ^ 2) and the effect size of the divergence thinking test.

The computed t value	the tabular t value	η2 value	value of the effect size
2,88	2,02	0,17	Huge

Through the results presented in the above table, we can see that the size of the effect is (large) and according to the reference standard taken from (Cohen, 1988).

The discussion and interpretation of the results that are related to the null hypothesis.

The results of the current research showed that there is a statistically significant difference between the scores of students of the experimental and control groups in the divergent thinking test, in favor of the students of the experimental group and with the size of a (large) effect. The experimental group, because Kagan's structures made the student reconsider his ideas, reorganize them and modify them in a conscious and expanded manner.

Conclusions

1- Kagan's structures contributed to raising the scientific level of fourth-grade students in divergent thinking skills.

2- Teaching according to Kagan's structures is more effective in improving the level of divergent thinking than the usual method for students.

Recommendations

1- The necessity to develop students' divergent thinking skills in biology and for the various stages.

2- The necessity of including biology curricula with questions that measure higher-order thinking skills, including divergent thinking skills.

Proposals

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

2- Conducting descriptive studies that include analyzing biology curricula in light of divergent thinking skills.

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