2025 Volume: 5, No: 5, pp. 5233–5246 ISSN: 2634-3576 (Print) | ISSN 2634-3584 (Online) posthumanism.co.uk

DOI: https://doi.org/10.63332/joph.v5i5.2194

# Effectiveness of a Teaching Strategy Based on Transformative Learning Theory in Divergent Thinking Skills of Fourth-Grade Science Students in Mathematics

Marwa Ibrahim Rahim Al-Kubaisi<sup>1</sup>, Rafid Bahr Ahmed Al-Maaiouf<sup>2</sup>

#### Abstract

This research aims to identify the effectiveness of a teaching strategy based on the Transformative Learning Theory in developing divergent thinking skills among fourth-grade science students in mathematics. A purposive sample was selected from a Preparatory School. Two sections (A and B) were randomly chosen, consisting of (42) students in the experimental group and (40) students in the control group. Equivalence between the two groups was established using the Otis-Lennon School Ability Test, and a divergent thinking skills test consisting of (15) items (prepared for the purpose of ensuring equivalence). A divergent thinking skills test was developed for the final application on the research sample (experimental and control groups) as a post-test. This test comprised (20) essay items. The validity and reliability of the test were verified, and statistical analyses were conducted. After the experiment concluded, the divergent thinking test was administered to both the experimental and control groups. The results indicated to difference at between degree average of the tow groups in the divergent thinking test, favoring the experimental group.

**Keywords:** Transformative Learning Theory, Teaching Strategy Based on Transformative Learning Theory, Divergent Thinking Skills.

## Introduction

#### **Research Problem**

We are currently living in an era of rapid progress and development across all aspects of life, including scientific and intellectual advancements and a massive influx of information and knowledge. This necessitates preparing generations capable of keeping pace with this progress. The secondary education stage is crucial for fostering students' thinking, as it aims to nurture them intellectually, enabling them to identify and solve problems using thinking skills. Mathematics is considered one of the most important scientific fields that stimulates students' mental abilities and develops their general thinking capacity due to its nature, which is linked to induction, innovation, and other cognitive processes (Obeid et al., 2000, p. 38).

To keep up with the accelerating pace of mathematics education, it is essential to consider the contributions of modern scientific and educational theories that facilitate the teaching and learning process and help improve performance to produce learners capable of applying mathematics in daily life situations and solving the problems they encounter. Among these theories is Mezirow's Transformative Learning Theory. This theory challenges the notion of

<sup>&</sup>lt;sup>2</sup> University of Baghdad / College of Education for Pure Sciences / Ibn Al-Haytham / Department of Mathematics, Email: rafid.b.a@ihcoedu.uobaghdad.edu.iq



<sup>&</sup>lt;sup>1</sup> General Directorate of Education Baghdad / Al-Karkh First, Email: <u>marwa.abd2203@ihcoedu.uobaghdad.edu.iq</u>

viewing the present through the lens of the past or considering the present and future as mere repetitions of the past. Radical change in education will occur when teachers embrace a shift from their traditional roles to new roles that encourage students' talent and creativity (Saeed, 2021, p. 461).

Mathematics is a companion and aid to learners in all aspects of life. It no longer aims solely to develop manual calculation skills but also seeks to equip students with sound thinking methods (Jassem & Hamad, 2018, p. 137).

Furthermore, thinking is a cognitive process and a fundamental element in the mental-cognitive structure. Through it, learners can find new solutions and methods for the problems they face currently and may encounter in the future. Our current era requires learners who possess higher-order thinking skills to keep pace with cognitive changes and think effectively, developing their abilities to apply different thinking patterns (Al-Zughoul, 2007, p. 273).

Moreover, the lack of positive interaction in the classroom by students may extinguish their creative spark. Therefore, it is necessary to develop and nurture their thinking skills (Majeed, 2022, p. 209).

One of the most important thinking skills that needs to be developed in learners is divergent thinking. Divergent Thinking is considered one of the most significant thinking patterns that curricula strive to develop in learners. This type of thinking encourages essential skills in the context of the information age and the diversity of scientific alternatives, enabling them to expand their ideas to divergent levels and not limit their activities to convergent ideas that focus solely on the cognitive aspect (Al-Muqhim & Abu Mughnam, 2014, p. 182).

Furthermore, most teaching strategies make students feel bored, which prevents them from engaging effectively with problems and numbers (Misharar & Al-Ameer, 2024, p. 1244).

Given the above, the researcher decided to experiment with a proposed teaching strategy based on the Transformative Learning Theory on the experimental group students to determine its effectiveness in developing their divergent thinking skills. Accordingly, the research problem can be defined by answering the following question:

"What is the effectiveness of a teaching strategy based on the Transformative Learning Theory in the divergent thinking skills of fourth-grade science students in mathematics?"

## Significance of the Research

Mathematics is an integral part of our real lives, and its use is not limited to daily activities but extends to a variety of situations. Therefore, it is necessary to transfer the knowledge and skills acquired in schools to real life, which requires learners to think mathematically and apply it to solve real-world problems (Qaeed & Faris, 2021, p. 900).

## Theoretical Significance of the Current Research

The importance of mathematics for all educational levels (Al-Aqaibi & Al-Kadhimi, 2023, p. 393).

This research may enhance divergent thinking skills among female students at this age, where they reach a degree of intellectual maturity to produce new and creative ideas in addressing the life problems they face.

This research may be a starting point for opening new horizons for other studies in this regard,

especially in educational studies within the Iraqi context, to draw the attention of those involved in the educational process to the necessity of bringing about a comprehensive change in the way learners think, instead of rote memorization and indoctrination, and guiding them towards correct ideas by reviewing their assumptions and ideas through criticism and dialogue with others.

## **Applied Significance of the Current Research**

Providing researchers in the field of mathematics teaching with a test that possesses the characteristics of a good test for divergent thinking skills, which will help them prepare similar tests.

The proposed strategy based on Transformative Learning can enhance the divergent thinking skills of the experimental group students, which may allow for the generalization of this result to the student population in general to promote this type of thinking and encourage them to think more deeply to solve the problems they encounter in their practical lives.

# **Objective of the Research**

The current research aims to determine the effectiveness of a teaching strategy based on the Transformative Learning Theory in the divergent thinking of fourth-grade science students in mathematics.

## **Research Hypotheses**

To verify the research objective, the following null hypothesis was formulated

**First Null Hypothesis:** There is no statistically significant difference at the significance level (0.05) between the mean scores of the experimental group students who studied1 the prescribed mathematics content according to the teaching strategy of the Transformative Learning Theory and the scores of the control group students who studied the same material according to the usual (traditional) method in the divergent thinking skills test as a whole in mathematics.

H0:  $\overline{x1} = \overline{x2}$ 

H1:  $\overline{x1} \neq \overline{x2}$ 

**Second Null Hypothesis**: There is no statistically significant difference at the significance level (0.05) between the mean scores of the experimental group students who studied1 the prescribed mathematics content according to the teaching strategy of the Transformative Learning Theory and the scores of the control group students who studied the same material according to the usual (traditional) method in the divergent thinking skills test for each sub-skill individually in mathematics.

H0:  $\overline{x1} = \overline{x2}$ 

H1:  $\overline{x1} \neq \overline{x2}$ 

# **Research Limitations**

The current research is limited to:

1. Fourth-grade science female students in public secondary and preparatory day schools affiliated with the General Directorate of Education in Baghdad / Al-Karkh First for the academic year (2024-2025).

- 2. The first semester of the academic year (2024-2025).
- 3. A teaching strategy based on the Transformative Learning Theory.

4. Divergent thinking skills, represented by (fluency, flexibility, originality, elaboration, sensitivity to problems).

#### **Definition of Terms**

Transformational Learning Theory:

#### Defined by (Mezirow, 2001) as:

A shift in perspective and a focus on how we learn to engage in dialogue and discussion with others according to our goals and values, rather than being influenced by what has been acquired without conviction from others and in a non-critical manner. Through this, we will gain a greater understanding of ourselves as thinkers and decision-makers with social responsibility for our actions (Mezirow, 2001, p. 10).

# **Operational Definition of the Proposed Strategy Based on Transformative Learning Theory**

A proposed teaching strategy based on the Transformative Learning Theory for teaching mathematics to the experimental group. It focuses on reviewing previous ideas and beliefs and transforming these ideas through discussions among students and practicing criticism and deep reflection to build new experiences. Its impact on the divergent thinking of the experimental group students in the research sample is measured.

#### **Divergent Thinking**

Defined by (Abu Hatab) as "generating logical or reasonable alternatives from the given information, where the focus is on the diversity, difference, abundance, and scarcity of outputs and solutions" (Abu Hatab, 1996, p. 235).

#### **Operational Definition**

It is the ability of the research sample, represented by the fourth-grade science female students from the experimental and control groups, to produce new ideas and solutions when exposed to problems and to reach the largest possible number of them through a divergent thinking skills test prepared for this purpose, which includes (fluency, flexibility, originality, elaboration, sensitivity to problems). It is measured by the total score they obtain through their responses to the items of the divergent thinking skills test prepared by the researcher for the stated purpose.

#### **Theoretical Framework**

#### **First: Transformative Learning Theory**

This theory emerged from the work of (Jack Mezirow), who initially called it "Transformation Theory" and then "Transformative Learning." It first appeared as a formal document in 1978, addressing a study on women enrolled in educational programs to return to work in numerous community colleges across the United States. The original study was conducted in the 1970s, where Mezirow used the term "frames of reference" to refer to the mental structures that implicitly guide how we experience, understand, and judge information. Throughout his work, Mezirow specifically focused on how individuals' meaning-making processes are examined and modified through critical dialogue and critical self-reflection. He was interested in

#### Journal of Posthumanism

demonstrating how adopted educational processes are used. In the late 1980s, a series of conversations began in adult education literature between Mezirow and critics and supporters of his theory. Since then, it has become the most researched theory in adult education literature in North America over the past 47 years (Hoggan, 2018, p. 36).

Transformative Learning Theory seeks to explain how adult learning is organized and to identify the processes through which the frames of reference (habits and ideas) by which we interpret our experiences (perspectives) are changed and transformed. Mezirow believed that individuals change their frame of reference, causing them to think about something differently than they did previously (Mezirow, 1991, p. 10).

Transformative Learning Theory provides a different perspective from theories that emphasize the storage and retrieval of information when needed. Older theories did not give special importance to the structure and process of interpretation and the reorganization of meaning, thus limiting their usefulness in the educational process. This is contrary to what we see in modern educational theories that are concerned with knowledge resulting from self-reflection, including attention to the way students express their opinions, ideas, and assumptions about the learning process and liberation from the constraints of traditional learning in order to activate their roles, which can affect the learning process. Liberation knowledge is acquired through (self-reflection based on critical reflection) and is fundamentally different from knowledge acquired through indoctrination (AL. Sharifi & AL.Zuwainy, 2022, p. 208).

## **Transformative Learning According to Mezirow**

In 1978, Mezirow identified ten phases that lead to transformative learning. These are:

(A disorienting dilemma, self-examination, a critical assessment of epistemic assumptions, relating or involvement, exploring options and trying out new roles, planning a course of action, acquiring knowledge and skills needed to implement the plan, provisionally trying new roles, developing competence and self-confidence in new roles, and a reintegration into one's life).

It is worth noting here that the aforementioned steps or phases occur in a different order, but all ten phases must be completed to experience a change in perspective and transformative learning (ŞAHIN & DOĞANTAY, 2018, p. 105).

Second: Teaching Strategy Based on Transformative Learning Theory:

Following the recent global emphasis on teaching thinking across educational systems, there has been a growing interest in the importance of improving and developing teaching methods by focusing on strategies that stimulate students' curiosity and develop their thinking skills to grasp mathematical concepts, which are considered the cornerstone of mathematics (Al-Ma'youf et al., 2017, p. 2).

The researcher believes that a teaching strategy is a comprehensive concept that involves a set of sequential, interconnected, and interactive movements, in addition to specific teaching methods and techniques and related aspects used by teachers within the classroom to achieve specific educational goals.

Based on this concept, the researcher will present the steps of the teaching strategy based on the Transformative Learning Theory. This strategy was proposed to enhance the divergent thinking skills of the fourth-grade science students in the research sample. The steps of this strategy were presented to referees and specialists in mathematics teaching methods for their comments and

5238 Effectiveness of a Teaching Strategy Based on Transformative opinions, and some steps were modified to become as follows:

(Figure 1) illustrates the steps of the strategy according to the Transformative Learning Theory

(The actual visual representation of Figure 1 with the steps would be included here if it were provided.)

## **Third: Divergent Thinking**

Thinking is a series of mental activities carried out by the brain to process information that enters memory. These activities include storing information, trying to interpret and classify it, and using it to solve problems (Hasan & Faris, 2019, p. 306).

Divergent thinking is sometimes called "out-of-the-box thinking." It is defined as thinking characterized by variety in outputs and the quality of ideas. As Guilford sees it, it involves generating and producing new information and ideas from given information. In this type of thinking, constraints on ideas are reduced, the search process expands, and information and ideas are produced abundantly (Qatami, 2003, p. 22).

Divergent thinking is considered one type of thinking that has received considerable attention from researchers and educators in the field of education. This is because it is considered an unconventional approach to searching for solutions and ideas, as it is based on starting from a single point to several different angles to see relationships and connections and employ them in solving problems (Yousef, 2018, p. 366).

The term "divergent" has been widely used synonymously with "innovative" or "creative" among educators. An individual who thinks in this way produces multiple solutions to a problem or dilemma that are characterized by novelty and originality. It is also a way to generate the largest number of ideas by examining the dilemma or situation from multiple perspectives that suit the individual and their experiences (Stamovlasis et al., 2015, p. 290).

Many research studies have found positive correlations between divergent thinking and performance in mathematics. They have focused on creativity and mathematics, primarily emphasizing divergent thinking, as new ideas and solutions to problems are believed to stem from divergent thinking. This confirms the theory that divergent thinking facilitates finding appropriate ideas for problem-solving. Looking at a problem from different angles helps students raise relevant issues or questions and apply different solutions and techniques, which is beneficial in solving mathematical problems (Devink et al., 2021, p. 3).

## **Divergent Thinking Skills**

These are the skills and mental abilities possessed by a creative individual. Guilford (1959) emphasizes that the characteristics of a creative person in creativity are predispositional traits that include (fluency of thinking, flexibility of thinking, originality, elaboration (perception of details), and sensitivity to problems). Each of these abilities can be classified under the umbrella of (divergent thinking) (Ibrahim, 2007, p. 371).

## **Research Methodology and Procedures**

The researcher adopted the experimental method and selected a true experimental design with two equivalent random groups (experimental and control) with a post-test to measure divergent thinking, as shown in the following table:

Al-Kubaisi & Al-Maaiouf. 5239

Group	Equivalence of the Two Groups	Independent Variable	Dependent Variable	Measurement of the Dependent Variable
Experimental Group	Divergent Thinking Test Intelligence Test	Proposed teaching strategy based on Transformative Learning Theory	Divergent Thinking Skills	Divergent Thinking Skills Test
Control Group		Usual Method		

Table (1) Experimental Design of the Research

#### **Research Population**

The research population consisted of all female fourth-grade science students in the public daytime schools affiliated with the General Directorate of Education of Baghdad / Al-Karkh First for the academic year 2024-2025.

#### **Research Sample**

The researcher purposefully selected (Al-Ameriya Preparatory School for Girls), affiliated with the General Directorate of Education of Baghdad (Al-Karkh First), as the school where the experiment would be conducted because it suited the research experiment. The researcher reviewed the number of classes in the school, and the individuals of the research sample were selected using a random drawing method. Class (B), with (42) students, was chosen to represent the experimental group that would be taught according to the proposed teaching strategy based on the Transformative Learning Theory. Class (A), with (40) students, was chosen to represent the control group that would be taught according to the usual method.

## **Equivalence of the Two Research Groups:**

## **1- Divergent Thinking Skills Test:**

Group	N 0.	Arith metic Mean	Stand ard Devia tion	Degr ee of Free dom	t-test		Leve	ne's Test	Statisti cal signific ance at level = 0.05
Experim ental	4 2	25,26	4,49	80	t- val	Signific ance	F val	Signific ance	Not signific
					ue	Level	ue	Level	ance
Control	4 0	23,20	5,14		1,9 37	0,056	1,18 2	0,280	

Table (2) Equivalence in Divergent Thinking Skills

5240 Effectiveness of a Teaching Strategy Based on Transformative 2- Intelligent Test

Group	N 0.	Arith metic Mean	Stand ard Devia tion	Degr ee of Freed om	t-test		Leve	ne's Test	Statisti cal signific ance at level = 0.05
Experim ental	4 2	22,38	5,77	80	t- val ue	Signific ance Level	F val ue	Signific ance Level	Not signific ance
Control	4 0	22,75	6,85		0,2 64	0,729	0,0 62	0,804	

Table (3) Equivalence in Intelligence

#### **Research Instrument: Divergent Thinking Test**

The researcher followed the following steps to construct the divergent thinking test:

1- **Defining the Concept of Divergent Thinking**: This was previously mentioned in the theoretical framework.

2- **Determining the Purpose of the Test**: To measure the divergent thinking skills of fourthgrade science students in the experimental and control groups of the research sample.

3- **Identifying Divergent Thinking Skills**: These were identified as (Fluency, Flexibility, Originality, Elaboration, Sensitivity to Problems) and were presented to experts and specialists in mathematics and its teaching methods.

4- **Defining Indicators for Measuring Each Skill**: These were determined by reviewing previous studies and carefully examining the definitions of each skill as discussed by theorists in this field.

5- Constructing the Divergent Thinking Test Items: The researcher constructed a divergent thinking test consisting of (20) essay-type items.

6- **Preparing Test Instructions:** Instructions for answering the test were formulated, as well as instructions for scoring the essay-type items of the divergent thinking test.

7- **Presenting the Initial Draft of Test Items to Referees**: The researcher presented the divergent thinking test items, its main and sub-skills, and indicators to a group of referees who are specialists in mathematics and its teaching methods.

8- First Exploratory Application (Pilot Study 1): Under her supervision, the researcher administered the achievement test to a first exploratory sample consisting of (45) female fourth-grade science students on Monday, December 23, 2024, at (Warqa bin Nawfal Secondary School for Girls), affiliated with the General Directorate of Education of Baghdad / Al-Karkh First. The aim of the first exploratory application was to determine the clarity of the items and calculate the test time. It was found that all items were clear and understandable to the students. The test time was calculated based on the time taken to answer the items, with five minutes allocated for each item, resulting in a total test time of (100) minutes.

## Journal of Posthumanism

9- Second Exploratory Application (Pilot Study 2): The researcher administered the test under her supervision to a second exploratory sample consisting of (100) female students from (Al-Radwan Secondary School for Girls), affiliated with the General Directorate of Education of Baghdad / Al-Karkh First. The test was conducted on Tuesday, December 24, 2024.

10- **Scoring the Test Items**: The researcher scored the test items after the completion of the second exploratory application, relying on the answer key for the essay-type items.

## 11- Statistical Analysis of Test Items:

• The difficulty coefficient for the essay items ranged between (0.3 - 0.59), thus the items are considered to have a good difficulty coefficient.

• **Discrimination Coefficient**: This refers to the ability of an item to differentiate between students with a higher level of knowledge and those with a lower level of knowledge in a specific area. (Jawad, 2011, p. 443)

Discrimination was determined in two ways: first, using the specific formula for the discrimination coefficient of essay items, the values ranged between (0.27 - 0.59), thus all items are considered acceptable and discriminating. Second, through the extreme groups (upper and lower) using the independent samples t-test. The calculated t-values for the essay items ranged between (6.308 - 10.058). The calculated t-value was considered an indicator by comparing it with the tabulated t-value (1.984) at a significance level of (0.05) and with (98) degrees of freedom. It was found that all calculated t-values were greater than the tabulated t-value.

## 12- Verification of Psychometric Properties:

• **Validity**: Three types of validity were used:

• **Face Validity**: The test was presented to a group of referees regarding the clarity of the items.

• **Content Validity**: Johnson (2014) states that content validity in qualitative tests is verified by ensuring that the research sample, the questions asked, and the observed characteristics adequately represent what is intended to be measured. (Johnson, 2014, p. 65)

During the construction of the divergent thinking skills test, the researcher ensured that it represented the skills to be measured (Fluency, Flexibility, Originality, Elaboration, Sensitivity to Problems) without addressing other skills, and by defining the indicators through which the test items were constructed.

**Construct Validity:** The researcher verified the construct validity of the divergent thinking skills test by using the scores of the students in the second exploratory sample (the statistical analysis sample) to find the following:

# • A- Relationship between Item Score and Total Test Score:

To determine the relationship between the score of each item on the divergent thinking skills test and the total test score, the Pearson correlation coefficient was used. The correlation coefficients ranged between (0.646 - 0.868), and at a significance level of (0.05), it was found that all test items were statistically significant when compared with the p-value (probability).

# • B- Relationship between Item Score and the Skill it Belongs To:

To determine the relationship between each item and the sub-skill it belongs to, the Pearson correlation coefficient was used. The correlation coefficient values ranged between (0.863 - 0.965). When comparing the correlation coefficients at a significance level of (0.05), it was found that all items were statistically significant when compared with the p-value (probability).

## **Between Skill and Total Test Score:**

To determine the relationship between each skill and the total test score, the Pearson correlation coefficient was used. It was found that all items were statistically significant when compared with the probability (alpha = 0.05), as shown in Appendix (23). The correlation coefficient values ranged between (0.795 - 0.935) at the significance level (0.05).

Skill	Pearson	Degree of	Probability	Significance	Statistical
	Coefficient	Freedom	p value	Level	Significance
Fluency	0,931	99	0,000	0.05	function
Flexibility	0,935	99	0,000	0.05	function
Originality	0,884	99	0,000	0.05	function
Elaboration	0,828	99	0,000	0.05	function
Sensitivity	0,795	99	0,000	0.05	function
to Problems					



## **Reliability:**

A. Using Cronbach's Alpha Equation: The calculated reliability coefficient using this method was (0.96), which is a good reliability coefficient.

B. Using Split-Half Method: By splitting the divergent thinking skills test items into two perfectly equal halves and using the Pearson correlation coefficient, the reliability coefficient for half of the test was (0.78). After correcting it with the Spearman-Brown prophecy formula, the reliability coefficient became (0.87), which is a good reliability coefficient, as a test is considered reliable if its reliability value reaches (0.70) or higher.

13- **The Test in its Final Form**: After completing the statistical analyses and ensuring the psychometric properties, the test became ready for its final administration to the experimental and control groups of the research sample.

## **Presenting and Interpreting the Results:**

**The First Null Hypothesis**: The researcher compared the results of the post-test scores between the experimental and control groups.

Group	N 0.	Arith metic Mean	Stan dard Devi ation	Degr ee of Free dom	t-test			Leve ne's Test	Statistica significa e at leve 0.05	al nc el =
Experi mental	4 2	67	13,83	80	Calcu lated t-	Tab ular t-	Signifi cance Level	F valu e	Signifi cance Level	D al

				value	valu				
					e				
Control	4	53,5	16,91	3,963	1,99	0,000	0,59	0,443	
	0	-	-		0	-	4	-	

Table (5)

shows the results of the final administration to the research groups in the divergent thinking test.

To determine the effect size of the independent variable (a teaching strategy based on transformative learning theory) on the dependent variable (divergent thinking skills):

Independent value	Dependent value	n <sup>2</sup> value	D value	Effect size value
Teaching strategy according to the theory of transformative learning	Divergent thinking	0.16	0.88	High

 Table (6) Effect Size of the Independent Variable on the Dependent Variable (Divergent Thinking Skills).

**The Second Null Hypothesis:** To statistically verify this null hypothesis in the divergent thinking skills test according to each of its skills:

Diverg ent	Group	N 0.	Arith metic	Stand ard	Degr ee of	Leve Test	ne's	T va	lue	signific ance
thinkin g skills			Mean	Devia tion	Free dom	F	Significanc e level	Т	Significanc e level	
Fluenc y	Experim ental	4 2	36,38	6,24	80	2,2 15	0,1 41	4,1 06	0,0 00	functio n
	Controll ed	4 0	29,90	7,98						
Flexibil ity	Experim ental	4 2	12,28	2,85	80	1,6 85	0,1 98	3,5 43	0,0 01	functio n
	Controll ed	4 0	9,80	3,48						
Origin ality	Experim ental	4 2	5,88	2,21	80	1,3 83	0,2 43	3,4 78	0,0 11	functio n
	Controll ed	4 0	4,05	2,55						
Elabor ation	Experim ental	4 2	5,71	2,27	80	1,6 14	0,2 08	2,3 37	0,0 22	functio n
	Controll ed	4 0	4,32	2,90						
Sensiti	Experim	4	6,76	2,27	80	0,0	0,9	2,5	0,0	functio

posthumanism.co.uk

5244 Effectiveness of a Teaching Strategy Based on Transformative

vity to	ental	2			 04	47	93	11	n
Proble	Controll	4	5,45	2,30					
ms	ed	0							

Table (7) Results of the T-Test and Levene's Test for the Experimental and Control Research GroupsAccording to Each Skill of the Divergent Thinking Test.

To determine the effect size of the independent variable (a teaching strategy based on transformative learning theory) on each skill of divergent thinking with the significance of eta-square.

Fluency			Flexibility			Originality			Elab	orati	on	Sensitivity to Problems		
Α	D	eff	Α	D	eff	Α	D	effec	Α	D	effec	Α	D	effec
yt		ect	yt		ect	yt		t	yt		t	yt		t
a			a			a			a			a		
0,	0,	Hi	0,	0,	Hi	0,	0,	Med	0,	0,	Med	0,	0,	Med
17	9	gh	14	7	gh	13	7	ium	06	5	ium	08	5	ium
	1			8			7			4			7	

 Table (8) Effect Size of the Independent Variable on Each Skill of Divergent Thinking with the Significance of Eta-Square.

This indicates that there are statistically significant differences between the experimental and control groups in the divergent thinking variables, in favor of the experimental group that studied according to a teaching strategy based on transformative learning theory. Therefore, the null hypotheses are rejected, and the alternative hypotheses are accepted.

## **Interpretation of Results**

Divergent thinking is a higher-order cognitive process that requires significant training and practice to master the application of its steps and to deal with situations that require understanding the relationships between givens and required information and reaching a solution to the problem at hand. This is what the steps of the strategy based on the Transformative Learning Theory provide.

There are mental abilities related to divergent thinking skills stored in the students' minds. The test was able to prove their existence, and the students used them in answering the items of the divergent thinking test.

Students' tendency to use thinking skills in general in their academic studies and its enhancement by the steps of this strategy clearly affected their ability to answer the items of the divergent thinking test better in the experimental group than in the control group.

# Conclusions

The proposed teaching strategy based on the Transformative Learning Theory is effective, and it favors the experimental group.

Students possess the ability to use higher-order thinking processes and apply them in appropriate situations.

#### Recommendations

Pay attention to divergent thinking skills and employ them in the educational process.

Provide a suitable learning environment for students based on practicing activities and involving them in them to develop divergent thinking skills.

#### Suggestions

Conduct a similar study using this strategy in other educational stages, such as the intermediate stage.

Conduct further research to develop divergent thinking skills using other theories or teaching.

#### References

Arabic References:

- Ibrahim, Muhammad Abdul Razzaq. (2007). The Teacher Formation System in Light of Total Quality Standards, 2nd ed., Dar Al-Fikr for Publishing and Distribution, Amman, Jordan.
- Abu Hatab, Fouad Abdul Latif. (1996). Mental Abilities, 5th ed., The Anglo-Egyptian Library, Cairo.
- Bin Haloul, Fatima Matar. (2023). The Impact of the Unlimited Talents Theory on Developing Divergent Thinking Skills and Motivations for Creativity among "H 2" Students in the UAE. Journal of Arts, Literature, Humanities and Social Sciences, (97), 155-176.
- Jassem, Basim Muhammad, & Hamad, Salwa Mohsen. (2018). The Level of Mental Mathematics among Intermediate School Students. Journal of Educational and Psychological Research, (31), 429-466.
- Jawad, Lina Fouad. (2011). Levels of Geometric Thinking among Mathematics Department Students in the College of Basic Education at Al-Mustansiriya University. Journal of Educational and Psychological Research, (59), 136-160.
- Johnson, Susan K. (2014). Mawhiba Publications: Identifying Gifted Students. Obeikan Publishing, Saudi Arabia.
- Al-Zughoul, Emad Abdul Rahim. (2007). Principles of Educational Psychology, 6th ed., Dar Al-Kitab Al-Jamae, Al Ain, United Arab Emirates.
- Saeed, Hebat Allah Helmy. (2021). The Effectiveness of a Proposed Program in History Based on Transformative Learning to Develop Future Thinking Skills among Secondary School Students. Journal of the Faculty of Education for Educational Sciences, 45(1), 459-497.
- Shawahin, Khair Suleiman. (2018). Modern Trends in Educational Measurement and Evaluation, 1st ed., The Modern Book World for Publishing and Distribution, Amman, Jordan.
- Obeid, William, Al-Mufti, Muhammad Amin, & Al-Qums, Samir Elia. (2000). Mathematics Education, Cairo: The Anglo Library.
- Al-Aqaibi, Ali Khazal Jabr, & Al-Kadhimi, Hayam Mahdi Jawad. (2023). The Effect of a Proposed Strategy Based on Realistic Mathematics Education Theory on Achievement and Mathematical Connection among Third Intermediate Grade Students. Journal of Educational and Psychological Research, 20(77), 391-451.
- Qatami, Nayfeh. (2003). Teaching Thinking to Children, 1st ed., Dar Al-Fikr for Printing, Publishing and Distribution, Amman, Jordan.
- Al-Ma'youf, Rafid Bahr Ahmed, Najad, Buthaina, & Hassan, Areej Khadr. (2017). The Effect of an Instructional Design Based on the Teaching for Understanding Strategy on the Achievement of Mathematics among Fifth Grade Science Students. Journal of Psychological and Educational Research, (54), 1-22.

Al-Muqhim, Ibrahim bin Muqhim, & Abu Mughnam, Karami Badawi. (2014). The Effect of Employing

Some Differentiated Instruction Strategies in Teaching Geography on Achievement and Developing Divergent Thinking Skills among First Secondary Grade Students. Journal of the Educational Society for Social Studies, (58), 179-252. Retrieved from http://search.mandumah.com/Record/722587

- Yousef, Wafaa Abu Al-Maati. (2018). The Effectiveness of a Program Based on the Open-Ended Story in Developing Divergent Thinking Skills among Kindergarten Children. Journal of Childhood and Education, 10(36), 361-424. Retrieved from http://search.mandumah.com/Record/1250667 Foreign Resources:
- De Vink, I. C., Willemsen, R. H., Lazonder, A. W., & Kruisbergen, E. H. (2021). Creativity in mathematical performance: The role of divergent and convergent thinking. British Journal of Educational Psychology, 93 (1), 269–287. https://doi.org/10.1111/bjep.12459.
- DOĞANTAY, Hidayet & ŞAHIN, Mehmet. (2018). CRITICAL THINKING AND TRANSFORMATIVE LEARNING. Journal of Innovation in Psychology, Education and Didactics. Vol. 22, No. 1. pp 103 – 114.
- Hasan, I.F. and Faris, E.J., (2019). "The of Effect Instructional Design based on Kagan Structure In Generating Information Skills for First Intermediate Student's In Mathematics", Journal Of Educational and Psychological Researches, 16(62), pp. 301-322.
- Hoggan Chad. (2018). Exercising Clarity with Transformative Learning Theory. The Palgrave international Handbook on Adult and Lifelong Education and Learning. Palgrave Macmillan. https://doi.org/10.1057/978-1-137-55783-4\_.chp.3 . pp 35-52.
- Majeed, B. H. (2022). "Impact of a Proposed Strategy According to Luria's Model in Realistic Thinking and Achievement in Mathematics", International Journal of Emerging Technologies in Learning (iJET), 17(24), pp. pp. 208–218. doi: 10.3991/ijet.v17i24.35979.
- Mezirow, J. (1991). Transformative Dimensions of Adult Learning .Jossey -Bass Inc.California.
- Mezirow, J. (2001). Learning to think like an adult: Core concepts in transformation theory. In J. Mezirow (Ed.), Learning in transformation: Critical perspectives on a theory in progress, (pp. 3-33). San Francisco, CA: Jossey-Bass.
- Misharar, A.A.A, Al-Ameer, L.F. J. (2024). "The effectiveness of a proposed strategy according to the Fraunhofer model of knowledge management in the achievement of second intermediate female students in mathematics", Edelweiss Applied Science and Technology, 8(4), pp. 1244–1251.
- Qaeed, N.S. and Faris, I.J., (2021)." Knowledge Economy Skills and their Relationship to Mathematical Culture among Secondary School Mathematics Teachers", International Journal of Early Childhood Special Education, 13(2).
- Al Sharifi, Alaa Mohammed Abed, AL. Zuwainy ibtisam sahib. 2022. The effectiveness of an instructional design based on transformational learning theory in the achievement of students in faculties of education. Journal for Educators, Teachers and Trainers, Vol. 13(4).pp 207–220.
- Stamovlasis, D., Kypraios, N., Papageoriou, G., 2015. A SEM model in assessing the effect of convergent , divergent and logical thinking on students understanding of chemical phenomena. Science Education International. 26 (3),p 284-306.