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THE IMPACT OF A STRATEGY BASED ON THINKING MAPS IN THE TEACHING OF SCIENCE ON EDUCATIONAL ACHIEVEMENT AND DEVELOPING MARZANO'S PRODUCTIVE HABITS OF MIND AT PREPARATORY SCHOOL PUPILS

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ABSTRACT

This study aimed to know the impact of a strategy based on thinking maps in the teaching of science on educational achievement and developing Marzano's productive habits of mind at preparatory school pupils. The researcher prepared a teacher guide and Pupil book based on a thinking maps strategy for the unit "periodic elements and their properties", also the researchers prepared an achievements test, Productive habits of mind scale, and self-esteem card of pupils.

The group of research is characterized by some preparatory school pupils (136 students), Divided into two groups (experimental and control group).

Results of the study have shown that:

1. There are statistically significant differences at (0.01) level between the scores of the experimental group and the control group on the achievement test in general and its three levels (knowledge, Comprehension, Application) in favor of the experimental group.

2. There are statistically significant differences at (0.01) level between the scores of the experimental group and the control group on the productive habits of mind scale, in favor of the experimental group.
3. There are statistically significant differences at (0.01) level between the scores of the experimental group and the control group on the self-esteem card of pupils, in favor of the experimental group.

The Impact of a strategy based on thinking maps in teaching science on the achievement and the development of Marzano's productive habits of mind at the preparatory level

INTRODUCTION AND TOUCHING THE PROBLEM

Thinking and different skills have become essential in all aspects of life, requiring preparation of instructional situations and a variety of teaching methods that encourage and motivate learners to think. Thinking maps are recent strategies that have emerged in teaching and that are concerned with the development of different thinking skills based on Hyerle's[(1)] ideas. As neuroscientists have found that the brain works to organize the information it receives in the form of networks and maps, and therefore the best way to teach and train students is to use the same method that the brain uses, which is to create visual maps inspired by the way the brain works. [(2)].

"Hyerle"[(1)] points out that the use of thinking maps is not limited to organizing the information in the student's cognitive structure in a meaningful way only, but also extends to the development and modification of the way the student thinks, and also enables him to build active interactive models that enable the student to understand complex materials.[(1)] Several studies have confirmed the use of thinking maps, including the study: [(3-8) (9-13)]

"Hyerle" (2007, 157)[(14)] stresses that there is a relationship between thinking maps and habits of the mind. The use of thinking maps supports the development of habits of the mind.

Interest in the habits of the mind has become evident through some educational projects that have adopted the habits of the mind as a basis for educational development. Including the scientific culture project from The American Association for the Advancement of Science, where the project has identified some mental habits whose development focuses on science education, including (integration, diligence, curiosity, openness to new ideas, skepticism based on knowledge, imagination, and others) [(15)].

The British National Curriculum is also called upon to develop the following habits of mind: curiosity, appraising evidence, critical thinking, perseverance, creative thinking, open-mindedness, environmental soundness, cooperation with others [(16)], and proposes the Dimensions of Learning model (Marzano , Et al., 1992, 8)[(17)] that the learning process requires the interaction of five dimensions of learning, namely:

- The first dimension: positive attitudes and perceptions towards learning.
- The second dimension: knowledge acquisition and integration.
- The third dimension: deepening and refining knowledge.
- The fourth dimension: meaningful use of knowledge.
- The fifth dimension: the productive habits of the mind, which Marzano classified into three levels: (the ability to organize oneself, the ability to think critically, and the ability to creative thinking).
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The current study adopts the habits of the mind produced according to the model of Marzano and his colleagues for the dimensions of learning, because it is based on constructivist philosophy and is concerned with teaching as an investigative process aimed at the learner's understanding of what is happening around him and dealing with it, and it also emphasizes the development of mental habits of the learner.

The results of some studies also showed the effectiveness of some strategies in developing the habits of the mind, and the habits of the mind were measured using several measures, including the habits of mind scale or the self-assessment card or by using the test of the ability to think critically, and the test of the ability to creative thinking and an observation card, and the current study adopts the development of habits Mind produced according to Marzano 'model. (18-23)

The study problem

The problem of the current study is the low productive habits of thinking of Marzano among preparatory school students, as shown by the result of applying the exploratory study to a sample of second-year middle school students in the academic year (2015/2016). By applying the learner's self-evaluation card to the productive habits of the mind[(17)], which consisted of 15 phrases to measure the habits of the mind produced by Marzano, the average score of the students was (28.5%). In an attempt to address this problem, this study stems from a main question: What is the effect of the strategy based on thinking maps in teaching science on achievement and developing the habits of reason that produce Marzano among second-grade middle school students?

The study limits:

The current study was limited to the following limits:

1- Unit (Periodical Elements and Their Properties) from the Science Book for the second year of middle school, the first semester (2018/2019).
2- Measuring the achievement of the study group at the levels of (remembering - understanding - application) to measure the extent of students' acquisition of the cognitive aspect.

3- Measuring the habits of the mind produced by applying the measure of the habits of the mind produced by Marzano, and the pupils' performance appraisal card by the students and by the teacher.
4- A group of second-grade middle school pupils at Saqr Quraish Intermediate School in Dammam affiliated to the Education Department in the Eastern Province of the Kingdom of Saudi Arabia. Their number reached (136) male and female students, then they were divided into:
• (68) pupils (an experimental group) at Saqr Quraish School in Dammam.
• (68) pupils (a control group) at Saqr Quraish School in Dammam.

Objectives of the study

The current study aimed at:
1- Identify the effect of using a strategy based on thinking maps on developing achievement among second-grade middle school pupils.
2- Recognizing the effect of using a strategy based on thinking maps on developing the habits of mind produced for Marzano among second-grade middle school students.

The study Approach

The current study used the quasi-experimental approach with two groups, experimental and controlling, to implement the strategy based on thinking maps, and applying tools to the two study groups, namely: the experimental group and studying the unit periodicity of elements and their properties in the strategy based on thinking maps, and the control group and studying the chosen unit in the usual way.

The theoretical framework and previous studies

The First Axis: Thinking Maps

What thinking maps are?

In 1988 David Hyerle designed so-called thinking maps when he was studying writing in California, David Hyerle found more than four hundred diagrams and extracted expressions for eight basic thinking processes, from which he developed eight basic maps of thinking [(25)].

To determine what thinking maps are[(26)], defines them as eight powerful visual tools that express eight basic processes. These maps are designed to help the learner generate ideas, collect and arrange information and evaluate ideas.

It can be defined procedurally as visual teaching tools that have eight forms, each related to the pattern of thinking, to help pupils to self-organize knowledge, as well

as the ability to think critically and the ability to think creatively until it becomes a habit for the learner.

The importance of thinking maps

Thinking maps have a clear importance in increasing the understanding of the educational content of the learners in a way that raises the cognitive awareness and allows the learner to self-educate and relate to his previous experiences, as it develops higher thinking skills and effective cognitive and mental communication skills. [(27)], (Hyerle, 2008)[(28)] indicates that the use of thinking maps helps in:

- Teaching students how to construct abstract concepts as results of the thinking process.
- Representation of the learner of his cognitive strategies using thinking maps.
- Enabling the learner to look at his thinking, that is, to see metacognitive processes, as if looking at his reflection in a pool of water.
- Learners share each other's thinking.

Shapes of thinking maps and associated thinking processes:

Thinking maps are based on eight shapes that are used together in the unit lessons according to the goals, skills and concepts of each lesson, and each map has specific goals and distinct functions in developing thinking skills.

Double bubble maps:

They are used to highlight comparisons

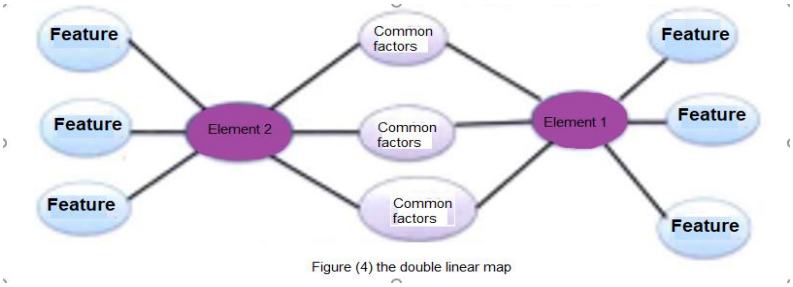


Figure (4) the double linear map

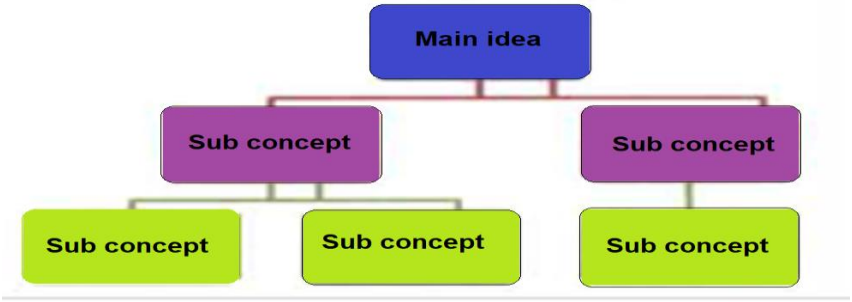
between two things or two concepts that have some similarities or differences.

Arc zigzag maps

used to clarify the whole-part relations of a topic and to analyze the whole situation into its components, elements, or sub-parts.

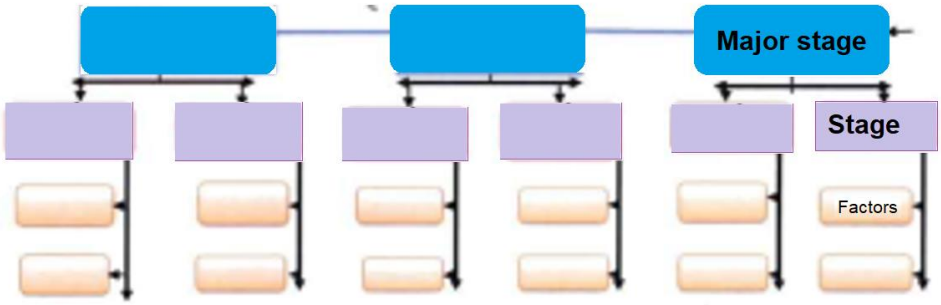
Tree maps

They are used to highlight the relationships between main ideas and the details that support them, and it aims to help students understand the content and understand its cognitive structure through the processes of organization and classification.



Flow charts:

They are used in the processes of sequencing events and recalling them from memory in an organized manner, where students identify the relationships between the main stages and the sub-stages, and thus understand the logical sequence of these events



Multiple flow charts

They are used to clarify causes and results or causes and effects, to help predict outputs, to clarify the causes of the event and the effect or to the result. It helps students to analyze situations through causes and results, in addition to feedback.

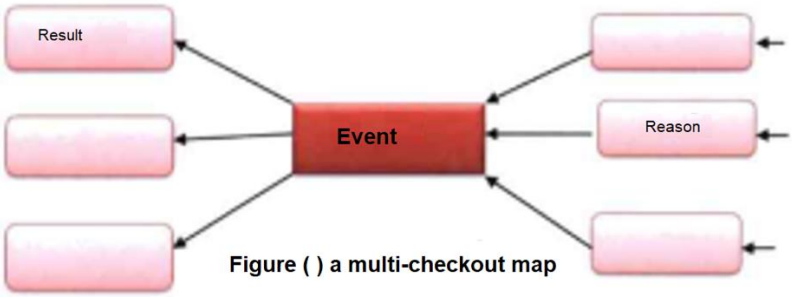


Figure ( ) a multi-checkout map

Bridge maps:

They help students in making similes and metaphors by identifying similarities and using them to create knowledge for students to learn new information and thus are useful for clarifying the relationship between reality and the abstract.[24, 25]

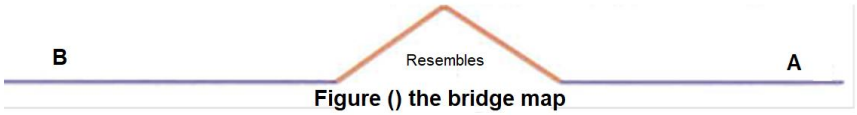


Figure () the bridge map

Commentary on previous studies:

It is clear through a review of the previous studies that:

- The novelty of using thinking maps.
- It is suitable for all educational levels, whether primary as in the study preparatory[6, 7] or secondary [13]
- Thinking maps help in the development of a number of learning outcomes and outputs, such as developing reflective thinking skills, high-order thinking, critical and creative thinking, as well as developing multiple intelligences, strategies for self-organization and decision-making, and the trend towards cooperative work and conceptual understanding as well as the development of achievement.[31]
- - Studies that dealt with the effect of thinking maps on the development of habits of the mind used habits of mind according to Marzano's classification.
- - The current study differs from previous studies in that it is based on preparing a strategy based on thinking maps, in order to develop achievement, and the habits of reason producing Marzano among middle school students.[31]

The Second Axis: Habits of The Mind

What are the habits of the mind?

Salih (197 2015)[32] defines it as: it is the intersection of knowledge, skills, trends, motives and values according to which a form of intellectual behavior is desirable and adhered to other detailed patterns, and includes a process of free choice of the form of behavior chosen from among the elements of a situation based on value given that this selection and preference are sustainable and sustainable.

The educational benefits of teaching mental habits:

Costa and Kallick[16] have mentioned four educational justifications for teaching mental habits from the point of view of human philosophy, which answer the question of why do we study the habits of the mind[29]

- Taking into account individual differences and special tendencies.
- Respect for your emotions.
- Take into account allergies.
- An integrative view of knowledge.

Marzano's productive habits and methods of guessing it

Dimensions of learning for Marzano are defined in the following: (Marzano et al. 1992, 8-10)[17]

- The first dimension / positive attitudes and perceptions about learning.
- The second dimension / thinking involved in acquiring knowledge and achieving knowledge integration.
- The third dimension / integrated thinking that is involved in expanding, refining and refining knowledge.
- The fourth dimension / integrated thinking in using knowledge in a meaningful and meaningful way.
- The Fifth Dimension / Habits of the Mind Productive.

(Marzano et al., 1992, 226-245)[17] divided the productive habits of the mind into three levels:

First: Habits of self-organizing ability.
Second: Habits of the ability to think critically.
Third: Habits of creative thinking ability.

Evaluating the productive habits of mind:

To evaluate the students' acquisition of productive mind-producing habits, the studies [19, 34] used one of the following tools:

- Pupil note card.
- Self-reports submitted by students.
- Test the ability to self-regulate.
- Test the ability to think critically.
- Test the ability to think creatively.
- Attitude scale for habits of mind.
- Writing reflective reports.
- Attitude scale to employ Habits of Mind.

Commentary on the previous studies

It is clear through a review of the previous studies that:

- Diversity of methods and teaching methods that dealt with developing habits of the mind.
- The possibility of developing the habits of mind in the different educational stages from elementary to university.
- The difference in the study of different classifications of the habits of the mind, including the handling of the habits of the mind according to the classification of Costa, kallikc[16] and others according to the classification of Marzano.
- The difference of the current study in presenting a strategy based on thinking maps in developing achievement, as well as developing habits of the mind according to Marzano's classification of habits of mind.

The Third Axis: The Strategy Based on Thinking Maps to Develop Productive Habits of The Mind:

(Hyerle, 2014)[24] points out that thinking maps can be used in teaching as a strategy, as they are more than organizational forms that are flexible, effective and evolving, and encourage lifelong learning, and can be used in pre-kindergarten, and even after graduation in practice.

The thinking maps strategy is adopted in science education in general within the framework of planned and appropriate procedural steps, because it is one of the visual thinking tools that gives students sufficient time to reflect and insight into the contents of the content to add new ideas, review alternatives, analyze them, identify similarities and differences, know complex sites and solve problems.[30]

Bases of building strategy based on thinking maps:

It is evident from previous studies that:

- The lack of studies linking thinking maps and habits of mind within the limits of researchers' knowledge.
- Previous studies dealt with the development of habits of mind according to Costa and kallikc's[16] classification using forms of thinking maps.
- The present study deals with developing the habits of mind according to Marzano's classification.
- Within the knowledge of researchers, there are no studies that have linked a strategy based on the shapes of the eight thinking maps and the habits of the mind produced according to Marzano's classification.

The Study procedures:

In order to answer the research questions and verify the validity of his hypotheses this necessitated following the following steps and preparing the materials and tools as the following:

Strategy based on thinking maps:

In light of the foundations of building a strategy based on thinking maps, the current study proposes a set of steps, as follows:

1- Divide the pupils into small, cooperating groups.
2- Preparing students: it includes introducing students to the contents of the lesson, habits of the mind and thinking skills that are the subject of learning.
3- Thinking out loud: in which the student remembers all the feelings and thoughts that occur to him when performing a task
4- Providing an opportunity for intellectual debate.
5- Providing the appropriate map for the content.
7 - Provide continuous feedback.

Determine the general objectives of the unit:

The general objectives of the unit were formulated in light of each of the objectives of science teaching, the nature of the chosen unit, the characteristics of the learners, and the aim of the study in light of thinking maps and the habits of mind produced by Marzano.

Preparing the student activity brochure:

The student activity brochure has been prepared according to the strategy based on thinking maps, so that every student can take notes and conclusions, train in drawing thinking maps, and carry out many mental processes to reach the development of the habits of the mind produced for Marzano.

Preparing the teacher's guide:

A teacher's guide has been prepared to guide the teaching process and includes: (Introduction, the importance of the guide for the teacher, general instructions for the teacher, steps of the strategy based on thinking maps, the proposed time plan for teaching, the general objectives of the unit, unit topics, presenting the unit lessons divided into paragraphs.).

Set the teacher's guide and student activity brochure:

After completing the preparation of the teacher's guide and the student activity brochure, the researchers presented them to a group of distinguished judges in order to find out the extent of:

1. Relevance of the objectives of each lesson to the topic of the lesson.
2. Scientific health of the subjects of the guide.
3. Agreement of the steps of building the lesson with the strategy based on thinking maps.
4. Appropriateness of the evaluation questions and their relevance to the objectives of the topic of the lesson.

Preparing the achievement test:

The researchers used the following procedures when preparing the achievement test:

1- Determine the goal of the test.

2- Determining the procedural objectives for the test.

3- Unit content analysis.

4- Preparing specification tables.

5- Formulating the test vocabulary.

6- Description of the achievement test:

In its initial form, the test consisted of (50) words in the three main levels: remembering, comprehension, and application.

7- Test instructions

8- Assessment of the test:

Only one score was specified for the correct answer and zero for the wrong answer, so the total score of the test would be (50), and the minimum score was zero.

9- Set the test:

In order to control the achievement test, the researchers presented it to a group of arbitrators from specialists in the field of curricula and methods of teaching science and some instructors and science teachers in the preparatory stage, and with this, the validity of the achievement test was verified.

10- The exploratory experience of the test:

The achievement test was applied to a group of second year middle school students at Saqr Quraish Preparatory School in Dammam, in the academic year (2018/2019), and their number reached (15) male and female students for the purpose of

A - Calculate the test time.

B- Calculating the ease and difficulty coefficients for the test items.

C- Calculating the discrimination coefficients for the test items.

D - Calculate the test reliability coefficients.

E- Calculation of the achievement test validity.

Calculation of test reliability factor:

The stability of the test was calculated by the half-segmentation method, and the following is detailed:

The reliability of the achievement test (for the sub-items and for the test as a whole) was calculated using two statistical methods:

- The first statistical method: The current research used the Kuder-Richardson equation to calculate the reliability of the achievement test, for the number of sub-items of the test, and every time the scores of one of the sub-items are omitted from the total score of the test, and that step resulted in all the sub-items being fixed, as it was found that the reliability coefficient For the test as a whole in the absence of one of the sub-items is less than or equal to the general stability factor of the test in the case of the presence of all the sub- items, and this means that entering any of the sub- items does not lead to a decrease in the overall stability factor of the test, and the value of the test reliability coefficient as a whole reached (78, 0).

- The second statistical method: To calculate the internal consistency factor of the test, the correlation coefficients were calculated between the scores of the sub-vocabulary and the total scores of the test, and it was found that all the correlation coefficients were statistically significant, which indicates the internal consistency and stability of all the sub-vocabulary of the achievement test, and the following table shows the coefficients of stability of the vocabulary Sub-of the achievement test in the two previous statistical methods:

Table (1)

Stability coefficients of the sub-vocabulary of the achievement test as a whole.

Correlation coefficients	Stability coefficient	Test No.	Correlation coefficients	Stability coefficient	Test No.
** 0.81	0.866	26	** 0.81	0.866	1
**0.82	0.9445	27	** 0.72	0.8425	2
**0.78	0.756	28	**0.88	0.956	3
**0.84	0.876	29	**0.84	0.976	4
**0.94	0.822	30	**0.86	0.987	5
**0.86	0.824	31	**0.76	0.724	6
**0.96	0.986	32	**0.86	0.986	7
**0.98	0.924	33	**0.88	0.924	8
**0.86	0.788	34	**0.86	0.888	9
**0.89	0.897	35	**0.88	0.997	10
**0.851	0.875	36	**0.83	0.960	11
**0.756	0.743	37	**0.88	0.957	12
**0.860	0.842	38	**0.79	0.875	13
**0.792	0.842	39	**0.81	0.793	14
**0.90	0.931	40	**0.914	0.953	15
**0.756	0.742	41	**0.862	0.874	16
**0.792	0.856	42	**0.872	0.756	17
**0.874	0.923	43	**0.862	0.875	18
**0.852	0.963	44	**0.845	0.7965	19
**.841	0.842	45	**0.845	0.9725	20
**0.892	0.875	46	**0.795	0.756	21
**0.845	0.856	47	**0.756	0.795	22
**0.953	0.953	48	**0.932	0.856	23
**0.876	0.854	49	**0.856	0.756	24
**0.813	0.879	50	**0.821	0.752	25
Total stability factor of the test 0.952					

* Statistically significant at (0.01) level*

It is clear from the previous table that:

- That the alpha coefficient of the test as a whole is less than or equal to the general alpha coefficient of the test, meaning that entering each sub-unit does not lead to a decrease in the overall stability factor of the test.
- That all the correlation coefficients between the score of each sub-item and the total score of the test in the case of a sub-item score (0.1), which indicates the internal consistency and stability of all sub-items of the achievement test.
- That the overall stability coefficient is equal to (0.952), which is a high stability coefficient.

E - Validate the test

The achievement test validity was calculated through the following:
- The apparent honesty calculation: where the test was presented to a group of gentlemen arbitrators, to know the extent of the suitability of the test to measure achievement, as was previously explained

Setting the Habits of Mind Produced Scale:

The researchers used the following procedures in preparing the scale:
Determining the objective of the scale:
This measure aims to know the effect of the strategy based on thinking maps on developing the habits of mind produced by Marzano in the experimental group.
Description of the Habits of Mind Productive Scale:
The habits of the mind produced in its initial form consisted of (30) behavioral attitudes for middle school students distributed into three sub-levels: habits of self-regulation ability (10) behavioral attitudes, habits of the ability to think critically (12) behavioral attitudes, and habits of the ability to creative thinking (8) Behavioral situations.

Scale estimate:

The scale contains positive and negative behavioral attitudes. The evaluation of positive statements was as follows: When the student's response to situations: I do this behavior (continuously), it is given 3 marks, (often) two degrees, and (never) one score, and vice versa if the statements were negative. Thus, the maximum degree of the scale is 90 degrees, and the small degree is 30 degrees.

Scale setting:

To adjust the scale of the habits of mind produced for Marzano, the researchers presented the scale to a group of referees, specialists in curricula and methods of teaching science, and field experts from mentors and science teachers.

The pilot experiment of the scale:

The scale was applied to a group of second-grade middle school students at Saqr Quraish Preparatory School in Dammam, in the academic year (2018/2019), and their number reached (15) students, to reach:
A - Calculate the scale time.
B- Calculating the scale stability factor:

The consistency of the Habits of Mind produced scale (for the positions of the scale and the scale as a whole) was calculated using two statistical methods, namely:

- The first statistical method: calculating the Alpha - Cronpach coefficient by the number of positions of the scale, and each time the scores of one of the positions are deleted from the total score of the scale, and that step resulted in all positions being fixed, as it was found that the alpha coefficient of the scale as a whole in the absence of one The positions are less than or equal to the general alpha coefficient of the scale in the case of all situations, that is, entering any of the positions does not lead to a decrease in the overall stability coefficient of the scale.

- The second statistical method: To calculate the coefficient of the internal consistency of the scale, the correlation coefficients were calculated between the parking scores and the overall scores of the scale, and it was found that all the correlation coefficients are statistically significant, which indicates the internal consistency and stability of all positions of the scale of habits of mind produced for Marzano, and the following table shows the coefficients of the stability of the positions of the scale Habits of mind produced by the two previous statistical methods:

Table (2)

Stability coefficients for sub-positions and the scale as a whole

Correlation coefficient	Alpha coefficient	Scale position	Correlation coefficient	Alpha coefficient	Scale position
0.87	0.952	16	0.88	0.956	1
0.872	0.924	17	0.84	0.976	2
0.840	0.875	18	0.86	0.982	3
0.83	0.970	19	0.86	0.986	4
0.84	0.976	20	0.88	0.924	5
0.86	0.942	21	0.88	0.997	6
0.88	0.957	22	0.83	0.960	7
0.87	0.945	23	0.88	0.957	8
0.923	0.954	24	0.87	0.945	9
0.87	0.950	25	0.86	0.934	10
0.867	0.911	26	0.87	0.952	11
0.840	0.850	27	0.867	0.913	12
0.947	0.945	28	0.845	0.852	13
0.912	0.930	29	0.943	0.946	14
0.88	0.925	30	0.923	0.954	15
The general alpha coefficient of the scale if all positions of the scale are present = 0.958					

It is clear from the previous table:

- That all the correlation coefficients between the degree of each position and the total score of the scale (in the case of the sub-position (0.01), which indicates the internal consistency and stability of all sub-positions of the scale.
- The overall stability coefficient is equal to (0.958), which is a high stability coefficient that reassures the stability of the scale.
- Validity of the scale:
- The validity of the scale was calculated through the following:
- Virtual honesty calculation:

Where he presented the scale to a group of gentlemen, in order to know the suitability of the scale, as was explained previously.

Preparing a student scorecard:

The researchers used the following procedures in preparing the card:

Determine the goal of the card:

This card aimed to know the effect of the strategy based on thinking maps on the extent of the study group's pupils practicing productive habits of mind.

Description of the Pupils Scorecard for Producing Habits of Mind:

The scorecard for the Habits of Mind produced in its initial form consisted of (30) phrases for the middle school students.

Card Instructions:

The researchers drafted the card instructions in a procedural way to direct middle school pupils to the performances to follow when answering the card's phrases.

Card settings:

To set the students 'performance rating card for the productive habits of the mind, the researchers presented the card to a group of referees who specialize in curricula and methods of teaching science and field experts such as mentors and teachers of science.

Card Rating:

The card contains positive and negative phrases.
The evaluation of positive statements was as follows: When the student's response to situations: I do this behavior (apply) it is given 3 marks, and (unsure) two degrees, and (not applicable) one score, and vice versa if the statements were

negative. Thus, the maximum score for the card is 90 degrees, and the micro score is 30 degrees.

Card Exploratory Experience:

The pupils 'performance score card was applied to a group of second-grade middle school students at Saqr Quraish Preparatory School in Dammam, in the academic year (2015/2016), and their number reached (15) students, with the purpose of:
A - Calculating the time of application of the card
B - Calculate the scorecard reliability factor:
The reliability of the students' performance scorecard for productive habits of the mind (for sub habits and for the card as a whole) was calculated using two statistical methods:

The first statistical method

The calculation of the Alpha - Cronbach coefficient by the number of the card's sub-items, and each time the scores for one of the sub-clauses are deleted from the total score of the card, and that step resulted in all the sub-clauses being fixed, as it was found that the alpha coefficient of the card as a whole was absent One of the sub-clauses is less than and equal to the general alpha coefficient of the card if all the sub-clauses are present, meaning that entering any of the sub-clauses does not lead to a decrease in the overall stability factor of the card.

The second statistical method

To compute the internal consistency coefficient, the correlation coefficients were calculated between the scores of the sub-statements and the total scores of the scorecard, and it was found that all the correlation coefficients were statistically significant, which indicates the internal consistency and the stability of all the sub-statements of the students' performance rating card for the productive habits of the mind. Stability of the sub-phrases of the students' performance score card for the habits of mind produced by the two previous statistical methods.

Table (3)
Scorecard statement stability parameters

Correlation coefficient	Alpha coefficient	Card phrases	Correlation coefficient	Alpha coefficient	Card phrases
**0.872	0.975	16	**0.89	0.846	1
**0.87	0.850	17	**0.88	0.874	2
**0.867	0.896	18	**0.87	0.889	3
**0.932	0.878	19	**0.89	0.976	4
**0.885	0.875	20	**0.90	0.974	5
**0.885	0.876	21	**0.957	0.967	6
**0.955	0.878	22	**0.924	0.870	7
**0.895	0.857	23	**0.89	0.859	8
**0.853	0.92	24	**0.896	0.897	9
**0.924	0.870	25	**0.892	0.865	10
**0.89	0.846	26	**0.863	0.952	11
**0.89	0.872	27	**0.847	0.913	12
**0.883	0.975	28	**0.924	0.870	13
**0.932	0.974	29	**0.89	0.859	14
**0.957	0.965	30	**0.896	0.897	15
The general alpha coefficient of the scorecard if all sub-clauses are present = 0.962					

* Statistically significant at (0.01) level*

It is clear from the previous table that

- All the correlation coefficients between the score of each sub-clause and the total score of the card (in the case of omitting the sub-phrase score) are statistically significant at (0.01), which indicates the internal consistency and stability of all sub-clauses of the card.
- The overall stability coefficient is equal to (0.94), which is a high stability coefficient that reassures the stability of the card.

E - Authenticate the card:

The apparent validity of the card was calculated, where the card was presented to a group of arbitrators, in order to know the suitability of the appreciation card, as was previously explained.

Tribal application of study tools:

The researchers selected a group at Saqr Quraish School in Dammam, affiliated to the Department of Education in the Eastern Province of the Kingdom of Saudi Arabia, which included (68) male and female students as an experimental group and another group of (68) male and female students as a control group. The current study tools were applied beforehand, and the tribal application of the study tools resulted in the sample members. On the equivalence of the two study groups in the

tribal application of research and study tools. Details of the tribal teaching of the two study groups have been monitored, and notes on the progress of the application are provided in Appendix (7).

Research results, their interpretation and recommendations:

First: - Demonstrating the effectiveness of the strategy based on thinking maps in teaching science on the development of achievement among preparatory school students:

Through a dimensional comparison between the performance of the two study groups, and to make sure of that, the first hypothesis was formulated, which states: "There are statistically significant differences at the level of (0.01) between the mean scores of the students of the experimental and control groups in the post-achievement test in favor of the students of the experimental group." To verify the validity of this hypothesis, the researchers used the statistical software package (SPSS. 18) as follows: where he applied the (T) test, and the ETA square was calculated to measure the size of the impact of the strategy. The results of the test application and the ETA box resulted in the data shown in the table. The following:

Table (4)
(T) test results and the standard deviation of the difference between the mean scores of the two study groups in the achievement test.

Degree of effectiveness	**The probability value**	(T) Value	Degree of freedom	standard deviation	Average	Number	Group
0.74	0.001	7.33-	134	7.80	39.08	68	Experimental
				7.12	23.82	68	Controller

The next graph also shows the difference between the mean scores of both of the experimental and the controller groups in the achievement test.

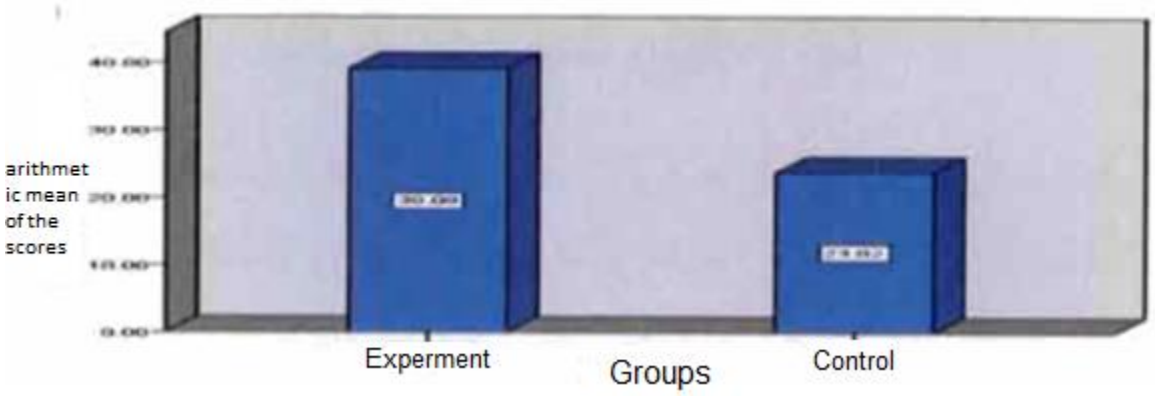


Figure (1) a graphic representation of the arithmetic means of the scores of the two study groups in the achievement test.

It is clear from the previous review that:

That the statistical value Sig 0.001 is less than the significance level (0.01), and this means that there is a statistically significant difference at the level of (0.01) between the mean scores of the experimental and control groups in the post-achievement test for the benefit of the experimental group.

The size of the impact of the strategy reached (0.074), which is the size of a high impact. If the value of the ETA square is (0.02), the size of the effect is weak and if it reaches (0.05) it is considered medium and if it reaches (0.08) it is considered high, which indicates the effectiveness of the strategy based on thinking maps in the teaching of science on the development of achievement among pupils of the experimental group.

To confirm the correctness of the previous result, the modified black's gain ratio was calculated for the Modified Blake's Gain Ratio, and the range of the adjusted gain ratio for Black extends from (zero) to (2), so that:

- If Adjusted Earning Percentage value <1 The strategy is considered ineffective or unacceptably ineffective, or of low effectiveness.
- If 1 the value of the modified gain percentage <1.2, the strategy is reasonable or moderately effective, meaning that the minimum acceptable level for the modified gain percentage is the correct one.
- If the value of the adjusted gain percentage of 1.2, the strategy is effective and acceptable, and this is the value proposed by Black to judge the effectiveness of the strategy.

• Calculate the Corrected Ezzat's Gain Ratio (CE Gratio), such that:

- If The corrected gain percentage value <1.5 The strategy is ineffective, unacceptable ineffective, or low ineffectiveness.
- If 1.5 the earning percentage value <1.8, the strategy is reasonable or moderately effective.
- If 1.8 ≤ the corrected gain percentage, the strategy is effective and acceptable

• The following table shows the adjusted gain percentage for Black and the corrected for Ezzat in the achievement test of the study sample students.

Table (5)

The adjusted gain ratio for (Black), and the corrected gain ratio for (Ezzat) in the achievement test of the experimental group

The corrected gain ratio for Ezzat	Adjusted gain ratio for BlackBerry	Great end to the test	Average post application	Average tribal application	variable
1.97	1.259	50	39.08	11.82	Achievement test

It is clear from the previous table that

• That the value of Black's adjusted gain percentage is equal to (1.259) in the achievement test, which is greater than the value (1.2) proposed by Black to judge

the effectiveness of the strategy, indicating that the strategy based on thinking maps is effective in developing achievement among the experimental group students.

• That the value of the corrected gain ratio for Ezzat is equal to (1.97) on the achievement test, which is a value greater than the value (1.8) proposed by Ezzat to judge the effectiveness of the strategy based on thinking maps, and it is an effective value in developing the achievement of the experimental group students of the study sample.

• From the total results of the first hypothesis, it is clear that it has been achieved, as the results of this hypothesis indicated that there is a statistically significant difference between the mean scores of the experimental and control groups in the post-application of the achievement test in favor of the post-application of the experimental group and that the strategy based on thinking maps has a very strong and effective effect. In the development of achievement among the experimental group students in the post-application.

From the above, the effectiveness of the strategy based on thinking maps in the development of achievement for preparatory school students.

In light of this accept the first assumption. The previous result can be interpreted as follows:

1- The strategy based on thinking maps has contributed an effective role in developing achievement by increasing the focus of pupils' attention on the readable topic, arriving at the ideas it contains, and presenting them in situations similar to natural situations.

2- The strategy based on thinking maps focuses on the pupils ’positivity through their work in cooperative groups, which led to the creation of a good educational climate dominated by cooperation, which led to an increase in students’ cognitive achievement.

3- Pupils' representation of knowledge in the form of diagrams, which facilitated the learning process due to the pupils ’ability to remember images and visual shapes.

4- Organizing the scientific content of the unit in the form of thinking maps that led to the students' use of knowledge in meaningful use, which in turn leads to increased achievement.

5- Gathering information and logically linking it in one form that provides an opportunity to explore the largest number of ideas and concepts found in the topics of the lesson.

Second: - Results related to the application of the productive habits of mind scale:

By comparing the performance of the two study groups in dimension, and to make sure of this, the second hypothesis was formulated, which states that: “There are statistically significant differences at the level (0.01) between the scores of the

students of the experimental and control groups in the habits of mind scale in the post-application in favor of the experimental group students.
This hypothesis was verified by applying the T. Test for the unrelated group and calculating the ETA square. The results of the test application yielded the following data:

Table (6)
(T) test results for the difference between the mean scores of the two study groups on the Dimensional Produced Habits of Mind scale.

Impact level	Effect size	The probability value	(T) value	Degree of freedom	standard deviation	Average	Application	Number
Very strong	0.82	0.001	-38.91	134	3.45	77.11	experimental	68
					3.93	52.57	controller	68

It is clear from the previous table that

• That the value of Black's adjusted gain percentage is equal to (1.259) in the achievement test, which is greater than the value (1.2) proposed by Black to judge the effectiveness of the strategy, indicating that the strategy based on thinking maps is effective in developing achievement among the experimental group students.
• That the value of the corrected gain ratio for Ezzat is equal to (1.97) on the achievement test, which is a value greater than the value (1.8) proposed by Ezzat to judge the effectiveness of the strategy based on thinking maps, and it is an effective value in developing the achievement of the experimental group students of the study sample.
• From the total results of the first hypothesis, it is clear that it has been achieved, as the results of this hypothesis indicated that there is a statistically significant difference between the mean scores of the experimental and control groups in the post application of the achievement test in favor of the post application of the experimental group, and that the strategy based on thinking maps has a very strong and effective effect. In the development of achievement among the experimental group students in the post application.
From the above, the effectiveness of the strategy based on thinking maps in the development of achievement for preparatory school students.

In light of this accept the first assumption. The previous result can be interpreted as follows:

1- The strategy based on thinking maps has contributed an effective role in developing achievement by increasing the focus of pupils' attention on the readable topic, arriving at the ideas it contains, and presenting them in situations similar to natural situations
2- The strategy based on thinking maps focuses on the pupils 'positivity through their work in cooperative groups, which led to the creation of a good educational climate dominated by cooperation, which led to an increase in students' cognitive achievement.
3- Pupils' representation of knowledge in the form of diagrams, which facilitated the learning process due to the pupils 'ability to remember images and visual shapes.
4- Organizing the scientific content of the unit in the form of thinking maps that led to the students' use of knowledge in meaningful use, which in turn leads to increased achievement.
5- Gathering information and logically linking it in one form that provides an opportunity to explore the largest number of ideas and concepts found in the topics of the lesson.

Second: - Results related to the application of the productive habits of mind scale:

By comparing the performance of the two study groups in dimension, and to make sure of this, the second hypothesis was formulated, which states that: "There are statistically significant differences at the level (0.01) between the scores of the students of the experimental and control groups in the habits of mind scale in the post-application in favor of the experimental group students.

This hypothesis was verified by applying the T. Test for the unrelated group and calculating the ETA square. The results of the test application yielded the following data:

Table (6)
(T) test results for the difference between the mean scores of the two study groups on the Dimensional Produced Habits of Mind scale.

Impact level	Effect size	The probability value	(T) value	Degree of freedom	standard deviation	Average	Application	Number
V.strong	0.82	0.001	-38.91	134	3.45	77.11	experimental	68
					3.93	52.57	controller	68

The following graph also shows the difference between the mean scores of the experimental and control groups in the scale.

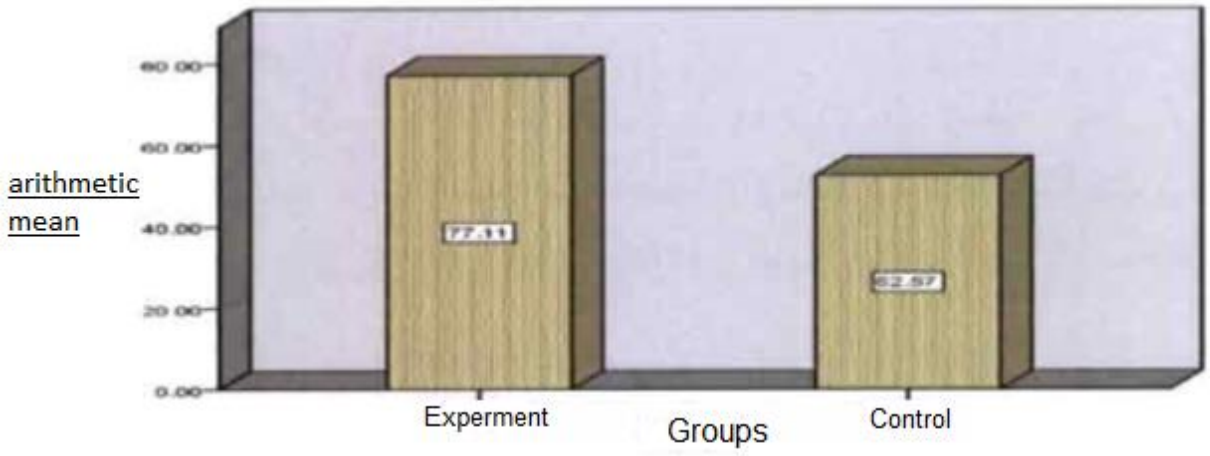


Figure (2) a graphic representation of the arithmetic means of the two study groups for the scale

It is clear from the previous review that:

• That the probability value Sig is equal to (0.001) and it is less than the level of significance (0.01). This means that there is a statistically significant difference at the level of (0.01) between the mean scores of the experimental and control groups in the scale.

• The size of the effect of the strategy reached (0.82), which is the size of the effect (high), which indicates the effectiveness of the strategy based on thinking maps in developing the habits of mind produced among the experimental group of the study sample.

To further confirm the correctness of the previous result, the adjusted gain percentage for Black was calculated, and the corrected gain ratio for Ezzat and the following table explains that:

Table (7)
Blake-adjusted gain ratio and Ezzat-adjusted gain ratio In the Habits of Mind Productive Scale.

The corrected gain ratio for Ezzat	Adjusted gain ratio for BlackBerry	Great end to the test	Average post application	Average tribal application	variable
1.51	0.88	90	77.11	54.76	the scale

It is clear from the previous table that

• That the value of Black's adjusted gain percentage is equal to (0.88) on the scale, which is close to the value (1.2) proposed by Black to judge the effectiveness of the strategy, which indicates that the strategy based on thinking maps is effective in developing the habits of mind produced among the students of the study sample.
• That the value of the corrected gain ratio for Ezzat is equal to (1.51) on the scale, and it is close to the value proposed by Ezzat to judge the effectiveness of the strategy, which indicates that the strategy based on thinking maps is effective in developing the productive habits of mind among the students of the study sample.

The previous result can be interpreted as follows

1- The strategy based on thinking maps includes many activities that allow students the opportunity to develop habits of mind, such as: the ability to organize oneself.
2- The work in cooperative groups contributed to increasing the pupils 'ability to develop an organized plan to work within the group to reach the best performance among the rest of the groups and the pupils' evaluation of themselves within the same group.

3- Working in cooperative groups helped students to criticize themselves and provide appropriate feedback to reach the group for the best performance.
4- Teaching with a strategy based on thinking maps helped students improve their way of thinking.

Third: **-** Results related to the application of the scorecard

- The third hypothesis was formulated as follows: There was a statistically significant difference at the level of 0.01 between the mean scores of the experimental group that was studied using the strategy based on thinking maps and the control group that was studied in the usual way for the performance rating card by the students for the benefit of the experimental group. This hypothesis was verified by applying the group's T-test, and the results of the test application resulted in the following data:

Table (8)
(T) test results for the difference between the mean scores of the two study groups in the scorecard.

Impact level	The probability value	(T) value	Degree of freedom	standard deviation	Average	Application	Number
0.92	0.001	9.22-	134	4.19	79.44	**experimental**	68
				5.68	56.91	**controller**	68

The following graph also shows the difference between the mean scores of the two experimental control groups in the scorecard.

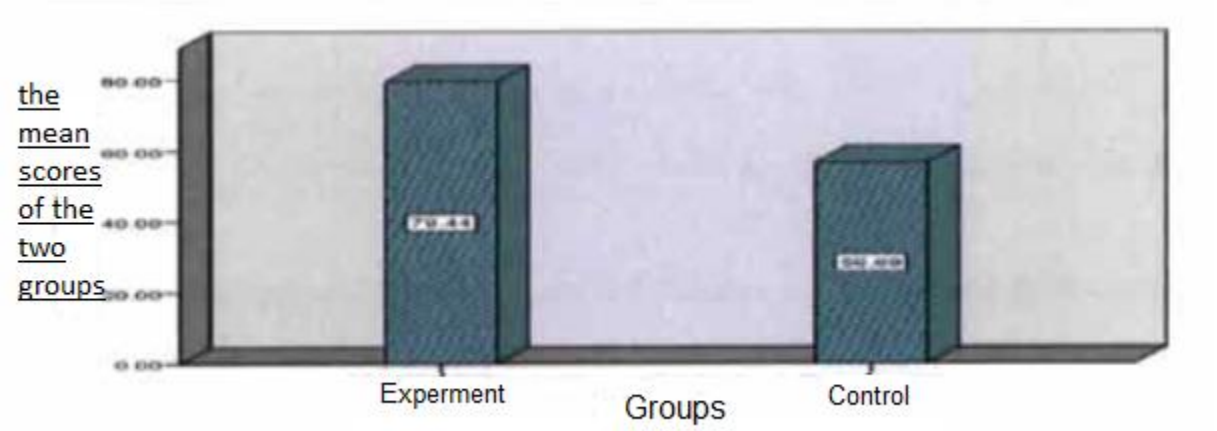


Figure (3) The graphic representation of the mean scores of the two groups of the study on the performance rating card. The previous presentation shows the following:

- That the probability value sig is equal to (0.001) and it is less than the level of significance (0.01), and this means that there is a statistically significant difference at the level of (0.01) between the mean scores of the students of the experimental and control groups in the rating card in favor of the students of the experimental group.
- The size of the impact of the strategy reached (0.92), which is considered high, which indicates the effectiveness of the strategy based on thinking maps in developing productive habits of mind.

To further confirm the correctness of the previous result, the adjusted gain percentage for Black was calculated, and the corrected gain ratio for Ezzat and the following table shows that: -

Table (9)
Blake Adjusted Gain Ratio and Ezzat Adjusted Gain Ratio in the Dimensional Rating Card

The corrected gain ratio for Ezzat	Adjusted gain ratio for BlackBerry	Great end to the test	Average post application	Average tribal application	variable
1.61	0.93	90	79.44	56.79	Appreciation Card

The previous table shows the following

- That the value of Black's adjusted gain percentage is equal to (0.93), on the grading card, which is close to the value (1.2) that Black suggested judging the effectiveness of the strategy, which indicates that the strategy based on thinking maps is effective in developing the habits of the mind produced in students Experimental group study sample.

- That the value of the corrected earnings ratio for Ezzat is equal to (1.61) on the rating card, which is close to the same value that Ezzat proposed to judge the effectiveness of the strategy, which indicates that the strategy based on thinking maps is effective in developing productive habits of the mind.

The previous result can be interpreted as follows

1- Using a strategy based on thinking maps, helped the pupils of the experimental group to make the most of their mental abilities through various activities within the unit in an attempt to develop habits of the mind.
2- The interaction between the cooperative groups and the flexibility in dealing between the group and some of them develops his listening to others and tries to

search for everything new to bring his group to a better performance level as a result of competition.

3- Providing a classroom environment for students in which creative activities can be practiced while learning the lessons of the selected unit according to the strategy based on thinking maps.

4- Increasing pupils' motivation and enthusiasm and eagerness to learn, as the strategy provided in conveying their ideas and expressing them more creatively.

Fourth

Comparison between the evaluation of the students' performance for themselves and the teacher's evaluation of their performance in the distance on the scorecard for productive habits of mind.

Comparison between the evaluation of pupils' performance and the teacher's evaluation of their performance remotely on the performance scorecard for productive habits of the mind. The fourth hypothesis was formulated which states, "There is a statistically significant difference at the level of 0.01 between the average performance scores of the students of the experimental group that studied the strategy based on thinking maps, and the evaluation scores The teacher for their performance afterward on the scorecard in favor of the pupils 'evaluation of their performance. To verify this hypothesis, the (T) test was used, and the results of applying the test (T) resulted in the data shown in the following table:

Table (10)

T-test results to compare students' evaluation of their own performance
The teacher's evaluation of students 'performance is dimensional on the scorecard.

Significance level	Degree of freedom	standard deviation	Average	Application	Type of evaluation
0.001	67	24.22	3	79.44	Pupils' performance evaluation
			3.99	64.68	Teacher evaluation of pupil performance

It is clear from the previous table that

There are statistically significant differences between the mean scores of the pupils 'evaluation of their performance, and the teacher's evaluation of the students' performance at the level of 0.001 in the scorecard. Habits of mind produced afterward in favor of the pupils 'evaluation of their performance and this means that the student was biased to his performance on the scorecard. Because of the productive habits of the mind, the average score of the student's evaluation of his

performance on the card was higher than the teacher's evaluation of the student's performance.

The previous results can be interpreted as

That the student is often biased towards his performance when answering the scorecard, and this is due to the fact that he may see himself performing the behaviors properly and not admit the error in performing some practices.

Study recommendations

In light of the study's findings, researchers recommend the following:

- The necessity of using thinking maps in teaching science and generalizing that as much as possible.
- Holding training courses for science teachers to train them in using modern teaching strategies such as thinking maps instead of the usual method.
- Paying attention to developing productive habits of mind related to the study of science because of their great role in overcoming common life problems and situations among students.

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