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THE EFFECT OF THE POST-BRANNAN STRATEGY ON ACHIEVEMENT AND SYSTEMIC THINKING AMONG MIDDLE SCHOOL GIRLS IN BIOLOGY

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Abstract:
The study aims to identify the effect of the post-Brannan strategy on achievement and systemic thinking among middle school female students. The research sample consisted of 72 students from one of the schools under the General Directorate of Education in Maysan for the academic year 2024–2025. The experimental group consisted of 36 students who were taught using the post-Brannan strategy, and the control group consisted of 36 students who were taught using the traditional method.
The researcher ensured the equivalence of the two groups in variables such as intelligence, prior achievement in science, and prior knowledge. The researcher also prepared two tools: the first was an achievement test composed of 24 multiple-choice questions with four options, and the second was a systemic thinking test composed of 30 multiple-choice questions with four options. The researcher verified the validity and reliability of both tools. After applying the experiment and analyzing the data statistically using the T-test, the results showed significant differences between the experimental and control groups in both the achievement test and the systemic thinking test, in favor of the experimental group.

Keywords: Post-Brennan Strategy Systemic Thinking, Biology Subject

Chapter One:
Introduction:
First: The Problem
The development, renewal, and modernization in the field of teaching methods is no longer a topic of debate or a matter of disagreement among specialists in educational sciences. Rather, it has become a vital necessity to create a balance between the advanced education systems, which aim for changes and goals on one hand, and the rapid pace of life and the challenges it brings, which are associated with the components of educational systems on the other. (Al-Faily, 2014: 143)
Many studies have pointed out that there is a gap in academic achievement in biology, including the study by Hadi (2019) and the study by Sheikho (2020). This weakness in learners' levels is

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due to relying on traditional teaching methods. From the above, it's clear that conventional teaching methods are no longer capable of effectively conveying scientific material in a way that improves students' performance and develops their thinking processes, including systemic thinking. This is one of the modern approaches in education, where its essence lies in structures and frameworks that learners are not familiar with and lack the ability to handle effectively; if they are taught these structures, they can interact with them efficiently (Ismail, 2012: 22). Many studies have confirmed this, including the study by Abed (2018), Dawood (2018), and Al-Shoubaki (2010), which led the researcher to use the Post-Brainan strategy to see its effect on students' achievement and systemic thinking. The research problem can be identified through the following question: What is the effect of the Post-Brennan strategy on achievement and systems thinking among middle school girls in biology?

Secondly: Importance of the research:- The current era is witnessing a huge increase in knowledge and information, which has contributed to making clear changes in the field of education. This rapid progress has led to reshaping the educational process, as the learner is no longer just a recipient of information, but has become a central figure in the educational system and in building scientific knowledge through modern technologies that enhance their abilities and develop their skills. (Abdel-Sahib & Susan, 2014:114)

Education focuses on the learner as the main center of the educational process, and the educational institution should provide all their basic needs, including attention to experiences and knowledge and presenting them in a way that suits their inclinations and abilities. Education concerns itself with the growth of the individual cognitively, emotionally, sentimentally, and physically, and it involves activities that guide the person's behavior, aiming at the development of their mental abilities, attitudes, and talents in a way that fits their society. (Atiyya, 2013, p. 261).

Biology is considered one of the important sciences in middle school because of its role in building students' scientific concepts and developing their abilities in observation, reasoning, prediction, and conducting scientific experiments. Moreover, its topics are connected to students' daily lives, especially in areas like health, nutrition, environment, and prevention. Studying biology at this stage also helps in forming positive scientific attitudes among students and raising their awareness about taking care of their health, environment, and living creatures around them. Teaching biology becomes even more important in middle school because students at this stage are developing their thinking processes and their ability to build scientific concepts and use them in new life situations. (Abdel Samad, Abdel Karim & Rawa Mardan Faleh, 2014, p. 365)

It has become necessary to adopt modern teaching strategies that focus on the learner, taking into account their abilities and needs, and contribute to activating their role in the learning process by involving them in activities, discussions, research, thinking, and problem-solving. These strategies also help develop thinking skills and enhance the learner's ability to apply knowledge and information in different learning situations. (Al-Adwan & Ahmed, 235:216)

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Among these strategies is the Post-Brennan strategy, which equips the learner with the basic skills to handle new situations and problems they have never encountered and enables them to understand a method of organized scientific thinking based on logical foundations. The student learns by solving the problems they face, which requires putting the student in the position of a truth-seeking researcher, thinking and experimenting for themselves until they gain experience in confronting and dealing with life's problems. (Al-Fayyad, 2014: 275)

Teaching thinking has become one of the important goals of the educational process, so educators need to focus on teaching thinking and its skills. Learning all types of thinking, especially systemic thinking, is considered one of the most important skills in modern education due to the rapid developments in scientific, social, cultural, and other systems. Moreover, the complexity of obtaining information and summarizing its components through satellites, the internet, and various communication systems has made paying attention to the basic components essential to keep up with the development of different sciences. (Saqr, 2014: 15)

In light of the above, the importance of the research is outlined as follows:

1 -The Post-Brennan strategy places the learner at the center of the educational process, aligning with modern teaching philosophy, as it helps create a learning environment that enables students to solve problems functionally.

2 -The importance of systemic thinking lies in its help to understand scientific topics and concepts in a comprehensive and interconnected manner.

3 -An experimental attempt that may contribute to improving students' skills, by encouraging them to rely on themselves in communication, problem-solving, perseverance, and striving to think through the scientific material presented to them in the Biology course.

4 -This research benefits researchers and those interested in developing various teaching methods by reviewing its results.

5- Achieving educational goals effectively and understanding the topics of Biology, which leads to raising learners' achievement levels.

Third: Research Aim and Hypotheses:

The Research Hypotheses and Its Aim the research aims to identify the effect of using the Post-Brienan strategy on achievement and systemic thinking among middle school female students in the subject of Biology.

To achieve the research goal, the following two hypotheses were formulated:

1. There is no statistically significant difference at the significance level (0.05) between the average scores of the experimental group students who study Biology topics according to the Post-Brienan strategy and the average scores of the control group students who study the material using the conventional method in the post-achievement test.

2. There is no statistically significant difference at the significance level (0.05) between the average scores of the experimental group students who study Biology topics according to the

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Post-Brienan strategy and the average scores of the control group students who study the material using the conventional method in the post-systemic thinking test.

Fourth: Research Limits

Human Limit: Second-year middle school female students .

Spatial Limit: Daytime middle and high schools for girls under the General Directorate of Education in Maysan .

Time Limit: The first semester of the academic year .(2025-2024)

Scientific Limit: The first four chapters of the Biology textbook prescribed for second-year middle school, 5th edition, for the year (2023) in the first semester.

Fifth: Definition of Terms

Determination of The Terms

1 -Post and Brennan Strategy:

A- Terminologically: It has been defined by:

•Abu Rish (2007): "A process through which the student can discover the connection between previously learned laws, and can apply them to solve a new problem, leading to learning." (Abu Rish, 2007: 296)

•Atiya (2008): "It is the basic steps planned by the teacher to achieve the curriculum objectives, including every action or procedure that has a purpose or goal." (Atiya, 2008, p.30)

B- Operational definition: A set of organized procedures, teaching plans, and educational activities carried out by the school based on the steps of the Post and Brennan strategy to encourage students to solve problems that lead to their learning of biology topics in order to achieve the desired objectives.

2 -Achievement:

A- Terminologically: It has been defined by:

•Ismaili (2019) as "a level of performance or competence in school work, evaluated based on teachers' assessments or standardized tests, or both" (Ismaili, 2019: 39).

•Ayadah (2001) as "the stage that students reach in their teaching of the academic subjects" (Ayadah, 2001: 146).

B- Operational definition: It is the accomplishment achieved by second-year middle school students in biology after completing the experiment, measured by the scores obtained by the research groups in the post-achievement test prepared by the researcher.

3 -**Systems Thinking:**

A- Terminologically: It was defined by both:

•Al-Kubaisi (2010) as a specific type of thinking that deals with concepts and content in the subject matter through an integrated system, where the relationships between these concepts become clear, enabling the learner to connect previous experiences with new ones. (Al-Kubaisi, 2010: 59)

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B- Operational Definition: The ability of the research sample students to think and solve the problems they encounter while studying biology, through reading, analyzing, and understanding the relationships and connections, leading to a comprehensive view in order to reach solutions to these problems. This ability is measured through the scores the students obtain in the systems test prepared by the researcher for this purpose.

Chapter Two-:

Theoretical Aspects and Previous Studies :- This chapter includes theoretical aspects to clarify the research variables, in addition to mentioning a number of previous studies related to its variables, as follows:

First Axis :- Theoretical Aspects

Firstly :- Post & Brennan Strategy

The Post-Brennan strategy is one of the modern strategies that help learners enrich their knowledge and improve their achievement by relying on themselves during learning instead of just memorizing and being lectured to. It gives them a chance to contribute to discovering information, discussing it, and encourages them to ask questions to express their new ideas. This strategy is linked to a practical way of solving human problems, ranging from simple everyday problems to complex social issues. The ability to solve problems is considered one of the most important outcomes of learning because solving a problem requires the learner to have a certain amount of information and skills. The ability to use and apply information and concepts is an essential part of the problem-solving process. (Al-Mutairi, 2022: 93)

The Post and Brennan strategy consists of the following stages :

Stage One: Recognizing, clarifying, and understanding the problem:

Recognizing the problem is the first step in the process of analyzing and understanding it and its causes. A person cannot make an effective decision unless they are aware that there is a problem that deserves attention. Recognizing the problem means that the individual understands there is a gap between reality and the desired outcome. The degree of problem recognition varies depending on the learner's scientific knowledge and personal experience, as recognition affects how the learner understands and analyzes the problem. Before solving an issue, a person needs to understand, visualize, and perceive exactly what the problem is. This relates to the characteristics of both the individual and the subject of the problem by clarifying and defining uncertainty and doubt. The problem should meet the following criteria:

1 -The problem should be within the researcher's scope and interest.
2 -The researcher's competence and scientific ability.
3 -The modernity and originality of the problem.
4 -The problem should be realistic and researchable.
5 -Availability of material and environmental resources and conditions.
(Jabri et al., 2023: 336)

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Stage Two: Confronting and Analyzing the Problem:- Confronting the problem (analyzed) This is done by:

• Gathering data and recalling facts, concepts, and laws, and looking for the necessary relationships for the solution.

• Retrieving missing information, testing information that has relationships with statements in the problem, and searching for new information.

• Determining the activities of the required approach by observing the obstacles present in solving the problem.

Phase Three: The Production Phase: - Productive Phase

It aims to achieve the following:

•Establish the relationship between the given and unknown information.

•Search for alternative hypotheses (possible solutions to the problem).

•Organize the information the student has during the test.

•Reject hypotheses that do not meet the problem's conditions.

• Test the validity of the solutions. Here, hypotheses are tried and chosen one by one until reaching the correct solution, which is supported by sufficient scientific evidence proving its validity. (Zayyer et al., 2014:108)

Stage Four: Ensuring the Solution is Correct: - Check the answer

In this stage, the person facing the problem looks for a solution by suggesting possible alternatives, which we call hypotheses. A hypothesis is a solution that needs to be applied. To be able to suggest alternatives and hypotheses, the problem-solver must analyze the problem and gather relevant data and information concerning its causes and influencing factors. Alternatives and hypotheses usually stem from the underlying causes of the problem, with the cause being transformed from an interrogative form into a declarative statement.
(Tawallabah et al., 2011: 65)

❖ Advantages of the Post-Brennan Strategy:

1 -Develops the learner's thinking.

2 -Develops the learner's scientific research skills.

3- Develops the student's personality by relying on themselves.

❖ The Learner’s Role in the Post-Brain Strategy:

The teacher's role in the Post-Brain strategy can be defined as follows:

1 -One of the sources of knowledge.

2 -A guide and mentor for learning.

3 -Involves the learner in the assessment process and utilizes self-assessment.

4 -Raises questions and provides students the opportunity to reach multiple answers to develop thinking.

❖ The Learner’s Role in the Post-Brain Strategy:

The learner’s role in the Post-Brain strategy can be defined as follows:

1 -Gathers, analyzes, and classifies information.

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2 -Initiates, discusses, works, and acquires the skills of an effective researcher.
3 -Takes initiative to solve the problems they face.
4 -Takes responsibility for their own learning.
5 -Applies the knowledge they've learned in new situations and uses it to solve new problems.
6 -Identifies issues and solves them in various ways.
(Abdul Amir & Ali, 2023: 1119-1120)

Second: Systems Thinking:
In educational literature, systems thinking is viewed as that style of thinking which includes managing the thinking process, as well as thinking about thinking itself. It thus requires higher-order thinking skills that demand a comprehensive future-oriented perspective, meaning moving from abstract thinking to holistic thinking about all the elements being dealt with. It is a type of thinking that addresses practical knowledge in an integrated way, where the learner becomes aware through their thinking in a connected, systematic manner, and is capable of building, analyzing, and discovering the relationships between elements of scientific knowledge .
(Ali, 2026: 41)

❖ **Characteristics of Systems Thinking:**
There are several characteristics of systems thinking:
•It looks at the situation as a whole and considers the broader context, resisting the tendency to oversimplify problems and solutions.
•It considers the general properties of the system as a whole, which arise from the relationships (connections) between the parts that make up this system.
•It encourages participation during problem-solving and works on integrating decision-making and management.
•It urges us to appreciate others' perspectives.
•Our theory can extend to science and makes us more aware of the assumptions and limits we use to define things.
(Hamada, 2024: 38)

❖ **Objectives of Systemic Thinking-:**
•Developing an individual's ability to analyze cultural, scientific, and social topics into their subcomponents to make it easier to link them interactively, inferentially, or logically.
•Connecting the overall components of knowledge to form an integrated system.
•Encouraging learners to see relationships in a comprehensive way for any topic without losing its components or details.
•Systemic thinking aligns with educational, social, and environmental systems as it requires individuals to understand and perceive them broadly.
• Systemic thinking works on developing learners' creative abilities by quickly reaching problem-solving solutions. (Al-Afoun & Muntaha, 2012: 165-166)

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❖ **Systemic Thinking Skills:- Skills of Systemic Thinking:**

First: System Analysis Skill:- This includes deriving sub-systems from main systems, drawing conclusions from a system, and detecting faulty parts within a system.

Second: System Evaluation Skill:- This includes judging the correctness of relationships between the parts of a system, developing systems, and gaining a comprehensive view of a situation through the system.

Third: System Construction Skill:- This includes building a system from several concepts, deriving generalizations of systems, and writing reports about the system.

Fourth: Relationship Management Skill:- This includes understanding the relationships between parts of sub-systems, understanding relationships between systems, and understanding the relationships between the whole and its parts. (Al-Saeed & Mohamed, 2006: 125)

Second Section:- Previous Studies

Table (1) shows previous studies on the two variables

Researcher's name, year, and country	Study Title	Sample size and gender	Topic	Methodology	Tools of study	The result
Pharaon, Ibrahim Kadhim (2019) – Al-Muthanna University, Iraq	The Impact of the Post-Brennan Strategy on Teaching Animal Physiology Topics: Developing Habits of Mind and 21st-Century Skills among Life Sciences Students	(56) students	Animal physiology	Test	Habits of Mind scale (consisting of 50 items) and 21st-Century Skills scale (consisting of 25 items)	The experimental group outperformed on both measures.
Hadi, Hanan Hadi Diwan (2019) – University of Babylon, Iraq	The Impact of the Post-Brennan Strategy on Biology Achievement and Self-Efficacy among Female Students in the Fourth Scientific Grade	(8) students	Biology subject	Experimental partial tuning	Achievement test (consisting of 50 items) and Self-Efficacy scale (consisting of 48 items)	The experimental group outperformed on the achievement test and the self-efficacy scale.
Abd al-Amir, Nagham Hadi (2023) – Baghdad, Iraq	The Effect of the Post and Brennan Strategy on Associative Thinking Among Fifth-Grade Science Stream Students	(62) students	Chemistry	Experimental	Associative Thinking Scale (consisting of 25 items)	The experimental group outperformed the control group on the measure.
Abed, Hamid Ihsan (2018) – University of Al-Qadisiyah, Iraq	The Effect of the Periodic Inquiry Model on Systems Thinking in Biology among Fifth-Grade Scientific-Stream Students	(74) students	Biology	Partially -tuned	Systems Thinking Test (consisting of 40 items(	There were differences in favor of the experimental group on the systems thinking test.
Mashikhu, Hashim Hassan Mastu (2020)Mosul – Iraq	The Effect of Instruction Using a Systems-Based Approach on Biology Achievement and the Development of Thinking Skills among Fourth-Grade Scientific-Stream Students	(55) students	Biology	Experimental	Achievement Test and Reflective Thinking Test	The experimental group outperformed the other group on the achievement test, while no statistically significant differences were found between the two groups on the reflective thinking test.

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❖ Benefits of using previous studies:

1 .They help in highlighting the research problem, its importance, and its hypotheses.

2 .Previous studies provided guidance on how to build the research tool and how to use appropriate statistical methods.

3 .They guide us to many books, scientific journals, and references that enrich the current research.

4. The results of some studies help in scientifically and objectively interpreting the research results.

Chapter Three: Research Methodology and Procedures

First: Research Method

The researcher relied on the experimental method as it is the most suitable method for achieving the research objective. It is characterized by high accuracy and scientific rigor, as it studies the causes of the phenomenon and what lies behind it, in order to obtain results that can be relied upon in the future.
(Al-Tal, 2017: 123)

Second: Experimental Design

The experimental design represents the researcher's plan to conduct the experiment. The researcher controls and manages the surrounding conditions affecting the variables to be studied. Experimental designs are defined as strategic plans that determine the precise, organized way to study the research hypotheses or questions derived from theory or practice.
(Habib, 2012: 188)

The researcher chose a quasi-experimental design with two groups: an experimental group exposed to the independent variable (Post-Brennan strategy), and a control group studied in the usual way, with achievement tests and systemic thinking tests being conducted.

Diagram (1) Experimental design of the research variables

Set	Equivalence	Dependent variable	Dependent variable	Post-test
Experimental	Equivalence	The variable	Equivalence	Achievement Test and Systems Thinking Test
Control		Normal way		

Third: Research Community and Its Sample

1- Research Community:

The research community consists of girls' day intermediate and secondary schools affiliated with the General Directorate of Education in Maysan / Maysan Governorate Center for the academic year (2023-2024).

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2- Research Sample:

After identifying the research community, Atika Bint Al-Hussein School for Girls was chosen as the place to apply the experiment. It is one of the girls' day secondary schools under the General Directorate of Education in Maysan Governorate Center, selected randomly to conduct the research. Class (B) was chosen to represent the experimental group taught according to the Post-Brinann strategy, and class (C) represented the control group taught with the regular method. The sample consisted of 83 students, and after excluding the students who failed statistically, totaling 11 students, the sample became 72 students: 36 students in the experimental group and 36 students in the control group, as shown in Table (2).

Table (2) Number of research sample members in the experimental and control groups

Set	dep	Number of female students before exclusion	Number of female students who failed	Number of female students after exclusion
Experimental	b	40	4	36
Control	k	43	7	36
Total		83	11	72

Fourth/ Equivalence of the Research Groups:

The researcher conducted a statistical equivalence check between the two research groups before starting the actual teaching, focusing on some variables believed to affect the dependent variables and the validity and accuracy of the experiment results. These variables are:

1- Intelligence Test: The researcher relied on Raven's Progressive Matrices test to determine the equivalence of the two groups in terms of intelligence. There was no statistically significant difference at the 0.05 significance level and a degree of freedom of 70 for the students in the research sample, as shown in Table (3) below. The calculated (t) value is less than the tabulated value, thus the two research groups are considered equivalent in this variable.

2- Previous achievement in Biology refers to the final grades that the students in the research sample received in Science for the first year of middle school for the academic year 2022-2023. When comparing the averages of the two groups using the T-test for independent samples, no statistically significant difference was found at the 0.05 significance level and with 70 degrees of freedom for the students in the research sample. As shown in Table 3 below, the calculated t-value is less than the table value, which means that the two research groups are equivalent in this variable.

3- Previous Knowledge in Biology: To find out what prior knowledge the students have in biology, the researcher prepared a test consisting of 20 multiple-choice questions with four options each. The validity of the test was checked by presenting it to a group of specialists in educational and psychological sciences to ensure the accuracy of its items. When comparing the averages of the two groups using the independent samples T-test, no statistically significant difference was found at a significance level of 0.05 and a degree of freedom of 70 for the students in the research sample. As shown in Table 3 below, the calculated t-value is less than the tabular value, meaning that the two research groups are equivalent in this variable.

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Table (3) Results of the T-test in the variables of intelligence, previous achievement, and prior knowledge

variable	group	Sample size	SMA	Standard deviation	Variance	Degree of freedom	T-value		at a significance level of(0.05)
							Calculated	Tabularization	
Intelligence Test	Experimental	36	30.361	3.016	9.096	70	1.296	1.994	Not statistically significant
	Control	36	29.417	3.166	10.023				
Prior Achievement	Experimental	36	70.250	10.020	100.514		0.904		
	Control	36	68.194	9.570	91.587				
Prior Knowledge	Experimental	36	7.806	1.704	2.904		1.648		
	Control	36	7.222	1.267	1.606				

Fifth / Research Requirements: (Research Procedures) -:

1 -Defining the subject matter: The researcher defined the subject matter studied in the first semester of the academic year (2023–2024), represented by the first and second chapters of Unit One: Classification and Diversity, and the third and fourth chapters of Unit Two: Characteristics of Living Organisms, from the Biology textbook prescribed for the second intermediate grade, as follows:-

•Unit One: Classification and Diversity: Chapter One: Taxonomy. Chapter Two: How Living Organisms Are Classified .

• Unit Two: Characteristics of Living Organisms: Chapter Three: Simple Living Organisms. Chapter Four: The Plant Kingdom.

2- Formation of Behavioral Objectives - :

The researcher formulated, based on the content of the scientific material, 98 behavioral objectives according to Bloom's classification in the cognitive domain for the levels of remembering, understanding, applying, and analyzing. The researcher presented these behavioral objectives to a group of judges and specialists in the field of education and methods of teaching biology to gather their opinions. Objectives with a 85% approval rate or above were accepted, as shown in Table.(4)

Table (4) Behavioral Objectives for the First Four Chapters of the Biology Book According to Bloom's Levels.

Unit	Part	Topics	Level				
			memory	Comprehension	The Application	Analysis	Total
First	First	Taxonomy	10	7	4	3	24
	Second	How living organisms are classified	11	8	4	4	27
Second	Third	Simple living organisms	10	7	5	4	26
	Fourth	The plant kingdom	8	7	3	3	21
Total			39	28	16	14	98

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3- Preparing Teaching Plans (Planning Instruction Preparation):- The researcher prepared (13) teaching plans for each of the experimental and control groups of the research sample, based on the educational content of the subject, represented by the first four chapters of the 2nd-grade intermediate biology textbook. These plans were then presented to a group of specialists in the field of education and science teaching methods.

Sixth: Preparing the Research Tool: Constructive Research Instrument

1 -The Achievement Test: Test Achievement

The researcher prepared an objective achievement test of the multiple-choice type consisting of 30 items with four alternatives. The researcher relied on the following procedures in constructing the achievement test:

A- Test Objective: The objective of the test is to measure the extent to which the students in the research sample have mastered the cognitive aspect of the scientific content from the Grade 2 Biology textbook, within Bloom's levels (Remembering, Understanding, Applying, Analyzing).

B- Preparing the Specification Table (Test Blueprint): The researcher prepared a test blueprint according to the content of the teaching material and the behavioral objectives, as shown in Table.(5)

Table (5) Test Blueprint for the Achievement Test Items According to Bloom's Classification

Part	Topics	Content weight	Level				
			memory %41	Comprehension %29	Application % 16	Analysis % 14	Total %100
First	Taxonomy	%23	3	2	1	1	7
Second	How living organisms are classified	%23	3	2	1	1	7
Third	Simple living organisms	%24	3	2	1	1	7
Fourth	The plant kingdom	%30	4	3	1	1	9
Total		%100	13	9	4	4	30

A- Test Validity:

To verify the validity of the test and its ability to achieve the objectives it was designed for, the researcher relied on two types of validity:

•Face Validity: The test was presented to a group of judges and specialists in educational and psychological sciences. A percentage agreement of 85% or more was considered a criterion for the appropriateness of the items.

• Content Validity: The researcher prepared the test items according to a test blueprint.

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B- Pilot Administration of the Test:

•First Pilot Test: To ensure the clarity of the test instructions and to calculate the time needed to complete the test, the researcher administered the achievement test to an initial pilot sample of 30 second-year middle school female students who were not part of the main study sample. It was found that the average time taken to answer the test was 40 minutes after calculating the average time for all students.

• Second Pilot Test: The test was administered to a second pilot sample of 100 female students, who were informed a week before the test date. After correcting and ranking the answers in descending order, 27% of the highest scores and 27% of the lowest scores were selected, making the total number of students in the high and low groups 54.

c- Statistical analysis of test items: - Item Difficulty Index: After calculating the difficulty index for each test item, it was found to range between 0.35 and 0.63, as shown in Table 6. Test items are considered acceptable if their difficulty range is between 0.20 and 0.80 and are rejected if they fall outside this range. (Malham, 2025: 444)

•Discrimination Index Item:

After calculating the discrimination power for each item in the test using the item discrimination power formula, I found it ranged between (0.29 – 0.67) Table (6). An item is considered good if its discrimination power is (0.25) or more. (Hamoud, 2023: 168)

•Effectiveness of Distractors:

A distractor is considered effective if it is chosen by at least 5% of the students who took the test (Majid, 2010, 30).

To check the effectiveness of the wrong options in the achievement test items, the researcher counted how many times each wrong option was chosen by the students in the high and low groups. The statistical results showed that all the wrong options for the 30 test items had a negative effectiveness index, which means that more students in the low group chose the wrong options than in the high group. Also, no wrong option had zero frequency. Based on this, all wrong options were considered statistically effective and acceptable .

Table (6) Difficulty and Discrimination Indices for the Post-Achievement Test

Paragraph sequence	Difficulty coefficient	Discrimination coefficient	Paragraph sequence	Difficulty coefficient	Discrimination coefficient
1	0.37	0.37	16	0.44	0.37
2	0.59	0.44	17	0.37	0.44
3	0.38	0.48	18	0.55	0.51
4	0.44	0.30	19	035	0.30
5	0.37	0.29	20	0.52	0.51
6	0.40	0.30	21	0.46	0.55
7	0.38	0.48	22	0.48	0.37

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8	0.38	0.41	23	0.46	0.48
9	0.63	0.59	24	0.44	0.37
10	0.33	0.30	25	0.54	0.41
11	0.54	0.40	26	0.56	0.52
12	0.40	0.67	27	0.35	0.37
13	0.35	0.41	28	0.41	0.37
14	0.40	0.44	29	0.40	0.30
15	0.37	0.30	30	0.41	0.44

A- Test Reliability :- Test Reliability

❖ Split-Half Method :- Split-Half Method

The test items were divided into two halves, the odd items and the even items, then the correlation between the two halves of the test was calculated using Pearson's correlation coefficient, which came out to be 0.69. Then this value was corrected using the Spearman–Brown formula, reaching 0.82, as a reliability coefficient is considered good if it is 0.67 or above. (Al-Jalabi, 2024: 121)

B- The Test in Its Final Form: The Final Version of the Test

After the researcher completed the steps of building the achievement test, which consists of 30 multiple-choice items with four alternatives, it was applied to the study groups after they were informed one week before the test date. The answers were graded according to the answer key, with one point for a correct answer and zero for an incorrect answer.

1- Systems Thinking Test:

A- Determining the purpose of the test: The purpose is to measure the systems thinking of second-year middle school students in the biology subject sample.

B- Preparing a list of systems thinking skills: After reviewing a number of research papers and educational studies, the researcher identified the systems thinking skills as follows: the first skill is systems analysis, the second skill is systems evaluation, the third skill is systems synthesis, and the fourth skill is relationship management.

C- Formulating test items: Based on the identified systems thinking skills, the systems thinking test items were formulated as multiple-choice questions, totaling 24 items.

D- Test Validity: To verify the validity of the systems thinking test and its ability to achieve the objectives for which it was designed, the researcher relied on two types of validity.

• Apparent honesty: - Validity Face - The systems thinking test was presented to a group of judges and specialists in educational and psychological sciences, as well as biology teachers, to verify its ability to measure the intended trait. A consensus rate of 85% or more was adopted as the standard for item validity.

• Discriminant Validity: Discriminant Validity is the ability of a measurement tool (test or scale) to distinguish between extreme or differing groups in the trait or phenomenon to be measured. It allows the researcher to statistically differentiate between the high-scoring group

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(those with a high level of the trait) and the low-scoring group (those with a low level of the trait), or to distinguish between different traits and concepts that are theoretically not expected to be highly correlated (Malham, 2025: 273). The scores of the second pilot sample consisting of 100 students were used as the analysis sample for the test items. The calculated t-value (15.33) is greater than the table value of 2.00 at the 0.05 significance level and 52 degrees of freedom, which indicates that the test is statistically significant and that its items effectively differentiated between the high and low groups, as shown in Table 7.

Table (7) Significance of the differences between the average scores of the high and low groups for calculating the discriminatory validity of the systematic test

group	Sample size	SMA	Standard deviation	Variance	Degree of freedom	T-value		At a significance level of 0.05
						Calculated	Tabularization	
The Higher	**27**	**20،19**	**2.39**	**5.70**	**52**	**15.33**	**2.00**	Statistically significant
The Lower	**27**	**7.11**	**3.74**	**13.95**				

A- Pilot Administration of the Test:

•First Pilot Administration: The researcher applied the Systems Thinking Test to an initial pilot sample consisting of 40 female students from the second grade of middle school, who were not part of the research sample. It was found that the average time taken to respond was 45 minutes after calculating the average time for all the students.

• Second Pilot Administration: The Systems Thinking Test was applied to a second pilot sample of 100 female students, also not part of the research sample. The students were informed one week before the test date. After correcting and ranking the answers in descending order, 27% of the highest scores and 27% of the lowest scores were selected, making the total number of students in the high and low groups 54.

b- Statistical Analysis of Test Items: (Statistical Analysis Of Test Items)

Item Difficulty Index:

After calculating the difficulty index for each item in the systems thinking test, it was found to range between (0.37 – 0.65) as shown in Table (8). Test items are considered acceptable if their difficulty falls between (0.20 – 0.80) and rejected if they are outside this range. (Al-Nabhan, 2004: 244)

• Discrimination Index: After calculating the discriminatory power for each item in the systems thinking test using the item discrimination formula, I found it ranged between (0.30 – 0.74) as shown in Table (8). An item is considered good if its discrimination power index is (0.25) or higher. (Hamoud, 2023: 168)

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Table (8) Difficulty and Discrimination Indices for the Systems Thinking Test

Paragraph sequence	Difficulty coefficient	Discrimination coefficient	Paragraph sequence	Difficulty coefficient	Discrimination coefficient
1	0.46	0.40	14	0.54	0.70
2	0.61	0.77	15	0.48	0.51
3	0.44	0.51	16	0.50	0.48
4	0.59	0.51	17	0.52	0.74
5	0.37	0.41	18	0.59	0.66
6	0.42	0.33	19	0.39	0.55
7	0.40	0.44	20	0.55	0.44
8	0.44	0.30	21	0.54	0.70
9	0.65	0.55	22	0.52	0.44
10	0.50	0.63	23	051	0.59
11	0.59	0.52	24	0.52	0.51
12	0.55	0.66	25	0.63	0.59
13	0.46	0.63			

a- Test Reliability: Kuder-Richardson Formula (KR20): Since the test consists of objective items with answers scored as either 0 or 1, the researcher chose this method to calculate reliability as it is one of the most common methods in psychological and educational measurement (Malham, 2025: 267). The reliability coefficient reached 0.80, which is considered good as it gets closer to 1.

b- The Final Version of the Test: After completing the steps to build the systems thinking test, which consists of 24 multiple-choice items with four options each, the researcher administered it to the study groups after notifying them one week in advance. The answers were scored according to the answer sheet, giving one point for a correct answer and zero for an incorrect one.

Seventh: Experimental Procedures :

1 -The experiment was applied to both the experimental and control groups starting on Sunday, 15-9-2024, with two sessions per week for each group from the first semester. The application ended for both groups on Sunday, 5-11-2024.

2- The postachievement test was conducted on Sunday, 3-11-2024, after informing the students one week before the test date. The systems thinking test was conducted on Tuesday, 5-11-2024.

Eighth: Statistical Methods: The researcher used the Statistical Package for the Social Sciences (SPSS) to analyze data and employ the appropriate statistical methods for the purposes of the research, including the T-test, item difficulty and discrimination indices, Pearson correlation coefficient, Spearman-Brown coefficient, and Kuder-Richardson formula (KR20).

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Chapter Four: Presentation and Interpretation of Results:

First: Presentation and interpretation of the achievement test results.

Table (9) T-test for the two research groups in the post-achievement test.

group	Sample size	SMA	Standard deviation	Variance	Degree of freedom	T-value		At a significance level of 0.05
						Calculated	Tabularization	
Experimental	**36**	**20.5**	**2.10**	**4.43**	**70**	**3.814**	**1.994**	Statistically significant
Control	**36**	**18.08**	**3.17**	**10.02**				

It turns out from Table (9) that the calculated value is greater than the tabulated value, so the null hypothesis is rejected and the alternative hypothesis is accepted, which indicates a statistically significant difference between the two research groups in favor of the experimental group that studied according to the Post-Brannan strategy in the post-achievement test. This result agrees with Hadi's (2019) study and Sheikho's (2020) study. The researcher attributes this result to the fact that understanding and clarifying the problem, along with the students' awareness of a problem that deserves attention and understanding, affects the way students approach comprehending the problem before solving it. Additionally, finding the relationship between the given and unknown information, searching for solutions, organizing information, testing the validity of solutions, choosing the best one based on scientific evidence, suggesting possible alternatives, and moving beyond treating information as mere abstract ideas without integrating it into conceptual or procedural frameworks helped the students improve their achievement.

Second: Presentation and Interpretation of Results for the Systems Thinking Test:

Table (10) T-test for the two research groups in the post-test for systems thinking.

group	Sample size	SMA	Standard deviation	Variance	Degree of freedom	T-value		At a significance level of 0.05
						Calculated	Tabularization	
Experimental	**36**	**14.36**	**1.94**	**3.78**	**70**	**9.31**	**1.994**	Statistically significant
Control	**36**	**8.08**	**3.55**	**12.59**				

It is clear from Table (10) that the calculated value (9.31) is greater than the tabular value (1.994) at a significance level of (0.05). Therefore, the null hypothesis is rejected and the alternative hypothesis is accepted, indicating a statistically significant difference between the two research groups in favor of the experimental group that was taught using the Post-Brennan strategy in the post-test for systems thinking. The researcher attributes this result to the use of unconventional strategies in presenting the educational material, which helped develop the students' abilities, use of systems thinking, and understanding of the main concept and derived concepts. This made the student capable of comprehensively grasping all aspects of the topic and helped them see relationships in a holistic way without losing any of its components or details.

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Third: Conclusions

1 -Teaching using the Post-Brain strategy contributed to raising the academic achievement level and systems thinking among female students in biology.

2 -Using the Post-Brain strategy in middle school stimulates students' motivation to learn and explore new knowledge.

Fourth: Recommendations

1 -Teachers should rely on modern teaching strategies that make the learner the center of the learning process, encouraging them to participate, interact, ask questions, and investigate scientific problems.

2- Organizing training courses and workshops by the Education Directorate for biology teachers to introduce them to how to use modern strategies aimed at developing students' thinking skills to keep up with developments in all aspects of life.

Fifth: Suggestions :

1- Conduct a study to find out the effect of the Post-Brennan strategy on other variables such as higher-order thinking, social awareness, and cognitive engagement in biology and other subjects and at other educational stages.

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