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THE EFFECTIVENESS OF A PROPOSED STRATEGY ACCORDING TO ACTIVE LEARNING STRATEGIES IN CRITICAL THINKING AMONG SECOND-GRADE INTERMEDIATE FEMALE STUDENTS IN PHYSICS.

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Summary:
The current research aimed to explore the effectiveness of a proposed strategy according to active learning strategies in enhancing critical thinking among second-grade intermediate female students. This was achieved by examining the hypothesis that there is no statistically significant difference at the 0.05 level between the average scores of the experimental group students, who were taught using the proposed strategy, and the control group students, who were taught using traditional methods, in a critical thinking test. The study focused on female students of the second-grade intermediate level at a middle school affiliated with the Directorate of Education in Al-Rusafa 3 for the academic year 2023-2024, covering the first three chapters of the physics textbook. The researchers randomly selected two sections out of six for the second-grade intermediate level, resulting in a sample of 64 students (32 in the experimental group and 32 in the control group). The students of both groups (experimental and control) were equated in variables such as chronological age in months, intelligence, prior knowledge, and critical thinking skills. To achieve the research objective, the researchers developed a set of plans according to the proposed strategy after preparing its steps and ensuring its applicability to the students. Additionally, a critical thinking test consisting of 45 items was developed, and its validity and reliability were confirmed. The experiment was conducted during the academic year 2023-2024, lasting twelve weeks with two sessions per week for each group. After the experiment, data were analyzed using SPSS, and the results showed that the experimental group students who were taught with the proposed strategy outperformed the control group students taught with traditional methods in the critical thinking test. Consequently, the researchers made several recommendations and suggestions.

Keywords: Proposed Strategy, Active Learning, Critical Thinking

Introduction

Firstly: Research Problem

Physics is an experimental science that relies on natural phenomena as its subject and experimentation and measurement as its methods. The aim of teaching it at the intermediate level is to equip the student with basic knowledge to understand phenomena, enhance precision in observation, and instill a scientific method that correlates causes with effects. Based on the researchers' extensive teaching experience, continuous discussions in this service always circulated among researchers as teachers in the educational sector, colleagues, and specialized

supervisors in physics for various educational levels. These discussions often resulted in acknowledging the difficulty in acquiring physics information and thinking skills by students in general, and female students in particular. This could be attributed, from some perspectives, to the use of traditional teaching methods and the lack of stimulation of thinking skills, especially critical thinking, due to teachers' lack of knowledge in modern teaching methods, particularly those based on active learning. However, some views from these discussions believed that while modern methods are good and stimulate thinking, they might not suit our local educational environment for our students. To reinforce this with evidence, the researchers conducted a survey among a number of teachers, totaling 20, **finding that:**

1. 90% of physics teachers use traditional teaching methods relying on rote learning and recitation.
2. 90% of physics teachers admitted to not having knowledge about active learning strategies.
3. 95% of teachers confirmed that students lack critical thinking skills.

These indicators motivated the researchers to move away from the conventional pattern to search for modern teaching strategies, models, and methods that offer solutions to these obstacles. This led to the proposal of a new strategy aligned with the local educational environment, potentially addressing the aforementioned issues by answering the following question: What is the effectiveness of a proposed strategy according to active learning strategies in critical thinking among second-grade intermediate female students in physics?

Research Importance

The current era is known as the era of the scientific revolution, characterized by technological advancements and openness, with a significant increase in knowledge and information across all aspects of life, whether scientific, economic, or otherwise. Educational and scientific institutions must keep pace with this development to serve students and ensure their safety. Most countries strive to prepare individuals with skills that keep up with and compete globally, always looking towards the future (Al-Harbi and Amin, 2020:61). Nations have recognized the reality of scientific progress and the accumulation of knowledge, striving for change by leveraging all their energy and effort to develop their societies materially and intellectually. Education serves as the means for societal change, bearing the responsibility of developing learners' skills and capabilities to engage with the outputs of the scientific revolution and adapt to its outcomes (Al-Dulaimi and others, 2020:36).

Education is a dynamic and evolving process that keeps up with modern scientific and technological advancements; hence, it is continuous and perpetual, not confined to a specific timeframe. It encompasses an individual's entire life from cradle to grave and involves multiple institutions including the family, community, and school. As a result of individual interaction, activities, and positive engagement, an individual's personality develops; moreover, education reflects the nature of society and its philosophy by inducing desired positive changes in individual behavior. It represents a continuous and permanent process targeting a group of individuals, preparing them comprehensively, integrally, appropriately, and balanced
ly to be useful and positive towards themselves (Rabie and Mohamed, 2021:62).

To achieve its goals, education must focus on scientific education to prove its worth in the face of this exponential growth; because scientific education plays a significant and effective role in preparing students scientifically, cognitively, and emotionally. It involves understanding the nature of science, applying knowledge to everyday life situations, recognizing the reciprocal relationships between science and society, benefiting from scientific inquiry processes, and embracing the values, attitudes, and interests associated with science (Nassar, 2016:90). Therefore, it is essential to align school curricula with the needs of the individual and society according to environmental changes (Al-Fatlawi & Al-Rubaiey, 2020:2214).

Furthermore, the responsibility of preparing science teachers, including physics teachers, to keep up with all innovations falls upon them, as the physics teacher plays a significant role within the classroom, accompanied by multiple roles. Their role is not limited to merely transferring knowledge but also achieving educational goals that include imparting students with skills, attitudes, and values, in addition to knowledge that helps in building their characters. Teachers must possess strong personalities, sharp intelligence, objectivity, fairness, firmness, vitality, and the ability to cooperate with others, as well as the capacity to appreciate others' situations, circumstances, and motivations, dealing with them based on freedom, understanding, and equality (Ghanem and Khaled, 2019:36).

The nature of cognitive processes and their levels vary from one age stage to another, indicating that precision is not only quantitative but also qualitative (Ali, 2022:63).

The importance of physics stems from the attention and care in its teaching methods. The physics curriculum at the intermediate stage plays a vital role in achieving the general objectives of the stage by providing students with physical information that helps them understand their environment, improve their scientific attitudes, and equip them with the necessary scientific skills to use science achievements, methods, and technologies effectively in serving the community, solving its problems, and developing it (Al Baty and Saad, 2020:37).

For the collaborative role between students and teachers to be effectively realized in active learning, which is one of the most important methods in providing students with knowledge, information, and cooperative skills through activating the student's role through work, research, experimentation, and reliance on themselves in obtaining information and acquiring skills and forming values and attitudes. It focuses not on memorization and rote learning but on developing thinking skills and the ability to solve problems and work collectively, shifting the focus of interest from the teacher to the student and making the student the center of the educational process (Attiyah, 2018:17).

Active learning strategies are those that emphasize the importance of students building their knowledge through their interaction with their environment, from one side, and the diversity of its methods and strategies in teaching from another side.

The use of a single strategy that can be applied in all educational situations is no longer effective, as it has been long believed that using diversity increases students' motivation and learning and positively affects their attention, making students more receptive to learning. Diversifying strategies is the key to enhancing education (Attiyah, 2018:23).

Through this, researchers see that in active learning, students should be the focal point of the educational process by increasing their activity in class and their interaction with learning strategies effectively and skillfully, with team spirit, and motivating them to apply and practice activities they encounter in their lives, which generally encourages them to think and stimulate it. Critical thinking, in general, is the ability to analyze and present relevant information to students. It is one of the preferred types of thinking in education because it uses mental skills and cognitive strategies. Undoubtedly, critical thinking aims to reach the truth after dispelling doubt through examining logical evidence and scrutinizing it, intersecting with concepts like logic and abstract thinking (Al-Tamimi and Al-Khaykanee, 2019:66).

One of the best ways to stimulate students' thinking is to rely on active and effective teaching programs that revolve around them, linked to their environment, and captivate their attention through the integration of science branches with a curriculum that meets their needs (Makawon, 2022:314).

Therefore, it has become necessary to prepare programs that develop students' thinking methods and provide all the necessities that facilitate the practice of these methods, including critical thinking (Amin, 2003:8).

As a result of continuous calls to adopt modern teaching strategies to enable generations to keep up with the rapidly evolving era (Hassan, 2023:55), researchers are keen to propose a modern teaching strategy suitable for our schools' classroom environment to contribute to solving or minimizing educational problems. This strategy meets students' needs in teaching physics and is based on the direction of active learning, encouraging students to record their ideas and reactions to the topic and express their thoughts, thus enabling students to interact and communicate with the material and their peers.

Therefore, the current research's importance centers on the following points:

1. The rarity of research and studies that addressed a proposed strategy according to active learning in teaching physics, particularly within Iraq (to the researchers' knowledge).
2. The necessity for learners to face problems that allow them the freedom to research, aligning this research with modern educational trends in teaching.
3. Benefiting from this research in conducting training courses for physics teachers organized by educational directorates to familiarize them with modern strategies and methods in teaching.

Thirdly: Research Objective

The current research aims to:

1. Develop a proposed strategy according to active learning strategies.
2. Assess the impact of a proposed strategy according to active learning strategies on critical thinking among second-grade intermediate female students.

Fourthly: Research Hypo

Thesis To verify the research objectives, the following null hypothesis was formulated:

1. There is no statistically significant difference at the 0.05 level between the average scores of the experimental group students who will be taught physics using the proposed strategy (active

learning transition) and the average scores of the control group students who will be taught using the conventional method in the critical thinking test.

Fourthly: Research Limits

1. Second-grade intermediate female students in daytime public schools affiliated with the General Directorate of Education in Baghdad/Al-Rusafa 3 for the academic year 2023-2024.
2. The first three chapters (Motion, Laws of Motion, Work, and Power) from the physics textbook for the second-grade intermediate for the year 2023-2024.
3. Critical thinking skills according to Watson and Glaser (Identifying Assumptions, Interpretation, Prediction, Deduction, Conclusion).

Fifthly: Definition of Terms

The following terms used in the research are defined as:

Firstly: Active Learning Strategies

Defined by:

1. Kojak (2006) as "The degree or extent of alignment between the actual outputs of the system and the desired outputs, meaning comparing results to goals." (Kojak, 2006:230).
2. Al-Hashemi (2016) as "A wide range of activities united by one important element, that students engage in some work while thinking about what they are doing, using teaching strategies in active learning to give learners the opportunity to think creatively and critically" (Al-Hashemi et al., 2016:36).

The theoretical definition by researchers:

Actions and methods undertaken by the teacher through prior planning of the used strategy, according to arranged steps, then applying those steps in the classroom where the student plays an active, dynamic role, and the teacher guides and monitors the educational process.

The operational definition of the proposed strategy:

A set of teaching procedures planned by the teacher to activate the student's role and rely on self-learning and group learning through several steps represented by (attracting attention, intensifying knowledge, feedback, applying and generalizing acquired knowledge).

Secondly/Critical Thinking

Defined by:

1. Al-Ajeeli (2009) as "A reflective and purposeful mental activity based on logical arguments aiming to reach truthful judgments according to accepted standards"
3. Watson & Glaser (1991) as "A continuous process testing the learner's ability to reach facts and knowledge through specific skills enabling them not to rush to conclusions and recognize, deduce, and interpret its correct conclusions and test the validity of results and evaluate them" (Abdul Aziz, 2013:109).

Researchers adopt Watson & Glaser's theoretical definition.

Operationally defined as: A process testing the individual's thinking ability through various skills, including (recognizing assumptions, interpreting, evaluating discussions, deducing, and concluding), measured by the score obtained by second-grade intermediate students through their responses to the test items prepared for this purpose.

Theoretical Background and Previous Studies:

The theoretical background includes two axes:

First Axis: Active Learning

Concept and Origins of Active Learning:

The concept of active learning is not as modern as some might assume, with its roots tracing back to 490 B.C. Socrates, a Greek philosopher and sage and one of the founders of Western philosophy, adopted a new system in learning. He directed his students towards problems and left them the space to solve them. In the 15th century, the Chinese philosopher Laozi, who is known for the saying, "If you let me experiment, I will learn," appeared. Then came the French philosopher Rousseau (1712-1778), who advocated for the importance of experience and using the senses in learning, as well as the importance of reasoning. Dewey appeared in the 1950s, emphasizing that knowledge comes through experience. He is the founder of the project-based learning concept, aiming for teamwork and problem-solving, among others. The modern concept of active learning crystallized in the 1990s (Nasr, 2012:21), with its roots also appearing in John Dewey's literature from 1916, writing that students learn by experimenting and that learning is an active process (Charles,2007:234).

However, the explicit concept of active learning has emerged over the past decades, with varying concepts and definitions of active learning. Felder & Brent (1997), cited in (Obaidat and Sohaila, 2015), define it as "learning that focuses on engaging students actively and directly in the learning process, centered around their participation in all activities presented within the classroom, and not just receiving information but also being receivers, participants, cooperators, thinkers, creators, and innovators" (Obaidat and Sohaila,2015:56).

Others see it as an active process resulting from the interaction between the student and their environment, then building their knowledge autonomously during this interaction, meaning they construct their knowledge internally. Learning is based on experience, observation, exploration, and deduction, with opportunities for learners to compare their results with their peers (Khairy, 2018: 121).

Importance of Active Learning:

Research has identified at least three styles that students must use to acquire knowledge: visual, auditory, and kinesthetic. Typically, an individual responds to one style over the others, while active learning employs all styles, resulting in better processing of different preferences reflected in student groups.

The importance of active learning is evident in all elements of the educational process (student – teacher – curriculum – teaching method – learning outcomes – evaluation) when compared to conventional education, showing its superiority in all the aforementioned elements, underscoring its importance.

Researchers believe that the importance of active learning stems from it being a learning method that bridges the gap between theories and their application. It helps students link their previous and current ideas while conducting activities, discussions, and evaluations, resulting in numerous gains for cognitive, affective, and skill aspects.

Teachers' Role in Active Learning:

The role of the teacher in the context of active learning differs from the traditional role as a disseminator of information and the center of education. The varied roles of an active teacher include:

1. Helping students discover knowledge and information by themselves.
2. Applying that knowledge and information in students' daily lives.
3. Integrating different academic subjects and specialties.
4. Training students on continuous individual learning and lifelong learning by linking it to their cognitive aspects (Al-Janabi, 2018: 33).

Researchers view that the teacher in active learning:

1. Trains students on cooperative work through forming heterogeneous groups.
2. Develops the affective domain in students by helping them interpret phenomena they encounter in their daily lives.
3. Acts as a guide, director, designer, encourager, and leader in the classroom.

Students' Role in Active Learning:

The student's role in active learning is characterized by interactivity, positivity, and vitality, being the center and focal point of the learning process. They participate in organizing activities and work within the classroom, and define educational goals based on their personal readiness, thereby determining their role as follows:

1. Actively participating in educational situations through planning, implementation, and evaluation.
2. Participating consciously and freely in the educational process, being alert, responsible, and capable of planning and decision-making.
3. Proposing ideas and questions and exchanging them with peers during the educational situation.
4. Seeking exploration, research, inquiry, gathering information, then analyzing it, reading thoroughly, and using observation and comparison skills (Awad and Zamel, 2010: 29).

Researchers believe that in active learning, students:

1. Work in groups and practice teamwork spirit.
2. Exhibit positivity and effectiveness through collaborative work with peers within the group.
3. Participate in lesson planning and the execution of this plan.

Proposed Strategy:

Its Concept, Naming, and Steps:

Researchers define it as a series of flexible stages based on the concept and strategies of active learning, where the student builds their experiences, reorganizes them, and acquires skills and experiences autonomously, collectively, and effectively to achieve their goals under the guidance and direction of the teacher.

The strategy was named Active Learning Transfer because it is based on the principles and fundamentals of active learning. This strategy is based on four teaching steps proposed by researchers in collaboration with supervisors, in addition to presenting it to a group of experts and specialists in physics teaching methods.

Steps of the Proposed Strategy:

1. Attention-grabbing phase: The teacher attracts students' attention to the topic through images, explanatory videos, or discussing a specific phenomenon, linking previous information to new information. This step is described as creating excitement and arousing curiosity, presenting questions that give a clear idea about students' prior knowledge. It's essential that stimuli and material presentation are related to what will be learned; if the lesson's goal is for the student to acquire new information, this stimulus should contain this information (Zair et al., 2017:71).
2. Knowledge intensification phase: The teacher divides students into cooperative groups, each ranging from 4-6 members, appointing a leader for each group. The teacher then presents an activity, question, or problem that needs solving. Students in each group discuss among themselves to reach a conclusion. The teacher records the answers on the board, then discusses the most accurate answer with them under his guidance and direction.
3. Feedback phase: The teacher guides students to summarize and organize the acquired information, helping them answer questions and clarify ambiguities or uncertainties to provide them with feedback.
4. Application and generalization of acquired knowledge phase: The teacher directs students to apply the knowledge and information gained during the lesson through everyday life examples to generalize the acquired knowledge.

Importance of the Proposed Strategy:

1. Helps students link previous information with new information.
2. Encourages students to enjoy cooperation through organized group work.
3. Aids students in understanding the topic and clarifying ambiguities through questions posed to the teacher and discussions among them.
4. Enables students to apply what they learn in lessons through life examples and conducting experiments.
5. Teaches students self-reliance and collaborative learning.
6. Activates democracy and respects opinions and counter-opinions among students during discussions.

Teacher's Role in the Proposed Strategy:

1. The teacher plays a key role as a facilitator, guide, and director of the educational process.
2. Designs engaging and exciting situations through films or illustrative images, as images remain in memory longer.
3. Helps students understand information well by answering their questions about the topic.
4. Engages all students in the lesson through work in heterogeneous groups.
5. Motivates students to practice the principles of active learning.

Students' Role in the Proposed Strategy:

1. Exchange opinions and ideas with group members.
2. Practice thinking in problem-solving.
3. Participate, discuss, and ask questions.
4. Apply what has been learned in daily life.

5. The student participates in planning and implementing the topics to be studied.

Second Axis: Critical Thinking

Concept of Critical Thinking:

Thinking is a mental activity used by humans when exposed to a stimulus, while criticism is used to indicate many meanings, including uncovering flaws and errors and judging something when sufficient information and evidence are available (Ibrahim, 2005:45).

Critical thinking is one type of thinking, characterized by careful examination, scrutiny, and precise observation of facts, using the rules of logical reasoning, avoiding discrimination in thinking and common errors resulting from generalizations in judging things. It involves evaluation according to agreed-upon criteria, reaching the correct conclusion, and solving the problem. It's also a thought process where an idea is investigated, evidence and objective testimonies are collected, its validity is assessed, and then a judgment is made to accept or reject it based on certain criteria or values (Al-Ghurairy, 2001:20).

Critical thinking includes the ability to respond to stimuli, including educational content, activities, processes, facts, and scientific concepts, making decisions about them, which requires hypothesizing, questioning, alternatives, analyzing information, testing it, choosing the best from it, and then integrating it with new knowledge. It involves five skills: identifying assumptions or premises, interpreting, evaluating discussions, deducing, and concluding (Noufal and Qasem, 2011:135).

Importance of Critical Thinking:

The development of critical thinking is an educational necessity summarized as follows:

1. Helping students critique information resulting from the knowledge explosion and immense scientific advancement, then reaching correct information and employing it to achieve their and the society's goals.
2. Preparing students with the ability to critique ideas and proposed solutions to problems, and subject these ideas and solutions to logic.
3. Preparing students capable of analyzing topics related to a discussion precisely to reach a correct conclusion.
4. Preparing students capable of keeping pace with scientific progress and following it in all fields without pause.
5. Protecting students' minds from harmful cultural influences prevalent in societies that they encounter in their lives.(Al-Waseemi, 2003: 29)

Critical Thinking Skills:

Watson and Glaser (2008) divided critical thinking skills into five skills:

1. **Identifying Assumptions**: Refers to the ability to distinguish between the truthfulness of specific information and its falsehood, differentiate between fact and opinion, and the purpose of the given information.
2. **Interpretation:** Means the ability to identify the problem, recognize logical explanations, and decide whether generalizations and conclusions based on specific information are acceptable or not.

3. **Deduction:** Refers to the individual's ability to determine some consequences based on premises or previous information.
4. **Inference**: Refers to the individual's ability to draw a conclusion from specific observed or borrowed facts, having the capacity to recognize the correctness or error of the results in light of the given facts.
5. **Evaluating Arguments**: Means the individual's ability to evaluate an idea, accept or reject it, distinguish between primary and secondary sources, strong and weak arguments, and judge the adequacy of information (Al-Atoum et al., 2015:78).

Researchers believe that teaching critical thinking skills elevates the human mind to meet the demands of the age and improve the educational process, moving away from the conventional method used in previous years. Therefore, researchers have developed a test for critical thinking according to Watson and Glaser's skills because it fits the age group undergoing the experiment and is closer to the scientific levels in the intermediate stage.

Previous Studies: Researchers divided the previous studies into two axes as follows:

Table (1) Axis One: Studies on Proposed Strategies

Study	Objective	Sample	Tools	Statistical Methods	Results
Musa & Zaher (2021): The effectiveness of a proposed strategy based on visual thinking in physics achievement and mental sharpness among fifth-grade biological students	To explore the effectiveness of a proposed strategy based on visual thinking in physics achievement and mental sharpness among fifth-grade biological students.	71 students Experimental: 35 Control: 36	Achievement test and a test for mental sharpness	T-test and effect size equation	The experimental group outperformed the control group in both the achievement test and mental sharpness.
Al-Rikabi (2018): The effectiveness of a proposed	To investigate the effectiveness of a proposed	60 students Experimental: 30 Control: 30	Physical sense scale	Cronbach's alpha, Kuder-Richardson Formula 20, and	The experimental group surpassed the control group

strategy based on decision-making strategies in physical sense among fourth-grade science students	strategy based on decision-making strategies in physical sense among fourth-grade science students.			correlation coefficients	in the physical sense scale.

Table (2) Axis Two: Studies on Critical Thinking

Study	Objective	Sample	Tools	Statistical Methods	Results
Al-Safi (2012): The effectiveness of teaching using the self-questioning strategy in achievement and critical thinking of second-grade intermediate female students in physics	To determine the effectiveness of teaching using the self-questioning strategy in achievement and critical thinking among second-grade intermediate female students in physics.	51 students Experimental: 26 Control: 25	Achievement test and critical thinking test	T-test for two independent samples	The experimental group outperformed the control group at a significance level of 0.05 in acquiring physical concepts and the critical thinking test.
Al-Saadi (2014): The impact of the self-generated analogical thinking	To find out the effect of the self-generated analogical thinking strategy on	60 students Experimental: 30 Control: 30	Test for acquiring physical concepts, critical thinking test	T-test for two independent samples of equal number	The experimental group exceeded the control group in both acquiring

strategy on the acquisition of physical concepts and critical thinking of fourth-grade science students	the acquisition of physical concepts and critical thinking among fourth-grade science students.				physical concepts and the critical thinking test.

Researchers' Insights from Previous Studies:

In light of the studies presented, the insights gleaned can be summarized as follows:

1. Understanding critical thinking skills that should be included in physics textbooks, especially for the intermediate stage.
2. Developing a critical thinking test consisting of situations spread over five skills, with each situation having three items for students to select the correct option for each case.
3. Identifying appropriate statistical methods to verify the research questions.
4. Comparing the results of the studies to the results of their study and identifying areas of agreement and difference between their study and previous ones.

Research Procedures

Firstly: Research Method and Experimental Design:

Researchers utilized the experimental method, relying on the post-test only control group design for equivalent groups.

Secondly: Research Population and Sample:

1. **Research Population**: Refers to the total group of elements to which the researcher aims to generalize the results (Ouda and Fathi, 2008: 159). The current research population is defined as second-grade intermediate female students in secondary and intermediate day schools in the center of Baghdad Governorate for the academic year (2023-2024), distributed across (124) middle and high schools, totaling (12,218) students, according to statistics from the Directorate of Planning affiliated with the General Directorate of Education in Baghdad/Al-Rusafa.
2. **Research Sample**: The sample is a subset of the research population that best represents its elements, enabling the researcher to generalize the results of that sample to the entire research population (Hamza et al., 2016: 104). Researchers deliberately chose (Al-Silasilah) Girls' Middle School, after obtaining approval from the directorate to facilitate their task of conducting the experiment there, which contains (6) sections for the second intermediate grade. From these, section (B) was randomly selected to represent the experimental group and section (D) to represent the control group. All failing students were excluded as they had studied the same topics, which could affect the research results negatively or positively. The number of failing students was (2),

and their exclusion was statistical when analyzing the results, allowing them to attend the research groups to maintain the school order. Thus, the total number of students undergoing the experiment in both groups was (64), with (32) students representing the experimental group and (32) representing the control group.

Thirdly: Equivalence of Research Groups:

Researchers conducted an equivalence between the research groups in some variables that could affect the experiment's progress, even though the research sample students come from a very similar social and economic background, study in the same school, and are of the same gender. These variables include:

A- Chronological Age: Researchers obtained the chronological age of the students in both research groups based on the general registration record of the school for both groups, then converted the ages to months as of Sunday, 1/10/2024. To verify the equivalence of the groups in chronological age, researchers used the T-test, and the results showed that the calculated t-value (0.209) is less than the table value of (2) at a significance level of (0.05) and degrees of freedom (62), indicating no statistically significant differences between the groups in this variable, meaning the groups are equivalent in chronological age in months.

B- Intelligence: Intelligence is typically measured by tests specially designed for this purpose. Researchers chose the Raven's Progressive Matrices test, adapted to the Iraqi environment, one of the most common and used intelligence measures. The test contains (60) items divided into five sections (A, B, C, D, E), each section presenting a matrix increasing in difficulty, and students are to complete it by choosing the appropriate alternative. The method of correction is one point for each correct answer, making the final score for the intelligence test (60) points. The test was administered on Tuesday, 10/10/2023, with researchers supervising the application and explaining the answer instructions. The test took (forty-five minutes), and accordingly, students' scores for the correct answer in each group were calculated. When comparing the scores of students in both research groups, using the T-test for two independent samples, the calculated t-value (1.507) was less than the table t-value of (2) at a significance level of (0.05) and degrees of freedom (62), indicating no statistically significant differences, thereby the groups are equivalent in the intelligence variable.

C- Prior Knowledge Test in Physics: To identify the prior knowledge possessed by students in both research groups (experimental and control) in science and physics topics for previous grades (fifth and sixth primary and first intermediate), researchers prepared a test consisting of (20) multiple-choice items. The test was administered to both research groups on Thursday, 12/10/2023, and answers were corrected to obtain the scores for both groups. A score of (one point) was given for each correct answer and (zero) for incorrect ones, making the highest possible score for the test (20) and the lowest (zero). Using the T-test for two independent samples, the results showed that the calculated t-value (0.854) is less than the table t-value of (2) at a significance level of (0.05) and degrees of freedom (62), indicating no statistically significant differences between the research groups in this variable, meaning the groups are equivalent in prior knowledge of physics.

D: Critical Thinking: The critical thinking test prepared by researchers from educational content outside the specific scientific material of the research experiment was administered to students in both research groups on Sunday, 15/10/2023. It was found that the calculated t-value for two independent samples (0.407) at a significance level of (0.05) and degrees of freedom (62) is less than the table value of (2), thus considering the research groups equivalent in the critical thinking test.Table (3) Significance of Differences Between the Mean Scores of Students in the Experimental and Control Groups Across Several Variables to Test Their Equivalence

Variable	Experimental Group		Control Group		Degrees of Freedom	T-Value		Statistical Significance at Level (0.05)
	Arithmetic Mean	Standard Deviation	Arithmetic Mean	Standard Deviation		Calculated T-Value	Table Value	
Prior Knowledge Test	9,22	2,282	8,72	2,399	62	0,854	2	0,05
Raven's Test	35,97	7,681	33,50	5,181	62	1,507	2	0,05
Chronological Age	158,31	2,375	158,19	2,416	62	0,209	2	0,05
Critical Thinking Test	21,34	7,250	20,59	7,50	62	0,407	2	0,05

Fourthly: Controlling Variables:

The researchers attempted to avoid the influence of extraneous variables on the experiment's progression. There were no incidents or unforeseen circumstances during the experiment, the students did not miss school days, and no student was transferred from the school during this period. The researchers randomly selected the research groups to mitigate individual differences between the students. The duration of the experiment was equal for both groups, lasting twelve weeks, with the same study material represented by the first three chapters of the physics textbook for the second-grade intermediate.

esearch Requirements:

1. **Identification of Scientific Material:** The researchers identified the scientific material to be taught to both the experimental and control groups during the experiment's duration (the first semester) of the academic year (2023 – 2024), which are the first three chapters of the physics textbook for the second-grade intermediate by Dr. Shifa Majid Jasim, Huda Butros Betam, and Adel Jasb Majid, 5th edition, year (2023).

2. **Definition of Behavioral Objectives:** Defining behavioral objectives is a fundamental and necessary step in the educational process. It is the first and crucial step in daily lesson planning,

prepared before teaching begins. Their clarity and definition aid in the orderly and integrated progression of the educational process (Zair, 2016: 55). The objectives were determined and formulated based on the content of the educational materials (Ahmed & Aziz, 2018: 510). The researchers formulated (100) behavioral objectives based on general goals, distributed among the four levels of Bloom's taxonomy: (Remembering, Understanding, Applying, Analyzing). The researchers presented them to a group of specialists in education and teaching methods to ensure their validity and comprehensiveness.

Table (4) Behavioral Objectives According to Bloom's Taxonomy

Unit	Scientific Content	Behavioral Objectives for the Cognitive Domain				Total
		Remembering	Understanding	Applying	Analyzing	
First	First	25	10	9	3	47
	Second	12	9	4	2	27
Second	Third	12	6	6	2	26
Total		49	25	19	7	100

3. Preparation of Teaching Plans:

Given that the preparation of teaching plans is a crucial requirement for successful teaching, the researchers prepared (32) teaching plans, with (16) plans for both the experimental group and the control group for the physics topics to be taught during the experiment, based on the content of the prescribed textbook and the formulated behavioral objectives, following the proposed strategy (Active Learning Transfer) for the experimental group, and the conventional method for the control group.

4. Research Tools:

Research tools are methods for collecting data that answer the research objective and test its hypotheses, also known as measurement tools such as questionnaires, observation, interviews, and tests (Hassan, 2011: 54).

According to the current research's objective, two measurement tools were required: one for measuring the dependent variable, which is the critical thinking test, and the second tool for the independent variable (the proposed strategy). Below are the detailed procedures followed by the researchers in preparing these tools:

Firstly: The Proposed Strategy:

This research required the construction of a new strategy proposed according to active learning strategies, built on the following stages:

Stages of Building the Proposed Strategy:

A- **Analysis Stage:** This stage involves analyzing the educational environment surrounding the strategy to be built, identifying the problem by understanding the necessary needs and converting them into information that aids in improving and developing the teaching process. This stage also includes identifying the physical, human, and material resources needed, as well as the learners' characteristics, abilities, needs, preferences, and attitudes, along with the general and specific objectives to be achieved.

B- **Planning Stage:** This stage includes the following procedures:
1. Reviewing literature and studies on active learning and its strategies as detailed in the theoretical framework - Chapter 2.
2. Reviewing previous studies and research that addressed proposed teaching strategies and benefiting from them.
3. Defining the steps of the proposed strategy, which were detailed in the theoretical framework - Chapter 2, to a group of judges and specialists in teaching methods and educational and psychological sciences to verify their appropriateness and suitability for the students' characteristics. Then, obtaining an agreement rate of 80% or above from the judges' opinions for the strategy steps to be valid for teaching.
C- **Implementation Stage**: This stage includes the following procedures:
1. Preparing teaching plans according to the steps of the proposed strategy (Active Learning Transfer), with models of the plans presented to experts for their opinions - Appendix (8).
2. Identifying teaching aids: The aids used in the plan models were mentioned - Appendix (8).
3. Determining appropriate activities: The researchers relied on various activities during teaching according to the proposed strategy, varying with the study topics.
4. Evaluation: Including preliminary evaluation used by the researchers to ensure the teaching steps' validity, in addition to the prior knowledge test, the formative evaluation used by the researchers throughout their teaching to the experimental research group, and the summative evaluation used by the researchers after the experiment to verify the effectiveness of the proposed strategy.
Secondly: Critical Thinking Test: The critical thinking test was built according to the following steps:
2-1- **Defining the Test's Objective**: This test aims to measure the critical thinking skills of the research sample, who are second-grade intermediate students.
2-2- **Defining the Test's Key Skills:** After reviewing educational, psychological literature, and previous studies related to classifying critical thinking skills, as mentioned by the researchers in Chapter 2, the researchers adopted Watson-Glaser's classification, which categorized critical thinking skills into five main skills:
- Predicting assumptions
- Interpretation
- Deduction
- Inference
- Evaluating arguments

(Al-Atoum et al., 2015:78)
Test Validity: The test's validity was ensured through two methods:

a. **Face Validity**: To ensure the test's face validity, it was presented in its preliminary form to a group of experts and specialists to determine the suitability of the situations, items, and their accurate distribution across the skills they belong to and their appropriateness for measuring the intended skill. Adopting an agreement rate of 85% or more as a criterion for

the test items' validity, some items were modified based on their comments while keeping the number of items constant at (45).

b. **Construct Validity (Internal Consistency):** This is more representative of the validity concept, also known as hypothetical construct validity (Al-Ma'yuf and Hayam, 2021), and the test's internal consistency was verified by calculating point-biserial correlation coefficients between each test item's scores and the total score for the skill, ranging between (0.202- 0.539), which is higher than the table value of (0.19) at a significance level of (0.05) and degrees of freedom (98). Additionally, correlation matrices of the skills were calculated using Pearson's correlation coefficient, ranging between (0.221- 0.475) compared to the table value of (0.19) at a significance level of (0.05) and degrees of freedom (98), showing that the calculated correlation coefficients are statistically significant.

Item Difficulty Coefficient:

The difficulty coefficient for each item of the critical thinking test was found after taking a pilot sample of (100), then arranging the students' scores in descending order and selecting (27%) from the upper group and (27%) from the lower group, making each group consist of (27) students, and then finding the difficulty coefficient using its specific equation. It was found that the difficulty coefficient ranges between (0.407 – 0.703), making all test items acceptable and of an acceptable difficulty coefficient, as good test items have a difficulty coefficient ranging between (0.20 – 0.80) (Allam, 2015: 269).

Item Discrimination Coefficient:

After arranging the students' scores in descending order based on their total score on the test, then selecting the two extreme groups, upper and lower, by (27%) as the best two groups representing the sample, making each group consist of (27) students, the researchers found the discrimination coefficient for each test item, ranging between (0.222- 0.518), thus considering all items good as they are higher than Ebel's criterion referred to in (Allam, 2019) for discrimination, which states that an item is considered good if its discrimination coefficient is more than (0.20) (Allam, 2015: 269).

Reliability: The researchers used two methods to find the test's reliability:

1- **Cronbach's Alpha Method:** This equation refers to the internal consistency among the test items (Wadi, 2018) and the reliability value by this method was 0.82.
2- **Kuder-Richardson Method**: The reliability value by this method was 0.85.

Statistical Methods: The statistical package was used for the statistical processing required by the research.

Presentation and Interpretation of Results

Presentation of Results Related to the Null Hypothesis: The second null hypothesis states that there is no statistically significant difference at the (0.05) level of significance between the mean scores of the experimental group students, who were taught according to the proposed strategy based on active learning strategies in physics, and the mean scores of the control group students,

who were taught the same material in the conventional way, on the critical thinking test prepared for the purposes of this research.

To verify the above hypothesis, the researchers extracted the arithmetic mean and standard deviation for the students of both research groups. It was found that the mean score of the experimental group students, who were taught according to the proposed strategy, was (34.50) with a standard deviation of (5.55), and the mean score of the control group students, who were taught in the conventional manner, was (30.06) with a standard deviation of (4.040). Using the t-test for independent samples, the statistical results showed that the experimental group outperformed the control group, with the calculated t-value (3.653) being larger than the table value of (2.000) at the (0.05) level of significance and 62 degrees of freedom between the mean scores of the students in both research groups (experimental and control) in the critical thinking test, in favor of the experimental group.

Effect Size of the Independent Variable on the Dependent Variable (Critical Thinking):

The researchers used the eta squared (η^2) equation proposed by (Kiees, 1989:445), to determine the effect of the independent variable on the dependent one, which was (0.17), indicating a significant effect of the proposed strategy on the critical thinking of students in physics. Then, the effect size (d) was found to be (0.9), which is considered large according to the standards set by Cohen. As (Julie Pallant, 2007) mentioned, Cohen classified the values to interpret the effect size as shown in Table (5).

(Julie Pallant, 2007:246)

Table (5) Reference for Determining Effect Size

Metric	Small	Medium	Large
η^2	0.01	0.06	0.14
D	0.2	0.5	0.8

Interpretation of the Results Related to the Hypothesis:

The results showed the superiority of the experimental group, which was taught using the proposed strategy based on active learning, in the critical thinking test in favor of the experimental group. This result can be explained as follows:

A. The proposed strategy, according to active learning strategies, allowed students to develop their critical thinking through activities and modern educational tools.
B. The proposed strategy, as per active learning, achieved an effect over the conventional method, as this strategy helped the research sample (experimental group) students move away from conventional learning and provided them with everything new and effective in the field of thinking in general and critical thinking in particular.

The current research results are consistent with previous studies that showed the superiority of the experimental group students over the control group in critical thinking, such as the study of (Al-Safi, 2012), and the study of (Al-Saadi, 2014).

Conclusions:

Based on the findings, the following conclusions can be drawn:

1- The proposed strategy, according to active learning strategies, contributed to encouraging students to strengthen their personality and flexibility in their critical thinking.
2- Regular use of the proposed strategy, according to active learning strategies, led to a positive interaction of students with the lesson, which was evident from their active participation during the experiment.

Recommendations:

In light of the results and conclusions of the current research, the researchers recommend the following:

1- Educating teachers about the importance of active learning strategies preferred by their students and encouraging them to use, exploit, and employ them in acquiring knowledge, achieving self-development, unleashing different latent energies, and enhancing critical thinking.
2- Emphasizing the importance of selecting the appropriate strategy for the scientific material and the scientific and age level of the student, which suits the needs and characteristics of the students before starting any lesson, as it is the correct starting point that provides a good educational environment that suits all students, helping to reduce waste of time and effort by the teacher and the student and achieving the desired goals and increasing students' achievement.
3- Focusing on increasing the role of the student as the focus of the educational process to make the teacher a guide and advisor to the teaching-learning process, giving the student the opportunity to learn and build their knowledge themselves, to have a positive role and move away from the negativity based on memorizing summaries and focusing on success only.
4- Raising the awareness of physics teachers about the importance of applying strategies in developing critical thinking due to their role in improving the level of thinking among students.
5- The necessity of knowing and identifying the educational needs of students because it helps in overcoming obstacles to teaching and learning physics.

Suggestions:

Based on the results and conclusions of the current research and to complement it, the researcher suggests:

1- Using the proposed strategy (active learning transfer) in other educational stages.
2- Using the proposed strategy with other variables such as reflective thinking and physical exploration.
3- Conducting a comparison between teaching with the proposed strategy and other teaching methods in increasing achievement.
4- Comparing the proposed strategy (active learning transfer) with other strategies derived from active learning.

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