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The Impact of the Cognitive Acceleration Strategy on Achievement in Chemistry and Deductive Thinking among Second Grade Intermediate Students

Mohammed Kamal Mohammed[a], Afrah yassen muhammed[b], [a]Ministry of Education, [b]Ministry of Higher Education and Scientific Research/ University of Baghdad/College of Education for Pure Sciences Ibn Al-Haytham, Baghdad, Iraq.

The aim of the research is to understand the effect of the strategy of cognitive acceleration on the achievement of chemistry and inferential thinking among students of the second intermediate grade. The research sample reached 62 students from the second intermediate class, 32 students for the experimental group and 30 students for the control group. The researcher formulated 233 behavioural purposes, looking at levels of remembering, comprehending, applying and analysing, according to Bloom's classification of the cognitive domain, and the researcher prepared an achievement test consisting of 40 objective multiple choice paragraphs, confirming psychological characteristics, with the researcher adopting a test (Al-Rubaie, 2014) for inferential thinking. Anat using an Altaia statistical test, two independent samples were found to exceed results from experimental group students who have studied chemistry, according to the accelerator strategy in cognitive test grades and test thinking deduction, and in the light of the results recommendations have been made.

Key words: *acceleration strategy, grade intermediate, deductive thinking.*

Introduction

Our world today is witnessing a rapid movement of scientific development and technological progress in all areas of science, and this progress has been accompanied by great and accelerating cognitive development in an abnormal way. The individual has an urgent need to

work hard to adapt to it to be able to participate in life effectively, matching information, working hard and organising thought to choose the best alternatives and solutions to push society forward and to catch up with this progress, so it is necessary to teach the learner how to think, not to simply memorise a curriculum without understanding, and absorbing and applying these lessons in life.

Therefore, the expansion in knowledge and information, the spread of education, the development of educational institutions, the different levels and diversity of education's goals are imposed on those who are interested in education, helping them find modern methods and strategies to help revitalise learners' thought. This allows them to be effective in the educational process, and this is why education in any country of the world is one of the most important fields, because it is concerned with human building and development. The educational process in Iraq is still limited to teachers offering memorisation approaches, while learners read and practice memorisation. This causes a lack of information retention and a low level of critical thinking, noted by this researcher in his modest experience in the field of teaching. As the chair of chemistry in secondary schools, over the last 10 years, there has been a noticeable decrease in the achievement of the average second grade students in chemistry, possibly due to the approved teaching methods that focus on memorisation and indoctrination, without the practice of applying critical thinking skills.

Research Importance

A teacher is no longer merely an indoctrinator, based on delivering information to their learners, but rather someone who can raise enthusiasm and activity, creating active participants. This results in self-learning, helping learners to educate themselves, encouraging cooperation, group work and providing customised activities, taking into account their involvement in explanation and discussion (Amer and Muhammad, 2008: 9).

Therefore, it should be the focus of educators to teach and develop methods and strategies with a focus on the psychological and educational aspects of the learner. In addition to providing them with science and knowledge, teachers must develop and improve their teaching methods in a manner commensurate with modern scientific and educational theories, as they are essential elements in educational success (Katame, 2005: 109).

The importance of chemistry is not limited to applied aspects of life, but also extends to preparing an individual scientifically and educationally. Teaching chemistry contributes to an individual's knowledge of the facts, concepts and natural laws that relate to the chemical composition of different materials and their properties, in order to use them in practical life (Qandil, 1988: 65). The teaching of chemistry must evolve, whether in its programs or teaching methods, as it is no longer acceptable to limit learning to memorisation, but rather promote

student understanding of knowledge and develop thinking, knowledge and skill. In recent years there have been important changes in the teaching of science in general, and the teaching of chemistry in particular, focusing on the basic aspects of learning that make up a learner's personality – their cognitive profile, skill and emotional aspects (Najdi et al., 1999: 23).

Scientific education emphasises learning as a process concerned with student growth (mentally, skillfully, and physically), integrating personality in various aspects. The primary task in teaching science is to teach students how to think, not how to memorise curricula and textbooks by heart without understanding, realising and employing them in life. Perhaps science teachers are the main key to achieving this, and thus achieving educational and science teaching goals. The best curricula, books, programs and school scientific activities may not achieve their goals unless science teachers are distinguished in the way they teach, their teaching method, and the use of their method (Olive, 1994: 133).

Teaching methods differ according to educational goals, the pattern of educational content, the psychological and professional characteristics of a teacher, or the physical conditions of educational situation (Alwan et al., 2011: 119). Educational studies have proven the effectiveness of using thinking education strategies, and some teaching methods, in developing students' thinking skills. Science teachers must work on understanding and interacting with them to improve the level of performance and achievement of students, achieving lasting and effective learning (Mustafa, 2011: 39).

Teaching strategies are numerous and vary according to the teacher, the teaching material, its nature and the teacher's experience in the field. A teaching strategy is defined as: "the plans that the teacher uses to help students gain experiences in a specific subject, and this acquisition process is planned, organized and serialized in which it determines the ultimate goal of learning" (Katame and Yusuf, 2001: 146).

The strategy of cognitive acceleration aims to develop students' thinking capabilities, based on Piaget's ideas of balance and cognitive conflict and on Vygotsky's ideas in social construction and epistemological thinking (Dusty and Khaled, 2011: 97).

One modern strategy, based on the rapid learning of knowledge, is the Cognitive Acceleration Strategy that helps learners participate effectively in the lesson and enhance learning, retain the material and develop their creative skills (Mayer, 2010: 27).

The importance of this strategy is highlighted not only in the teaching of science, but also in other subjects, such as mathematics and English, and has been applied in Britain using the Cognitive Acceleration Science Education (CASE) program, which emphasises cognitive acceleration for science learning (Adey, 1999), (Al-Ayasrah, 2011).

In addition, there are multiple research methodologies. The achievement levels of students who studied within these programs in science subjects were higher than those of students who did not study within these programs (Ghobari and Khaled, 2011).

Studies, including by Addy and Shayer (1994) indicate that the Cognitive Acceleration Strategy works to raise levels of mental growth, activate the work of the brain and develop thinking in all its forms, developing learners' abilities in analytical processes. It especially assists with sensory preparation, cognitive conflict, thinking in thinking (metacognition) and bridging (Afaneh and Youssef, 2009).

Therefore, interest has increased in teaching strategies, especially in the final decade of the last century, due to their role in effectively acquiring, storing and employing information, developing higher mental skills, including metacognitive skills that aim to help the learner to plan, control, control and straighten themselves. This improves the acquisition of different learning processes, allowing learners to take responsibility and control of cognitive processes associated with learning (Al-Harthy, 2007).

Ibrahim (1999) and Padilla (1990) explained that one of the most prominent goals of education is to raise the level of thinking among students, helping them reach mastery of abstract thinking processes, and that science plays an important role in creating opportunities and helping students rise to the level of using processes. When an individual thinks, they must know something and deal with a realistic problem, but many people do not improve the use of their knowledge stock, so it is necessary for students to learn how to learn from their previous experiences, and it is a school's duty to create scientific experiences presented in the form of problems.

Inferential thinking is one of the types of thinking that includes, in its essence, the discovery of relationships and systems that link information. It links causes to results, as it requires an individual to use higher mental processes such as imagination, understanding, discrimination, analysis, criticism and inference (Najdi et al., 2007).

That is why Swartize and Perkins (1990), citing Muhammad (2005), stressed the need to develop student inferential thinking as an essential goal of science education, helping students use the information and knowledge provided to them in solving problems. It also helps the student access new information, by analysing other available information, as well as identify the correct and useful information from a vast flow of information, so that they can use this information to achieve individual and community goals (Al Awad, 20072).

Al-Zoghbi et al. (2009) indicate that most scientific achievements are the product of thoughtful mentalities, able to solve problems and make decisions, and this is only developed when students are able to infer scientifically.

Inferential thinking is also a method that is included in many teaching methods. If we follow the movement of the mind while it is performing the typical process of reasoning, it passes stages parallel to the steps of the scientific method, followed by intelligence, to reach theories and laws. The inferencing individual is guided in solving problems according to what their memory and previous experiences suggest. Not once has it been provided with the characteristics of the situation through direct observation (Razuki and Abdel-Karim, 2013).

The reasoning process is one of the important processes that is used to predict future events and formulate hypotheses. In this mental process, more vertical expressions are formulated, describing a set of events and situations, rather than an event or one position. Reasoning as a process, as illustrated through Katame's (2003) formulation of general phrases from a group of events, is as follows:

1 - Understand the elements of a situation or event.
2 - Make simple inferences.
3 – Organise simple passages related to a relationship, then formulate inferences from them.
4 - Draft special provisions from general provisions.
5 – Create procedures for future forecasts based on simple present evidence.

Research Objectives

The Research Aims to Verify

1 - The effect of a Cognitive Acceleration Strategy on the academic achievement of middle school students for the second intermediate grade.
2 - The effect of a Cognitive Acceleration Strategy on inferential thinking for middle school students.

Methodology:

To achieve this, the following two hypotheses were developed:

• There is no statistically significant difference at the level (0.05) between the average scores of students studying the Cognitive Acceleration Strategy, and the average scores of students studying in a regular way, in academic achievement of chemistry.

• There is no statistically significant difference at the level (0.05) between the average scores of students studying the Cognitive Acceleration Strategy, and the average scores of students studying in the usual way, in the inferential thinking test.

Search Limits

The research is limited to:
1 - Students of the second intermediate class in Dhul-Noreen Secondary School for Boys, which is affiliated to the General Directorate of Education in Baghdad/Karkh Governorate/3.
2- Chapter Five (Water), Chapter Six (Acids, Bases, and Salts), Chapter Seven (Carbon and Some of its Compounds).
3- The second semester of the academic year 2015-2016

Defining Terms

The Cognitive Acceleration Strategy is defined by Adey and Shayer (2005) as:

> "a general term that includes a group of activities that enter at certain levels of the learners' ages within a specific context, in which a group of subjects varies in terms of the intensity of the content and the allocated period, with the aim of developing their ideas, using the phrase "to think together" (Adey, 2005).

This study defines it as: a group of steps in which activities are used, during the course of the implementation of the lesson, to lead a student in an experimental group to interact with sensory numbers, cognitive conflict, think about thinking and end with bridging.

Achievement: Custom

Oxford (1999) defined achievement as "the acquired result in accomplishing or learning something that requires effort or skill." This study defines it as: the information that the average second grader acquires after a specified experiment period has passed, and can be measured to the degree obtained in an achievement test developed for the purposes of this research and which was applied to the middle second graders in a chemistry subject.

Inferential thinking is defined by Jarwan (2007) as: "a mental activity that includes a set of mental processes that lead to generating and evaluating arguments and assumptions, searching for evidence, arriving at results, and knowing the relative relationship and relationships" (Jarwan, 2007).

This study defines inferential reasoning as: a type of thinking that requires a student to use different information and come up with organised relationships between different points of that information, whether from general to private (deduction) or from special to year (extrapolation), or deduction as a result of certain facts, measured by the degree obtained demand for the inferential reasoning test.

Cognitive Acceleration

A number of researchers, led by Michael Shayer at the Chelsea College of Learning Science and Mathematics in London in 1970, designed a project to solve the problem of difficulty in learning concepts in science, called Cognitive Acceleration through Science Education (CASE). It was considered an innovative approach to education, the result of research on cognitive development by the psychologist Piaget, as well as the ideas of Vygotsky, and was included in the scientific curriculum for students aged 11-14 years old in a number of schools. It was found that many of the scientific concepts contained in UK subjects, and throughout the world, required students to have high level mental skill. This is why the team, led by Shayer, took a scientific approach to solve this problem, where they described and measured levels of difficulty in scientific concepts, relying on Piaget's cognitive development theory, which describes thinking patterns in different stages. They analysed study materials, based on the cognitive requirements created by these curricula, to develop the cognitive development tests in a large-scale questionnaire, to understand all ages of children's thinking (Adey, 1999).

Adey (2002) and Shayer (2002) indicated that 11 year-old learners are able to enter the abstract thinking stage, and that a high percentage of them have become identical with those of 14 year-olds, and this confirms the importance of this project. This was later called the Cognitive Acceleration Strategy, increasing the growth of thinking levels of learners, and raising their level of mental abilities, increasing the activation of the brain and stimulating it (Adey and Shayer, 2002).

Cognitive development is accelerated in light of Adi and Shire's strategy, based on Piaget's cognitive building and social construction of Vygotsky, through four steps. In each step a special tactical strategy is used. These special strategies include a set of activities aimed at increasing the levels of cognitive development of learners and speeding them up through the transition, from the sensible stage to the abstract phase, through their awareness and awareness of their thinking processes. They also reconsider this thinking in order to improve, modify and develop it, and thus accelerate cognitive development. Vygotsky's theory is unique in focusing on processes beyond knowledge (thinking within thinking), also known as metacognition. The main purpose of this strategy is to urge the learner to prepare, interact with sensory numbers and discussion, to think within thinking, and to contemplate contradictions that are presented, in order to reach a specific stage of growth (Afaneh and Youssef, 2009). As for Piaget's theory,

learners build and grow knowledge across multiple stages of their development, assuming the learner uses various methods of thinking, governing their awareness and affecting behavioural patterns (Abu Hijleh, 2007).

Also, learners' awareness of thinking, and rethinking this thinking, helps them develop and grow mental abilities and improve them, and thus integrate thoughts, follow-up, organise and evaluate during the learning process (Adey, 1999).

The Cognitive Acceleration Strategy aims to rapidly grow thinking skills in science, and help students transfer and use those skills in other areas (Ayasrah, 2011).

This strategy was developed and evaluated in 1987, and it continues to develop, and has proven effective in education (Dusty and Khaled, 2011).

The Cognitive Acceleration Strategy aims to:

1 - Activate both sides of the right and left brain together, to raise levels of mental development, activating the brain and developing various types of thinking, such as visual thinking (by means of materials and tools necessary to do classroom activities), critical thinking (modifying the paths of thinking, i.e. thinking within thinking) and creative thinking (creating new and varied thinking patterns).
2 - Expand learning horizons on both sides of the brain, as it makes learners think better by linking concepts, imposing assumptions, resolving contradictions, and dealing with perceived access to abstract ideas.
3 - Develop learners' mental abilities in analytical processes, where learners analyse opposing situations, learn about contradictions, try to integrate patterns of thinking consistent with the brain and with the strategies stored in them, and build integrated knowledge structures and organise them among learners (Afaneh and Youssef, 2009).

Cognitive acceleration strategy includes four basic steps:

1 - Sensory Numbers: It Includes

• In this particular step or strategy, the teacher presents a problem to the learners and allows them to discuss.
• The teacher is directed to class activities and discussions that play an important role in developing thinking.
• The teacher has an opportunity for learners to express the relationships they have found or used, or the actions they have implemented.

• The teacher connects the experiences learners have acquired in the lesson to experiences in daily life.

2 - Knowledge Conflict: It Contains

• Learners are exposed, through sensory activities, to observations that are surprising to them, which do not align with their expectations, and do not correspond with their motives or previous experiences, or with their direct experiences at the beginning of the activity.
• The result of this surprise creates a state of wonder that calls on learners to reconsider their knowledge structure and their way of thinking, in order to adapt to new experimental evidence.
• Learners' knowledge and thinking skill development can be observed through a cognitive hierarchy – the transition from a lower level to a higher level.
• The teacher uses these classroom activities to disturb the learner, so they can reach maximum thinking capacity, and go beyond to reach a state of balance and stability.

3 - Metacognition (Thinking Within Thinking): Which Includes

• This step begins with a learner achieving awareness of their thinking processes, awareness of what they say and do, and critiquing their method of thinking.
• Learners then consider their reasons for thinking about a problem, through questions that the teacher asks, such as “How did you do that?”, “Why did you do that?”, and “How do you explain that?”
• Learners realise what type of thinking helped them solve the problem. They self-organise their thoughts and itemise their thinking steps, leading to accelerated growth of their thinking skills, increasing their cognitive development.

4 - Bridging

• This step aims to link experiences that learners have gained from their learning activity with their experiences in life and in other subjects.
• Building intellectual bridges between activities and life is necessary to yield educational experiences out of a theoretical framework, linking a practical framework with applications in life.
• Finding relationships and links between new learning experiences and other study materials helps transfer the impact of learning to different aspects of life, and thus build and create an integrated picture of knowledge (Afaneh and Youssef, 2009).

The researcher has benefited from these previous steps in preparing his plans on the experimental research sample, as his role was important in preparing class activities, as well as a guide for students. Through activities and cognitive conflict among students, a state of

surprise is generated, helping students think and find solutions, solving knowledge conflicts by thinking about the reasons that led to these conflicts, and finding a solution to their problems. The students then find relationships between new experiences and their previous experiences.

Inferential Thinking

Thinking is a mental process that the individual performs in order to obtain permanent or temporary solutions to a problem, an ongoing process in the brain that does not stop or end as long as the person is alert (Al-Khatib, 1993). The Arabs have a significant role in highlighting the importance of accurate sensory observation and sound thinking, and the advantages of using logic and reasoning methods. Researchers, such as Al-Hassan Ibn Al-Haytham, who are at the forefront of this area, recognised the scientific method and identified its elements before thinkers, such as Bacon, recognised the scientific method of thinking in the West (Sarhan and Kamel, 1993). Psychologists and philosophers have recognised the emergence of inference and growth, and have identified its various forms and definition, having almost agreed that it is one form of thinking individuals use when attempting to solve a problem. It is also agreed that there are two methods of inference, direct and indirect. One or more, if a case of two cases was called standard, and if the reasoning for more than two cases was called extrapolation (Ziada, 1986).

Theories that deal with the concept of reasoning travel in two directions – one camp includes working theories of intelligence, and the second includes theories of cognitive development. The first deals with the concept of reasoning in general, without emphasis on characteristics and growth, and without indicating the factors affecting it. One of the investigators of this trend, Sperman, considers intelligence to be synonymous with reasoning. Sperman knows that intelligence involves an awareness of relationships, essentially based on reasoning. Some of his research has shown that the most satiated tests in the general factor is the test of reasoning (Mr., 1976) and Thurston count. This includes the ability to use reading and deduction from the first of eight mental abilities (Sheikh, 1982). As for Burt, when describing the hierarchical model of intelligence, he referred to inference by its inductive and deductive types within the level of relationships that represented one of the four levels of mental formation (Atouf, 1981). Guilford established the inferential processes with two dimensions of cognitive thinking, knowing the relationships between symbols and knowledge of symbolic systems, and in two other dimensions of productive thinking as well – convergent production of relations between symbols, as well as converging production of symbolic systems (Okasha, 1986).

As for the second trend theories, the most famous was Piaget's theory of upgrading and cognitive development, which dealt with thinking and reasoning with detail and clarity, especially among children and adolescents. This is a pioneering study of cognitive development, defining its stages, analysing the inferential processes in children, and creating key concepts. His theory has become one of the most common theories of cognitive

development in the field of psychology, and one of the most influential in the mental cognitive curve. In addition, it brought attention to thought and reasoning in children and adolescents, especially in early adolescence. This was part of the initial consideration given in this study of inferential reasoning (Al-Hamdani, 1989; Al-Azrajawi, 1991).

Elements of Inferential Reasoning

The scholars have listed the elements of inferential reasoning as follows:

1 - Introductions, which indicate a correct result.
2 - Results from advanced delivery.
3 - Logical relations between introductions, in the case of their multiplicity, and they are then linked with each other.
4 - The mind then depends on several principles in its movement, and moves from the introduction to the result.

The main components of reasoning are introductions or results. These are connected by relationships, which start with the mind and end up connecting with others, according to certain rules known as the rules of reasoning (Al-Anbaki, 2002).

Reasoning Constraints

There are many factors that impede proper reasoning, including:

1 - Poor quality and quantity of information, if an individual relies on trial and error in facing situations and dealing with problems.
2 - An individual relying on inaccurate introductions and superficial observations, which results in hasty judgment delivery.
3 - Choices for a solution causing inertia around a specific idea.
4 - The lack of a suitable psychological climate for an individual.
5 - An individual's desire for a specific solution and not considering the preferences of others.
6 - Individuals having different opinions about certain concepts.
7 - Weak self-confidence among some individuals (Al-Tal, 1987).

Previous Studies

The researcher will address previous studies that have dealt with both Cognitive Acceleration Strategy and inferential thinking.

• Previous studies on the strategy of cognitive acceleration:
Al-Awadi study (2014)

This study was conducted in Iraq, and it aimed to know the effect of Cognitive Acceleration Strategy in the acquisition of biology knowledge and metacognitive skills for fourth-grade students. The study sample consisted of 56 students from the secondary school of Al-Daghara for Boys, which is affiliated to the General Directorate of Education Qadisiyah. The sample was divided into two groups: the first included 28 experimental students, who studied using the strategy of cognitive acceleration, and the second included 28 female officers, who studied in the usual way. Parity was conducted between the students of the two groups, based on age (in months), the degree of revival from the first semester, and testing of previous information in the subject of biology, as well as Raven's IQ test.

The research tools for the study included preparing an achievement test and adopting a test for metacognitive skills. The researcher used the following statistical methods: the T-test, Cooper's equation, the equation of faulty alternatives efficacy, the difficulty coefficient, the discrimination coefficient, the Alpha-Kronbach coefficient, and Kjord-Richardson's 20th equation.

The results of the study were as follows:

1 - There was a statistically significant difference between the experimental and control groups, in favour of the experimental group in the learning of biology.
2 - There was a statistically significant difference between the experimental and control groups, in favour of the experimental group in testing metacognitive skills.

In light of the results, the study recommended adopting a strategy of cognitive acceleration in biology teaching. (Al-Awadi, 2014)

• Previous studies dealing with inferential thinking:
Hagras study (2011)

This study was conducted in Iraq, and it aimed to know the effect of the obstetric learning model on achievement in physics for students of an institute for the preparation of teachers and the development of their inferential thinking.

The study's sample consisted of 40 students, from the third stage of the Institute for the Preparation of Women's Teachers at the Baghdad Governorate Center, affiliated with the General Directorate of Education of Karkh/First. A control group was studied in the usual way, then parity was conducted between students of the two groups in terms of age (in months), the

degree of physics learned during the first semester, and testing previous information in the subject of physics, as well as Raven's IQ test (intelligence).

The research tools for the study included preparing an achievement test and adopting a test for inferential thinking, The following statistical methods were used: the T-test, Cooper's equation, the formula for the effectiveness of wrong alternatives, the difficulty factor, the coefficient of excellence, and the Alpha-Kronbach coefficient, the Kjord-Richardson's 20th equation.

The results of the study were as follows:

• There was a statistically significant difference between the experimental and control groups, in favour of the experimental group in the acquisition of physics.
• There was a statistically significant difference between the experimental and control groups and the validity of the experimental group in the inferential thinking test.

In light of the results, the study recommended adopting the obstetric learning model in physics teaching (Hagras, 2011).

Search Procedures

First: The experimental design:

An experimental design with partial adjustment (experimental group and control group) was chosen, as shown below:

Table 1: Experimental design

The group	Equivalence	Independent variable	The dependent variable	Post test
Experimental	-Chronological age -IQ Raven -Achievement in Chemistry (First Course) -Previous information	Cognitive acceleration strategy	Collection +	Achievement test +
Control		Normal way	Deductive thinking	Deductive thinking test

Second: The research community and its sample:

The researcher chose a study sample from second year middle school students in Dhul-Nourain Secondary School for Boys, affiliated to the General Directorate of Education for the third Baghdad Al-Karkh, numbering 62 students.

Third: Equivalence of the two research groups:

Parity was carried out between the two research groups by looking at the factors of age, intelligence (Raven IQ test results), achievement in chemistry (within the first course) and previously gathered information. The following table shows the total equivalencies of agency:

Table 2: Total equivalencies of agency

t	Variables	The group	Number of students	SMA	Variance	Degree of freedom	T value		Significance level
							Calculated	Tabular	
1	Age in months	Experimental	32	171.59	157.57	60	0.2196	2	Is dallah
		Control	30	170.83	217.14				
2	IQ Test (Raven)	Experimental	32	12.12	66.04		0.508		
		Control	30	11.06	70.96				
3	Chemistry first course	Experimental	32	61.13	105.18		0.038		
		Control	30	61.23	109.63				
4	Previous information	Experimental	32	9.06	30.125		0.45		
		Control	30	8.43	31.56				

Fourth: Research requirements:

The scientific subject being reviewed by students during the second semester of the year (2015-2016) is within the last three chapters of the second intermediate class's chemistry books. The study also looks at the formulation of behavioural purposes of scheduled study of 233 behavioural presentations, distributed among the first four levels of knowledge. For Bloom, who analyses remembering, assimilation, application and analysis, they are as follows:

Table 3: The number of behavioural purposes for each of the four cognitive levels according to Bloom's classification, for three chapters (V, VI, VII) of the textbook

T	Content	Memory	Comprehension	Application	Analysis	Total
1	Chapter Five	24	29	11	9	73
2	Chapter Six	48	24	21	9	102
3	Seventh Chapter	20	22	10	6	58
Total		92	75	42	24	233

In addition to preparing 16 plans for the experimental group, and the same for the control group, the following test map has been developed:

Table 4: Test map for behavioural purposes for the achievement test

Content Ratio			Percentage of behavioural purposes				Total
Subject	Number of classes	Percentage	Remember 40%	Comprehension 32%	Application 18%	Analysis 10%	
Chapter Five (water)	4	25%	4	3	2	1	10
Chapter six (Acids, Rules and Salts)	7	44%	7	6	3	2	18
Seventh Chapter (Carbon)	5	31%	5	4	2	1	12
Total	16	100%	16	13	7	4	40

Fifth: The research tools:

The researcher prepared an achievement test consisting of 40 substantive paragraphs, and the achievement test used multiple choice. The apparent sincerity was extracted by using the Cooper formula (which shows the percentage of experts agreeing on each of the achievement test items). Eighty per cent showed the opinions of the arbitrators in education and methods of teaching science. A preliminary application of the exploratory experiment for chemistry test achievement, used in order to determine ambiguities, determined the time required for the test was 55 minutes. The second exploratory experiment, to conduct statistical analysis of the test items – by extracting the coefficient of the P amount of 0.26-0.72 – is considered good and acceptable. The strength of discrimination was 0.28-0.70 and is also considered good, acceptable and within the specified range. The effectiveness of wrong alternatives was also revealed, and the results were of negative value, thus revealing that the alternatives were effective, and the stability of the test was extracted using the Koder-Richardson's 20th equation method, where it reached 0.82, and this is considered a good stability factor.

As for the inferential thinking test, the Al-Rubaie test (2014) was adopted, and its apparent honesty and reliability were calculated.

Sixth: Statistical methods:

Two independent sample T-tests, difficulty coefficient equation for objective paragraphs, differentiation strength equation, alternatives efficacy equation, Cooper's equation, and variance, and the Koder-Richardson 20th equation formula were adopted as statistical means to address the results of the research.

Research Results

1 - For the purpose of verifying the first zero hypothesis, which states that:

"There is no statistically significant difference at the level (0.05) between the average scores of students studying cognitive acceleration strategy and the average scores of students studying in the usual way in the chemistry achievement test."

The researcher compared the scores of the control group and the experimental group in the achievement test, extracting the mean of the experimental group – 29,43 – and the variance – 50.44. For the control group, the mean was 22.3 and the variance was 68, although the average score for students of the experimental group was higher than the average score for the students of the control group on the achievement test. The researcher investigated the significance of difference between the average scores of the two groups, testing the validity of the above hypothesis, and adopting the equation (T-test) at the level of significance (0.05) and the degree of freedom (60), where the calculated T value is 3.67, and the zoom value tabulation of 2, as the table below shows.

Table 5: Arithmetic mean, variance, calculated and tabulated T value between achievement test scores and the statistical significance of the experimental and control groups

The group	Number of Students	SMA	Variance	Degree of Freedom	T value		Statistical Significance at the Level of Significance 0.05
					Calculated	Tabular	
Experimental	32	29.43	50.44	60	3.67	2	Function
Control	30	22.30	68.76				

This indicates that the difference between mean differences is statistically significant in favour of the experimental group that studied the strategy of cognitive acceleration, thus rejecting the first zero hypothesis.

2 - For the purpose of verifying the second null hypothesis, which states that:

"There is no statistically significant difference at the level (0.05) between the average scores of students studying cognitive acceleration strategy and the average scores of students studying in the usual way in the inferential thinking test."

The researcher compared the experimental group and the control group through the inferential thinking test, extracting the arithmetic mean of the experimental group, of 22.09, and a variance of 33.82. As for the control group, the mean was 18.26 and the variance was 37.57. By adopting the equation (T-test) at the level of significance (0.05) and degree of freedom (60), the calculated T value reached 2.55, which is greater than the tabular value of 2, as the table below shows.

Table 6: The mean, the variance, and the calculated T-tabular value of the differences between the scores of the inferential thinking test and the statistical significance of the experimental and control groups.

The group	Number of students	SMA	Variance	Degree of freedom	T value		Statistical significance at the level of significance 0.05
					Calculated	Tabular	
Experimental	32	22.09	33.82	60	2.55	2	Function
Control	30	18.57	37.57				

This indicates that the difference between the mean differences is statistically significant, and in favour of the experimental group that studied the strategy of cognitive acceleration, and thus rejects the second null hypothesis.

Interpretation of the Results

The results obtained indicate that the Cognitive Acceleration Strategy has a positive effect in increasing achievement in the subject of chemistry, as well as inferential reasoning among second-graders of the middle class, due to the following reasons:

1 - Exposure of students in the experimental group to situations and activities that they were unfamiliar with encouraged students to research and discover information, and this was achieved through sensory preparation.
2 - Discussing questions during class activities helped students interact with each other, investing in their knowledge and building on previous experiences, while linking them to

existing knowledge and information. This led to the expansion of students' experience, and the generation of new information at a deeper level, strengthened by an increase in their achievement of concepts and knowledge, included in the strategy steps.
3 - The Cognitive Acceleration Strategy helped to present study subjects in a new way that contributed by linking the subject matter to other areas of study. This led to a better understanding of the subject material, which is not achieved by the usual method of teaching followed by the control group in this research.
4 - The division of learners into equal groups at each level led to an exchange of opinions between them, benefiting learners with low-level thinking as they learnt from their colleagues with high-level thinking, which also strengthened especially inferential thinking.

Conclusions

In light of the results of this research, the researcher can conclude the following:
1 - Teaching with the Cognitive Acceleration Strategy helped improve the academic achievement of the second intermediate class students.
2 - The strategy can be applied by teachers, in light of the available capabilities in Iraqi schools.
3 - Teaching according to the Cognitive Acceleration Strategy led to the improvement of inferential thinking among middle school students in the subject of chemistry.

Recommendations

In light of the results of this research, the following is recommended:
1 - Chemistry teachers adopt the Cognitive Acceleration Strategy in teaching academic content to intermediate classes.
2 - Training courses and seminars be conducted for teachers, training them in modern teaching strategies, including the Cognitive Acceleration Strategy.
3 - Train students of colleges of education, including departments of chemistry, on adopting Cognitive Acceleration Strategy for individuals teaching and learning chemistry.

The Proposals

In completion of the current research, the researcher suggests the following:
1 - Researching the effect of the Cognitive Acceleration Strategy on students, and whether it is subordinate to other current study variables, such as scientific thinking, critical thinking, retention, and motivation for chemistry.
2 - Carrying out similar studies focusing on other subjects, such as biology, physics, computer and mathematics.

REFERENCES

Abu Hijleh, A.A.S. (2007). The effect of the science education acceleration model on achievement, motivation for achievement, self-concept, and test anxiety among seventh grade students in Qalqilya Governorate. Unpublished Master Thesis, An-Najah National University, Qalqilya, 2(51): 152 – 166.

Adey & Shayer (2002). Science Teaching and the Development of Intelligence In Good practice in Sciene Teaching What Research has to Say, Edited by Monk, M, Osborne, J. Open University press, U.S.A. Vol 5 (14) ; pp 194 - 201

Adey, P. (1999). The science of thinking & science for thinking Adscription of cognitive Acceleration through science Education (Case). International Bureau of Education. Geneva, Printed in Switzerland by PCL. © UNESCO: IBE. Vol 6 (36) ; pp 183 -199

Al-Anbuge, S. A. J. (2002). The effect of using the wave investigation method with current events in developing critical thinking among students in the subject of history. University of Baghdad, College of Education, Ibn Rushd, unpublished Master Thesis, 1(25): 244-256.

Al-Awad, Y.A.M. (2007). Using a strategy based on questions with higher cognitive levels in teaching science and its effect on achievement and the development of inferential thinking among sixth-grade primary students, (unpublished Master Thesis), College of Education, King Khalid University, Abha, 7(72): 152 – 168.

Al-Awadi, M. A. H. (2014). The effect of the strategy of cognitive acceleration in the acquisition of biology and metacognition skills for fourth-grade students. Unpublished Master's Thesis, College of Education (Ibn Al-Haytham), University of Baghdad, 1(73): 192 – 202.

Al-Ayasrah, W. R. (2011). Saber and creative thinking. 1st edition, Osama House for Publishing and Distribution, Amman – Jordan, 1(34): 156 – 167.

Al-Azrajawi, F.M. (1991) Foundations of educational psychology. Ministry of Higher Education and Scientific Research, Al Wasl, University of Mosul, 2(34): 126 – 138.

Al-Bayati, A. H. N. (2005). The effectiveness of two proposed therapeutic patterns for learning chemical symbols in the ability of second-graders to write chemical equations, unpublished Master Thesis, Diyala University, College of Basic Education, 1(31): 172 – 186.

Al-Harthi, S. M. (2007). Awareness of the metacognitive skills of female students of the College of Education, the scientific and literary departments and their relationship to anxiety of test and achievement. Unpublished Master Thesis, Princess Noura University, College of Education for Girls, 7(73): 262- 273.

Al-Khatib, A.M. & Abdel-Odeh, A. S. (1993). The role of the teacher in developing students 'thinking skills, Education Letter, Issue 9, Educational Research House, Muscat 0, 9(23): 123 – 137.

Al-Kubaisi, A.-W. H. & Sabri, B. A.-H. (2004). Diagnosis of some psychological and behavioral phenomena and their relationship to preparatory students in mathematics. Journal of Humanities and Economic Sciences, Anbar University, 4(5): 242 -253.

Al-Najdi, A. & others (2007). Modern directions for science education in light of international standards and the development of thinking and constructivism. 3rd floor, Cairo, Dar Al-Fikr Al-Arabi, 1(73): 138- 146.

Al-Rubaie, R.A.-S. (2014). The effect of active learning on the achievement of chemistry for intermediate second-grade students and their inferential thinking. Unpublished Master Thesis, College of Education (Ibn Al-Haytham), University of Baghdad, 7(82): 232 – 238.

Al-Saadi, B.M. (1987). Practical inorganic chemistry for the second classes of faculties of education. Dar Al-Kutub, University of Mosul, Mosul, 5(27): 214 – 236.

Al-Tal, S.A. (1987). Evolution of logical thinking, teacher's message, directorate of documentation and educational publications. Ministry of Education, Amman, 5(28): 166-178.

Al-Tamimi, A. J. M. (2009). Methodology and book analysis. Dar Al-Hawra, Baghdad, 6(71): 75- 88.

Alwan, A.A.H., Munir, F. S., Akram, J. & Ayyad, H. M. (2011). Teaching competencies and teaching techniques, 1st Floor, Al Yazouri Scientific House, Amman, 7(83): 225 – 241.

Al-Zoghbi, T. & others (2009). The level of scientific reasoning for students of the College of Science at Hussein Bin Talal University affected by gender variables, academic level, specialization. An-Najah University Journal for Humanities Research, 2(23): 235- 247.

Amer, T. A.-R. & Mohamed, R. A.R. (2008). Motor disability. 1st Edn., Thebes Publishing Establishment, Cairo, 1(23): 135 – 144.

Atouf, M.Y. (2017). Intelligence tests between extremism and moderation. First Edition, Dar Al-Andalus, Beirut 0, 1(53): 173 – 186.

Ghbari, T. A. & Khaled, M. A. S. (2011). Fundamentals of thinking. 1st Floor, Arab Community Library, Amman, 7(23): 225 – 236.

Hajras, B. A. A.-S. S. (2011). The effect of the obstetric education model on the achievement of physics subject for students of the Institute for the preparation of teachers and the development of their inferential thinking. Unpublished Master Thesis, University of Baghdad, College of Education, 5(25): 172 – 187.

Ibrahim, F. K. (1999). Following the discussion method by the method of small groups in obtaining and retaining knowledge among students of social sciences at the Teachers College / University of Mosul. Journal of the Center for Educational Research, Qatar University, eighth year, the fifteenth issue, January, Dar Al-Shorouk, Doha, 5(26): 225 – 238.

Jarwan, F.A.R. (2007). Teaching thinking, concepts and applications, 3rd floor, Amman, Dar Al Fikr for Printing, Publishing and Distribution, 1(15): 224 – 237.

Mayer, D. (2010). Accelerated learning Dalek the creator to design and implement faster, more effective training programs, translated by Muhammad. 1st Floor, Al-Dar Al-Qemayah, Damascus, 2(76): 231 – 246.

Mohamed, Z. M. Q. (2005). The effectiveness of using the Waseel Enrichment Program in developing inferential thinking skills and academic achievement for primary school students with attention-grabbing in hyperactivity. The Ninth Scientific Conference (Obstacles for Scientific Education in the Arab World), Ain Shams University, Cairo, 3(56): 152 – 163.

Mustafa, M. N. (2011). Thinking education strategies. 1st Floor, Dar Al-Bidaya, Amman, 5(26): 263 – 273.

Okasha, M. F. (2017). Extrapolating the training of workers to the evidentiary abilities of adolescence and adulthood, College of Education Magazine, Sana'a University, 5(62): 163 – 177.

Padilla, M. (1990). The science process skills. Research Research Matters - To the Science Teacher No. 9004, Publication of the National Association for Research in Science Teaching (NARST), 3(53): 172 – 184.

Razzouki, R. M. & Suha, I. A.K. (2013). Strategies for learning and teaching science newly. 1st floor, Dar Al-Abbad, Baghdad, 7(27): 183 – 197.

Sheikh, S. A.-K. (2016) Individual differences in intelligence, second edition, 2(62): 131 – 138.