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# The Effect of Motivated Abstract Thinking Model on Academic Achievement of Grade-5 High School Students

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**Abstract -** The authors of this study implemented an experiment to investigate the validity of the null hypothesis, which claimed that there was not a statistically significant difference (sig. = 0.05) between the mean score of the experimental group, who studied according to the motivated abstract thinking model, and the academic achievement mean score of students in the control group, who studied conventionally.This test was applied in the first semester of the 2020-2021 academic year in Al-Zoha high school, affiliated with the General Education Administration of Baghdad, Karkh 3rd. The researchers identified the first four chapters of the sciences course of the grade-5, high school students, studying empirical sciences[1], as the scientific material. The results of this research, which exploited an appropriate statistical instrument, indicated that the experimental group students, who studied according to the motivated abstract-thinking model, were outperformed the control group students, who studied conventionally.

**Keywords: Motivated Abstract Thinking Model, Academic Achievement**

## I. INTRODUCTION

### 1.1. Statement of the Problem

Due to the fast changes the world witnesses in the current age, education faces challenges not encountered before. Hence, the responsibility of education is very difficult. It has been criticized due to learning and education qualities, their results, and the low level of students in some lessons, in general, and chemistry, in particular (Ibrahim, 1996, p. 9). Since the dominant methodology is the conventional approach, which mainly relies on a single source; i.e., teacher, it is not adjustable with technology developments and cognitive acceleration. It is because memorization and concentration on scientific subjects, irrespective of the dexterous and sympathetic aspects of learners, are common in this method.

The results of many studies, such as Al-Bayati (2015), Al-Zahiri (2016), Faleh (2017), and Al-Rabei (2018), show that there is a transparent weakness in the academic achievement of the grade-5 high school students studying empirical sciences. These studies argue that the reason for this weakness is the pursued educational model (conventional), which is founded on dictation, teaching, memorizing, and learning by heart.

Thus, the authors of this study felt there was a real problem, which needed further investigation towards the enhancement of students' level of academic achievement. The endeavors of the authors to overcome this problem led them to test the motivated abstract-thinking model in teaching chemistry for the first time (to the best of their knowledge and as far as it was investigated). They hoped that this experiment would give rise to active and efficient learning, which increased students' level of academic achievement. The research problem was illuminated by the answer to the below question:

What are the effects of the motivated abstract thinking model on the academic achievement of the grade-5 high school students in chemistry?

### 1.2. Significance of the Study

Glorious God has granted the human a great and distinctive strength, not given to other creatures. It is wisdom, which is applied for thinking about all living affairs s/he encounters, and the knowledge-acquisition favor lies in its kinds and varieties, by the development of which s/he could build civilizations during long centuries and solve the problems ahead of him/her. Due to the rapid development of knowledge, the world witnesses progress and advancements in all aspects of life, including education. This progress is accompanied by cognitive acceleration (cognitive explosion), and humans need to adapt themselves to this scientific development and participate positively in life to concord themselves with this

[1] In Iraq, there are two science and literacy fields. The science field constitutes two biology and comparative subcategories. Literacy deals with human sciences; scientific/biologic relates to the medical and paramedical fields; and scientific/comparative associates with the engineering domain. Thus, we can state that scientific/biologic is equivalent to empirical sciences in Iran, and scientific/comparative is almost equivalent to the technical and math fields.

great bulk of information. Therefore, paying attention to education and its quality via the qualitative development of lesson plans in the course of sciences enhanced and necessitated the employment of different methods in the teaching and learning process. The improvement of the educational process depends on its capability in transforming education from its traditional form, which relies on impregnating and transferring information, to a new and modern one, which relies on discussion and reflection on diverse situations and practices, as well as research on thinking-enhancing teaching methods, and accords with the laws of human mentality and brain principles (Mahmoud, 2006, p. 10).

The coaches involved in the lesson planning and teaching of sciences foreground that the training sciences, in general, and chemistry, in particular, is not the mere transfer of information to students, its memorization and retrieval. It is rather a process that deals with activating the prior knowledge of students and making them accustomed to thinking, knowledge-creating, acquiring, perceiving, and applying.

Constructivism theory has many associations with teaching and learning and motivates and reinforces abstract thinking among students. It is recognized as a roadmap, which explains indications and ideas for meaningful and efficient constructive teaching and learning (Zeitoun, 2007, p. 14). In order to develop the thinking skills of students, education should foster the methods of thinking and attaining solutions for encountered problems in students. In this way, we assist them to express their thoughts and make learning easier for them. However, this objective is only realized by the utilization of novel models that highlight skill development among students. The social constructivism theory supports and reinforces thinking skills (Al-Advan&Davoud, 2016, p. 87).

Thinking is an abstract process that possesses specific principles and conditions, steered by motivations and stimuli and blocked by some barriers. The numerousness of the interwoven thinking-impacting aspects and factors has resulted in the provision of several definitions and classifications associated with thinking and its process and outcomes. In general terms, thinking is defined as an abstract or intellectual activity that differs from perception and sensation, passed for the purpose of obtaining abstract ideas. In specific terms, it is a mental flow that is provoked or motivated by any problem that needs a solution, such that it triggers the investigation of data, validating them, and recognizing the laws and mechanisms it employs (Mansour, 2001, p. 329).

Due to the numerousness of the perspectives linked to the thinking concept among researchers, this terminology is described as a problem-solving method accompanied by a motivating incidence and involving a set of skills that can be taught and developed besides being different from one person to another (Asr, 1999, p. 12).

The Holy Quran accentuates thinking greatly and has invited individuals to think, reflect, and contemplate. For example, the God glory makes remarks in this verse: “Indeed, there are indications in the creation of skies and earth as well as the difference in day and night for the wise and those who are used to think”. The scientific miracle of the Quran encourages humans to think and opens the windows of knowledge to them. It invites them to enter the trajectory of thinking and perceiving new scientific facts and motivates a scientific sense of thinking, comprehending, and reasoning. However, thinking without recognizing is impossible. This means that knowledge is the sole path that steers human life, such that wisdom actively embarks on conceiving and managing the meanings that enable it to produce new knowledge (Al-Ayasereh, 2011, p. 17-18).

The movement that happened in this modern and advanced world has not been achieved by the mere attention to education, different teaching methods, the application of teaching strategies and models, and thinking development. This issue has been highlighted by the observation of many international and local conferences, like the 4th international conference of new methods in human and social studies and applied mechanisms, held by Mustansiriyah University with the cooperation of the International Assembly of Culture and Sciences on October 15th-16th 2017. It recommended the employment of modern methods that were in concordance with current evolutions and their application mechanisms during teaching. Undoubtedly, teachers’ extensive awareness of the teaching methods and strategies and various educational models besides their capabilities in employing them to recognize the appropriate conditions of applied education assist the teaching process to be proportionate with students’ abilities and connected to their daily lives in addition to being funny and enjoyable (Marei& Al-Halileh, 2002, p. 25).

Many educational sciences mentors believe that the constructivism-based models are more effective in action training since real learning is not based on what students hear or repeat in front of their teachers.

It is rather founded on their inner knowledge and influenced by their surrounding environment (Al-Dalimi, 2014, p. 22). These models help with the motivation and reinforcement of learners' thinking and the development of their wills and capabilities. In addition to preparing talented students, this issue provides them with problem-solving abilities by considering their scientific levels and readiness, noticing their cognitive, skill, and emotional aspects to learning, and following the scientific method of thinking (Al-Masoudi, 2015, p. 57).

One of the priorities of developing the education process is to apply different strategies and models in teaching sciences, in general, and chemistry, in particular. Besides paying attention to perspectives, topic outlines, examples, and the methods used for stimulating students' motivation, this model refers to practicing along strategies as a particular method that conforms to educational content. This model includes various activities that can impact learning and help students to learn the information and ideas, as well as creative, social, and academic skills, according to an integrated framework. Likewise, it assists with economizing time, efforts, and use of diverse sources and aids teachers to teach the skills with high quality and dominance and plan effective and active learning experiences (Al-Masoudi, 2018, pp. 17-18). Thus, an urgent need is felt for an education that employs new models of teaching. Among these models, we can refer to motivated abstract thinking, reckoned as a new model that assists students to build awareness and develop their personalities in addition to fostering and reinforcing their thoughts. This model was first introduced by two theoreticians, namely Philip Adey and Michael Shayer. It is founded on Piaget's ideas on the levels of mental development and Vygotsky's social constructivism, applies them to develop high thinking skills, and enhances students' motivation and perseverance in science learning. Furthermore, this model meticulously investigates sciences courses and perceives it as an indication of task manual and idea perception. The phases of this model can be explained as follows: the preparation and discussion phase, the cognitive dissonance phase, the thinking in thinking phase, and the bridging phase (Adey&Shayer, 2009, p. 9).

Academic achievement is of utmost significance from the viewpoints of those engaged with education. Hence, it is noticed by numerous researchers and specialists who aim to perceive the reasons for a decline in students' level of academic achievement, as well as the solutions and methods that can enhance their achievement (Al-Zaghoul, 2004, p. 305). On the basis of what aforementioned, the significance of this study can be summarized as below:

New approaches to teaching sciences, in general, and chemistry, in particular, specifically underscore the utilization of modern methods in teaching development and addressing the critiques respecting the traditional and conventional methods employed in many schools at present. Amongst these modern methods used in teaching chemistry, we can refer to the motivated abstract thinking model, which plays a role in increasing grade-5 sciences students' level of academic achievement.

The results of this research, along with its instruments and phases, can be employed by chemistry teachers to develop their educational behaviors and organize classes and scientific content.

The present study, which investigates chemistry teaching and its effect on female students' academic achievement, is the first conducted study on the chemistry lesson in the region and among Arab countries. Likewise, it has not been so far addressed by researchers and higher education students working on their theses (to the best of researchers' knowledge). Therefore, this study is reckoned as a complement for educational sciences and central libraries for future investigations and studies.

### 1.3. Purpose of the Study

The present study aims to discover the effect of the motivated abstract thinking model on the academic achievement of grade-5 science students in chemistry.

### 1.4. Definition of Key terms

#### 1.4.1. Effect

The term *effect* is defined as the result of a desirable or unintended change that happens during the process of learning in students (Shahateh& Al-Najjar, 2003, p. 22). Also, Saghaf (2007) defines *effect* as the signs and indications the learner observes in what has been impacted. There is another motivator that impacts it, and it implicates an independent variable and the rate of its effect on the dependent variable.

#### 1.4.2. Model

Ghatami (2005) defines *model* as a delineated frame that solidly exhibits the events and their interrelationships to help with the interpretation of unintelligible events or facts. Abu Jadu (2008) defines

*model* as a set of actions a teacher pursues in educational situations and involves subject designing, presentation methods, and their processing.

1.4.3. Motivated abstract thinking model

Researchers define this term as a set of activities that enhance the level of intellectual growth and accelerate awareness of certain axes and foundations. These activities are concordant, regulated, and based on empirical frameworks and encompass four stages, including preparation and discussion, cognitive dissonance, thinking in thinking, and bridging (Adey, 1999, p. 1).

According to Sadig (2002), motivated abstract thinking is a model that assists students to reach the formal thinking stage earlier instead of attaining it gradually.

1.4.4. Academic achievement

Every researcher defines this term in a specific way. Najar (2010) defines it as the advancement in the level of information and skills students learn during a course and is revealed by their provision of answers to a set of questions. Esmaeili (2011) defines *academic achievement* as the rate of knowledge or skill students acquire by virtue of prior experiences and passing educational courses.

## II. Theoretical Framework and Research Background

### Theoretical framework

Abstract thinking reinforcement model: The present study relies on one of the theories of constructivism. The mentioned model is based on Piaget's constructivism and Vygotsky's social constructivism theories. Therefore, we will have a glance at these two theories in this section. Constructivism theory is an educational philosophy; i.e., the learners themselves construct the knowledge they store in their minds, and their self-awareness is individually or socially based on their current knowledge and prior experience (Zeitoun, 2003, p. 2012). Constructivism is a theory that pivots around a single thought or idea, arguing that knowledge is constructed by learners within their minds. Since constructivism appeared in the educational science realm and was considered and extended more than twenty years, educational scholars presented different definitions for constructivism. These definitions vary from one researcher to another with respect to the school they belong to and the attitude they pursue. Josef Novak defines constructivism as an idea or perception the learner constructs, and this process of meaning construction in mind is a result of endeavors for understanding something or extracting meaning from it (Al-Havidi, 2005, p. 299).

The international dictionary of educational sciences (1977) defines *constructivism* as a prospect in the child's learning and development theory. Children become active in constructing their thought patterns due to the interaction of their innate capabilities with experience. One of the most important properties of constructivism is reconstructing individuals' awareness. Jandi (2002) confirms this and believes that the constructivism theory is the reconstruction of students' awareness through social interactions with others and foregrounds the role of prior knowledge as a pillar on which constructive thinking is founded for the purpose of creating meaningful learning.

The content of the constructivism and social constructivism theories, besides their encompassing information, pave the way for the emergence of many educational models. Motivated abstract thinking is an example of these models. Introduced by two scholars, namely Philip Adey and Michael Shayer, this model relies on Piaget's ideas on intellectual development and Vygotsky's social constructivism. Teaching on the basis of the motivated abstract thinking model provides students with an opportunity to establish continuous and active relationships since suitable relational atmospheres make them maximize their energies and feelings during learning (Gandil, 2006, p. 5).

The exigencies of the cognitive constructivism and social constructivism theories are uncovered and realized in the motivated abstract thinking model, according to which the student takes an active role while the teacher plays the role of a coach or mentor. The purpose behind designing this model is to motivate the cognitive-mental development of students (Adey, 1999. P. 23).

Students are taught by freethought activities their teachers provide for them. These activities cater a secure psychological environment for students' expressions. When students are provided with an opportunity to discover a large number of solutions to a specific problem, they are put in a situation that helps them to review their mistakes, if there is any, and find a solution which they think is the best. This

issue means that the teacher and other students give their opinions about a student's task; however, it is important to know that the student himself/herself is capable of judging about his/her action, and this judgment can be true since it is based on his/her criteria and self-satisfaction. When an answer is true or false, the ultimate source of the solution is always external, which is often the teacher or the lesson book (Al-Kanani, 2002, p. 294). Furthermore, this model presents the explanatory additions and background information of the teacher during their application in the classroom based on the below four stages:

**First stage: Concrete Preparation**

Adey and Shayer call this stage concrete preparation. It is the first step after the introduction presented for the topic perception and confirms students' initial perception of the problem since it provides the general framework of the topic and introduces new topic-related terminologies to students. In this stage, students are assigned into several groups for more fruitful and efficient discussions. Furthermore, the teacher, whose role is more than an information source, introduces problems, manages discussions, asks students individually or collectively several questions in order to create a mutual language between herself/himself and students, and provide an opportunity for the expression of the relationships they have established (Ali, 2008, p. 217).

**Second stage: Cognitive Dissonance**

In this stage, the teacher poses a problem students are incapable of solving and resort to the traditional methods of thinking. This stage is the main axis of this model since students are exposed to concepts that are incompatible with what constitutes their cognitive structures. This problem invites them to refer to and examine their cognitive structures to make correspondence with the evidence. The developed conflict for students enhances their activation to solve the cognitive conflict problem. This sudden consideration creates a state of amazement and wonder, making students enthusiastically and eagerly operate to solve the dissonant problem (Al-Desoghi, 2001, p. 70).

**Third stage: Thinking about thinking**

'Thinking about thinking' means students think about their thinking, wherein the learner (student) is aware of his/her inferences, which show his/her high level of thinking. In planning methods and models, this stage aims at developing students' capabilities of employing thought processes and giving rise to desirable information generation. Thus, they are fully aware of the pursued processes while solving problems and reflect on their thoughts (285).

This stage embraces the following cases: making students think about their thinking or thinking processes in order to develop their abstract thinking; i.e., the teacher encourages his/her students to talk about how problems are solved. This objective is fulfilled by thinking activities they practice themselves (Adey, 2006, p. 89).

By posing some questions, such as 'why did you think about this solution? Why did you think about this thinking? and How did you perform this task?, the teacher makes students think about the reasons for selecting this kind of thinking. Thus, students figure out the thinking type they apply to solve problems.

**Fourth stage: Bridging**

In this stage, some bridges are built between the experiences students acquire by regularly pursuing the method on the basis of which they study and their daily life experiences and make strong associations between their lives and what they learn (Adey, 1992, p. 137). This problem means the application of thinking skills in different aspects of life and situations. The bridging stage includes the linking of the prior experiences of students in the classroom with their daily experiences by the teacher and the creation of intellectual bridges between activities and scientific life, being necessary for commencing educational experiences within the theoretical framework. At the end of every lesson, the teacher asks students to explain how they exploit what they have learned in practice. The bridging process can be explained by the next question the teacher poses: How can you relate what you have learned today with your work life? This means the establishment of an association between the newly shaped experiences and academic materials. This is the same thing that helps the construction and formation of an integrated picture of knowledge and awareness (Al-Kabisi, 2008, p. 217).

The significance of teaching by using the motivated abstract thinking model lies in the fact that it helps learners reach high levels of academic achievement and establish interrelationships among variables.

Moreover, by providing innovative activities, this model enhances learners' level of intellectual development and gives rise to the expansion of learners' thinking horizons for the purpose of better thinking. Also, by addressing the role of the teacher, it counts it as an aspect of work guide and idea perception (Sadegh, 2002, p. 61).

However, the role of the teacher in motivated abstract thinking can be described as below:

1. S/he manages discussions among students besides steering them towards the creation of a mutual language by posing questions.
2. S/he pounds questions in such a way that they bring about contradictions and encourages students to solve them.
3. S/he pays attention to the thinking patterns of students trying to attain a suitable solution.
4. S/he encourages students to review their thoughts and gain awareness of them.
5. S/he helps students to link their new experiences they learn during the class with their daily-life experiences.
6. S/he helps students to establish relationships between their learned experiences and real-life by creating some images in their minds (Afaneh& Yosef, 2009, p. 247).

The role of the student in the motivated abstract thinking model is as follows:

1. It helps with students' active participation in the classroom, development of creative skills, memorization of lessons, and reinforcement of learning.
2. It motivates the curiosity sense of students and makes them try to understand problems by posing thought-provoking questions and presenting ambiguous subjects to students.
3. It fosters thinking ability in students since the teaching methods the teacher follows play roles in developing a thought-fit atmosphere.
4. It encourages students to investigate and discover information by preparing and involving them in discussions. It is because they think better by linking concepts, solving contradictions, and establishing relationships with physical phenomena to reach abstract concepts (Rezoghi et al. 2016, p. 28)

Second axis: Previous studies associated with the model (motivated abstract thinking)

| Researcher | Purpose of research | Place | Sample | Instruments | Statistical methods | Results |
|---|---|---|---|---|---|---|
| **Al-Sadi** | Identifying the effect of Perkins and Bliss's and Adey and Shayer's models on grade-4 sciences students' learning of physical concepts and their reflective thinking | Bagdad University/ Ibn Al-Haytham | 54 students (27 for the first experimental group and 27 for the second experimental group) | The thought-provoking thinking scale and concept acquisition test | SPSS statistical software | The positive effects of Perkins and Bliss's and Adey and Shayer's models on grade-4 sciences students' learning of physical concepts |
| **Al-Soltan (2016)** | Identifying the effect of Adey and Shayer's model on the academic achievement of grade-5 sciences students studying biology and their cognitive representation | Babylon University / Iraq | 60 students equally assigned to experimental and control groups | Cognitive representation scale and academic achievement test | T-test for two independent samples | The positive effect of Adey and Shayer's model on academic achievement and cognitive representation |

## III. METHODOLOGY

This chapter consists of the below cases:

### 3.1. Method

This study employed an experimental approach to achieving its purposes. This approach is reckoned as a reliable and controlled change in the specific conditions of an event and considers the changes occurring in the same event and their interpretation (Molhem, 2006, p. 422).

### 3.2. Experimental Design

It is the exact planning of the process of hypothesis confirmation. A researcher who intends to prove his/her hypotheses through experiments needs to design an experiment by adopting integrated policies for this process (Halagh, 2010, p. 100).

Since the present study includes an independent variable (motivated abstract thinking model) and a dependent variable (academic achievement), a design with an experimental and a control group was selected (1).

Table 2. Design of two under-investigation groups

| Design | Equal actions | Independent variable | Dependent variable |
|---|---|---|---|
| Experimental | - Chronological age calculated in months | Motivated abstract thinking model | Academic achievement |
| Control | - Examining background information<br>- Prior education<br>- Intelligence | Conventional method | |

### 3.3. Statistical population and sample

A) population

The representatives of the research population are all grade-5 students studying empirical sciences in the whole all-girls state high schools affiliated with the Ministry of Education of Baghdad, Karkh 3rd, in the 2020-2021 academic year. The number of these female students was 2514, distributed in 44 junior and senior high schools.

b) Sample

The researchers of this study selected the research sample deliberately, resultant from the cooperation of the honored management of the schools and their consent for conducting the experiment in their schools in an interval many schools resorted to integrative (in-person and electronic) education and were disinclined to cooperate. To conduct the experiment, the researchers selected Zoha all-girls high school as the representative of the population. The number of students was 58, equally assigned to the experimental group (29 students) and control group (29 students) by simple random sampling. The experimental group studied under the motivated abstract thinking model, and the control group studied conventionally.

### 3.4. The homogeneity of the experimental and control groups

For the further accuracy and transparency of the research results, the students of the statistical sample in both groups (experimental and control) were homogenized before teaching with regard to the number of variables; for example, students' age, prior academic achievement in chemistry, prior information in chemistry, and intelligence.

Internal and external validities of the experimental design:

Endogenous variables are the ones that impact the dependent variable and cooperate with the independent variable in bringing about changes whose effects are far from the dependent variable. However, we can reason them through the effects of the independent and modifier variables on the

under-discussion phenomenon (Al-Mizan& Al-Atom, 2010, p. 66). The researchers endeavored to control some endogenous variables that might impact the experiment process and results as much as possible. The below cases are the methods they pursued to control some of these variables:

- The internal validity of the design includes the following cases:
a) Implementing equations
b) Experimental conditions
c) Experimental extinction
d) Maturation factor
e) Two measurement instruments
- The external validity of the design includes the following case:
a) Temporal period
b) Experiment confidentiality
c) Under-investigation lesson
d) Distribution of classes
e) Teaching the course

### 3.5. Research necessities

a) Defining the scientific subjects (content)
b) Setting behavioral goals
c) Preparing daily lesson plans

### 3.6. Research instrument: The academic achievement test

To attain the first objective of the research, the researchers measured the academic achievement of grade-5 sciences students in their chemistry lesson. They attempted to prepare a valid and reliable test containing specific topics. Hence, by relying on the book the students were to study during the 2020-2021 academic year, the researchers prepared and administered a test comprising 40 multiple-choice items. They followed the below stages in preparing the academic achievement test:

**a)** Preparing the test specification table

The specification table demonstrates a design for the distribution of items with respect to the distribution of the behavioral content and the set of goals the test measures (Al-Nabhan, 2004, p. 76). Considering the scientific subjects, the researchers embarked on distributing the items and questions of the academic achievement test. They determined the content weight of the first four chapters of the chemistry book of grade-5 students studying empirical sciences.

Content weight = (total number of classes during an academic semester) / (total number of classes) ×100

The content weight for 4 successive chapters is 15.625%, 37.5%, 9.375%, and 37.5%, respectively.

To determine the weight of the behavioral goals of every level of Bloom's cognitive taxonomy, the researchers used the below equation:

Goal weight = (number of goals of the behavioral level) / (sum of behavioral goals) ×100 (Al-Jaberi, 2011, p. 189)

The weights of the behavioral goals of Bloom's 6 levels amount to 33.9%, 32.5%, 11.4%, 13.3%, 4.3%, and 4.3%, respectively. The number of the questions of every cell, out of the total number of considered questions, is obtained by the equation below:

Number of question in each cell = goal percentage × content percentage × number of items (Odeh, 1995, p. 151)

**b)** Determining the type of sections

A topical test consists of 40 questions with respect to Bloom's cognitive levels. Topical tests are not influenced by the mental properties of the grader and enjoy the validity, reliability, and inclusion indices since they have scientific foundations and cover the components of the scientific material.

**c)** Course of test rubrics

The rubrics of the academic achievement test comprises the below cases:

- Rubrics associated with students' answering to test items: After being formulated by the researchers, these rubrics were presented via a special paper attached to the test paper of students.
- Rubrics associated with grading test items: Correct and incorrect responses were given scores 1 and 0, respectively, after the researchers provided standard answers to all test sections.
- Test validation: Test validity is one of the most important characteristics of tests, as well as educational and psychological criteria. It is because it is linked to the goal for which the test is constructed. (Elm, 2009, p. 156). Two kinds of validation were used for realizing the test validity:

1. Face validity: The general appearance of a test is reckoned as a measurement of face validity. It means that it denotes the fit of the test with the research sample and the clarity of its associated rubrics. (Al-Zaher et al. 1999, p. 129). The researchers presented the academic achievement test items, in their initial forms, to a group of experts in the field of teaching methods, measurement, assessment, and chemistry and ensured the face validity of the test by relying on the mean agreement percentage of 82% and Cooper's equation.
2. Content validity: Content validation permits presenting a test for the purposes that are to be measured. It is executable by the determination of the measured educational goals and the weight of every goal in relation to others. If the coefficient of content validity reaches its maximum value, it reveals that the content to be measured by the test is well manifested in the terms of the test (Shahateh&Zeynab, 2003, p. 204). This purpose is applied by the presentation of the test items and test specification table of the first four chapters of the lesson book of grade-5 empirical sciences students to a group of experts in teaching methods, measurement, assessment, and chemistry. The use of Coober's equation, yielding an average of 85%, brought about an agreement that the academic achievement test enjoyed content validity.

**d)** The application of the academic achievement test - exploratory: This test was applied in two stages:

1. Initial exploratory experiment to warrant the clarity of the items of the academic achievement test and determine the response time: To ensure the clarity of the academic achievement test items and know the required time for answering the test, the researchers selected the Roqayeh Bent Al-Hossein high school and administered the academic achievement test on Tuesday 2021-02-02. In the first exploratory sample, comprising 30 grade-5 female empirical sciences students, the first 5 students answered the test questions in 20 minutes, and the last 5 students answered after 50 minutes.

$20 + 50 = 70$; $70 \div 2 = 35$ minutes

2. The second exploratory experiment to statistically analyze the academic achievement test items: To examine the psychometric properties of the academic achievement test items, the researchers selected an exploratory sample of 100 high school female students (Al-Ezat all-girls school), affiliated with the Ministry of education of Baghdad, Karkh 3rd, on Tuesday 2021-02-09.

An investigation of the psychometric properties of the academic achievement test:

1. Test difficulty Index: The difficulty index is the ratio of the students that provide incorrect responses to the total number of students in two up and down groups. If the difficulty index declines, the facility index rises; i.e., there is a reverse relationship between these two indices (Majid &Yasin, 2013, p. 31). The difficulty index of every item of the test was calculated by the item difficulty equation, specific to topical items. This index fell into the 0.20 - 0.38 range, indicating that the test items were acceptable since their difficulty levels were in the 20% - 80% interval (Al-Zaher et al. 1999, p. 129).
2. Item discrimination index of test items: The authors applied the discrimination index equation to the topical items with the 0.22-0.77 interval. The items with discrimination indices of >20% are considered discriminating items and make a test to be well-recognized in terms of its items' discrimination indices (Alam, 2009, p. 115). Hence, these items are retained in the test with no omission, modification, or edition.
3. The efficiency of incorrect alternatives (distractors) on topical items: The process of judging the validity of alternatives is fulfilled by a comparison made between the number of respondents in up and down groups. If the number of respondents in the down group exceeds the up group, and the negative value is large, the alternatives are efficient and acceptable (Al-Dalimi& Al-Mahdavi, 2005, p. 93). The efficiency of incorrect alternatives on test items was estimated by the item efficiency equation, and the efficiency index of the incorrect alternatives fell in the 0.11-0.48 interval.
4. Reliability of the academic achievement test: The researchers estimated the reliability of the test at 0.79 using the Kuder Richardson 20 equation. It is worth mentioning that a test is reliable if its reliability index is ≥0.67 (Al-Nabhan, 2004, p. 240).

e. The final form of the academic achievement test: The academic achievement test, conforming to the statistical sample of the current study, was prepared for both groups (experimental and control) and administered in its final form.

### 3.7. The experimental procedure

After preparing the necessary conditions for the intervention, controlling some variables that might impact the experiment, homogenizing two groups; i.e., experimental and control, and agreeing with the school management, the researchers embarked on their teaching from Wednesday 2020-12-09 to 2021-02-17, and the respectful supervisor controlled the process of the intervention. After examining and correcting the students' responses in both groups, the researchers obtained their scores.

### 3.8. Statistical methods

The authors made use of appropriate statistical methods.

## IV. Results

With respect to the adopted null hypothesis, the findings of the study are described below:

a) The results of the null hypothesis: The null hypothesis argues that there is statistically no difference between the mean scores of the experimental group, who studied under the motivated abstract thinking model, and the control group, who studied conventionally in their academic achievement test. The mean and variance of the scores of both groups were computed by the t-test on two independent samples with equal numbers, and the T-value was obtained. The results of the academic achievement test revealed the superiority of the experimental group to the control group students, as Table 2 represents.

Table 3. Statistical significance of mean score of students in the academic achievement test in both groups

| Group | Sample No. | Mean | Variance | df | T-value | | Sig. (0.05) |
|---|---|---|---|---|---|---|---|
| | | | | | Calculated | Tabular | |
| Experimental | 29 | 35.17 | 3.79 | 56 | 4.65 | 2 | The experimental group had statistically significant performance. |
| Control | 29 | 32.75 | 4.17 | | | | |

The table above displays that the estimated T-value equals 4.65 and is larger than the tabular T-value, equaling 2, where the significance level and degree of freedom are 0.05 and 56, respectively. It indicates that there is statistically a significant difference between experimental and control groups in their mean scores of the chemistry achievement test, and the experimental group outperformed the control group.

## V. Interpretation of Results and Discussion

The interpretation of the results from the null hypothesis (academic achievement): The findings of the present study indicate that the students in the experimental group, who studied according to the motivated abstract thinking model, outperformed the students in the control group, who studied conventionally, in their academic achievement test, and this difference was statistically significant. The researchers believe that the reason may lie in the below factors:

Education based on the stages of the motivated abstract thinking model in small cooperative groups recognizes students as the axis of the educational process. In education, this model is reckoned as a modern trend, arguing that teaching is encouraging and beyond the usual educational system. The stages of the motivated abstract thinking model are regular, successive, and coordinated, such that the first step of the stages of this model aims to develop students' abilities through small and open group tasks in order to create a mutual language among them. Similarly, it provides students with opportunities to express their performed activities and learn through discussing and sharing their thoughts and ideas. This issue finally enhances their concentration due to the presence of cooperation and the absence of distraction.

This method creates a class atmosphere that invites students to innovate, undoubtedly participate in expressing ideas, and enhance their tendency to learning better. In addition, it assists students with forming new thoughts and concepts appropriate to their educational content and age. Thus, they review their ideas and establish relationships between chemistry concepts, which encourage them to continue thinking and employ their thoughts in teaching-learning situations. This model enables students to connect their diverse class activities to everyday life situations. Accordingly, the students in the experimental group did not have a sense of wearisome and impatience, especially the learners were not already acquainted with this teaching method, which was in line with the focus of modern philosophy in education and led to their academic achievement.

## VI. Conclusion

Concerning the results of the current study, the researchers conclude that the motivated abstract thinking model considerably impacts the academic achievement of students in the experimental group compared to the control group, who studied conventionally. The results of this study were for the benefit of the experimental group, who studied according to the presented model.

## VII. Pedagogical Implications

According to the results and findings of the present study, the below implications arise:

1. Employing chemistry teachers that are familiar with this model as teaching models in chemistry education. This objective is fulfilled by the observation of educational courses and seminars for chemistry teachers. In these courses, teachers become acquainted with the motivated abstract thinking model and how it fits with their schools.
2. Cooperating with chemistry teachers to exploit daily lesson plans and chemistry achievement tests to evaluate students.
3. Including the motivated abstract thinking model in the teaching methodology courses in educational sciences faculties to familiarize future teachers with modern teaching methods

### Suggestions for future studies

To complement the current research, the authors of this study offer the below suggestions:

1. Conducting a similar study on the effect of the motivated abstract thinking model on chemistry lesson in different stages of examination
2. Conducting a similar study on the effect of the abstract thinking model in combination with other variables, like motivation, curiosity, or mental skills

## References


1. Holy Quran
2. Ibrahim, N. (1996). An introduction to education, Edition 8th. Oman: Assembly of Printery Cooperative Publication
3. Abu Jadu. S. M. A. (2008). Educational sciences, edition 6th. Oman, Jordan: Dar Al-Masir Publication.
4. Abu Alam, R. M. (2004). Learning and its bases and applications, edition 1st. Oman, Jordan: Dar Al-Masir Publication.
5. Esmaeili, Y. A. (2015). Thinking models and academic achievement levels, edition 1st, Oman, Jordan: Dar Al-Yazurdi Publication.
6. Bayati, Z. F. F. (2015). Strategic reading and its association with the chemistry achievement of grade-5 empirical sciences students. Unpublished M.A. Thesis, Baghdad University/Faculty of educational Sciences –Ibn Al-Haytham.
7. Bayati, A. J. T. (2008). Statistics and its application in psychology and educational sciences, edition 1st. Oman, Jordan:Asra Publication.
8. Mustansiriyah University (2017). 4th international conference on modern approaches to social and humanistic studies and its applied mechanisms. Volume 15-16, October.
9. Jandi, A. A. (2002). Cognitive development acceleration through sciences teaching and its effect on the academic achievement and inferential and critical thinking of grade-3 high school students.

Egypt education Assembly, 6th scientific conference on scientific education and society culture, Educational Sciences Faculty, Ain Shams University, 2, 28-31, July.
10. Hayeri, K. K. (2011). Research methods in psychology and educational sciences: Bases and tools. Edition 1st, Baghdad.
11. Halagh, H. (2010). An introduction to scientific research methods. Edition 1st. Beirut: Dar Al-Nahzat Al-Arabia Publication.
12. Dasougi, A. A. (2001). Modern approaches to identifying misconceptions of students in sciences courses, Education Magazine, issued by the Assembly of Graduates of Education Faculties and Institutions, 3.
13. Dalimi, E. A., &Mahdavi, A. M. (2005). Measuring and assessing the education process, edition 2nd. Baghdad: Ahmad Dabagh Publication.
14. Dalimi, E. H. (2014). Constructivism theory and its educational applications, edition 1st. Oman: Dar Safa Publication.
15. Rabiei, R. A. Z. (2018). A teaching-learning design based on active learning models and its effect on chemistry achievement and divergent thinking of grade-5 empirical sciences students. Unpublished Doctoral Dissertation, Baghdad University, Faculty of Educational Sciences –Ibn Al-Haytham.
16. Rezoughi, R, &Akheroun (2016). Teaching-learning models in sciences teaching. Baghdad: Adel Publication.
17. Zahiri, J. K. M. (2016). The effect of instructional design on the academic achievement and learning styles of grade-5 sciences students in chemistry: Relying on Herman's whole brain model. Unpublished Doctoral Dissertation. Baghdad University, Faculty of Educational Sciences –Ibn Al-Haytham.
18. Zeitoun, K. A. (2033). Educational models and skills, edition 1st. Cairo: Alem Al-Kotob Publication.
19. Saghaf, M. A. H. (2007). The effect of teaching methods on math achievement of high school students. Unpublished M.A. thesis, Faculty of Education, Adan, Yemen.
20. Shahateh, H. &Najjar, Z. (2003). Dictionary of psychology-education terminologies, edition 1st. Dar Al-Mesr Publication, Cairo, Egypt.
21. Sadegh, M.M. (2002). The effectiveness of Adey and Shayer's program on academic achievement and cognitive development acceleration of grade-1 high school students in the physics course in Oman Sultanate. Egypt Society of Education, 6th scientific conference on scientific education and society culture, Faculty of Educational Sciences, Ain Shams University, Cairo, Egypt.
22. Zaher, Z. M. et al., (1999). Principles of teaching measurement and evaluation, edition 1st. MaktabSeghafeh Publication: Oman.
23. Kabisis, A. &Hadi, M. (2008). Academic achievement tests, item structure and analysis. Edition 1st. Arab Society Publication, Oman.
24. Kanani, M. (2002). Descriptive and inferential statistics in social and behavioral sciences. Edition 2nd. Dar Al-Nashr Cairo societies, Egypt.
25. Advan, Z. S., &Davoud. A. E. (2016). Social constructivism theory and its applications in education, edition 1st, Dibono Thinking Training Center, Oman, Jordan.
26. Asr, H. A. B. (1999). An introduction to teaching thinking and enriching it in lesson plans. Arab Modern Society, Alexandria, Egypt.
27. Afaneh, E. & Yosef, A. (2009). Teaching learning by two hemispheres, Dar Al-Saghafeh Publication, Oman, Jordan.
28. Ali, M. A. (2008). Teaching, models, and their applications in sciences, mathematics, Arabic language, and social studies. Arabic Dar A-Fekr Publication, Cairo, Egypt.
29. Odeh, A. S. (1998). Measurement and evaluation in the teaching process. Edition, 1st. Dar Al-Amal Publication: Irbid, Jordan.
30. Ayasireh, V. R. (2011). Approaches to learning thinking and its skills, edition 1st. Dar Asameh Publication, Oman, Jordan.
31. Faleh, Z. H. (2017). The effect of Barman's model on the academic achievement and convergent thinking of grade-5 sciences students in chemistry. Unpublished M.A. thesis, Baghdad University, Faculty of Educational Sciences –Ibn Al-Haytham.
32. Ghatami, Y. (2005). Education theory, edition 1st, Dar Al-fekr Publication, Oman, Jordan.
33. Ghandil, A. (2006). Modern educational technology, Alem Al-Kotob Publication, Cairo, Egypt.
34. Kabisi, A., &Hadi, M. (2008). Academic achievement tests, item structure and analysis. Edition 1st, Arab Community School Publication, Jordan.
35. Kanani, M. (2002). Descriptive and inferential statistics in social and behavioral sciences. Edition 2nd, Dar Al-NashrUniversity Books Publication: Cairo, Egypt.

36. Mahmoud, S. A. (2006). Unbounded thinking, contemporary teaching perspectives in teaching and learning thinking, edition 1st.Alem al-Kotob Publication, Cairo, Egypt.
37. Majid, A., &Yasin, A. (2013). Measuring and evaluating university students, edition 1st. Dar Al-KotobVesagh, Baghdad.
38. Marei, T. A., &Alhileh, M. M. (2002). General teaching methods, edition 1st. Dar Al-Masirah Publication, Oman, Jordan.
39. Masoudi, M. H. M. et al., (2015). Teaching models and methods in balancing lesson plans, edition 1st, Dar Al-Rezvan Publication, Oman.
40. Molhem, S. M. (2000). Measurement and evaluation in psychology and educational sciences, edition 2nd. Dar Al-Maeireh Publication, Oman.
41. Mansour, A. (2001). Educational sciences, University publication and books Administration, Damascus, Syria.
42. Najjar, N. J. H. (2010). Measurement and evaluation: An applied perspective with software programs, edition 1st, Dar Al-Hamed Publication: Oman, Jordan.
43. Havidi, Z. (2005). Modern methods in teaching sciences, edition 1st. University books Publication, Ain.
44. Adey, P. (1992)." The CASE results: Implication for Science Teaching "International journal of SCIENCE Education. Vol. (14). No. (2), PP: 137-140
45. Adey, P. (2006). "Thinking Science- Thinking in general ", Journal of Research in SCIENCE Teaching, Vol, (7) issue (2), P 122-145.
46. Shayer, M. &Adey, P. (2009). Cognitive Intervention and Academic Achievement,Dar Al-Fikr, Oman, Jordon.