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The Relationship between Mental Imagery, Creative Thinking and Academic Achievement of Tenth Grade Students in Physics

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ABSTRACT

This study aimed at inquiring the relationship between mental imagery, creative thinking and academic achievement of tenth grade students in Physics. To achieve the objectives of the connectivity study Descriptive Methodology was adopted, and Purposive sample was limited to (54) of female students. Three tools were also utilized to achieve the purposes of this study, its Validity and reliability were assured, and these tools are: (Mental Imagery, Creative Thinking, as well Standard Reference Academic Achievement) tests. The results of the study revealed that statistically correlation coefficient was found at the significance level ($\alpha = 0.01$) between the post-test (Mental Imagery and Academic Achievement, Creative Thinking and Academic Achievement, Mental Imagery and Creative Thinking) in physics.

Key words: Mental Imagery, Creative Thinking, Academic Achievement, Physics.

1.1 Introduction

As the science of physics represents the science of nature in all the characteristics that nature could have , And physics concepts immersed in three-dimensional space as nature exactly, so physics is an optical science spatial, imaginary, depends on the mental imagination associated with images of objects, , and various dimensions, and movement. It deals with the volumetric material that occupies a certain space. At the same time that it deals with Bi-dimensional surfaces or the longitudinal dimensions which is only a part of those volumes that fill the universe. And this makes the learner who has low spatial and imaginary abilities fall in a cognitive confusion which makes a gap in the right place and the space that the object occupy. If it is accompanied by object movement deformation in the educational message will be increased. And it will deform the movement and time dimension that is related to the movement. Which means an increase in the deformation of mental imagery? The deformation and failure in the educational message, that the physics and science teacher is one of the most important difficulties that face both learners and teachers. And this appears in the form of decrease in the learners scholastic achievements in the subject of physics in specific.

Beaney described imagination in his book (creativity and imagination) as the lost secret of educational sciences. This description came because of the paucity of studies that discussed the mental imagery as a subsidiary factor in general, and the paucity of studies that discussed its relational connectivity with creativity in specific. While Rashad sees that the idiom of mental imagery and its measures had disappeared historically from the Educational Psychology. But it has returned to appear again in many researches associated with innovation and creativity, even though it's not a synonym for it. Imagining his great role in meditation, planning and drawing new design, and it has a credit in developing ideas in the form of amazing inventions.

(Tasker & Dalton) see that the learner doesn't face an essential problem in imagining objects in one or two dimensions. But the problem begins to emerge when the learners is exposed to representations of three-dimensional objects through two-dimensional drawings and photographs. Where it is difficult for the teacher to draw it on the chalkboard without causing deformation in its real data; as well as the two-dimensional illustrations which is attached to school textbooks. Which may constitute an obstacle for learners who has low capacities in mental imagination and to convert it brainy from bi-dimensional representations to three-dimensional representations as they really are in reality. And they noted to that in their study that they made in the teaching of organic molecules through bilateral and three-dimensional representations.

(Sternberg, Sternberg & Mio) defined mental imagery: As "mental representation of objects, events and places that represent our past experience that we currently don't see. Rashad defined it: As "Pictorial power or represented force that makes you see the picture of the missing things so you imagine that its present. But this trend in the definition of mental imagination it didn't make it really clarified. It could be argued that the mental imagination in inclusion means "the ability to link images of objects, events and places with its brainy concepts", And the ability to call those images of long-term memory in accordance with the previous experience of the five senses – as outlets for the brain to the outside world- and to interact with it in different levels: as simple imagining by remembering images of objects, events, places, sounds and smells, taste and texture , as it is in

reality . and Analytical imagining, which includes the ability to perceive the deep relations between the ranges of mental images, and advanced creative imagination, which includes the ability to synthesize among mental images. And to structure it in creative images that don't exist in fact Characterized by modernity and originality, and psychological imagining in all types. Imagination accompanies all its patterns and levels of thinking.

The phenomenon of individual differences appear evident in mental Imagination as one of the most important facts of human existence that God created in His creation, where individuals differ in mental levels, making it a key pillar in determining current and mental performance levels and future members, and mental tests have become an important tool that aims to study the likelihood of success or failure in the mental subsequent period of time. (Nabhan)

(Stevenson) mentioned Twelve forms of Imagination, can be combined and summarized in the following forms and types with a bit of an act and addition which are: remembering or retrospective imagining of things and events as they are or as they occurred in reality at a specific time and place, and the predictive or expectant imagining for events that didn't occur, and how about if they occur in real life. Psychological or emotional imagining which is associated with fun or scary mental images that didn't occur, and how about if they occur in real life and interact with them. And adaptive imagining of mental images to coexist in a position that can't live with or a role can't actually do. And the evasion imagining of mental images of the opposite of what happens in reality. and irrational imagining without considering the causal or interpretation of those mental images or the possibility of their occurrence, in fact. And the creative imagining..

Which is connecting a set of mental images and structure it in a new unfamiliar image, and it includes creativity in all forms: representative, artistic, practical, educational, scientific etc. Sensuous aesthetic and moral imagining which links mental images of various artistic and creative works with morals and appreciation , and spiritual belief imagining associated with mental perceptions about the revelation and the concept of the universe and human life.

(Rashad) also noted to the functions of mental imagery and its relation with thinking which is a companion of memory, Because individuals with high visual and aural imagination are often strong memory owners, as it facilitates the process of storing information, and keep them in long-term memory, and retrieval, and serves creativity and problem solving, by linking information in memory . Here (Momany) sees the need for more clarifying, that linking is in the processes of creative thinking and problem solving at generating creative ideas and solutions that is unfamiliar. But the individual who is creative and capable of solving problems must be basically critic and he has to go through the process of analytical imagination before reaching the creative imagination, and before he reaches the various solutions to the problem. And it's considered as a base for many arts such as drawing, poetry, arts and literature. And it's considered as an important psychological function for the individual balance and agreement. That the resorts to indemnity with natural limiting through the imagination to fill what he needs psychologically and emotionally.

Through a review of the theoretical educational literature for the concept of creativity as a pattern of thinking patterns we note the lack of a specific and comprehensive definition, the scientists and researcher's definitions all over the world varied for the concept of creativity, according to their interests, scientific attitudes and Intellectual schools; although these definitions converge in the general framework of the definition. We have the following well- known trends for the definition of creative thinking. (Al-Momani): the first trend is (creativity as a mental process) which represents the standpoint of cognitive psychology, some people see creativity as a mental process to realize and be aware of the gaps, missing items, and then configure the ideas and hypotheses around, then test those hypotheses and link them with the results, then make adjustments and re-test the hypotheses as (Torrance) defined it.

While the second trend is (creativity as a personality) expresses the Psychoanalysis point of view; where creativity is defined according to this trend as a personality trait, where he sees that creativity is a personal trait that requires intelligence, common sense, sensitivity and the individual has to be brave to clarify and express his ideas and to respect the person individuality to be creative. (Hennessey & Amabile, 2010)

While the third trend focuses on: (creativity as a product) on the ability of new production, as (Guilford) sees. While the fourth trend: (creativity situation or environment) gives a role for the creative environment and what it provides for the creative thinker of special social and family circumstances (Fasko, 2001).

(Sand, 2002) mentioned other trends in defining creativity, that (Taylor) discussed in his book which he published in (1993) ,and classified it into six groups: (Gstalt Theory): considering it as a process of destroying existing Gstalt for building better Gstalt, the Gstalt theory says that the Gstalt is an image or idea that's realized in a complicated way of the total partial configurations. The final output definitions: which are definitions directed toward new innovations in various fields.

Expressive aesthetic definitions: considering it as a process of change and transformation in the organization of the personal life of the individual. Psychoanalysis definitions: it views creativity as a result of the interaction in the changing personality. And it defines thinking or creativity process: by focusing on the processes of mental thinking.

Creativity has several stages and several forms. One of the most famous forms is (Wallas) form in 1926, and it could be abbreviated in the preparation stage, the incubation stage, and the verification stage. (Al – Momani ,2014).

One of the most important skills and creative abilities, that the researchers tried to measure since the early sixties like (Guilford) and (Torrance) : Fluency is the ability to generate the largest possible number of alternatives or synonyms for ideas, or solutions, or uses when responding to a particular catalyzer, fluency focuses on quantity and it Includes verbal fluency (words), intellectual fluency (meanings), expressive fluency, associative fluency, fluency shapes (Abo Gharbieh,2010). Flexibility is the ability to diversify unexpected ideas by changing the thinking direction with the change of the catalyzer or the position requirements. Flexibility focuses on diversity, the method and direction. It Includes adaptive flexibility, Automatic flexibility, and the flexibility of re-defining by abandoning a concept or an old relationship in order to address the situation or new problem (Al-Saadi, 2007). Originality means uniqueness and modernity. And it's considered important to judge the level of creativity (Jarwan, 2008). Details or elaboration mean the ability to add new and diverse details for a solution, an author, or a theory. Help in developing, enriching and doing it (AL-Zayyat, 2009).

The sensitivity for problems means: The awareness of problems and weaknesses in the action or the surrounding environment. Which represents the most important step in solving problems, so the creative thinker is considered to be faster that other people in noticing problems and its existence? realizing the reasons for it, and asking questions and providing hypotheses for it (Jrawn , 2005).

Creativity could be regenerative and it expresses the ability to penetrate the laws, principles, theories and providing perspectives and new ideas, either by denying the previous ideas and placing new ideas instead or through expanding and editing it with substantial additions like what (Copernicus) did to (Ptolemy) theory. It could be creative imagining and it is the highest level of creativity through it you can reach or discover a theory or an assumption that is completely different and new. As (Einstein) did (Al-Momani, 2014).

Academic achievement was defined by (Abu Khatleh, 2005) as the process that the teacher performs at the end of the educational programme in order to issue a final judgment on achieving the educational objectives. While (Shidiefat, 2011) defined it as a set of definitions and expressions that the learner acquire through the experience in learning. And it's measured by the mark he gets in the achievement test. Whereas (AL-Momani, 2014) defined it as a measure to the extent to which educational outcomes associated with the cognitive treatments and its six levels in quantity and quality, and a criterion for judging the performance of learners, teachers, curriculum, teaching aids, and educational institutions.

This study shows important adjustments to (Bloom pyramid) for Cognitive levels, which is the most important thing in the achievement tests. As one of his students adjusted the order of levels, and he changed names to actions focusing on what we want from the learner as in the following figure 1:

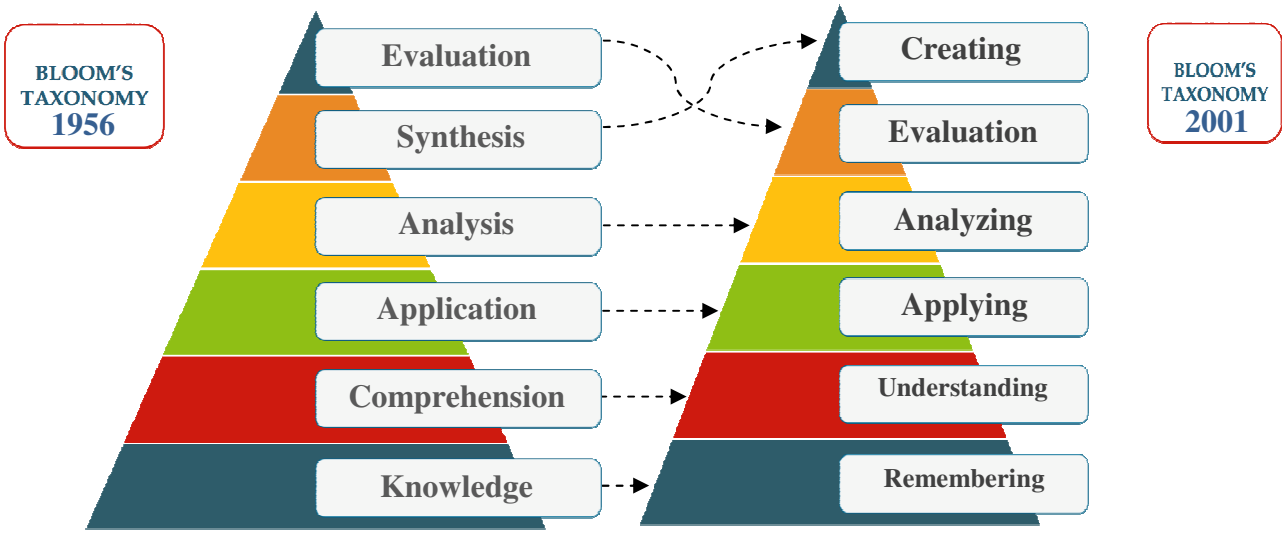


Figure 1: development of Bloom's taxonomy

Bloom pyramid for the six cognitive Levels 1956, before and after one of his students adjusted it in 1990 and it was published in 2001, the adjustment included changing names to actions and switches the sixth and the fifth levels (Smith, 2010).

It could be said that the adjustments to Bloom pyramid was justified, the reason could be the inability of passing from the analysis to the composition without evaluating the consequences of the information analysis process. And judge the relationship between them, then compose them, Followed by an analysis and evaluation to the new idea we have made to make sure that it's valid. Since the composition level includes composing and creating new and creative ideas. This shows that before and after the creative thinking there is a critical thinking. Hence the base for creativity is the critical thinking. Although creative thinking has no limits in the stage of inspiration or in creating the creative idea (Al-Momani, 2014):

Scheme illustrates the processes that link the structure, evaluation, and analysis from one side, and the creative thinking stages, and critical thinking on the other side. Due to our need in the twenty-first century for a lot of creativity and positivity ,investing potentials, and to reduce negativity , cognitive Bloom pyramid had been edited by turning it upside down by the math teacher (Darren Kuropatwa) in 2010 as follows:

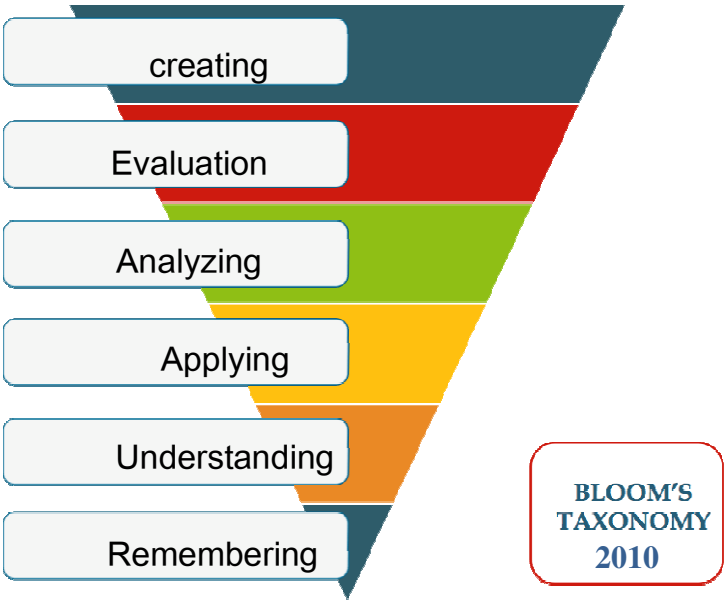
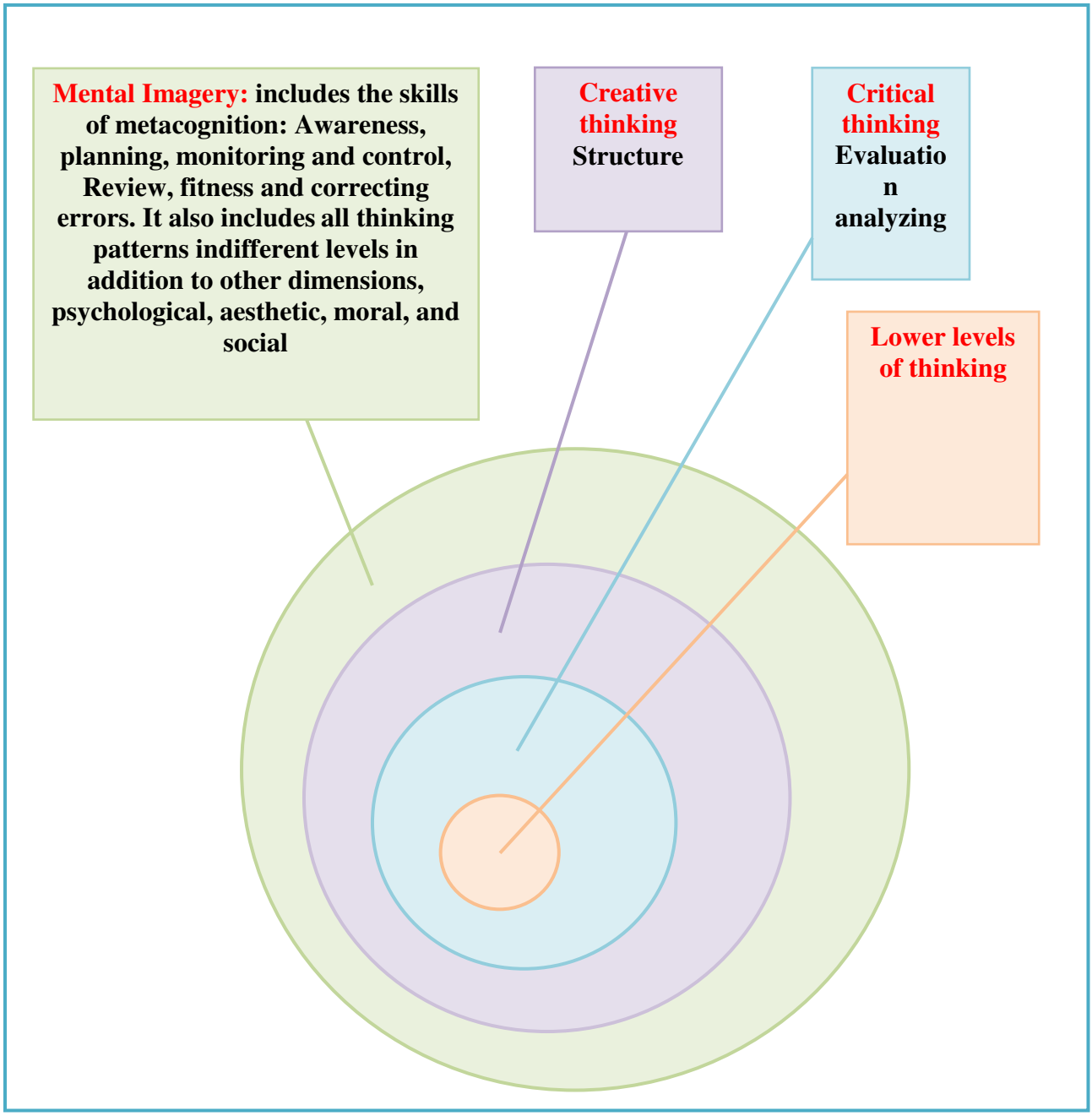


Figure (3): Bloom's taxonomy 2010

Bloom Pyramid after it had been edited to make the structure the most important element and it's the creativity axis (Kuropatwa, 2010). This to draw the attention of teachers, to the need of focusing on higher-order thinking skills more than their focus on keeping and information retrieval skills, for the next generations to be more creative and productive in their communities .

The relationship between mental imagination, creative thinking and academic achievement is a strong correlated relationship, Creativity is considered as a complex process, dialectic and overlapping with the individual environment, and his psychological and social circumstances, Sometimes creativity is an attribute or a divine gift, and sometimes it is acquired through learning, education and training, that's what we call cognitive creativity (Al-Momani, 2014). (Rashad, 2013) also noted that there is a strong relation between creative thinking, imagination and achievement considering that the individual can't be innovative without being able to use his imagination. Thus, we can say that the learner can't make progress in school performance, or on the creative

level of knowledge, or even on the psychological and social level without having keen Imagination rich in various experiences that are only audio, visual, tactile olfactory, or gustatory images that is pitted in the individual memory which is considered the base for the individual launch.



Scheme illustrates the relationship and interaction between mental imagination, creative thinking, and academic achievement (Momani, 2014). In experimental study that has been made by (Anwar, Aness, Khizar, Naseer & Muhammad, 2012) aimed to investigate the relationship between the creative thinking and academic achievement among high school students in Pakistan. The random sample included (256 students). The study tool was Torrance Test of Creative Thinking (TTCT), and students grades in their general academic achievement, after the study has been made the data was processed statistically according to Pearson coefficient to examine the relational ties, Where results revealed the presence of a relationship that is statistically significant between creative thinking and academic achievement on various creative thinking skills (fluency, flexibility, originality, and details)

1.2 Problem statement

A problem emerged When students dealt with physical issues and try to imagine and solve it, they suffer from the weakness of the ability to imagine a lot of abstract concepts, and imagine the third dimension for those concepts, applications, and issues, because of the individual differences in the ability of mental imagination, and convert images of two-dimensional mentally to three-dimensional commensurate with its status in reality through mental rotation. Which may affect their academic achievement negatively and this is consistent with previous studies like (Zacharia & Constantinou, 2008) in Astrology.

So this study aimed to answer the following question: Is there a statistically significant transactions correlation at the significance level ($\alpha = 0.01$) in the post-test (mental imagination and creative thinking, mental imagination and academic achievement, creative thinking and academic achievement) among students in the tenth grade in Physics?

1.3 Study importance

This study has a theoretical importance because it is a qualitative addition to the educational literature in the field of physics teaching, it is expected to address the fundamental problem facing both teachers and learners alike, through shedding light on the effectiveness of using a three-dimensional virtual worlds in improving both mental imagination and creative thinking and academic achievement. On the practical side this study may help the following:

1. Educational supervisors: This study may guide them in the training on planning to teach according to the use of virtual worlds and three-dimensional worlds of reality. and What this planning include of expected outcomes And methods of evaluation followed to ensure the achievement , as well as teachers through their benefit of those developed and modified plans and tools for the purposes of this study.

2. Researchers to conduct further studies based on the recommendations recommended by this study in the light of the findings, as well as take advantage of the tools of teaching plans, and tests that have been prepared and developed for the purposes of this study.

3. Schools and educational institutions by drawing its consideration of the importance of providing a rich educational environment by providing three-dimensional virtual worlds technology which gives learners the opportunity to learn through observation that is based on the brain, and the real worlds that give them the opportunity to learn through working and direct and indirect experience, which improves their creative imagining and their achievement.

4. Parents by pointing to the importance of their role in the development of their children's imagination, and by providing a rich learning environment to complete the role of school.

1.4 determinants of the study

This study was carried in the light of the following limits:

1. Spatial boundaries: This study was performed at two private schools in the capital, Amman.

2. Temporal boundaries: This study was performed in the second semester of the academic year 2013/2014

3. Objective limits: by using selected units of physics subject of the tenth grade, entitled "electromagnetic induction" for the purposes of this study.

1.5 Study glossary

This study has included many definitions that can be defined as follows:

1. (Mental imagery): defined by (Yang & Gham, 2007:476) as all you can recall and summoned from images stored in memory, and the graphics that we draw it expresses the concept for the mental images that we have.

2. (Creative thinking): defined by (Torrance, 1965:633) as a mental process in which the individual has a high degree of sensitivity to the problems and shortcomings, and knowledge

gaps, missing elements, and contradictory, etc, And the ability to identify difficulties; and the search for solutions and put guesses or formulating hypotheses about the shortcomings; then test and re-test these hypotheses and possibly modify them and retest them again, and finally reach the results.

3. (Academic achievement): defined by (Sirvastava and Joshi 2013:591) as a basic standard to judge the total potential and capabilities of individuals. But this is most urgent for students with high academic achievement ... as academic achievement generally refers to the output of the learning of students.

4. (Methodology): Descriptive approach adopted for its suitability for the purposes of this correlation study.

5. (Study sample): (54) students from two different schools. Then they were divided into three groups (18) students each. Two experimental groups: one of them the teacher used three-dimensional virtual worlds in teaching "electromagnetic induction) chapter. The second group the teacher used the real worlds to teach the same chapter. And in the third group the teacher used (2D) in teaching also the same chapter.

6. (Study tools): To achieve the aim of the study of investigating the relationship between metal imagery and academic achievement, and creative thinking for 10^{th} grade students who learned physics using the three-dimensional virtual worlds and real worlds, three tools prepared as follows:

1.5.1The first tool: a test of mental imagination

The test to mental imagination was used by adoption of mental tests guide, cognitive and its referring factors. In order to measure the level of mental imagination among the study sample. The test has included several tests of spatial ability represented by the three sub-factors: Spatial guidance by the test of (Cards rotation) which is a representative to test the two-dimensional spatial abilities, and each of the mental rotation by the test of (comparing figures), and the spatial imagination by the test of (Forming surfaces). The last two tests represented three-dimensional spatial abilities.

1.5.2 The authenticity of the mental imagination test

To ascertain the veracity of the mental imagination test content it was presented to a group of arbitrators from specialists in the field of curriculum and instruction, educational administration, education technology, and physics supervisors who are experienced enough, So as to give their comments and suggestions about its suitability for members of the sample, and its linguistic formulation accuracy.

1.5.3 The reliability of the mental imagination test

(test- retest) method has been used to check the reliability of the mental imagination test by applying it for the first time on (pilot study) Consisting of (35) students not from the study sample that has been randomly selected. After two weeks she applied it again on the same sample, then she calculated Pearson correlation coefficient between the first and the second applications, for the sub two tests of mental imagination (3D) and (2D) , and for the overall grade. Table (1) shows this as follows:

Table (1)

Correlation coefficients between the grades of the pilot study on each test

Of the subtests and the overall grade for the mental imagination test

Overall grade	3D Test	2D TEST	Mental thinking skill
**0.818	**0.790	**0.824	Pearon coefficient correlation

**** Coefficient correlation statistically significant at the significance level (0.01)**

Metal imagination Test correction: mental imagination test includes tow axis to measure the spatial abilities Represented by the three sub-factors, and needed 40 minutes to answer as follows:
The first Axis: two-dimensional (2D) spatial abilities test, the highest grade was (36) marks as follows:
Spatial Orientation (Card Rotation Test): the test consisted of (36) multiple choice branches, 1 mark each. The highest grade was (36) and the test needs (10) minutes to answer.
The second Axis: three-dimensional (3D) spatial abilities test, the highest grade was (36) marks as follows:
- The Second subtest: Mental Rotation (Marquette's Comparison Test) : the test consisted of (6) multiple choice branches, 1 mark each. The highest grade was (6) and the test needs (10) minutes to answer.
-The Third subtest: patial Visualization (Surface Development Test): the test consisted of (6) branches, 2 mark each. The highest grade was (30) and it needs (20) minutes to answer.
The second tool: Creative Thinking Test
(Torrance,1965) test was used in order to measure the level of creative thinking among the study sample .This test has (6) subtests, each test needs (7) minutes to answer.
• **The first test**: ask questions, and this is done by giving the student a text about the electric generator, and charges her with writing the largest possible number of questions that can be answered by using the text. The answer is considered correct if coincided with the information given in the text.
• **The second test**: Guess reasons, in which the student is assigned to write the largest possible number of reasons, which gave great importance to the discovery of the phenomenon of electromagnetic induction and its role in the production and transmission of electric power, which is the backbone of modern technology. The answer is considered correct if coincided with the information given in the text.
• **Third Test:** Guess results**,** in which the student is assigned to guess and write the largest possible number of results that are likely to occur due to loss of housing organization in one of the cities, which led to that the residential areas and public streets become very close to the electricity towers, electrical transformers and high-voltage lines, whether the results direct or long-term, the answer is considered correct if its consequential on the incident.
• **Fourth test**: improving the production, in which is the student is assigned to think about the best ways and suggestions that are unfamiliar and friendly with the environment to get the kinetic energy needed to generate electricity in power plants and at the lowest cost. The answer is considered correct if the proposed kinetic energy source is more sufficient that the running water power mentioned in the text.
• **Fifth Test**: unusual uses, in which the student is assigned to consider and propose the largest possible number of unusual uses for electrical transformers of both types of antihypertensive and leverage for the effort, regardless of the number and cost of these adapters. The answer is considered correct if it contains some modern and possible uses.
• **Sixth test**: Assume that, in which the student is assigned to guess and write the largest possible number of ideas and the consequences of the assumption that the scientists Michael Faraday and Joseph Henry didn't reach to the possibility of generating or induce an electric current using a magnetic field, and pushing the electric current to move in a circuit without a source of power of electric driving force, and here the student can imagine and predict about this assumption.
Creative thinking test Correction: the test included these skills (fluency, flexibility and originality) grades were given for these skills as follows:
• **Fluency**: Measured by the number of correct responses the students make in a specific unit of time of seven minutes.
• **Flexibility**: measured by the number of different categories of responses given by the student in a specific unit of time of seven minutes, with noting the following:

1. The first idea doesn`t give the degree of flexibility; because flexibility or interest don`t change in all directions.
2. Degree of flexibility is zero if the trend or the interest has not changed
3. The student takes one degree if the answers revolve around a single idea.

- **Originality**: measured by the number of new and not common answers given by the student in a specific unit of time (7) minutes, and this is based on its repetition as follows :
  1- Each idea was repeated by (9%) and more take (0) mark.
  2- Each idea was repeated by (6%-8.99%) and more take (1) mark.
  3- Each idea was repeated by (2%-5.99%) and more take (2) marks.
  4- Each idea was repeated lower than (2%) take (3) marks.

The authenticity of the creative thinking test: To ascertain the veracity of the creative thinking test content that is based on (Torrance Test for creative thinking) it was presented to a group of arbitrators from specialists in the field of curriculum and instruction, educational administration, education technology, and physics supervisors who are experienced enough, So as to give their comments and suggestions about its suitability for members of the sample, and its linguistic formulation accuracy.
The reliability of the creative thinking test: (test- retest) method has been used to check the reliability of the mental imagination test by applying it for the first time on (pilot study) Consisting of (36) students not from the study sample that has been randomly selected. After two weeks she applied it again on the same sample, then she calculated Pearson correlation coefficient between the first and the second applications, for the creative thinking skills, and for the overall grade table (2) shows this as follows:

Table (2)

Correlation coefficients between the grades of the pilot study on each skill of the creative thinking skills and the overall grade

Overall grade	Originality	Flexibility	fluency	Creative thinking skill
**0.77	**0.81	**0.74	**0.75	Pearson coefficient correlation

** Coefficient correlation statistically significant at the significance level (0.01)

The third tool: academic achievement test based on Mga measurement reference: The Mga reference test focuses on the degree of adequacy of the learner in specific skills, and if he acquired the required level of performance needed. The Mga reference is not subject to the general level of performance of learners.

The authenticity of the achievement test:
To ascertain the veracity of the achievement test content that is based on it was presented to a group of arbitrators from specialists in the field of curriculum and instruction, educational administration, education technology, and physics supervisors who are experienced enough, So as to give their comments and suggestions about its suitability for members of the sample, and its linguistic formulation accuracy. According to the arbitrators suggestions it was modified.
The reliability of the achievement test: to check the reliability of the achievement test by applying it on (pilot study) Consisting of (35) students not from the study sample that has been randomly selected. The internal consistency coefficient was calculated by using Codr- Richardson equation (KR-20), the internal consistency coefficient was (85.6) which were considered sufficient to the purposes of this study.
Achievement test Correction: the test consists of (35) multiple choice branches, one mark for each branch. The overall grade was (35).
Recommendations:

1. Conduct similar studies of the current study highlights the relationship between mental imagination, creative thinking, academic achievement, and other variables, like thinking critically, solving problems. To determine the best ways to develop them all in an integrated and balanced system.
2. The need to hold training sessions by the supervisory authorities in the educational institutions for teachers about the importance of mental imagination and creative thinking and their relationship to academic achievement among students, and the ways of develop them.

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