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The Effectiveness of Using Analogies in the Acquisition of Scientific Concepts Among Students with Learning Disabilities

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Abstract
The study aimed to measure the effectiveness of an Analogies-Based Instructional Program (ABIP) in acquiring scientific concepts among a sample of third-grade students with learning difficulties in Al-Shoubak district schools. To achieve the study objectives, a semi-experimental approach was used. The study was conducted on a sample of 60 male and female students, divided into two groups: an experimental group consisting of (30) students who were taught using the ABIP, and the second was a control group consisting of (30) students and were taught the traditional method. The results pointed out the effectiveness of using ABIP compared to the traditional method in acquiring scientific concepts among third graders with learning difficulties. It was also found that there are statistically significant differences attributed to gender variable in favor of males, and interaction between gender and the teaching method.
Keywords: analogies strategy, scientific concepts, individuals with learning difficulties, ABIP
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1. Introduction

Learning difficulties can be considered as an essential part of school learning. Thus, achieving the learning objectives depends on treating learning difficulties and overcoming their causes. Ignoring these difficulties may lead to a psychological pain for the learner, which hinders the learning process.

Despite the different definitions of learning difficulties, Hallahan et al (2007)indicated that most of them signified a difference between academic achievement and intelligence, and subjective differences in capabilities. Hence, difficulty liesin one field or more but not in all academic and developmental aspects, difficulties also appear in the psychological processes related to receiving, perceiving and processing sensory information, without being caused by other disabilities, but they might be due to the insufficiency of the nervous system performance. Such difficulties persist with the individual to the rest of his life, and usually affect his social relationships negatively. In this regard, some educational studies like Saloum& Kassem (2014) confirm that (60%) of the success of the educational process falls on the teacher's shoulders, while (40%) of the remaining success depends on management, library, family conditions of students and the potentials of the educational institution.

Costa & Garmston (2001) explains that developing mental habits requires teachers to use teaching methods that depend on embodying ideas to be easily comprehended; especially that developing these habits considers also the stages of cognitive development. Therefore, the educational activities through which we seek to develop mental habits must be appropriate for the learner's cognitive development stage.

Analogy thinking occupies an extremely significant position in human thinking and knowledge. In other words, humans try to find similarities between new unfamiliar situations he faces and other situations he is familiar with in order to figure out the extent to which familiar situations can explain unfamiliar situations, which justifies the use of similes and metaphors in scientific thinking (Alharahsheh, 2012).

The Analogy Strategy is based on simplifying students' understanding of abstract and impalpable concepts with concepts or components related to their perceived reality by focusing on similarities and differences between the analog and the source. This way, the analogy leads students to acquire the desired concepts and knowledge (Saeed & Abdallah, 2008).

This strategy is used when the subject to be learned is difficult for students to understand. It helps students connect between topics that are difficult to understand or unfamiliar to them with what is more familiar so that the new material acquires meaning and becomes familiar and easy for the student as it provides a visual perception of what is present, and thus adds an atmosphere of suspense and excitement (Alfatlawi, 2014). Therefore, using modern strategies in teaching students with learning difficulties may lead to improving teaching and assessment methods and strategies in line with the actual needs of students which improves their performance and consequently increases their academic achievement.

2. The Study Problem

Despite the importance of the analogies strategy in facilitating students' learning of many concepts, particularly scientific ones, and its role in forming positive orientations towards the learning process, many teachers of the elementary stage are unaware of it, thus it is not implemented in teaching, especially in the science curriculum.

This is confirmed by the study of Hassard (2004) that the weakness of elementary-stage students in science and the ambiguity of their scientific concepts are due to their weak attitudes towards the subjects of science teaching and its teachers, which is certainly reflected on students with learning difficulties in the classroom. The analogies strategy sets the scientific concept within the context of everyday life and links it with the student's reality and life experiences. This in turn affects the students 'thinking abilities and the mental efforts they exert to solve their problems (Shurman&Khataybih, 2015).

The mental habits of learners are not only about collecting and classifying facts or data, but rather a thinking method for solving complicated problems to find accurate interpretations. This process begins with a problem and in the way of trying to solve it, new knowledge appears, and thus scientific concepts begin to develop and be easily comprehended. Hence, the studying hand seeks to explore the effectiveness of this strategy by answering the following questions:

- what is the effectiveness of the ABIP in acquiring scientific concepts for students with learning disabilities?
- Are there statistically significant differences at ($\alpha \leq 0, 05$) in acquiring scientific concepts for students with learning disabilities due to gender?
- Is there any interaction between the teaching methods (Traditional, ABIP) and gender in acquiring scientific concepts for students with learning disabilities?

2.1 The Study Objectives

The study attempts to investigate the effectiveness of an Analogies-Based Instructional program (ABIP) in acquiring scientific concepts among students with learning disabilities.

2.2 The Study Significance

This study may contribute to improving the learning process of students, particularly those with learning disabilities. It also boosts their tendencies to improve their motivation towards learning. On the practical level, it may help researchers in their research work in the future, as well as helping specialists in designing science curricula based on the analogies strategy.

3. Literature Review

The analogies strategy is one of the modern strategies used in teaching science and it is based on Constructivism theory which considers the process of knowledge acquisition as an active and continuous constructive process that takes place through modifying the individual's cognitive structures through the mechanisms of the self-organizing process (assimilation and accommodation).It targets the individual's ability to adapt to societal cognitive pressures, where the role the teacher is directed to the educational process and the student is the central focus of it, which helps in transferring the impact of learning beyond the limits if classroom and thus making learning meaningful (Alwaher, 2002).

It was defined by Darwaza(2000) as: the process of linking two subjects that are equal in generality, difficulty, and share certain common features in order to make the unfamiliar familiar. It is a teaching strategy that makes it easier for students to absorb abstract concepts by comparing them to analogs from their real world which improves their mental processes. It is also a teaching method that is based on clarifying, comparing and likening new concepts and phenomena that are to be learned by students with the familiar concepts and phenomena present in their cognitive environment (Aldalain& Alkaline, 2018).

The analogies strategy is one of the most important teaching strategies used to facilitate the teaching of abstract scientific concepts. It enhances students 'competencies while studying science in constructing concepts and increases their cognitive abilities. For example, comparing the eye to the camera makes it easier for students to learn concepts related to the human eye (Chuang & She, 2013).

There are four components of analogies as stated by (Zaytoon, 2005, Afaneh&Aljaish, 2009). Hence, the desired goals cannot be achieved without these components: the analog, the target, the common characteristics and features, the unacceptable characteristics.

3.1 The Significance of Analogies Strategy

Analogy-based teaching is considered as a source for enabling students to understand and acquire scientific concepts, as well as boosting the child's mental and creative abilities. It also affects children's behavior and attitudes and makes them more active in the educational process (Alharahsheh, 2012). Analogy thinking also enables teachers to help students construct mental models that can be linked to new ideas and concepts that seemed to be abstract in their past experiences (Rena & Sandra, 2008).

Education specialists believe that analogy represents an effective tool in making a conceptual change to alternative perceptions among learners, especially students with learning difficulties. And it facilitates understanding abstract concepts through focusing on comparing to the real factor that relates to the learner's life,

since analogies play an important role in activating prior knowledge, as well as bringing about conceptual change (Alagha, 2007).

Analogies are also one of the most fundamental processes that enhance creativity. Rather, they have played a distinctive role in many discoveries that have been made so far. Johannes Kepler,for example, has developed concepts related to planetary movements through comparing them to the mechanism of the clock rotation (Vattam et al, 2010). Furthermore, analogies help learners develop some intelligence aspects, such as visual/spatial intelligence, especially when using image analogies, in addition to linguistic and mathematical logical intelligences.

3.2 The procedures of Teaching Using Analogies Strategy

Some teachers, particularly teachers of learning resources rooms, misuse analogies because of their ignorance in how to use them, which often harms learners. They also use them in a disorganized manner which causes confusion and misunderstanding among learners. Therefore, it is necessary to identify certain steps for organizing this work, as mentioned in (Alagha, 2007 Alqarara, 2009) as follows:

- Evaluating students'previous knowledge of the subject, through written or oral questions.
- Introducing the concept to be learned (target).
- Introducing the analogous component that is proper to the concept to be learned (analog).
- Determine common and different characteristics and features between (target and analog).
- Choosing the teaching strategy and presentation media that is appropriate to the concept.
- Making comparisons between the analogy components considering the common characteristics and features.
- Summarizing what has been taught and evaluating the outcomes.

There are three types of analogies-based teaching models used with students: firstly: the analogy is presented by the student himself which is an effective method of teaching. Secondly: using the analogies-oriented teaching where the teacher provides the students with the concept to be explained and selects the appropriate analog, then gives them the opportunity to infer the common and different characteristics between them. The third type depends on the teacher and students, where the teacher chooses the concept and selects the analog, and then the comparison and explanation processes are done under the supervision of the teacher and students are responsible for finding points of similarity (AmboSaeidi & Albloushi. 2009).

3.3 Children with Learning Disabilities

Learning difficulties 'is defined as a disorder in one or more of the main psychological processes involved in understanding the language or its use, whether orally or in writing, and this disorder appears as a disability to listen, think, speak, read, or spell and count (Alkhatib&Alhadidi, 2014).

The main problem for children with learning disabilities, as explained by Alrimony(2008),appears in the difference between tendency and actual achievement which is identified procedurally by comparing the child's actual performance in different academic fields with his expected performance based on his mental and chronological age, and it should be demonstrated that this variation requires providing special educational services to classify the problem as educational difficulties. Students with learning difficulties have school, family, and behavioral problems that lead them to poor compatibility and negative reactions.

3.4 Characteristics of Children with Learning Disabilities

Most of the times, the problems related to learning disabilities may be hidden or not obvious to teachers, because those with learning difficulties enjoy good physical health in terms of vision, hearing and other characteristics. Some teachers may sometimes describe them as stupid or mentally retarded because of their low academic achievement. In general, students with learning difficulties are usually distinguished by several characteristics such as: lacking self-expression and interaction with others, distracted attention, hyperactive, do not complete the work they have already begun to do when asked to do so, poor discovery of his mistakes by himself, poor movement consistency, deficiency in distinction and audio or visual memory, not writing what is required from them correctly, needing a long time to organize his thoughts before he responds (Afaneh et al, 2012).

4. Previous Studies

The study of (Daoud &Sawalha, 2018; Kiwan, 2014; Alharahsheh, 2012; Alshafiey, 2010) aimed to know the effect of using analogies strategy in learning the concept, building scientific concepts, developing critical thinking, as well as in developing the skills of solving mathematical problems. The results of the studies mentioned indicated that there is a positive effect of the analogies strategy, and consequently, there are statistically significant differences between the two arithmetic means on the post test, in favor of the experimental group.

Sodah&Ibraheem(2017) study aimed to determine the use of analogies strategy in developing the achievement of scientific concepts among elementary fourth grade students in science subject in Hama city. The study sample consisted of (50) students. The results indicated that there were statistically significant differences between the mean scores of the experimental group students and the control group students in the post test that examines their scientific concepts, and in favor of the experimental group. The results also showed that there were no statistically significant differences between the mean scores of the two groups 'students in the post test examining their scientific concepts according to the gender variable (male, female).

Shurman&Khataybih (2015) analyzed science textbooks in Jordan, in the purpose of identifying the analogies included in these textbooks and investigating the effect of using analogies on eighth graders' acquisition of scientific concepts. The study sample was a convenient sample and it consisted of (83) eighth graders in Irbid-Jordan. The sample was divided into experimental group consisting of (41) students taught by analogies; and control group consisting of (42) students taught traditionally. The study results revealed statistical differences between the means of eighth graders' acquisition of scientific concepts due to differences in the teaching strategy employed to teach science. These statistical differences were in favor of teaching by analogies.

The study of (Almeqdad&Kana'neh, 2014) came to reveal the effectiveness of using the pictorial letters strategy to help students with learning difficulties in Jordan learn similar Arabic letters. The results indicated statistically significant differences attributed to the teaching method and were in favor of the pictorial letter method in comparison to the abstract letters, and the absence of statistically significant differences with regard to gender. The results also showed that there were no statistically significant differences attributed to the interaction between the method and gender.

The study of Saloum& Kassem (2014) sought to know the attitudes of the primary stage teachers towards the use of the analogies strategy. The study sample consisted of (714) male and female teachers in Latakia city, and the results indicated that there were positive orientations among classroom teachers towards using the analogies strategy. Also, the results also showed that there were no statistically significant differences attributed to the gender variable in their attitudes towards the analogies method.

Rule and Furletti(2004) study investigated the effect of using form and function analogies in comparison to the use of the traditional lecture and worksheets method on students' learning of concepts related to four of the human body systems: (the skeletal system, the digestive system, the immune system and the nervous system).The study results indicated that there were statistically significant differences between the students' performance in the study groups on the post-test for the benefit of the experimental group.

The study of (Paris and Glyn, 2004) explored the attitudes of teachers towards the use of analogies in teaching science and acquiring scientific concepts. The study was conducted on (93) female and (47) male junior and senior undergraduate education majors enrolled at a public land-grant university with 31,288 students. The findings indicated that elaborate analogies improved the science knowledge and attitudes of preservice teachers by relating what is familiar to what is new. The findings are consistent with a constructivist view of learning science and suggest that science texts for preservice teachers should be adapted to take advantage of elaborate analogies in a systematic way.

The study of Hung & Wen (2002) aimed to investigate the conceptual changes that occur to children from electrical concepts that are characterized by a high level of abstraction and mixing between them. It revealed the supremacy of the experimental group students over the control group.

5. The Study Procedure:

5.1 Population and Sample: the study population consisted of all elementary third graders with learning disabilities in Al-Shoubak district. The study was applied on (60) male and female students who were randomly distributed as follows:

Table (1): the distribution of the study sample according to its variables

Group	Males	Females	Total
Experimental	17	13	30
Control	15	15	30
Total	32	28	60

*5.2 T*he Study Variables: the study included the following variables

- The independent variable: the teaching method, and it has two levels: the use of analogies in teaching "ABIP", the traditional method.
- The dependent variable: the degree of acquiring scientific concepts.
- The taxonomic variable: the gender of the third graders; males and females.

The Study Statistical Method: the study followed the following statistical model:

G_1: O_1 X O_1

G_2: O_1 - O_1

That: G1: The experimental group consisting of (30) third graders.
O1: The achievement test in scientific concepts.
X: Teaching by using ABIP.
G2: The control group consisting of (30) third graders.
- Teaching by using traditional methodology.

5.3 The Study Measurement Tools

- Scientific concepts test for students with learning disabilities: the study used the scientific concepts test concerning the subjects that were taught to elementary third-grade students with learning disabilities using the ABIP. It was prepared by researchers, and it consisted of (20) questions. The reliability of the achievement test was calculated through the Guttman Split-Half Coefficient, which was (0.63), an appropriate for the purposes of the study.
- The ABIP that was designed according to the analogies strategy for students with learning disabilities: The validity of the program was extracted through Content Analysis, and then presented to six arbitrators of university professors to examine its reliability to achieve goals related to the acquisition of scientific concepts among third-grade students with learning difficulties. About (85%) of its paragraphs was modified considering the arbitrators' notes.

The ABIP was designed as follows:

First: some of the scientific concepts that third graders are directed to acquire, as presented in the curriculum taught by the Jordanian Ministry of Education (2019-2020), were identified. They are **plants morphology, forces and machines, universe and life, states and changes of matter.**

Second: a list of analogies was set:

Concept	**Suggested analog**
Plant's stem Plant's leaves	human's spine The kitchen
Magnet Lever	Ka'ba human's arm
Earth layers Volcano	Egg layers Tea boiling
Iron rust: chemical change Water evaporation: physical change	Fruit rot Some people standing close to each other are asked to move away from each other

Third: a model for teaching a concept according to the analogies strategy:

The Concept (earth layers)

1. **Behavioral goals:**

Clarifying what is meant by earth layers.
Comparing between egg layers and earth layers.
Stating the differences between the target and the analog.

2. **Used tools and equipment's:** board, computer, data show, and school textbook.
3. **The procedures of presenting the concept to the learners:** earth layers (target) will be compared to egg layers (analog), and the lesson will be presented as follows:

The first phase: identifying points of similarity and difference between the target (earth layers) and the analog (egg layers).

Similarities	**Differences**
The eggshell is like the Earth crust.	The difference in shape, size, and structure.
The Egg white resembles the curtain layer in the earth's crust.	Unlike the egg layers, the layers of earth are invisible and intangible
The egg yolk looks like the earth core.	
The difference in the thickness of the egg layers is similar to that of the earth layers.	

The second phase: introducing the analogies: the teacher tends to ask different questions about the subject matter:

- What do you know about Earth? Have you seen Planet Earth? What does it look like? Then, they run a discussion.
- Then, the analogy is presented as follows:

* The teacher presents to the students the analogy of the layers of earth and begins to ask questions about the egg's shape then shows them that it consists of (the shell, the white, the yolk)and that the layers of the earth are

(crust, mantle, core).

* Students are distributed into groups and given worksheets to determine similarities and differences between the target and the analog.

* Along with the teacher, students discuss their ideas on similarities and differences, and write the most prominent ideas on the board in the form of points.

The third phase: feedback and assessment:

- The diagnostic evaluation: to know the students' prior knowledge.
- The formative evaluation: it is applied during the presentation of the analogy.
- The summative evaluation: the teacher assigns each student to give another analogy-based situation other than what was mentioned.

6. Findings and Discussion:

To answer the study questions, the arithmetic means of the two study groups were extracted in the pre and post applications as shown in the following table:

Table (2): arithmetic means and standard deviations of the acquisition of scientific concepts.

Group	Gender	No	Pre-test		Post-test	
			Means	S.D	Means	S.D
Experimental	Males	17	5.82	1.91	13.00	3.10
	Females	13	4.85	3.11	11.00	2.61
	Total	30	5.40	2.50	12.13	3.03
Control	Males	15	5.47	2.61	3.67	2.32
	Females	15	5.40	2.80	6.73	2.94
	Total	30	5.43	2.66	6.70	2.60
Total	Males	32	5.66	2.24	10.03	4.21
	Females	28	5.14	2.90	8.71	3.49
	Total	60	5.17	2.56	9.42	3.92

Results related to the study's first question: what is the effectiveness of the ABIP in acquiring scientific concepts for students with learning disabilities?

What was noted from Table (2) that there were apparent differences between the means of the experimental and control groups in the pre/post-tests. To examine the significance of the observed differences, (ANCOVA) was used as shown in the following table:

Table (3): ANCOVA Results

Variance Source	Sum of squares	D.F	Mean of squares	F	Sig.	η^2
Pre-test	95.059	1	95.059	15.505	0.000(a)	
Group	425.213	1	425.213	69.354	0.000(a)	0.56
Gender	7.319	1	7.319	1.194	0.021	
Group*Gender	9.566	1	9.566	1.560	0.028	
Error	6225.000	55	6.131			
Total	6762.157	59				

Result: The ABIP has an impact on the acquisition of scientific concepts. The Effect Size is (0.56), meaning that 56% of the dependent variable (acquiring scientific concepts) is attributed to the effectiveness of the ABIP.

This result is attributed to the effectiveness of the analogies strategy (ABIP) and its ability to arouse students' attention and interest in the educational material, as it helped them to remember the concepts by creating a visual link between the abstract concept and the form in which it was presented, through a visual tracking of the concept's details in another sense. Hence, the students tried to draw a mental image of the abstract concept and matching its shape as centered in the image. Also, this strategy created a sense of joy to the learning process, especially at the moment of presenting the analogies, which evoked the students' desire to form relationships between the two concepts to explore the connection between them. Thus, students were able to realize the similarities and differences between them. The analogies strategy also activated the students' role, which reinforced their attention, and thus contributed to the transmission of the learning effect.

This strategy, as stated in Afaneh&Aljaish, (2009) is considered one of the strategies that set both sides of the brain in motion by raising the levels of mental development for learners, and activating the work of the brain in an educational environment dominated by purposeful challenge, through presenting realistic and social problems derived from the learner's environment that urge and push the student to search in all educational sources for solutions to these problems and employ them in new situations. This finding was consistent with the study of (Daoud &Sawalha, 2018; Kiwan, 2014; Alharahsheh, 2012; Alshafiey, 2010).

Results related to the study second question: Are there statistically significant differences at (α≤0, 05) in acquiring scientific concepts for students with learning disabilities due to gender?

By referring to table (3), it can be noted that there are differences due to the gender variable and in favor of males with a mean (10.03) and a standard deviation (4.21) compared to the females; with a mean (8.71) and a standard deviation (3.49). The reason for this may be attributed to the gender differences with regard to mental abilities, as the left part of the females' brain is active, which is largely responsible for language processing, while the right part of the brain is more concerned with tasks related to spatial and visual ability, which is more active in males when undertake mental representations, and grows and develops earlier in males than in females. The reason for males' superiority may also be due to society's beliefs in the importance of science to males, which increases their interest in it and consequently their excellence as compared to females (Smith, 1994). Also, the level of anxiety resulting from scientific subjects is higher among females than males. This result disagreed with the study of Sodah&Ibraheem(2017).

Results related to the study third question: Is there interaction between the teaching methods (Traditional, ABIP) and gender in acquiring scientific concepts for students with learning disabilities?

TeacBy referring to Table (3), it can be noted that there is an interaction between teaching method and gender as shown in the following graph:

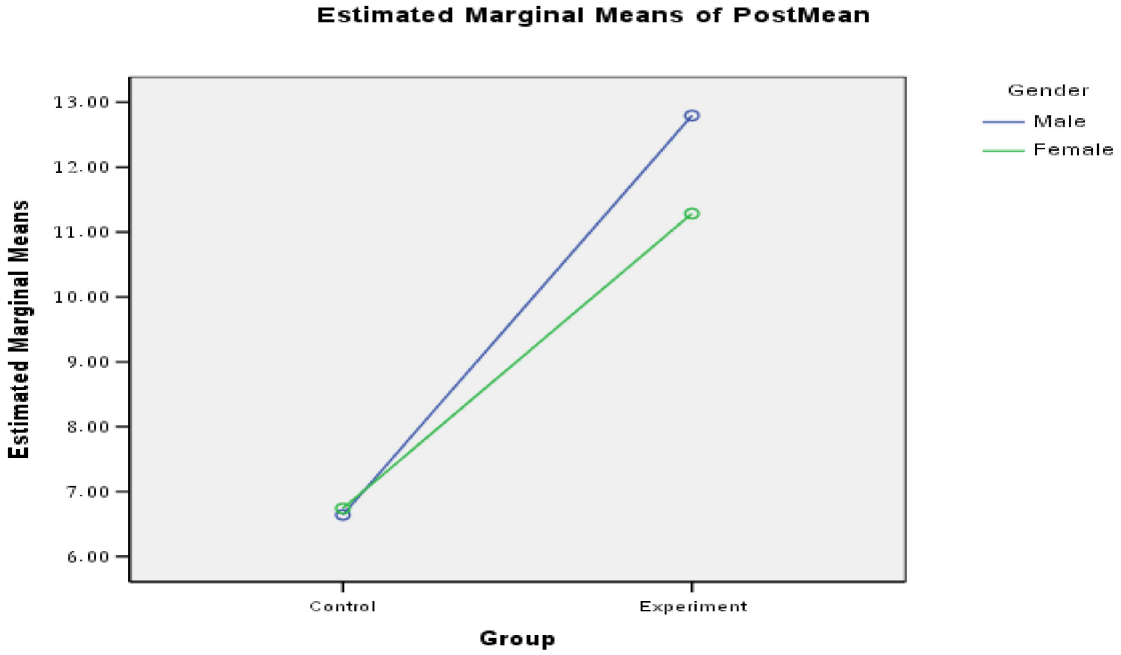

Figure 1: Interaction between Gender and groups (teaching methods

To examine which categories of variable are statically significant, the adjusted means were calculated as follows:

Table (4): Adjusted Means

Group	Gender	Mean	S.D	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	Male	6.64	0.64	5.36	7.92
	Female	6.74	0.64	5.46	8.02
Experimental	Male	12.80	0.60	11.59	14.00
	Female	11.29	0.69	9.90	12.67

The above table shows the following:

- The means of males and females in the control group are not different, where the upper bound of confidence interval reached(7.92) for males which is higher than the lower bound for females (5.46). Thus, there is no statistically significant difference between males and females means.
- The lower bound of males' confidence interval mean in the experimental group (11,59) exceeds the upper bound for males in the control group (7,92) as well as the upper bound for the females mean in the control group (8,02).As a result, there are differences in favor of males who studied using analogies in comparison to both males and females who studied using the traditional way.
- The lower bound of females' confidence interval mean in the experimental group (9.90) exceeds the upper limit of males in the control group (7,92) as well as the upper limit of the females mean in the

control group (8,023).Therefore, there are differences in favor of females who studied using analogies in comparison to both males and females who studied using the traditional way.

- The means of males and females in the experimental group are similar, as the upper bound of confidence interval mean for females reached (12.67) which is higher than the lower bound of males' mean (11,59). Hence, there is no statistically significant difference between the means of males and females in the experimental group.

These findings are attributed to the fact that the ABIP which based on analogies strategy focuses on the way learners work within groups to accomplish the tasks assigned and obtain feedback from the group members and the teacher to make the outputs more obvious and asserted in the students' minds. The researchers also noted that the learner following this strategy is no longer a passive recipient of information but rather a participant in it, as he is the researcher, critic and interlocutor of the information. This result disagreed with the study of (Almeqdad&Kana'neh, 2014).

7. Recommendations:

- Arranging training courses for the elementary stage teachers and teachers of resource rooms teachers on how to use the analogies strategy.
- Activating the teaching strategies that aim to clarify abstract concepts through the learner's previous knowledge, such as combining the analogies strategy and the learning cycle-5, which builds the learner's knowledge.
- Carrying out other studies on the analogies strategy for new concepts and different age stages.
- Reinforcing analogies in science books for the first elementary stage in various illustrative ways.
- Conducting a study using the analogies strategy to explore its effect on developing creative thinking among talented students.

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