Modern Applied Science; Vol. 13, No. 5; 2019
ISSN 1913-1844 E-ISSN 1913-1852
Published by Canadian Center of Science and Education

The Effectiveness of a Discovery-Learning Strategy in the Acquisition of Scientific Concepts Among Kindergarten Students in Jordan

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Received: March 4, 2019 Accepted: April 13, 2019 Online Published: April 31, 2019

doi:10.5539/mas.v13n5p122 URL: https://doi.org/10.5539/mas.v13n5p122

Abstract

The present study aimed to detect the effectiveness of using a discovery-learning strategy in the acquisition of scientific concepts among kindergarten students whose ages are between 5-6 years. The study used the experimental method through semi-experimental design with pre and post-test for the experimental and control groups. To achieve the goal of the study, a visual test for the scientific concepts was developed. After verifying the validity and reliability of the scale, it was applied to the study sample, which included 49 boys and girls randomly assigned to two groups,: An experimental group consisting of 24 boys and girls who were taught by using a discovery-learning strategy, and a control group consisting of 25 boys and girls were taught by using the traditional methods.

The results of variance analysis showed a statistically significant difference at the level $\alpha = 0.05$ between the mean scores of the responses of the control and experimental groups' participants in the post-test of scientific concepts, attributed to the use of the discovery-learning strategy, and for the benefit of the experimental group. The study found no statistically significant differences at the level of $\alpha = 0.05$ between the mean scores of the experimental group's participants in the post-test of scientific concepts attributed to gender variable, nor there was any statistical effect of interaction between gender and teaching strategy. In the light of these results, the study concluded the effectiveness of using a discovery-learning strategy in the acquisition of scientific concepts among kindergarten children.

Keywords: discovery-learning strategy, acquisition of scientific concepts, kindergarten children

1. Introduction

A widely accepted claim in the science Education community is the constructivist idea that discovery learning, is the best strategy to get deep and lasting understanding of scientific Concepts, particularly for Kindergarten child. (Klahrl and Nigam, 2004). The premise of constructivist theory implies that the knowledge children' construct on their own is more valuable than the knowledge told to them; or shown demonstrated, or explained to them by a teacher (Graaf, Segers & Verhoeven, 2015).

Kindergarten is one of the most important educational stages in a child's life (Graaf, Segers, Verhoeven, 2015), not only because it is the beginning of a long series of changes, but because it will also influence the subsequent stages of any human's life greatly (Eshach& Fried, 2005. Children at the age of kindergarten have the flexibility and the ability to learn fast; and they acquire skills and different cognitive abilities easily (Sackes, Trundle, Bell & Connell, 2011) It's a stage of preparing, forming and constructing the personality traits of any child; and defines the characteristics of behavior and human relations and outlines future directions (Patrick, Mantzicopoulos, Samarapungavan, & French, 2008). Kindergarten is also considered a fertile ground for creating children with healthy personalities, and well trained scientific and social skills. Children love to explore, guess, discover and experiment, so it is important that this stage feels fun for the child, and simultaneously gives him a sense of security, and freedom to exercise activities and explore the capabilities, tendencies and possibilities, so he can enter the next stage of education smoothly and easily. (Sackes, Trundle, Bell & Connell, 2011).

Science education aims to provide learners with a scientific way of thinking and problem solving skills, train them on methods of research, discovery, scientific observation, and teach them to use their senses to obtain information that enables them to acquire scientific concepts and use them rather than just memorize them. (Ahmed, 2011;

Magdy, 2007). Science programs in kindergartens should be designed to provide children with the opportunity to demonstrate their creativity, and develop their skills through manual work and the use of tools to reach results; children learn better when they engage in activities and deal with them personally (Uweys and Murtada, 2011). Teaching science in kindergarten has many goals, such as, encouraging children to use their senses to acquire information and evidence; and the development of observation methods and the skills of comparison and classification; and the development of predictions and intuition through questions and discussions with the teacher; and helping children to communicate, discuss, and present their experiences to others; and find results that will form the basis for their later formation of concepts; stimulating curiosity in children to explore their environments, adjust to it and use their potentials to detect the properties of things around them; and last but not least kindergarten sciences targets to teach children the scientific way of thinking and problem solving, and train them on experimentation and research and discovery (Khalaf, 2005).

Hejazin (2006) noted that achieving the goals of teaching science requires appropriate teaching methods and educational strategies that ensure the safety and quality of learning, where a child can discover the concept by himself through the appropriate and varied activities organized by the teacher. And "One of the most important and effective ways of developing science education is the ". Discovery- learning Strategy. The International Standards for Quality in teaching Science adopted the discovery-learning strategy advocated by Bruner because it achieves a comprehension-based learning that makes the learner the basic of the learning process and allows him to practice science and to follow the behavior of scientists in research and investigation. (Yunus, 2017). This kind of teaching gives the student self-confidence and a sense of accomplishment, and helps the student to develop positive attitudes toward science, and gives him pleasure while developing his thinking (Eshach& Fried, 2005; Patrick et al., 2008). Various definitions of the term discovery- learning exist within instructional research. As (Ahmad, 2009). The discovery-learning strategy is based on an educational philosophy that the child should be engaged in the learning rather than be a passive learner.

Although the child is the focus of the learning process in this strategy, but the role of the teacher is equally important: teacher assigns the scientific concepts and principles to be learned then introduces them in the form of a question or problem; teacher provides the educational materials necessary to implement the lesson; teacher formulates the problem in a form of sub-questions; set the activities or experiments to be carried out by the learners; evaluate learners' work; and finally help learners apply what they learned to new situations (Ahmad, 2009).

(Al-Nashif, 2001; Khalil, 2005) points out that the discovery-learning strategy aims at increasing child's motivation towards learning, achieve psychological development, acquire problem solving skills, and maintain the learning. Learning by discovery makes learning material more comprehensible to the child and provides him with multiple experiences that he can use in other contexts. In fact learning by discovery creates an active, thinking, and inventive learner. Brunner believes that discovery learning leads to the development of the child's abilities to research, discover and solve problems, as well as to maintain experiences and organize them in a meaningful way so that they can be remembered and used for later learning (Akani, 2017).

According to (Khalil, 2005) the discovery- learning strategy is based on three basic principles: feeling the problem and asking questions, engaging children actively and effectively in the process of discovery, and then processing the information mentally to reach understanding. Therefore, the discovery-learning is one of the best strategies for a kindergarten child. It allows planning and assigning of what concepts the child should learn, then determining the means and activities that will enable the child to discover while playing an active and positive role, with the help of the teacher.

The formation and development of scientific concepts among kindergarten children is one of the most important goals of teaching science in the kindergarten (Akerson, 2004). Forming the child's concept by using Discovery-learning Strategy goes through four stages: the stage of observation: where the child is exposed to different experiences and stimuli. The stage of comparison: in which the child distinguishes between common characteristics in each group of these experiences and stimuli. The abstraction stage: where the child draws the characteristics of each group or category. And finally, the generalization stage: in which the child casts judgments on everything he sees and classifies it in light of its characteristics, and puts it in the category where it belongs (Al-Qirban, 2012).

Auzubel believes that "The effective learning process is what enables the learner to acquire and retain scientific concepts, and transfer them to other educational settings.(Oliveira, 2010; Al-Sayed., 2011); so he was interested in the way the course should be structured and how it should be presented to the learner in a manner that combine new experiences with previous experiences in order to induce more learning. thus, the kindergarten teacher must emphasize the importance of learning scientific concepts by providing educational materials that help children

acquire scientific concepts and develop their innate potentials (Gallenstein, 2003). Brunner divided the stages of forming concepts among children into three stages: the practical stage: in which the learner deals directly with the tangible things. The mental image stage: in which the learner thinks of things and relations without dealing directly with them. And the symbolic stage: where the learner deals with symbols in an abstract way (Aziz, 2004; Balim, 2009).

A number of studies have been conducted to reveal the effect of discovery-learning on many variables: Yunus (2018) held a study aimed to investigate the effect of teaching by using the computerized discovery-learning strategy in the achievement among second grade students in an elementary school in Irbid. The sample of the study consisted of (41) male and female students randomly assigned into two groups, an experimental group of (20) students and a control group of (21) students. After processing the data using the experimental approach, the study results showed that there was a statistically significant difference in the achievement of second grade students due to the method and to the benefit of the experimental group. Results also showed no statistically significant difference attributed to gender or to the interaction between gender and method of teaching, also Akani (2017) held a study aimed to determine the impact of the discovery-learning strategy on the achievement of high school students in the state of Ebony, Nigeria. The study sample consisted of (201) students randomly distributed into two groups, an experimental group that studied using a discovery-learning strategy and a control group that studied in the traditional way. Results showed that discovery-learning was more effective than the conventional method in students' achievement, and showed no statistically significant effect attributed to the interaction between gender and the strategy of discovery-learning in students' acquisition of chemical concepts, also Ansariyya (2016) held a study aimed to investigate the effectiveness of discovery-learning in the development of science and achievement in science among fourth grade students in a school in North Al-Batinah Governorate in Oman. The study sample consisted of 57 male and female students distributed into two groups, an experimental group of (29) students who studied using a discovery-learning strategy and a control group of (28) students who studied using the usual method, the study tools consisted of an achievement test and a science test The results showed statistically significant differences in the post-test grades in both achievement and science tests between experimental and control groups in favor of the experimental group. Ahmed (2011) investigated the effect of the discovery-learning method on the achievement of sixth grade students in science. The sample of the study consisted of (70) sixth grade male and female students in Tabuk city in Saudi Arabia distributed equally in two groups. The experimental group studied using a discovery-learning strategy in the lab, and a control group who studied using the usual method. The researcher used experimental method; the study tool consisted of a pre-and post-test for achievement, and a teaching program designed according to the method of discovery-learning. The study found statistically significant differences between the mean scores of the two groups in the achievement test for the benefit of experimental group.

Balim (2009) also held a study aimed to determine the impact of the discovery-learning method on students' perceptions of inquiry learning skills, academic achievement, and maintenance of knowledge. The researcher used semi-experimental method for two groups, experimental and control groups. The study sample consisted of 75 7th grade students randomly distributed into an experimental group that studied using the discovery-learning method with daily activities and plans, and a control group who studied using the traditional learning method. The results of this study showed a statistically significant difference in the mean scores of perceptions of inquiry learning skills, academic achievement, and maintenance of knowledge in favor of the experimental group. Koen, Wouter& Ton (2006) conducted a study that used the method of discovery-learning in learning physics for the secondary stage. The sample consisted of 46 students randomly assigned to a control and experimental groups where all students undergone a pre and post-test. The results showed that the achievement of students in the experimental group is slightly higher than those in the control group, that is, there was no statistically significant difference in student achievement. Fahmi (2005) also conducted a study aimed to determine the effectiveness of using discovery-learning in developing basic science operations' skills and practical interests among kindergarten children on a sample of 140 children distributed equally into two groups. The experimental group studied using discovery-learning method, and a control group that studied using the usual method. Tools of the study were applied to measure science operations' skills and practical interests. The study found that there were statistically significant differences between the average scores of children in the experimental and control groups in acquiring scientific processes and practical interests for the benefit of the experimental group who studied using the discovery-learning method. Nawafala (2005) also held a study aimed to measure the impact of a teaching program based on science activities in the acquisition of scientific thinking skills, scientific concepts and scientific tendencies among kindergarten children. The study sample consisted of 88 kindergartens children from the city of Irbid distributed equally into two groups. The experimental group studied using science activities and the control group studied using the traditional way. The study found a statistically significant difference between the average

scores of the experimental and control group's for the benefit of the experimental group. The study recommended using activities in teaching and advised designing the curriculum accordingly. The study also emphasized the importance of practical activities in the development of scientific concepts and tendencies.

Based on all of these studies, the researcher believes that teaching science according to the method of discovery-learning can have a positive effect on learners and help develop their thinking to make them positive participants. This is what led the researcher to study the effectiveness of discovery-learning method in the development of scientific concepts in kindergarten children in Jordan. So this research comes to answer the follows main question:

What is the effectiveness of discovery-learning strategy on developing scientific concepts in kindergarten?

2. Hypotheses of the Study

According to the main study question, the following hypotheses were formulated:

1. There are no statistically significant differences at the level of significance ($\alpha = 0.05$) between the average scores of children in the experimental group and the control group in the acquisition of scientific concepts due to the teaching strategy.
2. There are no statistically significant differences at the level of significance ($\alpha = 0.05$) between the average scores of children in the experimental group and the control group in the acquisition of scientific concepts due to gender.
3. There are no statistically significant differences at the level of significance ($\alpha = 0.05$) between the average scores of the children in the experimental group and the control group in the acquisition of scientific concepts due to the interaction between strategy and gender.

3. Methodology

3.1 The Population

The population of the study consists of all kindergarten children in the second level (males and females) between the ages of 5-6 years during the academic year 2018/2019 in public and private kindergartens in Madaba Governorate in Jordan.

3.2 The Sample

The sample of the study consisted of (49) male and female children of the second level in kindergarten in the city of Madaba. (5-6 years of age). These children were purposefully selected from one school in the city of Madaba. This school contained three classes; two of them were chosen randomly for the study, while the third was used to find the psychometric characteristics of the study tools. The two classes were randomly assigned to two groups. The experimental group consisted of (24) male and female children, who were taught according to the strategy of discovery-learning, and the control group consisted of 25 male and female children who studied according to the traditional method. Table (1) shows the distribution of study subjects by group and gender.

Table 1. Distribution of study subjects by group and gender

group gender	control group	experimental group	Total
males	13	11	24
females	12	13	29
total	25	24	49

3.3 Equivalent Procedures

To verify the equivalent of the experimental and control groups, a pre-test was applied. The mean, standard deviations and T-test of two independent samples were calculated to detect the differences between the performances of the two groups as shown in Table (2).

Table 2. Mean, standard deviations and T-test of two independent samples in visual depicted scientific concepts pre-test

group	number	mean	standard deviations	T-test	significant level
control	25	9.08	3.34	0.133-	0.895
experimental	24	9.21	3.39		

Table (2) shows that there are no statistically significant differences at the level of significance ($\alpha = 0.05$) between the mean scores of performance of the experimental group and the control group in visual depicted scientific concepts pre-test, which proves the equivalent of the two groups before the application of the study.

3.4 Study Tool

3.4.1 Scientific Concepts Test

The researcher developed a visual depicted test to measure the extent to which the sample of the study obtained the scientific concepts included in the plant and animal units. The preparation of the visual test included taking into account all levels of knowledge (remembering, understanding, application, analysis, composition and evaluation). Accordingly, a specification table was prepared to achieve comprehensiveness and balance in the test questions.

To ascertain the validity of the scientific concepts test, It was presented to a number of arbitrators from the Department of Curriculum and Teaching, and Childhood Psychology. They were asked to express their opinions and judge the questions, language, and scientific accuracy, as well as the appropriateness of the test for kindergarten level in terms of form, content and level of difficulty. Based on the observations of the arbitrators, the final examination was made up of (22) paragraphs.

The test of the scientific concepts was administrated on a survey sample of 20 children (other than the study sample). In light of this administrations', the following was conducted:

- A computation of the time taken by children to complete the test questions, the average time was (35) minutes.

- A computation of the test stability: by calculating the internal consistency coefficient using the equation of Kronbach Alpha, where the value was (0.83), which confirms the stability of the test.

- Determination of the difficulty and discrimination coefficients of the test paragraphs. The difficulty coefficient ranged between 0.27 and 0.86. The coefficient of discrimination ranged between 0.25 and 0.77 which is considered acceptable for study purposes

- Grading the scientific concepts test: The total score of the test was (22), one point for each correct answer, and zero for each wrong answer.

3.5 Design and Statistical Processing

The current study followed the experimental approach with semi-experimental design, using two equivalent groups. The test for this study was applied to the study sample. The discovery-learning strategy was applied in teaching the experimental group members.

4. Results

The mean and standard deviations of the scores of the experimental and control groups were calculated as shown in Table 3.

Table 3. Means and standard deviations of the study subjects' scores on the pre and post-test of scientific concepts acquisition according to the variables of teaching strategy and gender

		pre test			**post-test**		
strategy	**gender**	means	standard deviations	number	means	standard deviations	number
control group	male	8.23	2.77	13	11.77	3.14	13
	female	10.00	3.84	12	14.08	4.10	12
	total	9.08	3.38	25	12.88	3.75	25
	male	8.73	2.72	11	17.18	1.94	11

experimental group	female	9.62	3.93	13	17.39	2.84	13
	total	9.21	3.39	24	17.29	2.42	24
total scores	male	8.46	2.70	24	14.25	3.78	24
	female	9.14	3.81	25	15.80	3.82	25
	total	9.14	3.35	49	15.04	3.85	49

As shown in table (3) that there is a marked difference between the average scores of the study subjects on the post-test of scientific concepts acquisition according to the variables of teaching strategy and gender. The mathematical mean for the experimental group members was 17.29 and the standard deviation (2.42). The mathematical mean for the control group was (12.88), and the standard deviation (3.75). The mathematical mean for female students was 15.80, the standard deviation was 3.82; while the mathematical mean for male students was 14.25 and the standard deviation was 3.78. Based on the various descriptive statistics of the scores of the study subjects on the post-test of scientific concepts acquisition, it was decided to test the impact of the strategy and gender and the interaction between them using the associated variance analysis, as shown in Table 4.

Table 4. scores of female participants on the post-test of scientific concepts acquisition according to strategy and gender variables and the interaction between them

source of variation	square total	independences scores	square means	F value	significant level	$^2(\eta)$ Eta Square
pre-test accompanying variance	101.364	1	101.364	13.251	0.01	0.231
teaching strategy	228.786	1	228.786	29.909	0.000	0.405
gender	5.224	1	5.224	0.683	0.413	0.015
strategy & gender	8.974	1	8.974	1.173	0.285	0.026
Errors	336.573	44	7.649			
total	709.918	48				

Table (4) shows statistically significant differences (α = 05.0) for the value of P (29.909) related to the effect of the discovery teaching strategy (science activities / normal method). This difference was in favor of the experimental group members.

In order to discover the effectiveness of the discovery teaching strategy in the acquisition of scientific concepts by kindergarten children, effect Size was found using the Eta Square **$^2(\eta)$** as shown in Table (4). It was found that Eta Square **$^2(\eta)$ is** 0.405; which means that discovery teaching strategy explains about (40.5%) of the variation in the acquisition of scientific concepts among the members of the study, while the rest is due to other uncontrolled factors.

In Table 4, there are no statistically significant differences (α = 05.0) for the value of P (0.683) related to the effect of gender in the post-test of acquiring scientific concepts. Effect Size was found using Eta square **$^2(\eta)$,** as shown in Table (4), to be equal to (0.015); this means that the effect of gender explains about (1.5%) of the variation in the acquisition of scientific concepts among the members of the study.

Table (4) shows no statistical significance differences (α = 05.0) for the value of "P" (1.173) related to the effect of the interaction between the strategy of teaching and gender in the post-test of scientific concepts acquisition. Effect Size was found using Eta square **$^2(\eta)$,** as shown in Table (4), where it was found to be equal to 0.026; this means that the effect of gender explains about 2.6% of variance in the acquisition of scientific concepts among the members of the study.

5. Discussion

The results of the analysis of the accompanying variance showed a statistically significant difference at the level of α = 0.05, between the mean scores of members of both control and experimental groups in the post-test of scientific concepts acquisition, due to the use of discovery-learning strategy and for the benefit of the experimental group. This finding can be explained by the fact that teaching using the discovery-learning strategy has greatly contributed to the understanding of the content of the animal and plant units; we think also that changing the atmosphere of the classroom may have been another reason for the children's acquisition of scientific concepts. The discovery-learning strategy has also contributed to the creation of an instructive environment under the

guidance of the teacher, and provided a learning environment based on fun and interest that led children to discover solutions to the problematic learning situations by themselves, resulting in an improved acquisition of scientific concepts.

This is confirmed by Brunner, who noted that learning scientific concepts in discovery-learning way makes the knowledge obtained by children last longer. When a child is confronted with a situation that challenges his thinking he will seek the skills of scientific inquiry such as observation, classification, experimentation, etc., and reorganizes his knowledge to discover the appropriate concept or generalization. All of this increases the child's motivation to learn and reinforce the concepts he has already learned.

Zaitoun (2007) emphasizes that learning the scientific concepts at different ages and levels of education, requires a method of teaching that ensures safe formation of scientific concepts that will help maintain these concepts for a long time. Learners also need the use of scientific concepts functionally in discrimination, organization and generalization (zaitoun, 2007).

Discovery-learning combines between extrapolation and deduction. When a child learns to discover, he or she will acquire a variety of experiences that enable them to extract a concept, a generalization or a rule. Thus, the discovery approach is one of the most important approaches to the teaching of scientific concepts. This was confirmed by some studies that investigated discovery learning.

The study also found that there are no statistically significant differences at the level of $\alpha = 0.05$ between the average scores of the experimental group's children in the post-test of the scientific concepts acquisition attributed to the gender variable; and found no effect of interaction between gender and teaching strategy. This can be explained by the fact that all students have the same desire to learn, participate and interact with the method of discovery-learning, which increased their motivation to learn, which in turn led to their understanding of the material well and at the same level, regardless of their gender.

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