Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.7, No.3, 2016
www.iiste.org

# The Effectiveness of Educational Games on Scientific Concepts Acquisition in First Grade Students in Science

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**Abstract**
This study aimed at investigating the effectiveness of educational games on scientific concepts acquisition by the first grade students. The sample of the study consisted of (53) male and female students distributed into two groups: experimental group (n=26) which taught by educational games, and control group (n=27) which taught by traditional method. To achieve the purpose of the study, the researcher developed a teaching guide included eight educational games, and a test to measure scientific concepts acquisition. Results showed that there were statistically significant differences in students' scientific concepts acquisition due to the method of teaching in favor of the experimental group. Also, there were no statistically significant differences in students' scientific concepts acquisition due to the gender or the interaction between method of teaching and gender. The study recommended using educational games in teaching science in primary education.
**Keywords:** Educational Games, Scientific Concepts, Science

## 1. Introduction and Literature review

Science teachers and researchers have a vision that all students are capable of learning Science, This is done best in socially organized environments, and with a curriculum that is more student-centered than teacher-centered (Hassard & Dias, 2009).

Scientific concepts are the axes around which science curriculum revolves. Zaytoon (2013) indicates that scientific concepts are considered basis of science and scientific knowledge that assist in understanding the structure of science transferring, the impact of learning, and connecting scientific facts. According to Murphy (2002), concepts are mental representations that allow us to draw appropriate inferences about the type of entities we encounter in our everyday lives. Concepts help us to make deductions and explain even more complex ideas. Concepts can thus act as building blocks of more complex or even abstract representations (Zirbel, 2006).

Despite the significance of the scientific concepts, students face difficulties in acquiring these concepts in particular in elementary school years such as lacking the scientific background as well as confusing between the scientific term with its meaning or verbal reference. One of these difficulties is represented in implementing traditional science learning (Khataybeh, 2011). Milne & Otieno (2007) indicates that, traditional science learning has been criticized for not engaging learners or fostering deeper understanding.

Educators believe that the above mentioned difficulties can be overcome by using entertainment and fun-based teaching methods in which the learner acquires direct experience from his/ her active interaction in the learning process. Educational games can be considered as an example of these fun-based teaching methods (Ambu-saidi&Balushi, 2009).

Jean Piaget once wrote, "Play is the answer to the question: how does anything new come about?" When we provide opportunities for—and allow time for—children's self-initiated play, we are ensuring the full development of their curiosity, imagination, and creativity (Elkind, 2008). Vygotsky remarked, "In play a child always behaves beyond his average age, above his daily behavior; in play it is as though he was a head taller than himself" (1978). According to Salen and Zimmerman (2004) a game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome. Kirriemuir & McFarlane (2004) reported two key themes for pursuing the development of games for education:

1. The desire to harness the motivational power of games in order to 'make learning fun'.
2. A belief that 'learning through doing' in games such as simulations, offers a powerful learning tool.

A number of researchers have reported the positive impact of educational games on fostering students' science learning. Inal & Cagiltay (2007) showed that games have potential to foster children's ability to communicate and interact with others during game play. In addition, Hsu, Tasi & liang (2011) revealed that young children, after the game play, could acquire concepts regarding light and shadow. Also, *Klisch, Miller, Wang and Epstein (2012) found that* science education game was effective in increasing adolescents' knowledge about the science content presented in the game. Furthermore, the increased knowledge resulted in a shift to more negative attitudes toward inhalants, indicating that the game was successful in enabling adolescents to identify inhalants as body pollutants. Furthermore, the results of research by Liu and Chen (2013) indicated that students demonstrated positive attitudes toward the use of the educational card game in science learning. Results demonstrate the effectiveness of the proposed education card game in improving students' scientific knowledge of transport and energy.

Based on the views discussed above on the benefits of educational games and based on the assumption that teaching and learning Science is more acceptable -for elementary school students- if tangible objects were employed to acquire scientific concepts, the present study investigates the effectiveness of educational games on acquiring scientific concepts in first graders.

## 2. Statement of Problem

First graders face difficulties in learning science due to the complexity of this school subject especially in the way it is taught that lacks creating interest which is typical of conventional teaching methods. This was confirmed in the results of the national examination for quality assurance as the results revealed a level of weakness in this school subject (Ministry of Education, 2011).

### *2.1 Aim of the study*

The present study aims at investigating the effectiveness of educational games on scientific concepts acquisition in the first grade students.

### *2.2 Questions*

1. Is there any statistically significant difference ($\alpha \leq 0.05$) in students' scientific concepts acquisition attributed to the instructional methods (traditional methods and educational games)?
2. Is there any statistically significant difference ($\alpha \leq 0.05$) in students' scientific concepts acquisition attributed to the gender?
3. Is there any statistically significant difference ($\alpha \leq 0.05$) in students' scientific concepts acquisition attributed to the interaction between instructional methods and gender?

### *2.3 Significance*

1. The study is in harmony of the new trends in teaching that aims at creating the learner's interest by teaching in an entertaining way.
2. It presents new teaching methods that are based on theories such as that suggested by Jean Piaget.
3. It focuses on one of the most important grades in elementary teaching as it is considered the first stage of learning.
4. It provides insights for Science teachers on how educational games can be utilized in teaching and learning of Science.

### *2.4 Terms and Procedural Definitions*

1. Educational games:

The educational games employed in the present study included: surprise box, close your eyes, identify sounds and fragrances, say then taste, what's in the bag, cold and hot, I'm the doctor. These educational games are purposeful activities first graders have practiced either individually or in groups. They have exerted efforts in carrying out these activities in accordance with pre-set rules for achieving particular objectives represented in understanding and acquiring the scientific concepts presented in the Unit on the Five Senses.

2. Acquisition of scientific concepts:

It is the first grader gains of meanings and understandings related to the scientific concepts in the unit on the five senses. This is to be measured based on the grade obtained in the test of the scientific concepts acquisition prepared by the researcher for this purpose.

### *2.5 Limitations*

1. Human limits: the study is limited to first graders.
2. Place limits: the study was conducted in elementary school of Um Attiyyah Al Ansariyah associated with the directorate of the Ministry of Education in the capital city Amman.
3. Time limits: the study was conducted during the first term of the academic year 2014/2015.

## 3. Methodology

### *3.1 Participants*

The present study was conducted on (53) male and female students distributed among two sections of first grade at the elementary school of Um Atiyyah Al Ansariyah one of Wadi Seir education directorate, in the capital city, Amman. One of the two sections was chosen randomly to represent the experimental group which taught by educational games while the other group represented the control group which taught by using traditional method. The following table illustrates the distribution of the Participants according to group and gender.

Table 1. the distribution of the Participants according to group and gender

| Group / Gender | males | females | Total |
|---|---|---|---|
| Experimental | 12 | 14 | 26 |
| Control | 12 | 15 | 27 |
| Total | 24 | 29 | 53 |

*3.2 Instrumentation*

*3.2.1 Teaching guidance*:

It was designed according to the following steps:

a. Analysis of the content of the material of the five senses subject related to the textbook of the science for grade one. the lessons included in the subject were: parts of human body, five senses, I see with my eyes, I listen with my ears, I smell with my nose, I taste with my tongue, I touch with my hands and I health care of our bodies.

b. Preparing teaching guidance: including study plans for educational games of each of the lessons mentioned above in which a specific number of classes were allocated to each lesson for a total of (8) lessons.

c. The researcher met the science teacher at the school where the study was conducted. The significance and aims of the study were explained to the teacher. The teaching guidance and the method of applying the educational games included in the study were intensively discussed.

d. The educational games were presented to a jury of six reviewers for suggestions and recommendations on the appropriateness of the guidance for first graders and the accuracy of the academic content as well as the validity of the design of the study plan for each lesson.

e. The recommendations of the jury were taken into consideration in particular with regard to the wording of some items and re-organizing some of the study plans related to the subject of the five senses. Appendix (1) shows lesson plan sample.

*3.2.2 Scientific concepts acquisition test*

The purpose of this test is measuring the extent to which scientific concepts related to the five senses were acquired by first graders. The test consisted of (23) items measuring three levels of objectives in cognitive domain (knowledge, comprehension, application). These were reflected in three types of questions:

a. Matching: match between the term and the picture to which it refers ((5) items).

b. Multiple choice questions ((11) items).

c. True or false consisting of ((7) items).

Note: The largest score in scientific concepts acquisition test is: (23).

*3.2.2.1 Test validity and reliability*

To ensure the validity of the test, it was presented to a jury of six reviewers. Some items were amended in light of the recommendations especially with regard to the linguistic and scientific structuring of the items. Thus, one item was deleted to end up with a test of (23) items.

To ensure the reliability of the test, a pilot study was conducted on (25) of the third section of first grade at the same school, the Kuder Richardson-21 formula was used (KR-21) which amounted to (0.85) that was considered acceptable for the present study. Appendix (2) shows sample of scientific concepts acquisition test questions.

*3.3 Design of the Study*

This type of study is a quasi-experimental in which the variables are:

1. Independent variables:

a. Teaching method represented in educational games and traditional method.

b. Gender: males and females.

2. Dependent variables: represented in the scores of the first graders in scientific concepts acquisition test.

The study design can be represented as the following symbols:

G1: O X O

G2: O O

Where:

G1: Experimental Group

G2: Control group

X: Experimental task using educational games.

O: Scientific concepts acquisition pre/post- test.

**4. Results and discussion**

*4.1 Results and discussion related to the first question*

Is there any statistically significant difference ($\alpha \leq 0.05$) in students' scientific concepts acquisition attributed to the instructional method (traditional method and educational games)?

To answer this question, means of scores were calculated as well as the standard deviation for the two groups, as illustrated in table (2) and table (3).

Table 2. Means and standard deviations of the scores of students in the two groups in a concept acquisition pre-test

| Gender / Group | males | | | females | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | mean | Std. deviation | n | mean | Std. deviation | n | mean | Std. deviation |
| Experimental | 12 | 5.92 | 2.19 | 14 | 6.36 | 1.08 | 26 | 6.15 | 1.67 |
| Control | 12 | 5.58 | 1.38 | 15 | 6.40 | 1.50 | 27 | 6.04 | 1.48 |
| Total | 24 | 5.75 | 1.80 | 29 | 6.38 | 1.29 | 53 | 6.09 | 1.56 |

Table 3. Means and standard deviations of the scores of students in the two groups in a concept acquisition post-test

| Gender / Group | males | | | females | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | mean | Std. deviation | n | mean | Std. deviation | n | mean | Std. deviation |
| Experimental | 12 | 17.25 | 2.30 | 14 | 17.50 | 1.50 | 26 | 17.38 | 1.88 |
| Control | 12 | 10.58 | 1.78 | 15 | 11.07 | 1.16 | 27 | 10.85 | 1.46 |
| Total | 24 | 13.92 | 3.95 | 19 | 14.17 | 3.53 | 53 | 14.06 | 3.69 |

Analysis of covariance (ANCOVA) was used to investigate the significance of the mean differences of the concept acquisition post-test according to the average scores due to instructional method and gender variables. Table (4) illustrates the results.

Table 4. Results of ANCOVA (with scientific concepts acquisition pre-test as covariate)

| Source of variance | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Pretest/Covariate | 54.740 | 1 | 54.740 | 30.250 | 0.000 |
| group | 545.149 | 1 | 545.149 | 301.257 | 0.000 |
| gender | 0.041 | 1 | 0.041 | 0.022 | 0.882 |
| group * gender | 0.001 | 1 | 0.001 | 0.001 | 0.979 |
| Error | 86.860 | 48 | 1.810 | | |
| Total | 708.830 | 52 | | | |

As shown in Table (4), statistically significant difference ($\alpha \leq 0.05$) was found in the scientific concepts acquisition post-test scores in favor of experimental group taught by educational games. Table (5) illustrates that the adjusted mean of the post-test of the control group (10.89) was lower than the adjusted mean of the experimental group (17.35).

Table 5. The adjusted means of the post-test of the control and experimental groups

| group | adjusted mean | Standard error |
|---|---|---|
| Experimental | 17.35 | 0.27 |
| Control | 10.89 | 0.26 |

The researcher believes that this result is attributed to the use of educational games which created a learning environment characterized by fun and entertainment. This method increased the learners' motives and interests in the material taught and increased their concentration and attention for the stimulations in the teaching-learning process. Acquisition of scientific concepts normally occurs through the learners' interaction with the stimulations faced and experiences went through. This assisted learners in shaping a mental image of these stimulations and experiences based on the common characteristics of the stimulations. The results can also be attributed to the fact that educational games increased self-confidence in students as they reinforce the active role of the students in the learning process by participating in gaining knowledge which is not excluded in this case to the teacher. The results can further be attributed to the fact that educational games can be practiced by all students regardless of their academic achievements; i.e., all students of low and high academic achievements can participate in these games. Numerous studies have indicated games as an engaging environment for learning. Tüzün, Yılmaz-Soylu, Karakuş, İnal and Kızılkaya (2010) have found that primary school students could make significant learning gains and demonstrate higher intrinsic motivation in a game-based learning environment. Folta (2010) showed that students not only enjoyed playing the game, but felt that it was a good educational tool because the outdoor science educational games made them felt they learned how to identify tracks, scat, trees, and invertebrates depending on the role they played.

*4.2 Results and discussion related to the second question*

Is there any statistically significant difference ($\alpha \leq 0.05$) in students' scientific concepts acquisition attributed to the gender?

The results showed in table (4) indicate that there is no statistically significant difference ($\alpha \leq 0.05$)in students' scientific concepts acquisition attributed to the gender variable. According to the researcher, this result can be attributed to the fact that the educational games included in the present study aim at achieving particular knowledge of content regardless of the gender of the learner. The result can also be due to the assumption that educational games encouraged both males and females to learn, it drew their attention and increased their motivation equally as students during this age tend to play and enjoy playful practices. In addition, the results can be attributed to the similarity of the learning environment that males and females are exposed to which played an essential role in the equivalence of the acquisition of concepts. This result concurs with Klisch, Miller, Beier & Wang (2012) finding that female and male students benefited equally from the educational game with regard to content learning.

*4.3 Results and discussion related to the third question*

Is there any statistically significant difference ($\alpha \leq 0.05$) in students' scientific concepts acquisition attributed to the interaction between instructional method and gender?

Table (4) reveals that there is no statistically significant difference ($\alpha \leq 0.05$) in students' scientific concepts acquisition attributed to the interaction between instructional method and gender. This indicates that educational games and traditional method have equivalent effects on males and females which can be attributed to the similarity of the socio-economic environment for the two genders as well as the similarity in the educational circumstances available for males and females.

**5. Recommendations**

In light of the results arrived at, the researcher recommends:

1. Employing of educational games in the teaching of first grade students as well as other grades.
2. Conducting workshops and training sessions for Science teachers to enable them to design and use educational games in Science.
3. Inclusion of models of theories of designing educational games in teacher preparation programs offered by the department of educational sciences to prepare students to use them in the future career.
4. Conducting similar studies on utilizing educational games in other school subjects and other grades.

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**Appendix (1)**

Lesson plan sample

Subject: Science Grade: 1st Grade

Lesson title: I see with my eyes

Materials (learning sources): some cut-outs, a ball, a triangle, a square, rectangle, blue ball, red flower, yellow lemon, a cut-out of a big bear and a cut-out of a small bear.

Scientific concepts: sight, eye, rectangle, circle, square, colors.

The suggested educational game: *Close your eyes.*

**Objectives**

By the end of this lesson, student is expected:

1. Recognize geometrical shapes (rectangle, circle, triangle and square).
2. Name colors he/she sees.
3. Distinguish between near and far objects.
4. Distinguish between big and small objects.

**Procedure**

Preparing for the lesson by connecting previous knowledge with subsequent experiences by asking them: can you identify the objects, colors, how near or far or big or small these objects are if your eyes are closed?

Applying the "C*lose your eyes* "game in the following order:

- After teacher makes sure that the student have closed his/ her eyes, s/he presents the objects : ball, triangle, square, rectangle
- Teacher asks the student: what shapes are these?
- Student: I don't know
- Teacher: why not?
- Student: because my eyes are closed
- Teacher: open your eyes
- Teacher asks again, what objects are these?
- Student: ball, triangle, square, rectangle
- Teachers ask another student to close his/ her eyes
- When teacher makes sure that the student has closed his/ her eyes, she presents the objects with different colors: blue ball, red flower, yellow lemon
- Teacher asks the student: what colors are these objects?
- Student: I don't know
- Teacher: why not?
- Student: because my eyes are closed
- Teacher: open your eyes
- Teacher asks again what color are these?
- Student: blue ball, red flower, yellow lemon
- teacher asks another student to close his/ her eyes and asks a class mate (Ahmad) to stand close to him and another class mate (Mohammad) to stand far from him
- The teacher asks the student: who is near to you and who is far from you?
- Student: I don't know
- Teacher: why not?
- Student: because my eyes are closed
- Teacher: open your eyes and asks again: who is near to you and who is far from you?

 

- Student: Ahmad is near and Mohammad is far
- teacher asks another student to close his/ her eyes and presents the two bear cut-outs : the small and the big
- The teacher asks: which bear is big and which bear is small?
- Student: I don't know
- Teacher: why not?
- Student: because my eyes are closed
- Teacher: open your eyes, and asks him again which bear is small and which one is big?

**Appendix (2)**

Sample of scientific concepts acquisition test questions:

Match between the expression and the picture to which it refers

I see different objects with it

I hear relaxing sounds with it

I smell nice fragrances with it

I taste food with it

I touch soft and tough objects with it