

## The Effect of Hands-on Activities on Third Graders' Achievement in Mathematics

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### ABSTRACT

This study aimed at investigating the effect of Hands-on Activities on Third Graders' Achievement in Mathematics. The individuals of the study consisted of 72 students, divided into two groups: experimental group which taught by hands-on activities, and control group which taught by the traditional method. After the completion of the study, an achievement test was applied and ANCOVA was used to answer the study questions. The study results revealed that there were statistically significant differences of achievement, between the two groups in favor of the experimental group. The study results which based on the achievement level revealed that middle achievers in the experimental group were better than those in the control group, meanwhile there were no significant differences between high achievers in the two groups, and also there were no significant differences between low achievers in the two groups.

**Keywords:** Hands-on activity, Achievement, Third graders, Mathematics.

### INTRODUCTION

Every student has preferable learning styles, that make his learning strategies differ from other students learning strategies, so he can processes information by seeing and hearing, reflecting and acting, reasoning logically and intuitively, analyzing and visualizing (Felder and Brent, 2005). This means that teaching methods also must be vary, it may be lecturing or leading students to self-discovery; or focusing on principles and applications. Students who are in classrooms based on lecture are not able to see how things work.

Teachers look for effective methods to make their math teaching meaningful. Mathematical meaning develops out of interaction with other people and environment and reveals itself as a new individual interpretation (Yackel, Cobb and Wood, 1999).

Jean Piaget's theory of cognitive development suggests that children develop best when they have interaction with the material they are learning. In the third stage (concrete), the child reaches a satisfactory level in terms of intellectual development, but what is done or

thought by him is done on a concrete level (Mangal, 2004). The Concrete operational stage of Piaget's theory is characterized by the following characteristics:

- Student can think logically about objects and events, can achieve conservation of number (age 6), mass (age 7), and weight (age 9)
- Student can classify objects according to several features and can order them in series along a single dimension such as size (Atherton, 2011).

Representation was identified as one of the important processes in the teaching and learning of mathematics In the National Council of Teachers of Mathematics Principles and Standards (NCTM, 2000). Being able to teach mathematics effectively requires educators to choose the kinds of representations that will support meaningful mathematics learning in classrooms. Through presenting an activity with the three components (activity, technology, formalizing) not only we give students with different learning styles different ways to see a problem, but also we give them the extra time they may require for learning.

Manipulation and experiential learning gives children a reference for importance of material. When manipulatives are used, the senses are brought into learning: students can touch and move objects to make visual representations of mathematical concepts. Through hands-on learning, children are given meaningful

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experiences that help them commit information to memory.

In modern mathematical teaching, it has become increasingly emphasized that mathematical knowledge should be taught by problem-solving, hands-on activities, and interactive learning experiences (Wang, 2009). The longer students participated in hands-on learning, the higher their scores were in science, writing, reading, and mathematics (Amaral and Garrison, 2002).

Hands-on learning is learning by doing, it is usually heightened when students are capable of performing good of assigned tasks on their own, it is often used to describe any activity in the classroom that uses materials, but it is not manipulating things, it is engaging in in-depth investigations with objects, materials, and ideas and drawing meaning and understanding from those experiences (Haury and Rillero, 1994).

Dark, Harbor and Riskowski, (2009) conducted a research study aimed at investigating the effect of hands-on projects on 126 eighth-graders from 10 classes was conducted in a rural, racially diverse Indiana middle school, the results showed that the students who learned by hands-on project had higher scores and a much higher degree of improvement than the traditionally taught students on both true/false and open-ended questions, and students who were involved in a hands-on project learned more and demonstrated a deeper understanding of the issues than the traditional group.

To illustrate the Probability in Genetics with Hands-On Learning (Pierce and Honeycutt, 2007) developed a set of hands-on, cooperative activities that allow students to determine empirically the probabilities of different combinations of events, and then compare these to theoretically calculated values. These exercises help students understand basic rules of probability, the use of the binomial, and the chi-square test.

The hands-on learning is a very good method of teaching, programs that include hands-on learning can help students become more engaged in learning (Cabral, 2006). The following are some of its benefits (Daniel, 2011):

1. **Greater retention of material:** The hands-on learning provides the students a visible, concrete foundation to learn all the necessary conceptual and abstract facts.
2. **Enhances creativity:** Children who work on projects are exposed to many raw materials that they can use to create original products which reflect their insights to various topics.

3. **More enjoyable:** With hands-on learning, the students are able to participate in the activities and thus it increases their motivation; meanwhile they claim that it is very boring to just sit around and listen to a very long lecture

4. **Develops a sense of achievement:** Performing a project successfully from start to finish gives the students an important sense of achievement, and also provides them the opportunity to get used to handling equipment better.

5. **Develops critical thinking:** Critical thinking can be applied in many places in life. The hands-on learning enables the student make the required resolutions which can affect the desired outcome.

Luke (2011) mentioned different Hands-on training methods that would introduce the new jobs, since many students learn quicker while doing the job than while watching someone else do it. Some of these methods are:

- **On-the- Job Training:** It involves watching managers and fellows while doing the job, and mimicking what they do in order to complete the job. It requires students to be motivated to learn and actively participate.

- **Simulations:** They involve a trained group (students) practicing making decisions for a real-life situation. This type of instruction requires trainers (teachers or fellows) to explain possible situations and students to study those situations and think about what they would do and why.

- **Role Play:** It is similar to simulations, except for the fact that students must assume different positions and communicate with each other as though they were on the job. Teachers typically assign each student a character, and may give each person a handout about his character and the situation at hand. Students must be able to act as they would if they were in the situation.

- **Behavior Modeling:** It is a technique in which students watch the teacher when handling a difficult situation, and then replicating the behavior. This is an interactive exercise meant to show students how a model student acts and behaves in the situations. Students are able to practice interpersonal skills, and this makes them more comfortable when facing situations on the job.

The power of hands-on learning appeared and made significant effect in a wide range of subject areas-particularly math (DeGeorge and Santoro, 2004). Whether using traditional activities, such as counting with beans or coins, or more sophisticated manipulatives, such as

tangrams, and pattern blocks, hands-on learning helps students to understand concepts and increases their self-confidence.

Al-absi and Nofal (2010) examined the effect of using manipulatives in the mathematical achievement of the first graders at UNRWA schools in Jordan. The sample of the study consisted of 155 students representing four sections, who were divided into two groups: experimental group which taught “numbers from 0-9” subject using manipulatives, and control group which taught by the traditional method. The study results revealed that there were statistically significant differences between the two groups in favor of the experimental group, which taught by using manipulatives.

Holstermann, Grube, and Bogeholz, (2010) investigated the influence of hands-on activities on students' interest. They researched whether students with experience in specific hands-on activities show higher interest in these activities than students without experience. A total of 141 students from the 11th grade completed questionnaires on interest in the hands-on activities. Findings indicated that the performance of various hands-on activities can influence students' interest differently, and for most hands-on activities, no effect of experience on interest was found.

Banfill (2006) mentioned some of hands-on activities that suite student of lower elementary stage (fourth grade), which were:

\* Use a scale or balance to determine weight/ mass in both metric units (grams, kilograms) and U.S. customary units (ounces, pounds).

\* Measure length in metric units (millimeters, centimeters and meters) and U.S. customary units (fractions of an inch, inches, feet, and yards).

\* Measure liquid volume in metric units (milliliters, liters) and U.S. customary units (teaspoons, tablespoons, cups, pints, quarts, gallons).

\* Measure the perimeter of plane geometric figures such as triangles, quadrilaterals, and irregular shaped polygons.

\* Draw points, lines, line segments and rays and understand how they are related.

\* Draw lines that are intersecting, parallel and perpendicular.

\* Collect data and display in bar graphs with incremental values labeled on the axes. Include a title and a legend.

\* Determine the approximate probability of a given

event using materials. For example, if a bag contains 5 blue marbles and 20 red marbles what is the probability of randomly picking a blue marble.

The Hands-on learning can be summarized by the Chinese Proverb which says: “*I hear and I forget, I see and I remember, I do and I understand*”.

### **Research Importance**

- The use of Hands-on activities will enhance students understanding and conceptualization of mathematical ideas, by engaging with things that make them do mathematics.
- The use of Hands-on activities gives the teacher an additional alternative assessment method to measure students' performance in a real situation.
- The importance of the study is related to the theoretical and practical benefits of the study results, which may reflect on students' achievement in mathematics.

### **Research Problem**

In the last years in Jordan, the Ministry Of Education (MOE, 2003) concentrated on applying new methods of learning and teaching, which give attention to students' work, such as, activity-based learning, which encourages students to learn by doing, through ensuring real world situations, that take them out of depending on pencil and paper in achieving their learning.

Hands-on activity is one of the common methods that depend on the engagement of the student in an activity, which requires from him using materials and objects, to manipulate the ideas.

The current study aims to examine the effect of using Hands-on activities on third graders achievement in mathematics. Specifically, this study tried to answer the following general question:

**Do using Hands-on activities in teaching mathematics make an effect on third graders achievement in mathematics?**

This general question is branched into the following two questions:

- 1- Are there any significant differences between means of the experimental group (which was taught by using Hands-on activities), and control group (which was taught traditionally) on the achievement test?
- 2- Are there any significant differences between means of the experimental and control groups due to the level of achievement?

The current study aimed at testing the following hypotheses:

- 1- There are no statistically significant difference at a significance level ( $\alpha=0.05$ ) between mean scores of the experimental group (which was taught by using Hands-on activities), and control group (which was taught traditionally) on the achievement test.
- 2- There are no statistically significant difference at a significance level ( $\alpha=0.05$ ) between mean scores of the experimental and control groups due to the level of achievement.

**Operational Definitions**

- **Hands-on activity:** is an activity, designed and prepared by teacher, which requires from the student to use materials and objects to understand ideas and earn experiences from dealing with these things.
- **Achievement in mathematics:** is the knowledge, understanding, and skills that student exquisite as a result of a specific educational experience. The achievement is measured by the students mark on the achievement test, which is developed to be applied in this study.

**Limitations of the Study**

- Instruments of the study were developed by the researcher, so the interpreting of the results depends

on the validity and reliability of these instruments. Despite the researcher verified from these psychometric characteristics.

- The research was applied to UNRWA schools in South Amman area, and this makes the generalization of results specified to study community or a similar community.

**Methodology and Procedures**

**Individuals of the Study**

The community of the study consisted of all third graders at UNRWA schools South Amman area, in the scholastic year 2011/2012.

The individuals of the study consisted of four sections, which were purposively assigned from South Amman area schools. Two sections were selected randomly as an experimental group, which was taught by using hands-on activities, and the other two sections were selected as a control group, which was taught by the traditional method.

According to students' final achievement marks in mathematics in the scholastic year 2010/ 2011, they were divided into three levels of achievement, depending on the following criteria: greater than 84% (high achievement), 84% -60% (middle achievement), and less than 60% (low achievement). Table (1) shows the individuals of the study distribution.

**Table 1. The individuals of the study distribution according to the level of achievement**

Level of achievement	Group		Total
	Experimental	Control	
High	8	11	19
Middle	22	18	40
Low	7	6	13
Total	37	35	72

**Study Instruments**

**The Achievement Test**

Depending on content analysis, an achievement test was constructed, related to the mathematical knowledge taught in unit “Adding and subtracting 6-digit numbers”, from the third grade mathematics curriculum in the scholastic year 2011/2012.

After the completion of the workout of the achievement test, it was given to a panel of (7) judges to give notes about the validity of the items and the overall test. These notes were taken into consideration, and the corrections were made.

To establish the reliability of the achievement test, it

was applied to 23 students; and by using a Split-Half method, a Spearman-Brown Formula, it was found that the reliability coefficient for the overall test was (0.84) which is an accepted value for the research purposes.

**Hands-on Activities**

During the period of teaching the unit “Adding and subtracting 6-digit numbers” (which was four weeks), students of the experimental group were exposed to activities require dealing with thing and materials, related to an idea of the lesson taught.

Here is an example of hands-on activity was:

**Aim:** Adding 6-digit numbers

**Participants:** two students (players).

**Procedure**

- Write 6-digit numbers on several cards, and put the cards in a box.
- Each player pulls out two cards from the box.
- Each player adds the numbers written in the cards, and registers the ones digit of the resultant number under his name.
- Repeat the process for the same players many times.
- The playing continues until one of the players reaches the number (30) from the addition of the ones digit from the resultant numbers.

**Study Procedures**

- The experimental group two teachers who participated in the application of the study were trained how to use hands-on activities in the teaching process, by concurring with the researcher before the beginning of the application, and describing how to apply a hand-on activity in the classroom, by giving him instructions about the period of the task, the time of application during the teaching process, the post treatment with students works.
- The two sections of the experimental group were taught the unit “Adding and subtracting 6-digit numbers” by using hands-on activities, meanwhile, the control group two teachers who participated in the application of the study were asked to teach the same unit by the traditional method during the four weeks.
- An achievement test was applied to the two

groups, and the results of the test were analyzed by using SPSS program to test the hypotheses of the study.

**Study Variables**

- 1- Independent variables: a) Group: It has two levels (experimental, control).  
b) Level of achievement: it has three levels (high, middle, low).
- 2- Dependent variable: Achievement in mathematics.

**Statistical Treatment**

To test the hypotheses of the study, means and standard deviations were computed to students’ marks on the achievement test, ANCOVA was used to compare between the means of the levels of achievement of two groups.

**Study Results and Discussion**

**1) Results of the first hypothesis and discussion:**

To examine the hypothesis: “There are no statistically significant difference at a significance level ( $\alpha=0.05$ ) between mean scores of the experimental group (which was taught by using Hands-on activities), and control group (which was taught traditionally) on the achievement test”, estimated means of the tow groups were computed, and table (2) reveals these results.

Table (2) revealed apparent differences between the estimated means of the tow groups, and to examine the significant of these differences, ANCOVA was used. Table (3) reveals these results.

**Table 2. Estimated Means of the two groups on the achievement test**

Group	Number of students	Pre-test Mean	Post-test Mean	Estimated Mean	Std. Error
Experimental	37	74.59	15.43	15.73	0.31
control	35	77.97	13.80	13.49	0.32

**Table 3. ANCOVA results to compare between the Estimated Means of the tow groups**

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre	357.904	1	357.904	104.298	0.000
Group	88.579	1	88.579	25.813	0.000
Error	236.777	69	3.432		
Corrected Total	642.611	71			

Table (3) revealed that there were statistically significant differences between the means of the two groups, since (F) value was 25.813, with significant level

0.000, which was less than the critical value (0.05).

According to the estimated means in table (2), it appears that the estimated mean of the experimental

group (15.73) was greater than the estimated mean of the control group (13.49), and this means that the experimental group students' achievement was greater than the control group students' achievement. And this result interprets the rejection of the first hypothesis, and this result agreed with the results of the studies of (Pierce and Honeycutt, 2007; Dark, Harbor and Riskowski, 2009; Al-absi and Nofal, 2010).

This result seems to be a logical result, since using hands-on activities gives the student a concrete, a visible, and a practical representation of the mathematical ideas taught, and this constructs a strong foundation for math conceptualization. Moreover, when using hands-on activities, we give students an extra time they may require for learning, so they have the opportunity to reveal their success in performing the tasks, which may gives them the sense of achievement.

In addition, when teachers use hands-on activities, they can assess students' misunderstandings by observing their doing, which is a good alternative assessment method to develop students' conceptual understanding and increases their achievement levels.

Moreover, the use of this kind of activity may

provoke students concerns and their ability to face the educational situations, and give them the opportunity to use the self learning to attain information, which reflect on his level of achievement.

Also, we can say that through using hands-on activity, the student do thing in most cases, and manipulate them cooperatively, and this makes him exchange his friends' experiences, and benefit from their common work in improving his knowledge.

**2) Results of the second hypothesis**

To examine the hypothesis: "There are no statistically significant difference at a significance level ( $\alpha=0.05$ ) between mean scores of the experimental and control groups due to the level of achievement", estimated means of the tow groups -according to the level of achievement- were computed, and table (4) reveals these results.

Table (4) revealed apparent differences between the estimated means of the tow groups according to the level of achievement, and to examine the significant of these differences, ANCOVA was used. Table (5) reveals these results.

**Table 4. Estimated Means of the two groups on the achievement test according to level of achievement**

Level of achievement	Group	Number of students	Pre-test Mean	Post-test Mean	Estimated Mean	Std. Error
High	Experimental	8	92.75	18.25	18.23	0.51
	Control	11	92.18	17.27	17.29	0.44
Middle	Experimental	22	73.55	15.77	15.83	0.35
	Control	18	75.72	12.72	12.65	0.39
Low	Experimental	7	57.14	11.14	11.23	0.85
	Control	6	58.67	10.67	10.56	0.92

**Table 5. ANCOVA results to compare between the Estimated Means of the two groups according to level of achievement**

Level of achievement	Source	Sum of Squares	df	Mean Square	F	Sig.
High	Pre	1.875	1	1.875	0.887	0.360
	Group	4.083	1	4.083	1.932	0.184
	Error	33.807	16	2.113		
	Corrected Total	40.105	18			
Middle	Pre	4.577	1	4.577	1.748	0.194

	Group	96.655	1	96.655	36.907	0.000
	Error	96.898	37	2.619		
	Corrected Total	193.600	39			
Low	Pre	1.670	1	1.670	0.344	0.570
	Group	1.349	1	1.349	0.278	0.609
	Error	48.521	10	4.852		
	Corrected Total	50.923	12			

Table (5) revealed that there were no statistically significant differences between the estimated means of the two groups, at the high and low achievement levels, meanwhile; there were statistically significant differences between the estimated means of the two groups, at the middle achievement level, and restitution to table (4) it appears that the differences of the tow groups are in favor to the experimental group in comparison with the control group.

This result may be logical result, because the students of the high and low level of achievement need specialized activities and tasks, suites their characteristics as a special educational groups, and this work requires more preparation from the teacher, and more follow-up during the implementation process, which makes an overload in the teachers work.

Meanwhile; the activities applied in the study were common for the majority of the students, and so it was

more suitable for the middle achievement students, and directed to them, which means that the middle achievement students of the experimental group benefited from these activities to enhance their achievement in mathematics.

### Recommendations

According to the results of the current study, which revealed that there was an efficiency of using hands-on activities in improving students' achievement in mathematics, the following can be recommended:

- 1- Training of mathematics teachers on using hands-on activities in teaching mathematics, in basic classes.
- 2- Generalizing the application of hands-on activities in the third class students in south Amman area schools.
- 3- Conducting other researches on the effect of hands-on activities on other variables, such as: thinking, problem solving ..., and on other classes and stages.

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## أثر استخدام أنشطة التدريب العملي في تحصيل طلبة الصف الثالث في الرياضيات

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### ملخص

هدفت هذه الدراسة إلى فحص أثر استخدام أنشطة التدريب العملي في تحصيل طلبة الصف الثالث في مادة الرياضيات، وقد تكون أفراد الدراسة من (72) طالباً، تم تقسيمهم إلى مجموعتين: تجريبية تعلمت باستخدام أنشطة التدريب العملي، وضابطة تعلمت بالطريقة التقليدية، وبعد الانتهاء من تطبيق الدراسة، تم تعريضهم لاختبار تحصيلي، واستخدام تحليل التباين المصاحب للإجابة عن أسئلة الدراسة. أظهرت نتائج الدراسة وجود فروق ذات دلالة إحصائية في الاختبار التحصيلي بين المجموعتين، لصالح طلبة المجموعة التجريبية، وأظهرت نتائج الدراسة حسب مستوى التحصيل أن الطلبة متوسطي التحصيل في المجموعة التجريبية أفضل من نظرائهم في المجموعة الضابطة، بينما لم توجد فروق ذات دلالة إحصائية بين طلبة المجموعتين التجريبية والضابطة على كل من مستويي التحصيل المرتفع والمنخفض.

**الكلمات الدالة:** نشاط التدريب العملي، التحصيل، الصف الثالث، الرياضيات.

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