

The Effect of Using Movement– Based Learning on First Graders’ Mathematical Achievement and Cognitive Curiosity

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Abstract

This study aimed at investigating the effect of using movement-based learning on first graders' mathematical achievement and cognitive curiosity, by using the quasi-experimental approach. To achieve the study aims, a mathematical achievement test for the first grade in the "Location and Movement" unit was administered, its validity and reliability have been verified. Also, a cognitive curiosity scale was administered, its validity and reliability have been verified. The sample of the study consisted of (44) first grade students in Jordan, distributed to two groups, one group chosen randomly as an experimental group who was taught by movement-based learning, and the other group as a control group who was taught using the traditional method of instruction. Results of the study revealed that movement-based learning had a positive effect on improving students' mathematical achievement, and their cognitive curiosity. In light of the study results, it was recommended to use the movement-based learning method in teaching mathematics.

Keywords: movement-based learning, mathematical achievement, cognitive curiosity.

أثر استخدام التعلّم المبني على الحركة في التحصيل في الرياضيات وحب الاستطلاع الاستدراكي لدى طلبة الصف الأول الأساسي

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الملخص

هدفت هذه الدراسة إلى استقصاء أثر استخدام التعلّم المبني على الحركة في التحصيل في مادة الرياضيات وحب الاستطلاع المعرفي لدى طلبة الصف الأول الأساسي، باستخدام التصميم شبه التجريبي. ولتحقيق أهداف الدراسة تم إعداد اختبار التحصيل في الرياضيات للصف الأول في وحدة "الموقع والحركة"، والتحقق من صدقه وثباته، كما تم إعداد مقياس حب الاستطلاع المعرفي، والتحقق من صدقه وثباته. وقد تكونت عينة الدراسة من ٤٤ طالباً من طلبة الصف الأول في الأردن، موزعين على شعبتين، تم اختيار إحدهما عشوائياً كمجموعة تجريبية درست باستخدام التعلّم المبني على الحركة، والشعبة الأخرى كمجموعة ضابطة تعلمت بالطريقة التقليدية. وقد أظهرت نتائج الدراسة أن للتعلّم المبني على الحركة تأثيراً إيجابياً في تحسين التحصيل في الرياضيات وحب الاستطلاع المعرفي لدى أفراد العينة. وفي ضوء نتائج الدراسة، يوصي الباحث باستخدام طريقة التعلّم المبني على الحركة في تدريس مادة الرياضيات.

الكلمات المفتاحية: التعلّم المبني على الحركة، التحصيل في الرياضيات، حب الاستطلاع الاستدراكي.

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Introduction

Education aims in its modern concept to develop all aspects of student growth. The interest in the knowledge side was previously the only interest, but now the interest in the psycho-emotional aspects has become among the priorities of educational goals. Therefore, focusing on the dynamic side within the educational process is among the areas that work to prepare an individual who is able to adapt to the environment and society in which he lives.

The investing of the kinetic energy for child, helps him to express his physical and mental activity, and makes him obtain information easily, through the use of the body and its senses, or through entertaining educational methods that depend on activating the kinetic energy of the child, and lead to improving his learning process. The physical activity plays an effective role in the learning and teaching process, it activates the brain, improves cognitive function, and is correlated with improved academic performance (Donnelly & Lambourne, 2011), so, one can say that any kind of physical activity, not just movement associated with the material a student is learning, can benefit students academically.

The tendency for movement in the child is an innate inclination, it drives him to discover his environment and knowledge of everything that is going on around him, and according to his activity and his desire to discover, the largest part of his learning is from and through the movement.

When using movement-based activities in the learning process, one can gain many benefits, they are low-cost and easily implemented interventions to improve students' physical and mental health, learning, executive

functioning, memory, on-task behavior, and academic performance (Savina, Garrity, Kenny, & Doerr, 2016).

Movement and exercise have a positive effect in the field of education and are connected to students' learning, and there is a «great deal of difference in the way people conceptualize the relationship between learning, movement and wellbeing» (Atkinson, Macnaughton, & Scott, 2010, p. 55). Strong foundational skills, such as running and hopping, are typically developed in an informal manner in young learners, thus providing a strong foundational base for further movement skills that may be learnt and mastered (Gallahue, Ozmun, & Goodway, 2012, p.186), so the fundamental movement skills can be defined as « movement patterns that involve different body parts, such as the legs, arms, trunk and head, and include such skills as running, hopping, catching, throwing, striking and balancing» (Department of Education, 2013, p.15).

The children's movements can be divided into two shapes, according to the purpose of it. First is: mindful (purposeful) movement, which are physical movement activities that directly relate to academic content. Children form a circle with their bodies in order to learn about a circle, he is walking around the edge of an object to understand the concept of perimeter or moving his hands to demonstrate how the planets revolve around the sun (Shoval, 2011, p.454). The second is non-mindful movement, which is the physical activity that is not directly related to academic content, such as going for a walk or run, taking a stretch break, yoga, sitting on an exercise ball instead of a chair, and doodling.

There are three types of movement-based activities that can be used in the learning process:

- 1) Discrete physical activities: Students' experience and practice activities include physical exercises in a purposeful way within a physical education lesson (Penney, Pope, Hunter, Philips, & Dewar, 2013).
- 2) Integrated movement-based activities (IMBAs): it can be integrated into general classroom lessons, not necessarily related to physical education lessons (Riley, Lubans, Holmes, & Morgan, 2014).
- 3) Activities that are commonly referred to as brain break activities: they are movement-based activities that are not necessarily integrated into

the teaching of key learning areas (Brain Gym International, 2014).

It is important to incorporate movement into elementary school lessons in many subjects, such as: reading, math; because it can boost students' interest and academic learning and helps them meet recommendations for daily involvement in physical activity (Lindt & Miller, 2017). Students in these classrooms can show greater engagement and interest than their peers in non-movement-based classes.

Ford (2016) conducted a research that reviewed many previous research articles to answer the question: How do physical movement activities affect students' academic achievement in an elementary school setting? The researcher hoped to introduce and learn that for young children in grades kindergarten through third grade, physical movement activities are essential and likely to increase student academic achievement. The findings of the study summarize a growing body of evidence indicating a relationship between students' academic achievement and physical activity.

Nadler & Northcote (2015) conducted a research aimed to investigate the impact of Integrated Movement-Based Activities (IMBAs) on lower and upper primary school aged students, with a sample of 24 students (14 boys, 10 girls) from New South Wales, Australia. The data was collected from the perspectives of students, teachers and a researcher using self-reflection journals, numeracy tests, self-rating scales of concentration levels, teacher interviews and researcher observations and reflections. The study revealed that, when a supporting and structured classroom environment is established, IMBAs impact positively on students' concentration, enjoyment of learning, engagement in learning and interpersonal.

Riley, Lubans, Holmes, Hansen, Gore, and Morgan (2017) conducted a research aimed to report student and teacher perceptions of using movement-based learning experiences for enhancing learning and engagement in mathematics and increasing physical activity levels in children. The sample of the study consisted of four classroom teachers and 66 students. The study results revealed that the program provided positive experiences for teachers and students, while ensuring high quality learning experiences, and it has a significant positive effect on children's enjoyment

and engagement.

Omidire, Ayob, Mampane, and Sefotho (2018) conducted a research aimed to evaluate the use of structured educational activities to teach mathematics and language concepts. The sample of the study consisted of 20 Grade R learners aged ± 6 years old in Gauteng, South Africa, one class teacher and one head of department. Data were collected using observation, analysis of worksheets, visual data and an interview. The study results emphasized the integration of structured movement activities with mathematics and language concepts because it has a positive impact on learners' physical, social and cognitive development.

The current study, then, comes to complement the literature on the subject of movement-based learning. Most of the previous studies concentrated on students' achievement, meanwhile the current study concentrated on the effect of movement based- learning on first graders' cognitive curiosity, in addition to their mathematical achievement. The current study, also, can be considered as one of the rare studies that deals with this subject in the Arab world.

Research problem

The child desires to know his surrounded environment and understand the world around him, and this makes him a constant pursuit of kinetic activities and works on the presence of a curiosity impulse in him, which affects his learning better, so the student who has curiosity works to use the senses as multiple sources of knowledge, and this may leads to improve his academic achievement.

The results of the current study are highly important as they help teachers and educationalists improve the teaching of mathematics in the first three years (first cycle) of basic education and cope with the ensuing problems of teaching and learning mathematics in schools, not to mention the importance of finding innovative ways to raise pupils' awareness and motivation in the process of learning simple mathematics in schools.

Consequently, the current study aims to examine the effect of using movement-based learning on first graders' mathematical achievement and cognitive curiosity. This study tried to answer the following questions:

1. Is there any statistically significant difference between means of the experimental group (which was taught by using movement-based learning), and the control group (which was taught using the traditional method of learning) on the mathematical achievement test?
2. Is there any statistically significant difference between means of the experimental group (which was taught by using movement-based learning), and the control group (which was taught using the traditional method of learning) on the cognitive curiosity scale?

Research hypotheses

The current study aimed at testing the following hypotheses:

1. There is no statistically significant difference at ($\alpha=0.05$) between the mean scores of the experimental group and the control group on the mathematical achievement test.
2. There is no statistically significant difference at ($\alpha=0.05$) between the mean scores of the experimental group and the control group on the cognitive curiosity scale.

Research importance

The importance of this study stems from the following points:

1. The use of movement-based learning is an alternative method to teach and examine students' level of mathematical achievement; it enhances what teachers tend to know about students' understanding to help them overcoming their misconceptions and measuring their performance in a real situation.
2. This study is considered as one of the rare studies in the Arab world that examines the effect of using movement-based learning in improving students' mathematical achievement, and their cognitive curiosity.

Operational definition of terms

1. Movement-Based Learning: is a learning type in the learning process, which requires from the student to learn through the application of movement that related directly to the content of what he is learning.
 2. Mathematical Achievement: is the knowledge, understanding, and
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skills, that student has acquired as a result of an experience he passed. In the current study, the mathematical achievement is measured by the student's score on the corresponding Test of Mathematics.

3. Cognitive Curiosity: is the desire of the student to understand his environment, so as to explore the world around him. In the current study, it is measured by the students' scores on the corresponding Cognitive Curiosity Scale.

Limits of the Study

1. Instruments of the study were developed by the researchers, so the interpretation of the results depends on the validity and reliability of these instruments. Although the researchers properly verified the psychometric characteristics of the used tools of study, the accuracy and objectivity of the learners' responses to the tools were still out of the authors' control.
2. The tools of study were applied to the females of the first graders in mathematics subject (Location and Movement), and this fact makes the generalization of results specific to the study population or a similar community a difficult task.

Methodology and Procedures

Methodology

The quasi-experimental approach was used in the current study.

Study Population and Sample

The population of the study consisted of all first graders in Nazzal elementary girls' school, in Amman south area, at UNRWA, in the academic year 2019/2020, their number is (89) students distributed to four sections. The sample of the study consisted of two sections, selected randomly from the four sections. One section (22 students) was selected randomly as an experimental group, who was taught by using movement-based learning, and the other section (22 students) was selected as a control group, who was taught by the traditional method of learning, and the two groups were taught by one teacher.

Instruments of the Study

Movement-Based Learning Activities:

Movement-based learning activities were designed and developed by the researchers, to be applied during the learning process of the unit “Location and Movement”. They were given to the experimental group students as tasks related to the subject learned, during the instructional process. The control group was taught the same unit traditionally. The aims of the unit were:

- 1) The description of the relation between the location of two things:
 - a) The description of the relation using the expression: inside.
 - b) The description of the relation using the expression: outside.
 - c) The description of the relation using the expression: in front of.
 - d) The description of the relation using the expression: next to.
 - e) The description of the relation using the expression: between.
 - f) The description of the relation using the expression: in the middle.
- 2) The description of one thing’s location according to another thing:
 - a) The description of the relation using the expression: left.
 - b) The description of the relation using the expression: right.
 - c) The description of the relation using the expression: straightening.
 - d) The description of the relation using the expression: back.
- 3) Knowing the rotation and its parts:
 - a) Knowing the full of the rotation, using the clock hands
 - b) Knowing the half of the rotation, using the clock hands
 - c) Knowing the quarter of the rotation, using the clock hands

The Mathematical Achievement Test:

The mathematical achievement test which applied in the current study was developed by the researchers through the following steps:

- 1) The general and specific aims of the unit subjects were restricted.
 - 2) The specification table was used to give the relative weight to every subject.
 - 3) Items of the test were administered to represent the subjects of the unit, as they were distributed in the specification table.
 - 4) The test consisted of 20 items, and it has been corrected by marking one
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score of each item, so the total score of the mathematical achievement test was (20).

For the purposes of content validity, the mathematical achievement test was presented to five arbitrators to give their suggestions about the test, such as: the inclusion, linguistic and scientific formulation of test items. Their suggestions were taken into consideration in modifying some items of the test, such as the linguistic corrections, and an illustration of graphics.

The test also has been administered to a sample of (20) students of the study population (not included in the sample), and the consistency of each item of the test were computed using the Pearson correlation coefficient between the item scores and the whole test scores. The correlation coefficients were between (0.39 – 0.83), which are an acceptable value, at the significant level ($\alpha=0.05$).

For the purposes of determining test reliability, the mathematical achievement test has been applied to a sample of (20) students of the study population and the reliability of the test were computed using the split – half method, since the test items can be divided into two equal parts. The reliability coefficient was (0.82), which is an acceptable value at the significant level ($\alpha=0.05$). Appendix (A) reveals the mathematical achievement test in its final form, according to arbitrators' comments about the linguistic formulation and graphic illustration.

The Cognitive Curiosity Scale:

The cognitive curiosity scale items were prepared depending on the study of (Kashdan, Gallagher, Silvia, Winterstein, Breen, Terhar, & Steger, 2009) through the following steps:

- 1) The scale is translated from English language to Arabic language.
- 2) To verify the translation, it was given to a specialist in English language.
- 3) The scale was consisted of (10) item in its original version.

For the purposes of content validity, the cognitive curiosity scale was presented to five arbitrators to give their suggestions about the test, such as: the appropriateness of each item to the first-class students, linguistic formulation of test items. Their suggestions were taken into consideration in modifying some items of the test, such as the linguistic corrections, and

deleting three items that are not suitable for the first-class students.

The scale was consisted of (7) items in its final form. It has been corrected by marking three grades for the scaling (big degree), two grades for the scaling (medium degree), and one grade for the scaling (low degree), so that the total score of the cognitive curiosity scale was (21).

The scale also has been administered to a sample of (20) students of the study population (not included in the ample), and the consistency of each item of the test were computed using the Pearson correlation between the item scores and the whole test scores. The correlation coefficients were between (0.32 – 0.78), which are an acceptable value at the significant level ($\alpha=0.05$).

For the purposes of determining scale reliability, the cognitive curiosity scale has been applied to a sample of (20) students of the study population and the reliability of the scale were computed using the test - retest method. The correlation coefficient between the two applications was (0.76), which is an acceptable value at the significant level ($\alpha=0.05$). Appendix (B) reveals the cognitive curiosity scale in its final form, according to arbitrators' comments about the linguistic formulation and delete of items.

Study Procedures

- Before the beginning of the study, the mathematical achievement test and the cognitive curiosity scale were developed.
- Two sections of the study population were selected randomly, and they were distributed randomly, one of them as an experiment group and the other as a control group.
- The cognitive curiosity scale was applied on the two groups as a pre-scale.
- The two groups' results on the second month exam in mathematics were relied upon, as a pre- achievement test.
- The experimental group was taught during their study the unit "Location and Movement" by using the movement-based learning; meanwhile, the control group was taught by the traditional method.
- The period of the study was three weeks, which took 10 lessons.
- After the completion of the study, a mathematical achievement test and

the cognitive curiosity scale were administered to the two groups as a post-test, and data was analyzed by using SPSS program to test the hypotheses of the study.

Study Variables

- 1) Independent variable: Teaching method, which has two levels: (teaching using movement-based learning, teaching traditionally).
- 2) Dependent variables: Mathematical achievement, Cognitive curiosity.

The mediating/ intervening variables were controlled by using the same common conditions in the teaching process, such as: classroom environment and time and space conditions, also, the two groups were taught by the same teacher.

Statistical Analysis

To test the hypotheses of the study, 1-way ANCOVA was used to compare between the means of the two groups in the mathematical achievement post- test, and the cognitive curiosity post- scale, after removing the effect of the pre-test, and the pre- scale.

Study Results and Discussion

To examine the first hypothesis: “There is no statistically significant difference at ($\alpha=0.05$) between the mean scores of the experimental group and the control group on the mathematical achievement test”, descriptive statistics of the two groups on the mathematical achievement post-test and the estimate values - in relevance to the pre-test results - were computed. They are shown in table 1 seen below:

Table (1)
Descriptive Statistics of the Two Groups on the Mathematical Achievement Post-test and the Estimate Values in Relevance to the Pre-test

Group	N	Pre-test		Post-test		Estimates	
		Mean (25 marks)	Std. Dev.	Mean (20 marks)	Std. Dev.	Adjusted Mean	Std. Error
Experimental	22	22.59	3.45	17.95	1.65	17.76	0.46
Control	22	21.59	3.79	14.00	3.22	14.20	0.46

Table 1 revealed that there were apparent differences between the means of the two groups, in the post-test and the estimate values. To examine the significance of these differences, the ANCOVA test was administered. The results are shown in table 2 seen below:

Table (2)
ANCOVA Test Results to Compare between the Two Groups on the Mathematical Achievement Post-test in Relevance to the Pre-test

Source	Sum of Squares	Df	Mean Square	F	Sig.	Eta Squared
Pre	85.195	1	85.195	18.408	0.000	0.310
Group	136.771	1	136.771	29.551*	0.000	0.419
Error	189.759	41	4.628			
Total	446.977	43				

* Significant at the significant level $\alpha = 0.05$

Table 2 revealed that there were statistically significant differences between the means of the two groups, since the F- value was (29.551), and with significant level (0.000), which was less than the critical value (0.05). Table 2 also revealed that Eta Squared equaled (0.419), which means that about 42% of the variance in the mathematical achievement due to the variance in the teaching using movement-based learning.

Analyzing the results shown in table 1, and comparing the estimated means of the two groups, it was found out that the adjusted mean of the experimental group (17.76) was greater than the adjusted mean of the control group (14.20), and this means that the mathematical achievement of the experimental group was much better than that of the control group. This result refutes the first hypothesis.

This result revealed that using movement-based learning in mathematics learning gives the students an extra power and potential in mathematical achievement and increases their level of achievement. This seems to be a logical one since the movement-based learning makes the student have an active role in the classroom, through doing the work required by implementing the movements associated with learning, and not through the follow-up of the teacher only as he works in front of students, and

sometimes the teacher suffices to provide knowledge in theory without applying it in practice in front of students; so when the student implements the movement, as this will raise the level of knowledge, understanding and skill included in those experiences, which will lead to raising the level of achievement for him.

The use of movement that is related directly to the learned subject gives the student the opportunity to make some connections between the mathematical concepts, skills, and generalizations that are required to understand the subject easier. Teachers also can benefit from using movement-based learning in the assessment process, because they can restrict and border students' mistakes during their working on the movements, so they can reform students' conceptual misunderstandings, to improve their level of achievement.

This result coincides with the study results of (Ford, 2016) and (Omidire, et al., 2018) in the positive effect of using movement-based learning in improving the mathematical achievement.

To examine the second hypothesis: "There is no statistically significant difference at ($\alpha=0.05$) between the mean scores of the experimental group and the control group on the cognitive curiosity scale", descriptive statistics of the two groups on the cognitive curiosity post-scale and the estimate values - in relevance to the pre-scale results - were computed. They are shown in table 3 seen below:

Table (3)
Descriptive Statistics of the Two Groups on the Cognitive Curiosity Post- scale and the Estimate Values in Relevance to the Pre-scale

Group	N	Pre-scale		Post-scale		Estimates	
		Mean (21 marks)	Std. dev.	Mean (21 marks)	Std. Dev.	Adjusted Mean	Std. Error
Experimental	22	17.77	4.21	19.68	1.96	18.64	0.36
Control	22	14.73	3.56	16.18	3.96	17.23	0.36

Table 3 revealed that there were apparent differences between the means of the two groups, in the post-scale and the estimate values. To examine

the significance of these differences, the ANCOVA test was administered. The results are shown in table 4 seen below:

Table (4)
ANCOVA Test Results to compare between the Two Groups on the Cognitive Curiosity Post- scale in Relevance to the Pre- scale.

Source	Sum of Squares	Df	Mean Square	F	Sig.	Eta Squared
Pre	299.903	1	299.903	111.637	0.000	0.731
Group	18.918	1	18.918	7.042	0.011	0.147
Error	110.142	41	2.686			
Total	544.795	43				

* Significant at the significant level $\alpha = 0.05$

Table 4 revealed that there were statistically significant differences between the means of the two groups, since the F- value was (7.042), and with significant level (0.011), which was less than the critical value (0.05). Table 4 also revealed that Eta Squared equaled (0.147), which means that about 15% of the variance in the cognitive curiosity due to the variance in the teaching using movement-based learning.

Analyzing the results shown in table 3, and comparing the estimated means of the two groups, it was found out that the adjusted mean of the experimental group (18.64) was greater than the adjusted mean of the control group (17.23), and this means that the cognitive curiosity of the experimental group was much better than that of the control group. This result refutes the second hypothesis.

This result seems to be logical since the using of movement-based learning raises students' self-efficacy, and makes them more motivated and confident in their skills in comparison to the study without movement-based learning; because when using the movement-based learning, students strive to discover and better understand the world around them, they use self-regulatory strategies, such as: (consciously attend to breathing, relaxing, exercise, movement, awareness of body sensations, and self-expression, etc...), they rely on themselves, and this can help them to rise their cognitive curiosity. We can say that students become more motivated

and have a great desire to do their tasks when they are confronted with challenging opportunities to understand the world around them.

The use of movement-based learning can affect students' concentration in the learning process, so the student will engage and enjoy in learning positively, and he can easily make social relationships and cognitive development, which reflects on his positive cognitive curiosity.

This result coincides partially with the study results of: (Nadler et al., 2015) in students' concentration, enjoyment of learning, engagement in learning, (Riley et al., 2017) in the positive effect on children's enjoyment and engagement, and (Omidire et al., 2018) in the positive impact on learners' physical and social development.

Conclusion

Movement-based learning is an effective method on raising students' mathematical achievement, through increasing their level of knowledge, understanding, and skills, by using their extreme abilities to reach the solution, and this reflects on their cognitive curiosity, through their pursuit to discover and understand the world.

Recommendations

It is recommended to use movement in the learning process to assess students' learning of mathematics. For future work in this area, researchers might conduct other studies to examine the effect of movement in the learning process on samples of other communities and other variables such as: thinking, motivation.

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