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The Effect of the Kolb Model in First-Grade Students' Learning of Mathematical Concepts and the Development of Problem Solving

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This study aimed to identify the effect of the Kolb Model in teaching middle school students' mathematical concepts and developing problem solving skills. Two divisions were chosen from the first intermediate class of middle school students at the Makkah for Girls school, affiliated with Nineveh education. One of them was an experimental group taught according to the Kolb Model , consisting of 30 students, and the other was an officer group, taught in a standard way. The number of individuals appointed to study was therefore 60 students. Equivalence between the two study groups was analysed considering the following variables: temporal age, degree of intelligence, as well as previous knowledge. Statistical data was processed using SPSS. The results of the study showed that there were statistically significant differences between the average scores of students of the two groups for acquiring mathematical concepts and solving mathematical problems. The results showed that this was of benefit to the experimental group.

Key words: *Kolb Model, previous knowledge, mathematical concepts*

Introduction

There is no doubt that mathematics is an important subject, relevant to life. It deals with multiple and useful topics and helps solve many problems, developing creativity and innovation (Regeluth, 1997). Despite its usefulness, students often show weakness in mathematics comprehension, as well as a weakness in acquiring new mathematical concepts. This has been proven in previous studies, such as Saber's analysis (2018). Mathematical concepts require cognitive application, which many students lack (Al-Lahibi, 2015), and because of these difficulties, this research focuses on the Kolb Model, a modern model that helps students acquire new concepts and tackle mathematical problems.

What is the effect of the Kolb Model on middle school students comprehending mathematical concepts and developing problem solving?

Importance of research:

1. Current research sheds light on how a modified Kolb Model reveals the best learning style among students, making learning more effective. There has been a lack of previous studies, which adopt a modified Kolb model in teaching mathematics.
2. This research builds a mathematical problem-solving test and mathematical concept test, which can be used for researchers and teachers of mathematics.
3. The Kolb model may contribute to improved learning of mathematical concepts and help improve problem-solving skills, knowing the effect of the Kolb Model on teaching middle school students.

Research objectives

This research aims to know the effect of the Kolb Model:

1. On students' comprehension of first intermediate grade mathematical concepts.
2. On the development of problem-solving skills for middle intermediate students.

Hypothesis

1. There is no statistically significant difference at the level of significance (0.05) between the average results of female students in the experimental group that are not taught according to the Kolb model, and the grades of female students in the non-studying control group.
2. There is no statistically significant difference at the level of significance (0.05) between the average degrees of female students in the experimental group that are not taught according to the Kolb model, and the grades of female students in an officer group, who studied in a standard way.

Research Limits

This research is limited to:

1. Intermediate first students in secondary and high schools in governmental day schools affiliated with Nineveh Education.
2. Classes (first, second, third, and fourth) learning from the mathematics book scheduled for students of the first intermediate class, Edition 1, 2016.
3. The first semester of the academic year (2019-2020).

Defining Terms

Kolb´s Model

Kolb (1984) defined his model as:

> "The choices that the learner prefers in solving any problem faced during educational situations, and it consists of a set of distinctive performances for the learner in receiving, realizing and processing information that comes from the environment in order to adapt to it and is determined by four methods: divergent style, assimilation method, convergent method, adaptive or adaptive method" (Kolb, 1984).

Comprehending the concept

Reigeluth (1997) defined this as the process in which a learner can understand the concept by helping them collect examples that indicate or classify it in a way that enables the learner to reach concepts.

Mathematical concept

Merill (1977) wrote that mathematical concepts are a group of things perceived by the senses, or events that can be grouped together on the basis of common and distinct characteristics and may be referred to by a special name or symbol (Merill, 1977).

Solving problems

Mathematical problems are a major component of mathematical knowledge – problems that need to be solved, or questions that need to be solved (Merril, 2017).

Theoretical Background: The Modified Kolb Model

Learning Methods and Knowledge

The study of learning methods is important, as they are one of the main components of efforts to understand factors affecting the learning process. Keefe has defined learning methods as "psychological behaviours, knowledge and emotionalism, which serve as indicators to indicate how a learner perceives a learning environment, interacts with it and responds to it." The need for a study learning style is increasing in the light of a rise in group learning within heterogeneous classes (Novell and Freya, 2011). Kolb's model is a cognitive model of learning style (Aqeelan, 2000).

Kolb adopted the foundations of learning theories for Dewey (1938) (Dewey's Theory in Learning), Piaget's works in epistemic growth, Levin's theory of sphere of learning, and Young Jung's (1923) theory in personality patterns and modelling, and Guilford's mental formation, (1978), who developed his theory in learning through experience. These theories were the basis for envisioning the model of learning methods presented by Kolb, a model characterised within a frame of reference that other learning methods lack (Al-Otoum, 2004).

Kolb's Model

In 1984, Kolb proposed four main types of learning styles, which he described as concrete, tangible experience, reflective observation, conceptual abstraction, and active experimentation (Al-Hadidi and Jamal, 2005).

Kolb's model of experiential learning styles is based on his theory – experimental learning theory, which describes learning in two dimensions:

First dimension: Relating to the process of perceiving information.
Second dimension: Describing, or information processing (Lu, et al, 2007).

Kolb classifies teaching experiences, which he uses to define learning methods, into four categories.

The Kolb model examines these four processes that include: sensory experience, reflective observation, abstract perceptions, and active experimentation. These are four successive processes in a continuous circular form, and this is continually related to two dimensions of learning: how the learner receives new information, and how the information is processed (i.e. reflexive observation or effective experimentation). This results in a cycle of four methods: divergent, comprehensible, convergent, adaptive or adaptive. Collectively, this creates a model of measurement tools, such as the Kolb List (1984) and the modified Kolb List (2005), which are easy to use lists (Al-Atoom, 2004).

A learner reflects on what has already been learned, according to Kolb's model, which differs from his old view of learning, so learning is not only an output, but also a process. A learner needs to receive advice, guidance and feedback to help them learn effectively. This is a process characterised by a constructive process, based on integration and an interaction between an individual and their environment. It is the goal of an integrated learner to build in all aspects of cognition, skill, and sentiment, after adapting an individual with the surrounding community. Kolb's learning methods reflect an important model, developed from theory. Experiential learning and its methods are a form of mental process, used by a learner commensurate with the changes in a society.

Comprehending Mathematical Concepts

Mathematical concepts are the cornerstones of mathematical knowledge. They play an important role in forming and building mathematical knowledge. Learners learn facts, but facts are not usable alone, and are only easy to remember if they form a concept, hence the importance of concepts in the educational process (Al-Qudsi, 2006).

Characteristics that mathematical concepts display, as noted by researchers, include:

1. They consist of an idea, or a group of ideas, that make sense.
2. They can be expressed via representation in more than one way, whether verbal or symbolic, etc.
3. They are generated by experience and practice.
4. They depend on the student's previous experiences.

(Matar, 2004)

Mathematical Concepts Classification

There are many other categorisations for mathematical concepts, including:

1. Deniz classification
2. Frank Lester classification
3. The classification of two men
4. SCMP classification
5. Classification

(Hamzawah Al-Balawneh, 2011)

Solving Problems

The عايير Standards National Council عايير Teacher of Mathematics (NCTM) indicated that learners must be prepared to use mathematical knowledge in solving problems. They must display their ability to communicate mathematically and use mathematical justification. Their criteria showed the effect of different strategies, which help learners with mathematical thinking and clearly indicate a need for mathematical problems for challenging thinking (NCTM, 2000).
Abu Zainah pointed out that one problem with education is that students do not have ready solutions in their learned cognitive structure to solve mathematical problems. Therefore, the hurdles might not be purely mathematical. Conditions for a solving mathematical problem are:

1. That the learner displays a clear effort to solve the problem.
2. There is an obstacle in this way of the learner, which they seek to remove.
3. The problem is completely clear and understood by the learner.

Kinds of Mathematical Problems

1. Mathematical problems: a type of problem that learners face at a primary and secondary stage, where difficulty lies in challenging mathematical operation.
2. Algebraic problems: algebraic problems introduce mathematical symbols when being solved.
   Engineering problems: questions that depend on axioms, divided into two types, stereotypes and non-stereotypes.

Steps to Solve a Mathematical Problem

These are mental steps that a learner follows to reach a required solution. The solution is accomplished by following a specific thinking strategy to solve the mathematical problem. Learners may encounter difficulty in solving problems because they did not use the correct method or thinking required to reach the solution. There are dozens of strategies used to solve mathematical problems, and each strategy has specific steps.

General strategies include:

1. Puglia Model (1975).
2. John Dewey Model (1910).
3. Frank Lester Model (1978).
4. Bear Model (1978).

This study analyses the Polya Model (1975) in problem solving. Polya is one of the pioneers of the field of mathematical problem solving in his famous book, *Search for a Solution*. This model helps the learner follow certain steps to reach a desired solution. Four steps are presented:

1. Read the matter and understand
- Read the issue with focus, more than once, and reformulate it.

Define data
- Selection required.
Determine conditions.
Convert data to a physical drawing and write it down.
Determination of required information.

- Make sure that the information provided is sufficient for the solution.
2. Create a solution plan
Is there a problem similar to the current one?
How can you link facts together?
Can you solve part of a problem?
Did you use all data?
What is a suitable strategy to solve your problem?
3. Denies a dilemma:
Execute your plan.
Writing a solution plan in mathematical steps.
- What is the solution?
4. Reviewing solving a problem through compensation or via another way.
(Aqilan, 2000)

Previous Studies

Result	Statistical Means	Independent Variable and Continued	Kind of Curriculum	Matter	Volume of Sample	Class	Educational Level	Researcher Name and Country	S
Studies related to the modified Kolb model									
There is a statistically significant difference in the learning styles attributable to the academic specialisation.	Chi-squared, mono-contrast analysis, Dinkan test for dimensional analysis (to determine the difference direction).	Preferred learning styles, type, and academic achievement.	Experimental method	Instructional design course	206	Student	College	Hassan and Fadl, 2014 Iraq	1
Studies dealing with the acquisition of mathematical concepts									
There is a statistically significant difference for a trial group	Use appropriate methods	Acquire mathematical concepts Systemic thinking	Experimental approach	Surf strategy overlapping		Students	Medium	Hopes 2018 Iraq	
Studies dealing with solving mathematical problems									
There is a statistically significant difference for a trial group	Use appropriate methods	Collectible	Experimental approach	A strategy to solve math problems	112	Students	Medium	Abu Yunus Suleiman Palestine2017	3

Research Methodology

Experimental Design

This study relied on one of the semi-experimental designs, with partial control of two equal groups, as shown in Table 1.

Table 1: The design of research, semi-experimental

Measurement of the Dependent Variable	Independent Variable	Dependent Variable	Equivalence Between Two Groups	Groups
- Test comprehension of mathematical concepts - Test conceptual problem-solving	- Comprehension of mathematical concepts - Problem-solving	Kolb model	**Intelligence- Otis Lennon** **- Previous collection** **- Chronological age**	**Experimental**
		Normal method		**Control**

Society and Research Sample

The research community identified included first-grade middle school students in middle and secondary schools affiliated with the Nineveh Governorate Center for the academic year (2019-2020).

A sample was selected intentionally. Division B represents the first group, including female students studying with the Kolb Model, with 30 students. Division D represents the second group, which will be taught in the usual way, also with 30 students.

Adjustment procedures: two groups were given variables, namely previous mathematical knowledge, age, time, intelligence, and the Levin test, which were applied to two independent samples to determine the significance of difference between students of the two groups, as well as knowledge of the value of F at a particular significance level, and the level of significance for the value of F for each of the equivalents greater than the approved significance level (0.05). This means that two groups are homogeneous in this variable, as in Table 2.

Table 2: Equivalence of the research sample according to age, previous achievement and intelligence

At the Level of 0.05	Value t-test		DF	Standard Deviation	Average Calculation	Order Number	Division	Group	Variable
	Scheduling	A calculated							
No sign	2	0.014	58	6.065	175.8	30	B	Experimental	Chronological age
				9.289	175.9	30	D	Control	
No sign	2	0.196	58	12.2	76.9	30	B	Experimental	Previous collection
				14.0	76.2	30	D	Control	
No sign	2.01	1.45	58	3.63	10.1	30	B	Experimental	Intelligence Otis Lennon
				3.16	11.3	30	D	Control	

Research Tool: Building a Mathematical Concept Comprehension Test

The researcher followed the following steps when developing a research tool:

1. Determine the main objective of the test.
2. Define the number of test items in light of the content of an educational subject and define concepts within that subject. This resulted in 15 concepts, with the test including 45 multiple choice paragraphs.
3. Draft paragraphs for the test. This involved drafting paragraphs for each behavioural purpose, commensurate with students' level of knowledge, according to a table of specifications for comprehending concepts. As mentioned earlier, a test of 45 paragraphs was prepared.
4. Draft instructions for marking the test. Criteria were set for marking and correction. A single mark was offered for correct answers, with zero marks offered for incorrect answers.
5. Certify the test. Check that it has been validated considering the following academic precepts:
    A) By offering the test to mathematics experts and specialists, obtaining agreeance of more than 80%. This is considered an honest test when measuring the comprehension of mathematical concepts (Al-Thahri).
    B) The sincerity of the content has been extracted when setting paragraphs for all three chapters. In light of previous procedures, the comprehension of concepts was ready for exploration:
    - The first survey sample consisted of 45 students in a second intermediate class. The average time taken to answer questions was 67 minutes.
    - One hundred female students from the second intermediate class were randomly selected to form a second survey sample. Its aim was to find psychometric properties of the test, so a test was applied to a prospective sample (moderate intents for girls). Correct answers were confirmed by agency correction.
6. Correct/marking the test. Grades were listed in descending order, for the purpose of conducting statistical analysis from the highest degree to the lowest degree. The highest (27%) of the students' answers represented the higher group, and the lowest (27%) of the students' answers represented the lower group. When marking, the following must be considered:
    A) The ranges between 0.35 and 0.68, as outlined by Allam (2006), are appropriate. The coefficient of difficulty of the test items should range between 0.15 and 0.85.

B) Test paragraphs with ranges between 0.37 and 0.58, as noted by Al-Dulaimi and Adnan (2005), indicate that the paragraph is considered acceptable, if the coefficient of its discriminatory force is 20% or more.
C) The efficacy of the wrong alternatives ranged from 0.259 - 0.074,.
D) The stability of the concept comprehension test was calculated using the Alpha Cronbach coefficient. Stability was 0.88, which is considered effective.

Solving Mathematical Problems

The test was constructed for middle school students by adhering to the following steps:

1. Determine the objective of the test.
2. Examine the literature and note previous studies.
3. Define a mathematical problem-solving test. In this research, a number of specialists in the field of mathematics teaching methods were consulted and, in light of expert opinion, 35 test paragraphs were developed.
4. Formulate test clauses in light of specific fields. Thirty-five multiple choice clauses were formulated.
5. Present skills with paragraphs to arbitrators. Define skills considering the four issues – data required, idea, solution, implementation. Paragraphs should be formulated according to these principles. Paragraphs were then presented to a number of arbitrators, for the purpose of understanding arbitrators' observations, which achieved an agreement rate of more than 84%.
6. Prepare test instructions.
    A) Prepare a page at the front of the test including test instructions, explaining how to best answer the test.
    B) A score of one was allocated for correct answers, zero for wrong answers. The test included 35 objective multiple choice paragraphs.
7. Confirm the validity of the test. Test validity was verified using two methods:
    A) By offering the test to arbitrators and specialists in mathematics and its teaching methods. The test was accepted by more than 80% of the arbitrators.
    B) Internal consistency was verified by finding the correlation between:
    - The correlation coefficient for the values of each paragraph, within the degrees of its field. The correlation coefficient was extracted based on the Pearson correlation coefficient. The results showed that all test items were statistically significant, as the values of correlation coefficients ranged between 0.30 and 0.76, a good indicator of test validity.

- The correlation coefficient between the scores of each field and the scores of the total test. The correlation coefficient was extracted using the Pearson correlation coefficient and the results showed that all the test items were statistically significant, as the values of correlation coefficients ranged between 0.56 and 0.75, a good indicator of test validity.

8. Sample information and use statistical analyses to test mathematical problem-solving, by considering:
   A) The sample of information: a mathematical problem-solving test was applied to a sample of information, confirming the clarity of the test items and instructions. It also determined the necessary time, and the mean time was 65 minutes for students to answer all test items.
   B) The statistical analysis sample: after the exploratory sample test was applied (medium intents for girls), making appropriate adjustments, it was ready to be applied again for the purpose of performing statistical analyses of total test items.
9. Perform a statistical analysis of test items. After applying a test on the sample, a statistical analysis of intermediate destinations for girls was carried out considering the following: the students answer papers were validated and a final score for each student was arranged, with the answer sheets being arranged in descending order, and the identification and sorting of the scores of the group with the highest grades and grades A group with the lowest scores by using a higher percentage (27%) and a lower score (27%) for the two groups for statistical analysis.
   A) The difficulty coefficient for test items was calculated and it was found that it ranged from 0.29 to 0.74.
   B) The discrimination factor for test items was calculated and found to be between 0.63 and 0.40.
   C) The effectiveness of wrong alternatives ranged from ([0.03] - [0.30]), indicating their effectiveness.
10. Test reliability. The stability parameter for the test that was applied to a statistical sample, calculated according to Kuder-Richardson 20th formula, with a value of stability of 0.83. If a stability value reaches 0.80 or above, it signifies high stability, and thus the test was ready to be applied.
11. Apply the test in its final form. The test was applied concurrently to two research groups.

Statistical Means

The researcher used the appropriate statistical means for this study, via the use of statistical package SPSS.

Research Results and Discussion

The research revealed the following:

1. There is no statistically significant difference, at the level of significance 0.05, between the average grades of students in the first grade of the experimental group average (who studied using the Kolb model) and its control (who did not study according to a model) when testing the comprehension of mathematical concepts.

Table 3: A statistical description of the experimental and control groups, with reference to the comprehension of mathematical concepts variable

Statistical Significance	Sign	DF	T value		Standard Deviation	Average Calculation	Order Number	Group
			Calculated	Tabular				
Sign	0.05	58	2	485.2	688.2	0.33.3	30	Experimental
					075.2	833.3	30	Control

2. There is no difference in statistical significance, at the level of significance 0.05, between the average grades for the experimental group (who study in the Kolb model) and their officers (who do not teach higher degrees) in mathematical problem analysis.

Table 4: A statistical description of the experimental and control groups in reference to mathematical problem-solving

Statistical Significance	Sign	df	T value		Standard Deviation	Average Calculation	Order Number	Group
			Calculated	Tabular				
Sign	0.05	58	2	47.6	88.1	5.6	30	Experimental
					28.11	9.5	30	Control

Conclusion: the Kolb model is one of the models that eliminates the difficulties a teacher faces, reduces effort, limits wasted time and helps students comprehend mathematical concepts and develop their problem-solving skills.

Recommendations

1. Reconsider the teaching of a mathematics subject in intermediate stages, and rebuild and organise its vocabulary in light of the Kolb model, or any of its modern strategies.
2. Train teachers of mathematics, and female teachers in an intermediate stage, on the Kolb model, as it has a positive impact on the learning and teaching processes.

Fifth: Proposals

1. Carry out studies to get to know the effectiveness of the Kolb model in mathematics considering other variables, such as gender, attitudes, creative thinking and structural thinking.
2. Compare the use of Kolb's model to other strategies in mathematical problem-solving.

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