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The Effectiveness of a Teaching Strategy Based on the Dean Model in Enhancing Secondary School Students' Achievement in Mathematics

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ABSTRACT

This research aims to identify the effectiveness of a teaching strategy based on the Dean model in improving the achievement of fourth-grade scientific stream students in mathematics. Al-Muakha Secondary School, affiliated with the General Directorate of Education in Holy Karbala, was intentionally selected. The school has four classes (A, B, C, D), and two were randomly chosen: class (C), consisting of 40 students, represented the experimental group taught according to the Dean model, while class (B), consisting of 42 students, represented the control group taught using traditional methods. The two groups were matched on variables such as students' age (in months), intelligence, previous achievement in mathematics, prior knowledge test, and complex thinking test. An achievement test consisting of 36 items was developed—33 multiple-choice questions and 3 essay questions. The test's validity and reliability were verified using Cronbach's Alpha. The experiment was conducted during the first semester of the 2024–2025 academic year, starting on Sunday (October 20, 2024) and ending on Thursday (January 2, 2025), with the achievement test applied on Sunday (January 5, 2025). Statistical analysis showed a significant difference at the 0.05 level between the experimental and control groups in favor of the experimental group. Accordingly, the Dean model positively affected students' achievement. The researcher recommends training mathematics teachers on using the model and suggests future studies to explore the model's effectiveness on other variables such as types of thinking, intelligence, or attitudes toward mathematics.

Keywords: mathematics, significant, Statistical, intelligence

1. Introduction

Definition of the Problem

First: The Research Problem

The research problem emerged from the fact that our current era is witnessing significant development in all fields, which in turn has cast a shadow over the field of learning. The development of communication methods has enabled students to easily access knowledge sources, learn and acquire the knowledge and educational experiences that the curriculum seeks to provide to students. This is confirmed by the researcher's experience working in secondary schools in the Karbala Governorate Education Department for more than nineteen years, and is confirmed by numerous studies. This

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prompted the researcher to contact some of his fellow teachers and consult with specialized supervisors. He concluded that the weak level of achievement may be due to some teachers following traditional teaching methods that lack the necessary instructional steps prepared by the teacher. These methods make the learner passive and receptive, and his role is limited to memorizing and reciting what the teacher presents inside the classroom without understanding or comprehension. The reason for the low achievement may be the failure to use modern teaching methods that are carefully and precisely prepared and to follow carefully studied steps according to teaching models that depend on experience or the learner's passing through an educational experience. Thus, the decline in the level of achievement is a natural result of these premises. Therefore, one of the biggest challenges facing our educational institutions is raising the level of achievement among secondary school students. This is one of the problems that has preoccupied many researchers and educators. It was necessary to search for teaching methods that contribute to raising the level of achievement among students and overcome the difficulties of the academic subject.

Given the importance of the problem, the researcher proposes following a teaching strategy according to the Dean model of learning, which is a model consisting of seven stages. This model assumes that the learner learns through work and participation and not remaining a passive recipient, but rather an active participant, meaning that the learner will understand the material more if he actively participates in that material. Based on the above, the researcher believes that following a teaching strategy according to the Dean model, It may contribute to raising their level of achievement, in addition to the fact that this strategy has not been studied in teaching mathematics at the secondary level in any previous study, according to the researcher's knowledge. The researcher identified the research problem by answering the following question:

What is the effectiveness of a teaching strategy based on the Dean model on fourth-grade science students' achievement in mathematics? Second: The importance of the research: Following a teaching strategy with these steps may contribute to raising learners' levels of understanding and comprehension, and may enhance their academic performance. (Chesimet & et al., 2016: p. 52)

It also supports a learning process that prioritizes the learner and places them at the center of the educational process. Experiential learning focuses more on the process and makes learning meaningful. (Mutmainah, Rukayah, 2019, p. 61). Recent studies confirm the importance of this type of learning and its ability to create a generation of learners capable of self-directed learning. (p. 21, Ghofur et al. 2021)

The importance of this research lies in two aspects:

Theoretical aspect:

1- The current research sheds light on the Dean model, which emphasizes that the learner should be active and engaged in the educational process.

2- The research may contribute to finding solutions and raising student achievement in mathematics by following the steps of the teaching strategy.

The practical aspect: The importance of this aspect can be summarized as follows:

1. The research may contribute to assisting mathematics teachers at all secondary levels in enriching their knowledge by developing lesson plans based on the model.

2. This research may open the way for researchers to conduct further studies in this field.

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3. This research may interest curriculum development agencies to include the model's steps in the teacher's guide.

Third: Research objectives: The research aims to identify the effectiveness of a teaching strategy based on the Dean model on mathematics achievement among fourth-grade science students.

Fourth: Research hypothesis (There is no statistically significant difference at a significance level of (0.05) between the average scores of students in the experimental group, who will study according to a teaching strategy based on the Dean model, and the scores of students in the control group, who will study according to the traditional method, on the mathematics achievement test).

$$H_0: \overline{x_1} = \overline{x_2} \quad , \quad H_0: \overline{x_1} \neq \overline{x_2}$$

Fifth: Research Limits: The current research is limited to:

1. Fourth-grade science students in middle and high schools for boys affiliated with the Karbala Education Directorate.

2. The scientific content of the three chapters of the mathematics textbook prescribed for the fourth-grade science class (Chapter Two: Equations and Inequalities, Chapter Three: Bases and Roots, Chapter Four: Trigonometry).

3. The stages of the Dean learning model.

4. The first semester of the 2024/2025 academic year.

Sixth: Search Terms

- Dean's Model: The Dean Model (Dean, 1999) is one of the learning models. Dean views experiential learning as a process in which the teacher, acting as a facilitator, develops the learner's experience. He presents a seven-stage model for developing and implementing learning (Dernova, 2015, pp. 53-55). Operational definition of the Dean model: It is a set of teaching procedures that begin with planning and participation, through comprehension and reflection, and end with the stages of generalization, application, and follow-up. It can be used to present mathematics topics to fourth-grade science students in the experimental group to achieve the effectiveness of the teaching strategy that was built according to the steps of the model.

- Achievement: Abu Jado (2009) defined it as: "The sum of what a learner learns over a period of time, which can be measured by the score they obtain on an achievement test. This is to determine the extent of the success of the strategy the teacher develops and plans to achieve their goals. The knowledge the learner attains is translated into grades." (Abu Jado, 2009, p. 425)

2. Theoretical Framework and Previous Studies: First: Theoretical Framework:

Dean's Model: Dean's model is one of the learning models that applied experiential learning to the educational process, focusing on experience in the learning process. These models include Kolb's model, the Budd and Bowker model, the Pfeiffer and Jones model, and the Dean model (Dernova, 2015, pp. 53-55).

Experiential learning is consistent with the principles of Jean Piaget's constructivist theory, which states that learning consists of the learner's interaction with their environment and is the product of work and shared practical experience to form knowledge. (Schellhas, 2006, p. 19)

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Experiential learning emphasizes the advanced role of experience at the beginning of the learning process.

(Eaton, 2020, p. 6)

Stages of the Dean Model

1- Planning - Initiation

2- Engagement - Initiation

3- Comprehension - Learning through Experience

4- Reflection - Making Meaning

5- Generalization - Making Connections

6- Application - Transfer of Learning

7- Monitoring – Evaluation

Second: Previous Studies

To the researcher's knowledge, there are no previous studies that have addressed this model in its entirety.

3. Research Methodology and Procedures

Research Methodology: The researcher adopted the experimental approach because it is appropriate for achieving the two research objectives.

Second: Experimental Design of the Research:

The researcher relied on a partially controlled experimental design for two equivalent groups with a post-test appropriate for the research purposes.

Third: Research Community.

Fourth-grade science students from morning secondary and preparatory schools for boys affiliated with the General Directorate of Education in Karbala were selected for the 2024-2025 academic year.

Fourth: Research Sample:

After the researcher visited a number of schools in the research community, Al-Mu'akhah Preparatory School, affiliated with the General Directorate of Education in Karbala, was intentionally selected.

Fifth: Control Procedures:

To achieve valid results in the current study, the researcher worked to control a set of variables that could influence the research variables. These include two types of validity, as follows:

1- Internal validity of the experimental design of the study: Ensuring equivalence between the experimental and control groups in terms of chronological age, intelligence, prior knowledge, prior knowledge test, and complex reasoning test.

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2- External integrity of the experimental design: The researcher was keen to control other external variables that might have an impact on the research experiment.

Sixth: Research tools (tests): The researcher constructed an achievement test in mathematics to verify the research objective and hypothesis. The following procedures were adopted:

1- Defining the test objective: The goal of this test is to measure the achievement of the students in both groups in the content of the educational material specified for the current research.
2- Determining the educational material: It is the educational material for the three chapters (Chapter Two: Equations and Inequalities, Chapter Three: Bases and Roots, and Chapter Four: Trigonometry) from the mathematics book prescribed for the fourth scientific grade for the academic year (2024-2025), 15th edition for the year 2024.
3- Formulating behavioral objectives: The researcher formulated (192) behavioral objectives in light of Bloom's cognitive levels, which are (remembering, comprehension, application, analysis, synthesis, and evaluation).
4- Determining the number of test items: The total number of test items was determined using the opinions of a number of judges and mathematics teachers for the fourth grade science stream. (36) items were identified, including (33) objective items and (3) essay items, distributed across the three chapters of the first semester of the mathematics textbook for the fourth grade science stream.
5- Preparing the specifications table: (test map): The researcher prepared the test map.
6- Formulating the Test Items: The researcher formulated (36) items designed to measure students' performance at the levels of (recall, comprehension, application, analysis, synthesis, and evaluation).
7- Validity: The validity of the achievement test was confirmed using two types of validity:
   A. Apparent Validity: The researcher presented the achievement test to a group of judges in mathematics and its teaching methods. The judges' opinions were taken into account when correcting and modifying some items, achieving an agreement rate of more than (80%).
   B. Content Validity: Preparing a specification table (test map) and presenting it to the judges using mathematics teaching methods is an indicator of the content validity of the test.
   (8-1) Application to the First Experiment:
   The test was administered to a first experimental sample of 43 fourth-grade science students at Al-Rujaiba Intermediate School for Boys, affiliated with the General Directorate of Education in Karbala, on Tuesday, December 24, 2024, to calculate the time and ensure the clarity of the test items.
   (8-2) Application to the second survey:
   The researcher applied the test to a second survey sample of a group of students different from the students in the first survey sample, numbering (100) students from the fourth grade science stream at Al-Khairat Secondary School for Boys, affiliated with the General Directorate of Education in the Holy Karbala, on Wednesday, December 25, 2024.
   After ensuring that the students had completed the three semesters covered by the research, the researcher collaborated with the school administration and the subject teacher to implement the test and notify the students a week before the test date.
   9) Statistical analysis of the achievement test items: The researcher followed the following steps:
   a) Corrected the students' answer sheets and completed the final grades for each student.
   b) The scores were arranged in descending order from highest to lowest (Appendix ( ).
   c) Determining the upper and lower groups.
   9-1) Difficulty coefficient for the achievement test items:

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The difficulty coefficient was determined for each of the (33) objective test items according to the special difficulty coefficient equation. It ranged between (0.6 - 0.33).
The difficulty coefficient was determined for each of the (3) essay test items, according to the special difficulty coefficient equation. It ranged between (0.68 - 0.33). It is considered acceptable if the difficulty coefficients for the test items range between 0.80 - 0.20 (Bloom et al., 1983, p. 607).
9-2) The discrimination coefficient for the achievement test items: The discrimination power was calculated for each item of the objective and essay test items, and it ranged between (0.70 - 0.33). Therefore, it is a good indicator for the acceptance of all items as good and acceptable, as their discrimination power coefficient is within the period (0.80-0.20). (Bloom et al., 1983, p. 607)
9-3) Effectiveness of Incorrect Alternatives:
The effectiveness of the incorrect alternatives for the objective test items, numbering (33), was calculated according to the equation for the effectiveness of incorrect alternatives. All of them were negative, with the exception of the correct choice. This means that these incorrect alternatives were attractive to students in the lower group, indicating their effectiveness in the test. Therefore, the researcher decided to retain all alternatives.
.
10-): Reliability: The reliability of the achievement test for the objective and essay items in the achievement test was calculated using the Cronbach's alpha equation, and the reliability value was 0.82.
11- Final Achievement Test: The final form of the achievement test was administered to both the experimental and control groups at the same time on Sunday, January 5, 2025, after the researcher notified the sample students a week prior to the test date.

Presentation and interpretation of results:

The results of the null hypothesis related to the achievement test in mathematics, which states that: (There is no statistically significant difference at a significance level of (0.05) between the average scores of students in the experimental group who studied according to a teaching strategy according to the (Dean) model and the scores of students in the control group who studied according to the usual method in the achievement test in mathematics). The following was taken:
A) The researcher administered the achievement test to the students of both groups. He corrected their answers and entered them in a special table. The arithmetic mean value was (80.150) for the students of the experimental group, with a standard deviation of (6.647). The arithmetic mean value was (68.905) for the students of the control group, with a standard deviation of (7.855), as shown in table (1).

Table (1) Statistical description table for the experimental and control groups in the achievement variable

95% confidence interval for the arithmetic mean		Standard error of the mean	Standard deviation	Arithmetic mean	number Students	Division	Group
Minimum	ceiling						
8.040	14.451	1.051	6.647	80.150	40	أ	Experimental

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8.052	14.438	1.212	7.855	68.905	42	ب	Control

b) The Kilmogorov-Smirnov and Shapiro-Wilk tests were applied to learn the distribution of the data for the achievement test (normal, non-normal), where the nature of the statistic will be determined (parametric, non-parametric), and it succeeded in reaching the significance level of the differences (Kilmogorov-Smirnov and Shapiro-Wilk) (0.200) and (0.635) twice the amount of the significance level to become (0.05), and accordingly the distribution of the data is the normal distribution and the nature of the statistic is parametric as ended in Table (2).

Table (2) Kilgorov-Smirnov and Shapiro-Wilk test schedule for the two research groups in the mathematics achievement test

Shapiro-Wilk test			Kolmyroff-Smirnov test			variable
Connotation	Degree of freedom	Statistical value	Connotation	Degree of freedom	Statistical value	
0.635	40	0.979	0.200	40	0.090	Collection

(Levene's-Test for two independent samples, to reveal the significance of the difference in the variance of the scores of the students of the two groups, and the value of (F) reached (0.560) at the significance level (0.456), and this level is greater than (0.05) the approved significance level, which means that the two research groups are homogeneous in the achievement variable, and the table shows this. Th) To reveal the significance of the difference between the average scores of the students of the two groups, the researcher resorted to the (t-test) for two independent samples, as the t-value reached (6.981) at the significance level (0.000).

This level is smaller than the approved significance level (0.05) with a degree of freedom of (80), as shown in the table3.

Table (3) of Levene's test and t-test values for the two research groups in the mathematics achievement test

Statistical function at level ((0.05	Degree of freedo (m (df	(t-test) To equal the averages		(Levene's test) To equalize the two variances		variable
		The significance of both parties	valu (e (t	Connotation	valu (e (F	

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Statistically significant	**80**	**0.00**	**6.981**	**0.456**	**0.560**	**Achievement test**

Thus, the first null hypothesis was rejected and the alternative hypothesis was accepted. Therefore, there is a statistically significant difference at a significance level of (0.05) between the average scores of students in the experimental group who studied according to a teaching strategy based on the Dean model and the scores of students in the control group who studied according to the traditional method in the mathematics achievement test in favor of the experimental group.

To determine the magnitude of the effect of the independent variable (the effectiveness of the teaching strategy according to the Dean model on the dependent variable), the researcher used the eta square test (η^2) to determine the effect size of the independent variable. The t-test was used to ensure that the difference was a true difference due to the independent variable and not to any other variable. The value of (d) was then calculated, which represents the magnitude of this effect.

Table (4) shows the values of (eta) and (d) and the effect size of achievement for the two groups (experimental and control).

The amount of effect size	d) value) effect size	Eta value η^2	df value	t value	Dependent variable	Independent variable
big	1.6	0.379	80	6.981	Collection	Effectiveness of teaching strategy according to the Dean model

From the table 4 we note that the size of the effect of the teaching strategy according to the (Dean) model on the dependent variable, achievement, is large, as the value of eta square (η^2) reached (0.379), meaning that the value of (d) reached (1.6), which is greater than (0.8). This means that the effect of the teaching strategy according to the (Dean) model on the dependent variable, achievement of fourth-grade science students in mathematics, was large and in favor of the experimental group**.**

4. Results and Interpretation:

The null hypothesis stated that there would be no statistically significant difference at the 0.05 level between the mean scores of the experimental and control groups. After conducting the test:
- The experimental group's mean score was 80.15 (SD = 6.65).
- The control group's mean score was 68.91 (SD = 7.86).
- Normality tests (Kolmogorov–Smirnov and Shapiro–Wilk) indicated a normal distribution (p > 0.05).
- Levene's Test confirmed homogeneity of variance (F = 0.560, p = 0.456).
- The independent samples t-test revealed a significant difference (t = 6.981, p = 0.000) favoring the experimental group.

Effect Size:

The researcher used Eta squared and Cohen's d to measure the effect size:
- Eta squared = 0.379
- Cohen's d = 1.6

These values indicate a large effect size, confirming the effectiveness of the Dean model in enhancing students' achievement in mathematics.

5. Conclusions:

Based on the research findings, the following conclusions were drawn:
- The teaching strategy based on the Dean model had a positive and clear impact on improving students' achievement in mathematics compared to traditional methods.
- The effect size of the Dean model strategy was large, indicating its effectiveness in enhancing learning outcomes.

6. Recommendations:

- Encourage mathematics teachers to adopt the Dean model in secondary education.
- Include the Dean model strategy in training programs by educational directorates to familiarize teachers with its implementation.

7. Suggestions for Future Research:

- Conduct further studies on the Dean model strategy at different educational levels.
- Investigate its effectiveness with other variables such as types of thinking, intelligence, or mathematical reasoning skills.

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