

The Impact of Problem Based Learning Model on Developing Mathematical Thinking Skills for Eleventh Grade Students in Palestine

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Abstract: *This study aimed to determine the impact of Problem Based Learning Model on Developing Mathematical Thinking Skills for Eleventh Grade Students in Palestine. The researcher used the experimental approach. The study sample consisted of 86 students divided into two groups: (43) students in the experimental group, and (43) students in the control group, both from East Gaza-Palestine. To achieve the objectives of the study, the researcher used a Mathematical Thinking Skill test. Results showed significant differences at significant level ($\alpha \leq 0.05$) among the average scores of the student's test between the experimental group and the control group. The findings of the study indicate that students felt motivated and stimulated their attention in the learning of the subject matter with a positive development on Mathematical Thinking Skills.*

Key Word: *(Problem Based Learning, Model, Mathematical Thinking Skills)*

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I. Introduction

Making the learning process exciting and valuable is the goal that all educators strive for. Therefore, they try to discover and find the models and strategies that contribute to achieving this goal.

Research in educational psychology has found that traditional educational approaches (e.g., lectures) do not lead to a high rate of knowledge retention. Despite intense efforts on the part of both students and teachers, most material learned through lectures is soon forgotten, and natural problem solving abilities may actually be impaired. In fact, studies have shown that in 90 days students forget 90% of everything they have been told (Smilovitz, 1996). Motivation in such traditional classroom environments is also usually low.

Problem based learning (PBL) is a student-centered educational method that uses problem solving as the starting point for learning (Bligh, 1995). PBL is designed to develop problem-solving strategies, disciplinary knowledge bases and skills simultaneously by placing students in the active role of problem-solvers (Doig, 1993). This is achieved by confronting students with problems typical of the real world.

Problem-based learning (PBL) is described as experiential learning focused around investigation and resolution of messy, real-world problems (IMSA, 2014). Learning using this approach is roughly organized in three stages. The first stage requires students to understand the problem by defining, describing, and clearly stating it. Then, learners must complete exploratory research, gather data, and generate possible solutions to the problem. In the third stage, students must select the resolution that best fits the situation, and present a case supporting their conclusions. It is the problem that provides the impetus from which the learner structures the investigation, selects appropriate resources, and is motivated to develop solutions. Fundamentally constructivist in nature, PBL forces students to plan, reflect on, and regulate their strategies and tasks, resulting in deeper learning (Strobel & van Barneveld, 2009).

Piaget (1983) has proposed some of the key elements during the implementation of this method in the classroom which are:

- 1) Pupils will be given responsibility in planning their own learning.
 - 2) Problem is the main key in this method.
 - 3) Teachers act as facilitators.
 - 4) Pupils must do reflections.
 - 5) Pupils must learn something in the process of resolving the problem.
- In Addition, Graff and Kolmos (2003) have listed nine major principles in this method:
- 1) Problem is the main element.
 - 2) Student-centered learning.
 - 3) Teachers play roles to create problems that are linked to the pupils' real life.
 - 4) Problem must be related with daily life situations.
 - 5) Pupils show interest during the process to resolve the problem.

- 6) The foundation of this method is learning activities.
- 7) Pupils have a higher percentage of understanding the topic.
- 8) Collaboration between group members.
- 9) A form of active and reflective learning.

Rusman (2013:232) States "problem-based learning is the use of all sorts of intelligence needed to confront real-world challenges, the ability to deal with everything new and Complexity ". In Problem Based Learning, students are placed in positions that have an active role in resolving each of the problems they face (Harisson in Wardoyo,2013:72). Problem-based learning models help students develop high-level thinking skills, solve problems, learn to act as adults through their involvement in real life experiences and simulations of being independent learners (Trianto,2011:96).According to Rusman (2013: 214), problem-based learning has characteristics including:

(1) Problem-based learning is a series of learning activities, meaning in the implementation of problem-based learning there are a number of activities that students should do. Problem-based learning does not expect students to just Listen to record, then memorize the subject matter but through the problem-based learning students actively think, communicate, search and process the data and eventually conclude, (2) learning activities are geared towards Solve the problem. Problem-based learning puts problems as keywords from the learning process. It means that without problems there could not be a learning process, (3) problem solving is done using a scientific thinking approach. Thinking using scientific methods is the process of deductive and inductive thinking. The process of scientific thinking is done through certain stages; While empirical means the problem solving process is based on clear data and facts.

Within PBL environments, teachers' instructional abilities are more critical than in the traditional teacher-centered classrooms. Beyond presenting mathematical knowledge to students, teachers in PBL environments must engage students in organizing information and using their knowledge in applied settings. Teachers in PBL settings should have a deep understanding of mathematics that enables them to guide students in applying knowledge in a variety of problem situations. Teachers with little mathematical knowledge may contribute to student failure in mathematical PBL environments. Without an in-depth understanding of mathematics, teachers would neither choose appropriate tasks for nurturing student problem-solving strategies, nor plan appropriate problem-based classroom activities (Prawat, 1997).

Thinking involves critical and creative aspects of the mind. Developing mathematical thinking is the main goal of mathematics education. In today's information-based society, it is desirable to develop process skills such as innovative ways to find a solution to a problem. As for the extent to which mathematical thinking is effective, it is important to have the proficiency to mathematical processes of questioning; to understand the content and areas of application of mathematics; In certain situations, mathematical and statistical thinking develop creative and critical thinking (Mason, Burton, & Stacey, 2010, Isoda & Katagiri, 2012).

a mental activity specific to mathematics and includes the following nine methods:

Mathematical Thinking Skills in this study are :Induction, deduction, generalization, formal logic, mathematical proof, relational thinking.

1.2. Study Problem

The study aims to investigate Problem Based Learning Model on Developing Mathematical Thinking Skills for Eleventh Grade Students in Palestine. The problem was formulated in the following main question:

What is the Impact Problem Based Learning Model on Developing Mathematical Thinking Skills for Eleventh Grade Students in Palestine?

It has the following sub-questions:

1. What is Problem Based Learning Model?
2. Are there statistically significant differences at the level of ($\alpha \leq 0.05$) between the mean scores of the experimental and the control groups in developing the Mathematical Thinking Skills for students?

1.3. Study Hypothesis

1. There are no statistically significant differences at the level of ($\alpha \leq 0.05$) between the mean scores of the experimental and the control groups in developing the Mathematical Thinking Skills for students.

1.4. Research Objectives

The study aims to achieve a number of objectives including:

- Determining the Problem Based Learning Model.
- Examining the impact of Problem Based Learning Model on Developing Mathematical Thinking Skills for Eleventh Grade Students.

1.5. The limitations of the study

The study was conducted in the second semester of the academic year 2019/2020 in AL- ZAHRAA secondary school in east area of Gaza on 86 students divided into two groups (43) students in the experimental group, and (43) students in the control group.

1.6. Study Importance

The importance of this study is that:

This study can benefit the teachers in identifying new models for student education and developing positive attitudes towards mathematics by a new learning that makes the learner more effective.

1.7. Study Terms

The researcher define the study terms operationally as:

- **Problem based learning:**

Problem-Based Learning (PBL) describes a learning environment where learning begins with a problem to be solved, and the problem is posed in such a way that students need to gain new knowledge before they can solve the problem.

Mathematical Thinking Skills

represents performance outcomes that indicate the extent to which a student has accomplished specific goals.

II .Methodology

2.1 Research design:

The study used the experimental design (two groups design, experimental and control groups) to examine the impact of The Impact of Problem Based Learning Model on Developing Mathematical Thinking Skills by applying the achievement test, analyzing the data and detecting the impact.

2.2 Data Collection Instruments:

After reviewing the previous studies, the researcher constructed an achievement test consisting of 15 questions. Students were tested in one session in the same circumstances. The experimental group was tested after applying problem based learning model and the control group was tested after learning with the usual method .

2.3 Procedures of the study:

The control group studied in the traditional way for two weeks, then the achievement test was applied. The test session lasted approximately 1 hour and the tasks were about Statistics and Probability. The experimental group studied with problem based learning model and had the same achievement test of the control group.

2.4 Data analysis:

Data collected in the study were analyzed by using SPSS Statistics version 22 program, independent samples test was conducted to determine if the difference between the experimental and the control group scores was significant, the value of η^2 was computed to determine the effect size of the Impact of Problem Based Learning Model on Developing Mathematical Thinking Skills.

III. Findings

Answer of first question. What is Problem Based Learning Model?

This study focus on the Problem Based Learning Model where during learning, students collaborate in small teams to explore the presented problem situation. "Through this exploration students are expected to examine gaps in their own knowledge and skills in order to decide what information they need to acquire in order to resolve or manage" the problem situation (Savin-Baden, 2004, p. 3). the steps used in this study are:

1. Group settings.
2. Problem identification.
3. Idea generation.
4. Learning issues.
5. Self- directed learning.
6. Synthesis and application.
7. Reflection and feedback.

Results of question 2 : Are there statistically significant differences at the level of $(\alpha \leq 0.05)$ between the mean scores of the experimental and the control groups in developing the Mathematical Thinking Skills for students?

The researcher formulate the hypothesis:

There are no statistically significant differences at the level of $(\alpha \leq 0.05)$ between the mean scores of the experimental and the control groups in developing the Mathematical Thinking Skills for students.

Table1: (Independent Samples T-Test)

Mathematical Skills in unit(1)	df	App.	Means	Standard deviation	t-test	sig
Total	84	Experimental group	33.407	5.029	20.078	0.000
		Control group	14.732	3.450		

As indicated in table 1, there is a significant difference at level ($\alpha = 0.05$) between students scores in the experimental group and the control group. This result reflects the positive impact of Problem Based Learning Model on Developing Mathematical Thinking Skills. To determine the effect size, the value of η^2 was computed as shown in table 2. The value of η^2 for all the Mathematical Skills was > 0.14 which means that the Problem Based Learning Model has a big effect size in developing Mathematical Thinking Skills for students.

Table2: (Effect Size η^2)

Mathematical thinking Skills in unit(1)	t-test value	t ²	df	η^2
Total	20.078	403.126	84	0.828

IV. Discussion

This study was conducted to investigate the impact of Problem Based Learning Model on Developing Mathematical Thinking Skills for Eleventh Grade Students in Palestine. Through the results of the student's scores, it was found that there was a positive impact on developing the academic achievement and Mathematical Thinking Skills comparing the results of the experimental and control groups. The reason of this improvement refers to the concept of problem-based learning which is a form of teaching that focuses on student-centered learning and is based on real life issues or problems. In this study, student's tasks were about Unit 1 in Mathematics book of eleventh grade "statistics and probability". The classes for the experimental group are designed according to the problem-based learning model where students faced some real problems as finding the probability of elementary or compound events, normal distribution and making a decision. The study reveals that the problem-based learning model made students feel motivated and stimulated their attention in the learning of the subject matter with a positive development. Also, this model helps to promote students' problem-solving skills, communication skills, critical thinking, and lifelong learning attitude.

The results of this study are consistent with other studies that searched in problem-based learning model, such as (Boye, 2019) and (Zakaria et al., 2019) which indicated the importance of the problem-based learning model.

V. Recommendation

- 1- Enhancing teaching strategies as PBL in the various centers for pre-service teachers.
- 2- Choose a model and strategy that promotes collaborative work among students and enables them to think and solve problems.
- 3- Holding specialized courses for the teachers about problem-based learning.

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