

**THE EFFECTIVENESS OF PROBLEM – BASED LEARNING STRATEGY IN THE ACQUISITION OF SCIENTIFIC CONCEPTS IN PHYSICS AND THE DEVELOPMENT OF SCIENCE OPERATIONS AMONG THE NINTH GRADE FEMALE STUDENTS**

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**ABSTRACT:** *The purpose of this study is to design the unit of the mechanics and its effect on substances among the ninth grade female students in Jordan depending on problem – based learning strategy. The study also aimed at identifying the problem – based learning strategy as well as highlighting the applied importance of physics in the students' daily life in addition to specifying the effect of the problem – based learning strategy in the student's acquisition of scientific concepts in physics and development of their science operation. The study produced a set of results and recommendations the most significant of which were that there is an effect of the problem based learning strategy in the ninth grade students' acquisition of the scientific concepts in physics, and that there is an impact of the problem – based learning strategy in the development of science operations in physics among the ninth grade students. The researcher recommends to construct and design the units of the scientific subjects by means of modern learning strategies like the problem – based learning strategy to facilitate the learning process by male and female students.*

**KEYWORDS:** problem – based learning, scientific concepts, science operations development, the mechanics.

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## **INTRODUCTION**

Physics is one of the most important basic scientific subjects which should be perfected by a student to move forward in their academic life, be unique and distinctive in thinking and use modern scientific learning styles. It is of the subjects that increase the individual's ability to problem solving and learning for its potential applied sciences. It is also of the most upscale natural sciences known by mankind being built on Mathematics and the real value of different substances and objects and its correlations are usually studied through accurate scientific methods. Since conferences and educational administrations meantime tend to prepare qualified individuals able to deal with the accelerating rearrangements in the world, it is necessary to focus on thinking and its tools being the instrument which will enable people to keep up with the changes and development in different natural and humanistic sciences (Al-Khatib, 2002).

Moreover, modern attitudes assert that physics curricula and its teaching styles are of the most stimulating to thinking and problem solving based on understanding, reason and application. It also depends on the approaches of exploration, experiment, error and discussion to reach at the right solution (Lutfiyya, 1998). Therefore, modern strategies have to be available to deal with the physics curriculum and of those strategies is problem solving the importance of which is manifested in that it helps students to improve their analyzing abilities and thinking. It also

develops the science and learning processes in the scientific subjects and natural sciences. It also helps to learn facts and the mutual relations of the scientific subjects as well as understanding issues more accurately. It also helps to keep information for longer period and develops the students ability to inference and conclusion in addition to providing appropriate solutions or choosing the best available solution (Harting, 1994).

Based on the aforementioned, problem – based learning strategy is of the most important strategies the impact of which has to be studied. Moreover, the acquisition of scientific concepts in physics and the development of science operations among students are of the most significant teaching elements which guarantee the students' excellence in physics.

### **The problem and Hypotheses of the Study:**

Jordan witnessed many efforts and endeavors through the educational development conferences to improve teaching outputs, raise its quality and care for the students' thinking and their attitudes toward learning scientific subjects especially physics. However, it is noticeable that the teaching outputs in physics have not reached at a desirable level as it is penetrated by many problems represented in the poor acquisition of scientific concepts and the feebleness of the science operations in physics (Al-Khatib, 2004). Based on the aforementioned, the study problem lies in identifying the effectiveness of a problem – based learning strategy in the acquisition of scientific concepts in physics among ninth grade students as well as the development of their science operations in relation to this subject.

Precisely, this study is trying to answer the following questions:

- 1- What is the effectiveness of a problem – based strategy in the acquisition of scientific concepts in physics and the development of science operations among the ninth grade students in Jordan.
- 2- What is the effectiveness of a problem – based strategy in the development of science operations in physics among the basic ninth grade students in Jordan.

### **The study Hypotheses:**

- 1- There are no statistically significant differences at ( $\alpha=0.5$ ) between the average ninth grad students' scores on the pre – test and the post – test of scientific concepts acquisition in physics due to the problem – based learning strategy.
- 2- There are no statistically significant differences at ( $\alpha=0.5$ ) between the average ninth grad students' scores on the pre – test and the post – test of the development of science operations in physics due to the problem – based learning strategy.

### **The study Importance:**

This study derives its importance from the significance of its theme which is physics with all its information, correlations and significance for all the substances existed around us and with all its production of data about the mechanical and kinetic nature of different industries and architectural constructions and many other fields. It is a fertile field to train students on thinking patterns and provoking science operations and knowledge acquisition. The importance of the study also comes from its adopted strategy which is the problem – based strategy as one of the best and most important teaching strategies that help students to think profoundly, find solutions and apply those solutions practically. It also helps to increase their ability to maintain the information for longer periods because of its practical application of how to get information.

### **The study objectives:**

The current study aims at:

- 1- Identifying the problem – based learning strategy.
- 2- Highlighting the applied significance of physics in the daily life of students.
- 3- Specifying the effect of the problem – based learning strategy in the students acquisition of scientific concepts in physics.
- 4- Specifying the effect of the problem – based learning strategy in the development of science operations among the students in physics.

### **Definitions and Procedural Terminology of the Study:**

**1- Physics:** Physics is one of the natural sciences and has different names as some people call it the science of nature. Physics is concerned with studying matter, energy and particles movement and whatever affects the course of their action to come up with equations and laws that explain those aspects and predict their course by means of models close to reality (Bush, Gerd, 2016).

**2- Problem Solving strategy:** It is an organized mental activity for the student and a scientific approach which starts with provoking the student's thinking with the presence of a problem that worth thinking and solving according to scientific steps and through practicing a number of educational activities. (Abdul – Maqsoud, 2001).

**3- Acquisition of Scientific concepts:** It is procedurally defined in this study as the total score achieved by the student in the scientific concepts acquisition in Physics.

**4- Science operations Development:** It is procedurally defined in this study as the degree of improvement of the students after applying the problem – based learning strategy and which can be measured through the test specially prepared for the purposes of this study.

### **The Study Limitations:**

The present study was restricted to the following limits:

- 1- One of the governmental schools at Mafraq Directorate of Education in the academic year (2016 / 2017).
- 2- The unit of The mechanics and its effects on substances.
- 3- The academic year (2016 / 2017).

### **THEORETICAL FRAMEWORK AND PREVIOUS STUDIES:**

#### **Problem – based learning strategy**

This strategy expresses the constructivists' ideas in teaching science and Mathematics. The founder of this strategy – Grayson Wheatley – is of the greatest defenders of modern constructivism. He believes that the learner through this strategy is provided with meaningful understanding through the problem presented to them, so they work with their colleagues to find solutions in small groups. Although there are several teaching models that utilize problems, this model is described to be the most effective. (Abdul – Haleem, 2003).

John Dewey believes that experience represents the basic concept of problem – based learning. (Mast, 2000). Diane points out that the rapid changes in the field of education and the variety of knowledge sources have an impact in the massiveness of the challenge before the comprehension of this increasing amount, and consequently, the supporters of this strategy see that it is able to develop the self – learning of the learner. (Alderman, 2007). This is confirmed by the study of Mast (2000) which aimed to clarify the effect of comparing the use of problem – based learning strategy and the traditional method in the development of self – learning and

the job guidance among the medical school graduates in Canada. The sample consisted of (18) pupils and was compared with the results of the graduates who used the traditional approach from (1984 to 1988). This study indicated that using the problem – based learning strategy contributed in the development of self – learning and job guidance better than the traditional method. Moreover, there are also the study of (Walker, 2001) which aimed at investigating the effectiveness of problem – based learning strategy in the development of learning among the students of the Faculty of pharmacy at the University of Mississippi; and the study of (Moore – Hayse, 2001) which aimed at identifying the effect of using the problem – based learning strategy in the development of self – learning in the job guidance program among the students of the professional college in Canada (Al-Najdawi et al., 2005).

Bruce states that the primary goal of the problem – based learning is the development of the cognitive environment. This can be achieved by giving the students the opportunity to choose the subject they are going to learn and to determine the method of learning. Here, learning is self – directed, and the students are the real owners of the learning process which, in turn, supports their ability to solve problems in new situations. Studying (820) high schools in the United States of America, it was found that when 11000 students are taught through the problem – based learning strategy, they achieve higher progress in Mathematics, reading, social studies and science.

The study of Stohr – Hunts, which compared the manual skills of the eighth grade students in two groups, one of which used this strategy while the other followed the traditional method; clarified that the students who used the strategy scored higher progress than the students of the traditional method. The repetition of those activities in the classroom is connected to the strength of scientific and academic achievement even if the test did not measure the laboratory skills. (Dempsey, 2000). Bound (1985) believes that the problem – based learning begins by giving the students a real problem to practice without any previous presentation. The students can identify the learning areas through the preliminary analysis of the problem. The knowledge and skills acquired in this way are applied to solve the problem. This final phase enables the students to summarize what they have learnt and merge it with the former knowledge of each student. Of the claimed privileges of this type of learning is that it increases motivation and helps to combine knowledge in different sections concerning other curricula. This is because the problem – based learning theories meet the requirements of the learner's programs starting with technical preparation and ending with practical experience.

Bridges and Hallinger specify four grounds for using problem – based learning strategy instead of the traditional method, which are:

- 1- Students retain very little of what they learn in the framework of the traditional lecture.
- 2- Students do not usually use the knowledge they acquire in a correct manner.
- 3- Students forget a lot of what they have learnt.

Problem – based learning is distinguished by three aspects as information is employed through this strategy in the different life situations, and this helps to retrieve it and connect it with previous information. It also activates the former knowledge and reconstructs it to conform with new knowledge. (Dempasey, 2000).

### **The problem – based learning strategy's elements**

This strategy consists of three main elements which are tasks, cooperative groups and sharing.

#### **Tasks (problems):**

In this phase, the students are encountered by a real scenario of life through problems or tasks that require to be accomplished. For example, the students can be asked to perform a task of drawing a portrait that shows the architectural style in the old times. Thus, each student will have their own perspective of how to build old historical sites. In this phase, the student needs to formulate the problem in a clear phrase even though it might change whenever they reached at new information. (Behrand, 1997).

### **Cooperative Groups:**

In this phase, students normally cooperate during the group's joint discussions as in the light of this strategy, the students are divided into small groups, and the teacher is to encourage the students to cooperate. The cooperative work among the group's students could be the most important element of learning and finding problem solutions as they help each other through exchanging ideas and viewpoints and formulating an understanding to the problem. This cooperation allows the students to develop confidence and freedom of thinking, and in this stage, the tutor provides guidance and direction. Hays and Anderson indicate that students work in small groups using mutual interaction through debate, sharing an information exchange which leads to deepening their understanding, feeling confident about what they have learnt, asking questions with no threat or domination and evaluating the viewpoints of each other. (Cai, 2000).

### **Sharing:**

This is the last phase of teaching through this strategy where the students of each group offer their solutions on the class with the methods they used. Considering the possibility of differences among the groups about those solutions and methods, discussions take place to reach an agreement if possible because those discussions deepen their understanding to the solutions and methods in solving problems and turns to become an intellectual symposium to develop their interpretations and mental inferences (James, 2005).

### **Characteristics of the problem – based learning strategy:**

Of those characteristics are:

- 1) Makes students hold responsibility while learning as they place potential solutions to the problem they face and use information sources expected to be helpful.
- 2) The hub of teaching through this strategy depends on the skillfulness of designing the problem that allows free research.
- 3) This strategy develops the concept of self – learning as well as many social skills like communicating with others, respecting their opinions and listening to them.
- 4) Cooperation is a key principle in this kind of learning as the students debate through it, learn together and help each other to understand and apply what they are learning.
- 5) Students do not control their ideas and views, but rather they feel freedom of expression without domination from the teacher.
- 6) The teacher's role in this model is restricted to guidance and direction in the learning process.
- 7) The students are evaluated through measuring their performance when they face other problems.
- 8) This strategy modifies the negative attitudes of the students toward science as they get accustomed to working eagerly without embarrassment or fear of error (Duch, 2001).

## METHODOLOGY AND PROCEDURES

The study population and Sample: The study population consisted of the basic ninth grade female students in the academic year (2016 / 2017) at the schools of Mafraq directorate of education counting (553) distributed on (7) schools. The study sample consisted of (90) female students of the basic ninth grade chosen following the random cluster method rating (%16.2) of the local population. The sample was embodied in three sections in one of the schools chosen randomly where they were taught physics through the problem – based learning strategy.

### The study Tools

The researcher designed the unit of The mechanics and its effect on substances according to the problem – based learning strategy with the help of the theoretical literature and previous studies and also with the help of science female teachers in Mafraq directorate of education to apply the strategy on their students. The researcher then prepared one measurement tool for the study which is an achievement test that consisted of (40) items the first twenty items of which are to measure the acquisition of the female students to scientific concepts and the last twenty items to measure the development of their science operations. (Al-Khatib, 2004; Al-Katib, 2002; Fredrk and Jerd, 2016, Al-Najdi, 2005; Alderman, 2007).

### Statistical Treatment

The data of this study was treated according to the following methods:

- 1- Chronbach's Alpha coefficient to determine the reliability of the tool.
- 2- Arithmetic means and standard deviations.
- 3- One – way ANOVA.

### Reliability of the Tool:

The researcher used the internal consistency reliability equation (split – half) to find and correct the study tool through Spearman Brown equation. The following table indicates the values of split – half reliability and the corrected reliability.

The split – half reliability coefficient of this study, for the test of acquisition of scientific concepts in physics and the development of science operations, reached at (0.89) while the corrected reliability coefficient was (0.94) which is an acceptable rate in this type of humanistic studies. See table No. (1).

**Table No. (1), the reliability coefficient of the first study tool**

Split – half Reliability coefficient	Corrected reliability coefficient
0.89	0.94

Corrected reliability equation =  $2 \times \text{split – half reliability coefficient} / 1 + \text{split – half reliability coefficient}$

### Data Analysis and Hypotheses test:

**The first main hypothesis:** There are no statistically significant differences at ( $\alpha=0.5$ ) between the average scores of the ninth grade students in the pre – test and post – test of the acquisition of scientific concepts in physics due to the problem – based learning strategy.

**Table No. (2) The arithmetic means, standard deviations and F – value of the responses of the sample members to the first part of the study tool**

Test	Arithmetic mean	Standard deviation	df	F – value	Significance level
Pre -	28	1.447	1	6.542	0.000
Post -	34	0.998	99		

Viewing the former table, we find that there is statistically significant effect at (0.05) between the average scores of the ninth grade students in the pre – test and the post – test to the acquisition of scientific concepts in physics due to the problem – based learning strategy, where the calculated significance level was less than the significance level alpha (0.05) and consequently the acceptance of the alternative hypothesis and the rejection of the null hypothesis. Also, the arithmetic mean of the post – test which came at (34) indicates the effectiveness of the problem based learning strategy. And the arithmetic mean of the sample member on the pre – test was (28), which is a clear and statistically significant difference.

**The second main hypothesis:** There are no statistically significant differences at ( $\alpha=0.5$ ) between the average scores of the ninth grade students in the pre – test and post – test in the development of science operations in physics due to the problem – based learning strategy.

**Table No. (3) The arithmetic means, standard deviations and F – value of the responses of the sample members to the second part of the study tool**

Test	Arithmetic mean	Standard deviation	df	F – value	Significance level
Pre -	23	0.78	1	7.548	0.000
Post -	33	1.02	99		

Viewing the former table, we find that there is statistically significant effect at (0.05) between the average scores of the ninth grade students in the pre – test and the post – test in the development of science operations in physics due to the problem – based learning strategy, where the calculated significance level was less than the significance level alpha (0.05) and consequently the acceptance of the alternative hypothesis and the rejection of the null hypothesis. Also, the arithmetic mean of the post – test which came at (33) indicates the effectiveness of the problem based learning strategy. And the arithmetic mean of the sample member on the pre – test was (23), which is a clear and statistically significant difference.

### THE STUDY RESULTS:

- 1- There is an effect of the problem – based learning strategy in the acquisition of scientific concepts in physics among the ninth grade students.
- 2- There is an effect of the problem – based learning strategy in the development of science operations in physics among the ninth grade students.
- 3- There is a desire among the female students to learn through the problem – based learning strategy where there is great interest among the students to track and utilize this strategy.

**RECOMMENDATIONS:**

- 1- Generalizing the study over different educational establishments in Jordan to urge teachers to follow the problem – based learning strategy when giving lessons in different subjects.
- 2- Constructing and designing the scientific subjects units through modern learning strategies like the problem – based learning strategy to facilitate the learning process for the male and female students,
- 3- Preparing and developing teaching curricula elevated to the required level by the Jordanian Ministry of Education to provide modern and easy learning strategies for students.

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