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The Effectiveness of Using the 7E's Learning Cycle Strategy on the Immediate and Delayed Mathematics Achievement and the Longitudinal Impact of Learning among Preparatory Year Students at King Saud University (KSU)

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Abstract
This study aimed to investigate the effectiveness of teaching Mathematics by using 7E's Learning Cycle strategy in immediate and delayed achievement and retention among Preparatory Year students at King Saud University (KSU) - Saudi Arabia, in comparison with the traditional method. The study sample consisted of (73) Preparatory Year students at KSU who were divided into two groups: the first group consisted of (35) students, who studied mathematics by using the 7E's Learning Cycle; and the second group consisted of (38) students, who studied the same content by using the traditional method. ANCOVA results analysis of the students' scores on the mathematics achievement tests indicated that the 7E's Learning Cycle is more effective than the traditional method on the immediate and delayed mathematical concepts achievement. Also, the results analysis of paired-samples t-test indicated that the 7E's Learning Cycle has a positive longitudinal effect on retention among the Preparatory Year students at KSU, while the traditional method is not effective in this aim.
Keywords: 7E's Learning Cycle Strategy, Mathematical Concepts, Immediate Achievement, Delayed Achievement, Retention, Mathematics.

1. Introduction

The world has witnessed a lot of dynamic changes and so many challenges in the different fields of life, resulted from what is known as the knowledge explosion, and this has put the specialists in mathematics and teaching methods facing a critical challenge, due to their great responsibilities and tasks in search for solutions that help them understand the resulting mathematical knowledge, encourage and motivate the math teachers to help their students acquire and cope with such knowledge, considering that as some of the major objectives of teaching mathematics. For that reason, the US National Council for Mathematics Teachers (NCTM, 2000) considered the process of teaching students to comprehend what they have learnt from the mathematical knowledge is a major objective of the general objectives of teaching math.

Moreover, Al Todari (2004) considered the mathematical knowledge as one of the most important branches of knowledge that the individual needs in order to solve his daily problems and to find reasonable answers to events that are going on around him. Abu Zeineh (2003) pointed out that the mathematical knowledge occupies a prominent position among the different human knowledge, and is considered as a basic requirement in all fields of life, and has become as a propellant that pushes the society wheel of development forward without any obstacles, due to its various practical applications in the individual's daily life. US National Council for Mathematics Teachers (NCTM, 2000) also emphasized on the fact that mathematics teachers need to encourage and motivate their students to develop their mathematical knowledge through investigation, exploration and examining the hypothesis, approximation, solving problems, researching, and discussing ideas.

Mathematical concepts are considered as the principles and foundations on which the mathematical knowledge is built on, as principles, rules and theories which are the relationships that link between concepts, and the mathematical skills. In its essence, they are a practical application of these concepts by putting them into rules and algorithms, which are used to solve the mathematical problems (Obeid, Al Mufti, & Eilia, 2000). Abu Zeineh (2003) also mentioned that modern mathematics is no longer just a routine processes, or separate skills, but it has become coherent structures which are firmly connected together to become one integrated structure, in which concepts form its basic foundation.

Baker and others (Baker et al., 2004) revealed that students who study the traditional curriculum, are offered the concepts in a superficial and a passing method, where focus is mainly made on procedures only. This leads to make students memorize the procedures without a thorough comprehension to the conceptual basis of such procedures, leading them to form incomplete and erroneous images of concepts that have been offered to them. Moreover, students study so many concepts in Algebra, Arithmetic and geometry without an actual understanding. Maously (2004) said that the mathematical concepts are being taught without focusing on its practical usage, or linking them to the students' interests and personal experiences, and this reduces their motivation towards learning the new concept. (Morey, 2010) also pointed out that students' failure to comprehend the compositional and the cumulative relationship between concepts constitutes one of the major causes for the difficulty of learning mathematics in general.

In the light of the great importance to teach and learn the mathematical concepts, and the difficulties that students encounter in learning concepts during their different stages of study, interest has appeared in projects to develop the teaching of mathematics curricula through the implementation of different flexible educational methods and theories in different actual learning situations (Al-Todari, 2004). Interest has increased to look for new teaching strategies that help reduce and overcome the difficulties in the teaching and learning process, and achieve the main objectives of learning the mathematical concepts, which enable students realize such concepts and develop them.

Some of the teaching methods that could achieve this objective are those methods that have adopted what the constructive theory has offered, which concentrates on the student's activity and effectiveness in the learning situations. Qaraleh (2012) pointed out that this theory is considered as one of the most important theories that focused on the learner's cognitive structure, where it considered learning as an active process in building knowledge, and focused on the process that takes place in the learner's brain during the learning situation, where the learner establishes a relationship between the new knowledge and his previous knowledge.

Al Khalili, Hider & Younis (1996) mentioned that for the learner, the constructive philosophy considers that, the meaning is a self- built process, which is formed by the learner's self - cognitive processor, and the formation of meanings for the learner is an active psychological process that requires intellectual activity. The constructive theory derives its philosophy from Piaget theory in the cognitive development, in which he described the learner's cognitive development and his acquisition of knowledge through the concept of cognitive balance, which enhances the learner to restore the balance between his previous knowledge and the new knowledge, that he has just learnt, that is, through the process of illustration and simulation, which ultimately leads into the development of his cognition.

Neo & Neo (2009) pointed out that the constructive learning environment makes the activities in which the learner is the center of the learning process, take place, where learners work together, support each other, use different tools and learning resources in order to achieve the learning objectives and solve problems.

Learning Cycle appeared in the United States in 1962, it was a method for lesson planning, designed primarily to develop the methods of teaching science, and in fact it achieved a great success, as it considers learning as an investigative process, and commensurate with the way that students learn, that provides them with an excellent domain for an effective planning for teaching (Lawson, 1995).

In its initial stages, the Learning Cycle consisted of three stages: The concept exploration, introducing the concept and the concept application (Zeitoun, 2007). Abraham & Renner (2006) mentioned that the three stages of the Learning Cycle match the basic foundations in Piaget pattern for the cognitive development (illustration, adaptation and organization), where information is illustrated in the stage of exploration, and adaptation process is made in the stage of the concept introduction, and information or concept is organized in the stage of application. In 1974 Karplis introduced a set of amendments, which appeared as a part of the science improvement project for the elementary stage, which was introduced by California University, and consisted of four stages: exploration, explanation, expansion and assessment.

Then Bybee in 1993 developed a constructive educational pattern which he named 5E's that consisted of five stages: Involvement, exploration, explanation, expansion and assessment. Then in 2001, the educational experts team in Miami University USA developed a teaching strategy consisted of seven stages, which was named the 7E's Learning Cycle (Al Eid, 2014).

Sadeq (2003) defined the 7E's Learning Cycle as an educational pattern consists of seven teaching and learning steps, used by the teacher with his students inside the classroom, aiming at enabling the student to build his scientific knowledge acquisition by himself. Also, it aims at developing a lot of other scientific concepts and skills, depending on motivation, reconnoitering, curiosity, explanation, exploration, and expansion, connecting concepts together and amending some of students' wrong concepts.

7E's Learning Cycle is featured by a lot of advantages that help learners acquire concepts and apply them in new contexts and real situations, it also develops the students' skills of scientific research, improves their problem solving abilities, develops their skills of dialogue and team work spirit, in addition it helps them amend their wrong visions on the previous mathematical concepts related to the lesson topic, (Khataibeh, 2005 ; Shalayel, 2003).

The 7E's learning cycle strategy includes the following seven stages (Afaneh & Al Jaish, 2008):

1. Excitement: This stage aims at motivating learners and enhancing their curiosity for learning the concept. Teacher motivates his students and creates the element of curiosity among them and encourages prediction.
2. Exploration: This stage aims at satisfying the learners' curiosity through providing them with necessary experiences and aid, in order to enable them to acquire the meaning of the concept. Teacher in this stage designs activities that enable learners to recognize the concept structure, and will be responsible for providing sufficient and clear instructions and suitable tools related to each activity, giving them the opportunity to work in groups to practice investigation. This stage leads to enhance students intellectually, that is, due to the variety of new well-designed activities it contains, and so the student's cognitive balance is disturbed, and this motivates him to ask questions and seeking answers, that he cannot answer, and then

reach primary conclusions about the concept, discovering new ideas or relationships which were not recognized for him before.

3. Explanation: This stage aims at explaining the concept as well as the terms. In this stage, teacher directs his students towards the concept construction and identifying it in a cooperative manner through emphasizing on certain sides of the activities that they practiced in the exploration stage. To achieve that, teacher collects the information that his students gathered in the exploration stage and helps them organize and process these information, providing them with the necessary explanations that help them organize their exploratory experiences in its correct position and put them in order to identify the concept. This stage helps the student recover his cognitive balance, in accordance with the concept of matching which was talked about by Beige in his theory about the cognitive development.
4. Expansion: It is also called the application stage, aiming at the discovery of new applications for the concept, in this stage learners use their acquired experiences about the concept and apply it in new situations and problems so as to expand their comprehension of such experiences, leading into a deeper understanding of the concept. Teacher at this stage will focus his efforts to expand the students' understanding by providing more related examples on this concept.
5. Extension: This stage aims at clarifying the relationship of the concept with other concepts, in which the teacher helps his student recognize how the concept relates with other concepts, through asking questions that help them discover such relationships.
6. Exchanging: This stage aims at exchanging experiences and ideas or changing them, where the teacher encourages the students' cooperation and participation through well-designed activities and exchanging experiences.
7. Evaluation: Teacher in this stage evaluates his students' learning of the concept and provides them with the suitable feedback, that is, through putting them in new situations and dealing with new problems. Evaluation process may be carried out through each stage of the learning cycle stages instead of the final stage only.

Educational literature emphasizes the effectiveness of using the 7E's Learning Cycle strategy in improving the mathematics teacher's performance in teaching the mathematical concepts. In the study conducted by (Al Azmeyeh & Al Shrahid, 2015) aiming at investigating the effect of using the Learning Cycle in teaching one of the mathematical units for the 7th grade, in the development of achievement and mathematical thinking among students in Abian (Yemen) Governorate. The sample consisted of (80) students, divided into two groups, experimental group learnt by using the Learning Cycle, and control group studied by the traditional method. The results showed a statistically significant difference between the mean scores of students of experimental and control groups in their achievement and in the mathematical thinking skills: generalization, induction, using symbols, logical thinking, and proof.

Ahmad & Khudair (2014) conducted a study aimed at investigating the impact of the Learning Cycle on the acquisition of the mathematical concepts among the fifth primary girls students, the results showed the distinction of students who learnt in the experimental group that studied by the 7E's Learning Cycle on those who learnt by the traditional one in the acquisition mathematical concepts test.

Al Eid (2014) also conducted a study aimed at investigating the effect of teaching a suggested unit based on 7E's Learning Cycle strategy in the development of mathematical communication skills in geometry and their retention by the 9th grade students in Gaza strip (Palestine). To achieve the objectives of the study, the researcher used semi-experimental research method with a pre-post test equivalence group design. The study sample consisted of (72) female students were selected randomly, and they have been divided into two equal groups: the experimental group students taught using a suggested unit based on 7E's strategy, and a control group students taught using the usual way, where the study was applied to the "Circle Unit" of the mathematics curriculum for the 9th grade primary in Palestine. The study indicated that there was a statistically significant difference between the mean scores of students of experimental and control groups in the post application to measure communication skills in mathematical geometry, in favor of the experimental group. The study also indicated that there was no statistically significant difference between the mean scores of students in the experimental group in the post test application and deferred post test to measure mathematical communication skills in geometry.

Tona & Kacar (2013) conducted a study aimed at investigating the effect of 5E learning cycle model, based on the constructivist approach, which is used for teaching trigonometry in 10th grade of elementary mathematics education, on the students' academic achievement and on the permanence of their trigonometry knowledge is investigated. The participants of this research are 10th grade students registered for spring semester of 2010-2011 academic year to an Anatolian high school in Kastamonu (Turkey). These students were divided into two equal groups, a control and an experimental group. The students in the experimental group took the course about trigonometry from the researcher in an environment where the 5E learning model based on the constructivist approach is used. The students in the control group took the same course from their mathematics teacher in an environment where the activities of official mathematics curriculum are used. The statistical findings of the

research show that the experimental group students' scores of academic achievement and permanence of trigonometric knowledge are higher than those in the control group. The difference between these groups is statistically significant and is in favor of the experimental group.

Al Shahri (2013) carried out a study aimed at investigating the effect of teaching mathematics using the 7E Learning Cycle in Achievement and developing creative thinking Skills of the 7th grade Students. To achieve this goal, the researcher prepared two mathematics tests (achievement and creative thinking skills). The sample consisted of (60) students in Aseer Educational District (Saudi Arabia). It was divided into two equivalent groups: experimental students studied the "Integers Unit" using 7E learning cycle, while the control group students studied the same unit using the traditional method. Two post tests (achievement and creative thinking skills) were applied for both groups. The research results indicated statistical significant differences between the mean scores of students of experimental and control groups in their achievement and in the creative thinking skills.

Saleem (2012) carried out a study aimed at investigating the effect of using the 7E's Learning Cycle strategy on developing some mathematical thinking skills in the both sides of brain of the 8th grade female students in Gaza Strip. A purposive sample of (85) female students was chosen. The purposive sample consisted of intervention group (43 students) & control group (42 students). Brain control test and mathematical reasoning skills test were applied. The research results indicated statistical significant differences between the average degrees of both intervention & control groups in the dimensional application of some mathematical reasoning skills development test of the both controlled sides of the brain (the left & the right).

Al Jawaani (2011) conducted a study aimed at investigating the impact of the 7E's Learning Cycle strategy on achievement and the ambition level among the 8th grade students in mathematics. The sample consisted of (60) students who were divided into two equivalent groups: experimental group students studied using 7E learning cycle, while the control group students studied using the traditional method. The study indicated that there was a statistically significant difference between the mean scores of students of experimental and control groups in both achievement test and measuring the level of ambition, in favor of the experimental group.

Al Kubaisi study (2009) aimed at investigating the effect of using the 7E's Learning Cycle model on acquiring the mathematical concepts among the 8th grade students, and raising motivation for learning mathematics. The study revealed that there was a statistically significant difference between the mean scores of students of experimental and control groups in both achievement test and motivation scale for learning mathematics.

Yenilmez & Ersoy (2008) conducted a study aimed at determining opinions of mathematics teacher candidates towards applying 7E's instructional model on computer aided instruction environments. The descriptive case study model was used in this study. The sample of the study consists of (52) mathematics teacher candidates which were selected randomly from elementary education program at one of the Turkish universities. Data were collected by "applying 7E instructional model on computer aided instruction environments" questionnaire and a demographical form. The findings of this study have been evaluated within mean, standard deviance, maximum and minimum values as dependent to the descriptive case study model. The study results revealed that the teachers' opinions on using the 7E's Learning Cycle based on a computer supported environment were positive.

In the study conducted by Barojas & Dehesa (2001), aiming at investigating the effectiveness of using various strategies in teaching mathematics for the social sciences section students, the study results indicated the effectiveness of using the Learning cycle strategy in building the mathematical cognition and facilitating its concepts for non-specialists, and its effectiveness in dealing with problems occurred from learning mathematics by the social science students. The study conducted by Frid (2000) to investigate the effectiveness of the training program for the mathematics teachers on using the Learning cycle strategy in teaching mathematics, indicated that the significant effectiveness of the training program improves the teachers' performance when teaching, by using the Learning Cycle strategy.

On the other hand, there were some studies which opposed what the educational literature has indicated, regarding the effectiveness of the Learning Cycle strategy in the mathematics achievement. In the study conducted by Al Otaibi (2008), aiming at investigating the effectiveness of the Learning Cycle strategy in the mathematics achievement and in the development of the critical thinking skills among 8th grade students in Makka (Saudi Arabia). The study results revealed the ineffectiveness of this strategy in the achievement of the mathematical concepts, in comparison with the traditional method. In the study conducted by Al Harbi (2007), aiming at investigating the effect of the Learning Cycle strategy in the development of the mathematical concepts and retention among 7th grade students. The researcher applied her experiment on a sample consisted of (147) students in Al Madina (Saudi Arabia). The study revealed the ineffectiveness of this strategy in the development of the mathematical concepts and the retention, in comparison with the traditional method.

2. Problem of the study

Through his work as a coordinator at Preparatory Year at King Saud University (Saudi Arabia), and during his attendance of so many lectures with the department teachers, the researcher recognized that teachers spend most of the time in teaching the skills, algorithms and the procedures, paying less attention to the development of

concepts among their students. Furthermore, when teaching a concept, they did that just by writing the definition of this concept and providing some related examples without linking this concept with the students' previous Knowledge and experiences or with other related concepts. The researcher also noted that the students' level in the acquisition of concepts was very low, and observed the students' weakness in reconstruction of the mathematical concepts in the form of conceptual systems and implementing the same in constructing the mathematical cognition. He also noted the prevalence of the traditional methods and strategies in the teaching practice, which depend on the lecture and memorization method that establishes some of the most prominent flaws, such as the learner's passivity, cancellation of his motivation for learning and makes the learner just memorize and repeat information without sense or understanding.

Due to the great importance of teaching and learning the mathematical concepts, and taking into consideration its development and longevity of learning among students as one of the basic objectives of teaching mathematics, and the problems that students encounter in their different stages of study, in addition to the wrong mathematical concepts that have been formed (Abdurrahman, 2000), due to its abstract nature, in addition to the negativity of some students and the retraction of their activities during the learning process (Al Todari, 2004). A tendency and desire of searching for new strategies and models of teaching, appeared to help students solve the problems they encounter in comprehending the mathematical concepts, and acquire the deep conceptual understanding, and the ability to apply the scientific thinking skills in building the mathematical knowledge in a meaningful way that helps them see and perceive the components and relationships between concepts, theories and rules.

From this point, the main objective of this study is to find the most appropriate method for teaching the mathematical concepts that addresses the shortcomings of the current strategies used in teaching mathematical concepts at our universities, which focus mainly on lecturing and memorizing methods that have a lot of disadvantages such as the learner's passivity, lack of motivation, memorization of information, and repeating it without understanding. The majority of the university teachers depend on the lecture approach in their teaching process, in which the lecturer delivers and explains the information, or by a question – answer method between the teacher and his students, and by both methods, the student is not given the opportunity to acquire the mathematical concepts, resulting into a situation in which the student does not understand the cumulative and interrelation between concepts.

Proceeding from what the previous studies had indicated, that is, the prominent role that the Learning Cycle could play in the students' achievement in the area of the mathematical concepts, and the impact of learning and its longevity on the learner, (Al Eid, 2014; Tuna & Kacar, 2013), the idea of this study had originated, with a major aim represented in investigating the effectiveness of using the 7E's Learning Cycle in the immediate achievement, the delayed achievement, and the retention among the Preparatory Year students at KSU (Saudi Arabia), by providing an answer to the following specific and major question: What is the effectiveness of teaching mathematics by using 7E's learning cycle in immediate and delayed achievement and retention among the Preparatory Year students at KSU?

3. Hypothesis of the study

To answer the major question of the study, the following Hypothesis were tested:

First Hypothesis: There is no statistically significant difference at a significance level ($\alpha = 0.05$) between the scores mean achieved by the preparatory year students at KSU, who study mathematics by using the 7E's Learning Cycle, and those students who study mathematics by the traditional method, in the post immediate application of the achievement test.

Second Hypothesis: There is no statistically significant difference at a significance level ($\alpha=0.05$) between the scores mean achieved by the preparatory year students at KSU, who study mathematics by using the 7E's Learning Cycle, and those students who study mathematics by the traditional method, in the post delayed application of the achievement test.

Third Hypothesis: There is no statistically significant difference at a significance level ($\alpha=0.05$) between the scores mean achieved by the preparatory year students at KSU in the post immediate application of the achievement test and their scores in the post delayed application test that can be attributed to the teaching method 7E's Learning Cycle strategy, traditional method).

4. Significance of the study:

- This study is considered as an objective response to so many demands from the specialists and educators for the necessity of introducing the mathematical concepts in new methods and approaches emphasizing on the element of interaction between the teacher and the learner, where the learner plays a positive as well as a significant role in this process. It is also considered as an extension to studies which applied the strategy of the Learning Cycle in its different stages and fields of learning, in a way that it enriches knowledge in this field, which is still in its experimental stages at the university

education.

- This study is of great importance for the educational institutions and universities due to what it may add, The strategy of the 7E's learning Cycle, whose results might contribute to shedding light on the effectiveness of this strategy in teaching the subject of mathematics, and open wider areas and scopes for other studies aiming at the development of new and different teaching methods in order to improve the learning process, which is our major target.
- This study results might introduce an effective teaching method that help school teachers as well as university teachers introduce the mathematical concepts in a way that help their students acquire and apply them in different situations and contexts.
- Taking into consideration that the Learning Cycle is not just a method of teaching, but it is also a method of organizing the learning material in the curriculum, and the validity and effectiveness of this study shall encourage the curriculum designers in Saudi Arabia to use it in organizing the scientific material contained in the mathematics books.

5. Procedural definitions

The 7E's Learning Cycle: A teaching strategy used by the teacher inside the classroom in teaching the educational content for the experimental group, during which the teacher presents his learning material by the 7E's Learning Cycle strategy, that consists of seven stages: Excitement, Exploration, Explanation, Expansion, Extension, Exchanging, and, Evaluation.

The traditional method: A teaching method used by the teacher inside the classroom in teaching the content for the control group, during which he presents the learning material by explanation, depending on the whiteboard and the power point presentations, during which the teacher asks few questions and gives a little opportunity for the oral discussions.

The immediate achievement in mathematics: The amount of the mathematical knowledge that the student acquired within the three levels of the mathematical knowledge (conceptual knowledge, procedural knowledge, problems solving) after he has finished learning the content immediately. The student's immediate achievement in mathematics is measured by the scores that he has obtained in the post immediate application of the achievement test, which was applied on the study sample immediately after the study experiment had ended.

The delayed achievement in mathematics: The amount of the mathematical knowledge that the student acquired within the three levels of the mathematical knowledge (conceptual knowledge, procedural knowledge, problems solving), after three weeks of completing the study experiment. The student's delayed achievement in mathematics is measured by the scores that he has obtained in the delayed immediate application of the achievement test, which was applied on the study sample 3 weeks after the study experiment had ended.

Retention in mathematics: The student retains the mathematical knowledge which he has acquired after he had studied the learning content, and this knowledge continue to exist for 3 weeks after the experiment has ended. The retention was explored among the students of the group by finding out the statistical significance difference between the mean of scores in the post immediate application of the achievement test and the mean of their scores in the delayed application of this test

6. Limitations of the Study:

The study results could be distributed in the light of the following limitations:

- The study sample was limited to a number of students from the Scientific - Engineering Colleges track in the preparatory year at KSU, who were registered in the first semester 2014/2015.
- The learning material was limited to the second unit (The Functions) from the approved book for teaching the course of "Differential Calculus, Math 140" (Khashan et al., 2014).
- The study was limited to applying the 7E's Learning Cycle strategy, which consists of seven stages (Excitement, exploration, explanation, expansion, extension, exchanging, and evaluation).

7. Method and procedures

7.1 Population and sample

The study population consisted of the Science and Engineering Colleges track students, from the preparatory year at KSU, who were registered in the course of "Introduction in mathematics Math 140" – the first semester - 2014/2015. While the study sample consisted of (63) students of the Science and Engineering Colleges track, from the preparatory year at KSU, who were registered in the course of Math 140 - First semester - Academic year 2014/2015, divided into four sections, taught by one of the course teachers, and were divided randomly into two groups. the first group, the experimental group, consisted of two sections with (36) students, who were taught the content by using the 7E's Learning Cycle strategy, while the second group, the control group, consisted of two sections with (38) students, studied the same content by the traditional method.

7.2 Treatment the content according to the 7E's Learning Cycle strategy

The researcher treated the topics of the 2nd unit (The Functions) from the text book in accordance with the 7E's Learning strategy. The topics included: Definition of the function, graphs, operation on functions, combining functions, inverse functions, and logarithmic and exponential functions. The treatment was conducted through the following steps:

1. Handling the topics according to the 7E's Learning Cycle strategy, on the bases of the seven stages documented by (Afaneh & Al Jaish, 2008).
2. Presenting the handled learning material to a group of specialists in the methods of teaching mathematics, and a group of teaching staff specialized in mathematics, so as to add, amend or cancel any of the study items.

7.3 Preparation of the achievement test

After, reviewing the previous educational literature, determining the objective of the achievement test, the learning content analysis, determination of the study desired objectives, classification of these objectives into three levels (conceptual Knowledge, procedural knowledge, problem solving), determination of the comparative weight for the objectives of each level, determination of the comparative weight for each topic of the learning material topics, preparation of table of specifications that include the three levels (conceptual Knowledge, procedural knowledge, problem solving), according to those weights, the researcher prepared a test to measure the sample students' mathematics achievement. The test consisted of twenty multiple choice questions, four different answers were provided for each question, from which one is the correct answer. These questions covered all of the content, and were distributed as follows: Eight questions related to the conceptual knowledge level, seven questions related to the procedural knowledge level, five questions related to problems solving level. The researcher depended on the International study in Mathematics made in 1991, in his classification of the mathematical knowledge into its three levels, which classified knowledge into: conceptual knowledge, procedural knowledge, and problem solving (Abu Zeineh, 2001).

Validity of the achievement test: To ensure the validity of the achievement test content, and the validity of its questions to measure the desired educational objectives of teaching content, it was presented to a group of arbitrators specialized in curriculum and teaching methods of mathematics, measurement and evaluation, and to a group of the teaching staff, specialized in mathematics. After reviewing the comments and suggestions of the arbitrators, some the test questions were reformulated, and two questions were replaced by other questions of the same cognitive level, and so it was ready in its final form, without any change in the number of questions for any of the three levels of knowledge.

Reliability of the achievement test: Measuring the constancy of the achievement test, which has been applied on an exploratory sample of the study population, and outside designated sample, consisting of (23) students, and the internal consistency coefficient was found, represented in Cronbach's Alpha Coefficient (α), and found that it was equal to (0.85), and an appropriate value to achieve the purposes of this study.

Test Scoring: One mark was given for each correct answer, and zero was given for the wrong answer, so the maximum mark of the test was (20) marks, and the minimum mark was zero, then the student's obtained mark was turned to be calculated from 100 marks.

The difficulty coefficients and the differentiations coefficients of the test questions: Using the exploratory sample scores in the achievement test, the difficulty coefficients and the differentiations coefficients were made for each question of the test, and it was revealed that the difficulty coefficients ranged between (0.34) and (0.79), and the differentiation coefficients ranged between (0.31) and (0.83), which indicates that they are appropriate values to realize the objective of this study.

7.4 Determination of the study variables

Having the study sample been chosen and the groups been determined, its variables have been determined, as follows:

- Independent variable: The study included one independent variable, that is, the teaching method which has two levels: The 7E's Learning Cycle strategy and the traditional method.
- Dependent Variables: The study included three dependent variables that the study tends to determine the impact of the independent variable in them, they are: The immediate achievement in mathematics, the delayed achievement, and the retention.

7.5 Determination the design of the study

The study sample was chosen intentionally from the preparatory year students at King Saud University. The experiment was applied on four sections, which were taught by the same teacher, distributed randomly into two groups, each group included two sections classes. The experiment was applied on groups without any change. Therefore this study is considered to be "a descriptive quasi experimental", and its design can be described as

follows:

G1 : ---- 01 X 02 03
G2 : ---- 01 X 01 03

Whereas:

- G1: First group (Experimental group).
- G2: Second group (Control group).
- O1: Pre- application of the achievement test.
- O2: Post immediate application of the achievement test.
- O3: Post delayed application of the achievement test.
- X: Experimental treatment, that is, teaching by using the 7E's Learning Cycle strategy.

7.6 Pre- application of the achievement test

Before carrying out the study, the achievement test was applied on the study sample to check the equivalence of the two groups in this test, and so to determine the statistical analysis pattern that would be used to identify the statistical difference between the mean scores of both groups in the post immediate application and the post delayed application of this test. In order to examine this equivalence, the means and the standard deviations were calculated for both groups in the pre-application of the achievement test, and the results were presented in table 1.

Table 1. The mean and standard deviations of the study sample's scores on the pre-application of the achievement test (max. score= 100)

Group	N	Mean	SD
Experimental	35	20.14	9.43
Control	38	24.60	8.80

Table 1 shows that there is a difference between the mean scores of the two groups in the pre-application of the achievement test, where the scores mean of the experimental group was (20.14), while that of the control group was (24.60), that is with a difference of (4.46) in favor of the control group. In order to examine the significance of this difference, the t- test was used, and the results were presented in table 2.

Table 2. t-test results of the study sample's scores on the pre-application of the achievement test (N=73)

Group	Mean	df	t	Sig. (p)
Experimental	20.14	71	2.09	0.040
Control	24.60			

Table 2 shows that the calculated t for the difference between the two means was (2.09), and its significance level was (0.040), which indicates that there is a statistically significant difference at the level (α=0.05) between the mean scores of the two groups in the pre-application of the achievement test, and so the two groups were unequal in this test.

7.7 Implementation of the study experiment:

The study experiment was applied on the members of the study sample according to the following steps:

- Training was provided to the mathematics teacher on applying the 7E's Learning Cycle strategy in teaching the experimental group.
- Training was provided to the experimental group by the mathematics teacher on applying the 7E's Learning Cycle strategy in teaching the accredited learning material.
- During the first semester of the Academic year 2014/2015, and after the completion of the required procedures for the implementation of the study experiment, the Math teacher taught both of the study groups, in accordance with the proposed method for each group, where the implementation of this experiment took (6) weeks, by (4) hours a week.

7.8 Post immediate application of the achievement test

Immediately after the completion of the experiment, the achievement test was applied for the second time on the study sample, then the scores were recorded in order to process them statistically and examine the veracity of first hypothesis.

7.9 Post delayed application of the achievement test

Three weeks after the completion of the study experiment, the achievement test was applied on the members of the study sample for the third time, then the scores were recorded in order to process them statistically examine the veracity of second and the third hypothesis.

7.10 Statistical processing

After the completion of the study experiment, and the scores of the members of the study sample in the pre-

application and the post- application of the of the delayed achievement test, were inserted into the statistical program SPSS, then the arithmetic means and the standards deviations were calculated, and the analysis of covariance: ANCOVA were used to examine the veracity of first and the second hypothesis, and the (paired – samples t-test) to examine the veracity of the third hypothesis.

8. Results

8.1 Results related to the first hypothesis

To examine the first hypothesis, the scores of the study sample in the pre-application and the post immediate application achievement test were inserted into the statistical program SPSS, then the mean and standard deviation of both groups were calculated, which were indicated as in table 3:

Table 3. The mean and standard deviations of the study sample's scores on the pre-application and the post immediate application of the achievement test (max. score= 100)

Group	N	Pre-application		Post immediate application	
		Mean	SD	Mean	SD
Experimental	35	20.14	9.43	67.71	11.96
Control	38	24.60	8.80	63.82	9.82

Table 3 shows that the mean scores of the experimental group in the pre-application of the achievement test was (20.14), and its mean scores in the post immediate application was (67.71), that is, with a difference of (47.57) in favor of the post immediate application. Table 3 also indicates that the mean scores of the control group in the pre-application of the achievement test was (24.60), and its mean scores in the post immediate application was (63.82), that is, with a difference of (39.22) in favor of the post immediate application. This means that the difference between the post immediate application and the pre-application of the achievement test was in favor of the experimental group. To examine the significance of this difference, the ANCOVA analysis was used, and the results were presented in table 4.

Table 4. ANCOVA results of the study sample's scores on the post immediate application of the achievement test

Source	Sum of Squares	df	Mean Square	F	Sig. (p)
Pre-test	1034.10	1	1034.10	9.78	0.003
Teaching method	570.95	1	570.95	5.40	0.023
Error	7404.76	70	105.78		
Corrected total	8715.75	72			

Table 4 shows that the calculated F for the teaching method was (5.40), and its significance level was (0.023). This indicates a significant difference between the means of the two groups in the post immediate application of the achievement test in favor of the experimental group, and this leads to reject the "first hypothesis". So, the 7E's learning cycle method was more effective than the traditional method in the immediate achievement of mathematics among the Preparatory Year Students at KSU.

8.2 Results Related to the second hypothesis

To examine the second hypothesis, the scores of the study sample in the pre-application and the post delayed application of the achievement tests were inserted into the statistic program SPSS, then the mean and standard deviation were calculated for the scores of each group, and the results were presented in table 5.

Table 5. The mean and standard deviations of the study sample's scores on the pre application and the post delayed application of the achievement test (max. score=100)

Group	N	Pre-application		Post immediate application	
		Mean	SD	Mean	SD
Experimental	35	20.14	9.43	62.57	7.89
Control	38	24.60	7.69	57.63	7.69

Table 5 shows that the mean scores of the experimental group in the pre-application achievement test was (20.14), and its scores mean in the post delayed application was (62.57), that is with a difference of (42.43) in favor of the post delayed application. Table 5 also indicates that the mean scores of the control group in the pre-application of the achievement test was (24.60), and its mean scores in the post delayed application was (57.63), that is with a difference of (33.03) in favor of the post delayed application. This means that the difference between the post delayed application and the pre-application of the achievement test was in favor of the experimental group. To examine the significance of this difference, the ANCOVA analysis was used, and the results were presented in table 6.

Table 6. ANCOVA results of the study sample's scores on the post delayed application of the achievement test

Source	Sum of Squares	df	Mean Square	F	Sig. (p)
Pre-test	265.81	1	265.81	4.61	0.035
Teaching method	594.91	1	594.91	10.31	0.002
Error	4039.60	70	57.71		
Corrected total	4750.00	72			

Table 6 shows that the calculated F for the teaching method was (10.31), and its significance level was (0.002). This indicates a significant difference between the means of the two groups in the post delayed application of the achievement test in favor of the experimental group, and this leads us to reject the "second hypothesis". So, the 7E's learning cycle method was more effective than the traditional method in the delayed achievement of mathematics among the Preparatory Year Students at KSU.

8.3 Results related to the third Hypothesis

To examine the third hypothesis, the scores of the study sample in the post immediate application and the post delayed application of the achievement test were inserted into the statistical program SPSS, and the paired-samples t-test was used. The results were presented in table 7.

Table 7. t-test results of the study samples in the post immediate application and the post delayed application of the achievement test

Group	Application	N	Mean	SD	df	t	Sig. (p)
Experimental	Immediate	35	67.71	11.96	34	1.78	0.084
	Delayed	35	62.57	7.89			
Controlling	Immediate	38	63.82	9.82	37	3.73	0.001
	Delayed	38	57.63	7.69			

Table 7 shows that the mean scores of the experimental group in the post immediate application of the achievement test was (67.71), and its mean scores in the post delayed application of the achievement test was (62.57), that is with a difference of (5.14) in favor of the post immediate application, and the calculated t of this difference was (1.78), and its significance level was (0.084), which indicates that there is no a significant difference between the two means at the significance level $\alpha = 0.05$. Furthermore, table 7 shows that the mean scores of the control group in the post immediate application of the achievement test was (63.82), and its scores mean in the post delayed application of the achievement test was (57.63), that is with a difference of (6.19) in favor of the post immediate application, and the calculated t of this difference was (3.73), and its significance level was (0.001), which indicates that there is a significant difference between the two means at a significance level $\alpha = 0.05$. This indicates that the retention among the experimental group, and the lack of this retention among the control group. This leads us to reject the "third hypothesis", and it also indicates the effectiveness of using the 7E's learning cycle in the retention among the Preparatory Year Students at KSU, and the ineffectiveness of the traditional method

9. Discussion

Results indicated that using the 7E's Learning Cycle strategy is more effective than the traditional method in both the immediate achievement and the delayed achievement in mathematics, besides the retention among the Preparatory Year Students at KSU. This might be attributed to the fact that the 7E's Learning Cycle strategy made the experimental group student more active and the center of the teaching – learning process, where he learns in an exploratory environment which is rich in internal and external enhancers, during which he practices investigative processes, and meets experiences and various learning situations that help him explore the concept and determine its verbal meaning, and this created an active learning that contributes to the learner's acquisition of the new scientific knowledge, and increased his motivation and enthusiasm for learning, and so improved his achievement in mathematics, and what is more the longitudinal of the impact of learning to a degree which is more than that of the traditional method of learning used for teaching the control group. Moreover, the 7E's Learning Cycle pays more attention to the student's previous knowledge and experiences, and it is interested in selecting and organizing the content's skills, by which it made it easy for the learner to absorb and process the learning material in his cognitive structures, besides forming new cognitive structures. This helped the students of the experimental group to link the new knowledge with their previous knowledge and experiences, that is, before constructing the new knowledge in their cognitive structures, and so the occurrence of their development and improvement, that is, when they learned in accordance with the stages of this strategy which is bases on the "Constructive theory" which focused on the "Learner's cognitive structure", during which the learner creates a link between the new knowledge and his previous knowledge and experiences, which is based on Piaget theory of the "cognitive development", which says that when the individual faces a new knowledge, a state of cognitive unbalance is occurred to him, which motivates him to recover balance between his previous knowledge and experiences and the new knowledge, that is, through a process of matching and comparison, and this caused the

occurrence of the knowledge development among the experimental group students, and so learning something meaningful and significant.

In the excitement stage, the teacher motivated his students and raised their curiosity for learning the concept. In the exploration stage, the teacher designed activities that enable students explore the concept structure, and gave them the opportunity for investigation, through cooperative groups. In the explanation stage, the teacher directed them for constructing the concept and identifying it in a cooperative groups of work, through concentrating on certain areas of the activities which they had practiced in the exploration stage, he also helped them in organizing and processing the data that they had gathered in the exploration stage, and provided them with the required explanations that helped them in placing the exploratory experiences in its correct position in order to reach the concept itself. While in the expansion stage, the learners used what they had learnt of new experiences about the concept to apply in new problems and situations, so as to expand their understanding of such experiences. In the extension stage, the teacher helped his students to realize how the concept relates with other related concepts, that is, through asking questions that help them discover such relationships. In the exchange stage, the teacher encouraged the students' cooperation and participation through activities and exchanging experiences. While in the evaluation stage, the teacher evaluated his students' learning and their acquisition of the concept, and provided the required feedback, that is, through putting them in new situations and problems of a higher level than that of the usual method used in teaching the control group, where the teacher played a limited role in the learning and teaching process, and where the teacher played the central role when he presented the learning material, using the method of explanation, depending on the board and on the power point presentations, with few questions and limited oral discussion.

Larson (2001) confirmed this when he mentioned that using the 7E's Learning Cycle helps students build concepts and develop constructive patterns among them in an environment where the learner is the center of the teaching –learning process. Also (Blank, 2000) emphasized that when he pointed out that using the 7E's Learning Cycle helps students to link the new knowledge with their previous knowledge and experiences. (Zeitoun, 2007) and (Musheno & Lawson, 1999) emphasized that when they considered the 7E's Learning Cycle is based on the investigative pattern, and using it maintains the availability of the scientific investigative environment that enables students practices investigation, research and exploration, which in its turn results into an actual learning. This also was confirmed by (Ibrahim, 2008) when he considered the social interaction that is occurred in this strategy among the learners themselves and their teacher contributes greatly to the learning process.

Furthermore, this strategy provided the learner the opportunity to learn the concept as a research method, during which the teacher moves from the part into the whole, and this in itself suites the learner's nature who depends on the inductive method in learning concepts. This was emphasized by (Zeitoun, 2007) when he pointed out that the Learning Cycle pattern is considered as one on the prominent patterns used in teaching concepts, due to various advantages, as it helps the teacher facilitate the difficult concepts for his students, and helps the learner acquire the abstract concepts that require an ability of abstract thinking skill to be understood, and which are difficult for some students with ordinary thinking skills to understand by usual methods. (Al Todari, 2004) also confirmed that when he regarded the Learning Cycle pattern as one of the important patterns of teaching courses in general, and teaching mathematics in particular, due to its numerous merits in this regard that help extend the learners' perceptions towards learning mathematics concepts, which might appear unfamiliar for them, besides the role that this pattern can play in reinforcement of the meanings of the concepts in the learner's mentality.

This was also emphasized by Marek et al. (1994) when they pointed out that the Learning Cycle generates a kind of a functional learning among learners that lasts for a longer period than that which is caused by the traditional methods of teaching. This was also emphasized by Al Khalili and others (1996) when they pointed out that the Learning Cycle achieves a meaningful learning, based on understanding, that is, due to the learners' active role they perform within the learning situations, and through their effective participation in the learning process. This was also confirmed by Al Bakri & Al Keswani (2001) and Al Khalili & others (1996) when they considered that the Learning Cycle develops and enhances the learners' cognitive experiences and improves their achievement, increases their comprehension to concepts as they integrate their new experiences with their previous ones, takes into account the individual differences among learners as it depends on the learner's personal experience, helps students of perceived thinking acquire the abstract concepts, helps create proper learning environment that supports the active learning, helps create an active investigative learning environment during which the learner is the center of the learning process which makes the learner's role more positive and increases the degree of his motivation and participation, and most importantly causes the learning impact lasts for a longer time.

In reviewing the educational literature, it is found that there are so many studies which have conformed and agreed with the results of this study, for instance: Al Azmeyeh & Al Shrahid study (2015), Ahmad & Khudair study (2014), Al Eid study (2013), Al Shahri study (2013), Tuna & Kacar study (2013), Saleem study (2012), Al Jawaani study (2011), and Al Kubaisi study (2009), which all confirmed in their results that the 7E's Learning Cycle strategy is more effective than the usual strategy in the students' achievement of the mathematical concepts. However, it was found that the results of this study contrast with the results of two of the aforementioned studies,

they are: Al Otaibi study (2008) which pointed out that the Learning Cycle strategy is ineffective in the students' achievement of mathematical concepts, compared to the traditional method, and Al Harbi study (2007) which pointed out the ineffectiveness of the Learning Cycle in the achievement of the mathematical concepts, and the longitudinal of the learning impact, compared to the traditional method.

10. Recommendations

In accordance with the study findings, it is recommended that:

- Teaching staff at universities shall use the 7E's Learning Cycle strategy in teaching the mathematical concepts.
- Providing the proper training for the university teaching staff on using the 7E's Learning Cycle strategy in teaching the mathematical concepts.
- Conducting more studies to investigate the effectiveness of the 7E's Learning Cycle strategy in the achievement of the mathematical concepts by the university students in other mathematics courses.

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