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Another Approach to Teaching Logarithmic functions through Discovery and Construction- Grade 12-Lebanon

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Abstract

This research aims to investigate the impact of discovery learning on students' achievement in logarithmic function competencies among third-year secondary school learners in Lebanon, in both the Life Sciences and General Sciences branches. The study presents the difficulties students face when this lesson is taught using traditional methods. The researcher then conducts an experiment involving a total of 133 students from three schools (both public and private), delivering the lesson through discovery learning using researcher-prepared activity cards, in addition to modern technologies such as software, programmable calculators, and project-based learning strategies.

The study concludes that there is a statistically significant difference between students who received the lesson through traditional methods (the control group) and those who learned through guided discovery (the experimental group). Additionally, the study indicates that there is no statistically significant difference between male and female students in terms of learning this lesson.

In conclusion, the study recommends the adoption of discovery learning as an effective strategy due to its positive impact on both students and teachers in the context of this lesson.

*** Introduction**

1- Rationale: Mostly, in common math lessons, the teacher writes the objectives and the titles and derives formulas on the blackboard, and then,

goes on solving the problems related to it. The students study for the exam by "memorizing" these concepts and formulas, and by solving the related problems, the purpose here is to have a large practice more than teaching the student how to think and deal with different situations. But, meanwhile, some of the students cannot understand the concept, some others are not interested in the subject as they think that it is not useful to them, and the others are spectators while few students share the teacher and solve the problems. Most of the students do not participate lesson actively and cannot comprehend the concept. They are forced to study the lessons for the sake of exams. Teacher only expects them to write, memorize and solve questions. In the end, math lesson becomes a boring, meaningless, abstract, hard and problematic.

Some of the basic problems that mathematics education face with are rote learning, abstraction of subjects, lack of teaching utility of algebraic concepts and lack of adapting technology.

Therefore, we started by preparing some activities to enhance mathematics lesson. Many researchers argue that logarithm is a problematic and hard concept for high school students. Thoumasis (1993)[1] asserted that for students who approaches logarithm concept with a routine definition for the first time, it is impossible to understand its relation to the real world. The term "logarithm" seems completely arbitrary, unconnected as it were to the mathematical process. Therefore, we selected the topic logarithm to study and to teach this topic by discovery and applications.

2- Purpose of the Study: The purpose of this study is to investigate different approaches for teaching logarithm as well as the effect of Discovery and Application Based Logarithm instruction (DABI) on students' logarithm achievement and to determine opinions of students about DABI.

A very useful and valuable article was provided by Dr. Ibrahim Abo Halloun in 1998[2] , criticized the new curricula in Lebanon, that was held in 1997. He said that even though the books had been changed, but the teachers still teaching in the same way they learned with, and thus

1. Thoumasis, C. (1993). Teaching Logarithm Via Their History, School Science and Mathematics 8(12), p. 428-434

the new curricula did not provide new approaches for students since the teachers did not change their ways and methods.

3- Significance of the Study: It is very important to take into consideration nowadays that discovery learning takes place in problem solving situations where the learner makes on his own experience and uses his prior knowledge to discover the truths that he needs to learn and achieve.

Students are on the most part keep quiet, not allowed to collaborate, sit in assigned seats arranged in rows facing one way towards teacher. In most schools, during lessons, teacher's voice is heard. It is asking a question and then answering it, lecturing, yelling or just rambling. In the same way, in mathematics lesson, teaching is often interpreted as an activity mainly carried out by the teachers. He or she introduces the subject gives one or two examples, may ask a question and invites the students who have been passive listeners to become active by starting to complete exercises from the book.

There are several studies which aimed to diagnose high school students' misconceptions[3] as Erbaş, A. K. (1999) and ÇETİN, Yücel, (2004)[4] in logarithm but a few have some attempts in overcoming those misconceptions. This study proposed a suitable way of recovering students from their misconceptions. In this respect, it may be beneficial in contributing to the related field.

4- Definition of Terms: -

1- Control Group (CG): the group which continued to study logarithm with the Lebanese curriculum traditional approach.

2- Experimental Group (EG): It refers to the group which will study logarithm using DABI.

3- Discovery and Application Based Instruction (DABI): It refers to the instruction, in which students learn logarithm with activities designed by the researcher. Students carry out

1. Erbaş, A. K. (1999) An Investigation into Students' Performances, Difficulties and Misconceptions in Elementary Algebra, A Thesis Submitted to the Faculty of Education, The Middle East Technical University of Ankara, for the Degree of Master, Turkey

2. ÇETİN, Yücel, (2004) TEACHING LOGARITHM BY GUIDED DISCOVERY LEARNING AND REAL LIFE APPLICATIONS, Turkey

their work with activity sheets and graphing calculator

4- Traditionally Based Instruction (TBI): It refers to the instruction in the classroom without any equipment. Students carry out their work with paper and pencil.

5- Students' views and attitudes (SVA): it refers to the students' opinions and feedback toward learning.

5- Prior theorem

This study depends mainly on Bruner's[5] discovery learning theory (1961)[6]. In what follows I will mention the main points that this theory depends on as well their use in my study.

Bruner views people as being active in the process of learning, continually structuring and restructuring their environment. Thus, he is quite opposed to the view of the passive learner mechanically associating stimuli and responses. Instead, Bruner believes that people selectively perceive certain aspects of their environment, represent those perceptions internally, and then act on those internal representations. Bruner has written about the course of cognitive development in which a child progressively develops three modes of representation: enactive (characterized by direct manipulation of objects without any internal representation of the objects), iconic (characterized by internal representation of external objects visually as images or icons), and symbolic (characterized by symbolic representation of external objects through words, formulas or other symbolic means). To be successful, the mode of instruction should match the mode that the learner is using.

*** Review of literature**

1- History of logarithm: The Scottish mathematician John-Napier[7] published his discovery of logarithms in 1614. His purpose was to assist in the multiplication of quantities that were then called sines.

2- Different traditional approaches in teaching logarithm: It is well known for mathematics teachers that we have several approaches for teaching Logarithm, such that: logarithm as an area, logarithm as inverse of exponential function, logarithm as a

1. Jerome Bruner (1915-2016): is a Harvard-educated psychologist who has been very influential among educators, particularly during the curriculum reform projects of the 1960s.

2. Bruner, J. S. (1961), The act of discovery. Harvard Educational Review

1. John Napeier: A Scottish mathematician who invented Logarithm.

Taylor series $(f(x) = \ln(1+x) = \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n} x^n.)$

3- Discovery learning: The art of teaching mathematics lies in the ability of the instructor to motivate and inspire individuals to look beyond the numbers and understand the concepts Hammack, R. & Lyons, D., (1995)[8].

Discovery learning is simply "Exercises versus Problems", it encourages students to actively use their intuition, imagination, and creativity because the approach starts with the specific and moves to the general. The teacher presents examples and the students work with the examples until they discover the interrelationships. Bruner (1961)[9] believes that classroom learning should take place through inductive reasoning, that is, by using specific examples to formulate a general principle. For instance, if students are presented with enough examples of triangles and non-triangles, they will eventually discover what the basic properties of triangles must be.

Tomei (2003)[10] stated that Bruner's ideas for discovery learning can be implemented in the classroom as follows: It Presents both examples and non examples of the concepts you are teaching, i.e. the cases that we can apply the concept or not. It helps students see connections among concepts, and encourages students to make intuitive guesses

Schulman (1965)[11] stated that discovery learning gives students experience in discovering truely patterns in abstract situations in an exciting way .

4- Using and applying logarithm: If the logarithm method had no utility, it would have died with Napier.

2. Hammack, R. & Lyons, D., (1995). A Simple Way to Teach Logarithm, Mathematics Teacher 88(5), p.174-175

3. Bruner, J. S. (1961), The act of discovery. Harvard Educational Review

1. Tomei (2003) Challenges of Teaching with Technology Across the Curriculum http:// www.daq.edu/~tomei/ed711psy/c_bruner.htm Reached 3-22-2025

2. Schulman, L. S.(1965): Psychological Controversies in the Teaching of Mathematics, In Aichele, Douglas B. and Robert E. Reys (Eds.), Readings in Secondary School Mathematics, Boston: Prindle: Weber, and Schmidt, 1971.(pp. 178-192).

Logarithm plays an important role in Medicine (hearing for example), psychology(Hick's law [12], Weber–Fechner law[13]), probability and statistics(log-normal distribution), computer science(Logarithm of base 2), seismology(M=log(I/S)where I is the intensity of the earthquake (measured by the amplitude of a seismograph reading taken 100 km from the epicenter of the earthquake) and S is the intensity of a "standard earthquake" (whose amplitude is 1 micron $=10^{-4}$cm) Music (sound frequency) ,Chemistry(calculation of ph) , growth-decay problems (population, half-life, financial Maths)

5- Software: Nowadays, there are a lot of software have been used in all fields of sciences. In particular one can find a huge number of software used in mathematics and applied mathematics such as C LANGUAGE, MATLAB, MATHEMATICA, MAPLE, and much more, these software had made a big jump in mathematics teaching and learning. These software make the lesson full of life and far away from traditional boring classes.

6- Graph calculator[14]: Hand-held calculators appeared in the 1960s, soon became popular, and were brought into the mainstream of economic and technical life (Zand and Crowe, 1997)[15]

Graphic calculator is best described as an extremely portable, hand-held, minicomputer. 'Graphic calculators are a quite powerful new technology for mathematics teaching (Demana & Waits, 1990)[16]. Moreover, by means of graphic calculators technology becomes part

3. Hick's law: describes the time it takes for a person to make a decision as a result of the possible choices: increasing the number of choices will increase the decision time logarithmically.

4. Weber's law and Fechner's law. Both relate to human perception, more specifically the relation between the actual change in a physical stimulus and the perceived change.

1. Dunham, Penelope H. & Dick, Thomas P. (1994). Research on Graphing Calculator.

2. Crowe, W. D.; Zand, H. (1997) Novices Entering Mathematics 2: The graphic Calculator and Distance Learners. Milton Keynes: Elsevier Science Ltd Lochead, P. & Mestre, J. (1988) From Words to Algebra: Mending Misconception In A. Coxford & A.Shulte (Eds) The Ideas of Algebra, K-12

3. Demana, F. & Waits, B. K. (1990). Enhancing mathematics teaching and learning through technology, p145

of the normal classroom activity and not just a special activity.

Graphic calculators help the students represent their mathematics in different forms, improve classroom efficiencies, impel students to be active learners, provide an environment where students enjoy learning.

*** Project Based Learning**

Project-Based Learning, or PBL, is the use of in-depth and rigorous classroom projects to facilitate learning and assess student competence (not to be confused with problem-based learning). Project-based learning is an instructional method that provides students with complex tasks based on challenging questions or problems that involve the students' problem solving, decision making, investigative skills, and reflection that includes teacher facilitation, but not direction. PBL is focused on questions that drive students to encounter the central concepts and principles of a subject in a hands-on method. Students form their own investigation of a guiding question, allowing students to develop valuable research skills as students engage in design, problem solving, decision making, and investigative activities. Through PBL, students learn from these experiences and apply them to the world outside their classroom. PBL emphasizes creative thinking skills by allowing students to find that there are many ways to solve a problem.

Teacher role in Project Based Learning is that of a facilitator and the Student role is to ask questions, build knowledge, and determine a real-world solution to the issue/question presented.

More important than learning science, students need to learn to work in a community, thereby taking on social responsibilities. Although students do work in groups, they also become more independent because they are receiving little instruction from the teacher. With Project-Based Learning students also learn skills that are essential in higher education. The students learn more than just finding answers, PBL allows them to expand their minds and think beyond what they normally would. Students have to find answers to questions and combine them using critically thinking skills to come up with answers.

Problem-based learning is a similar pedagogic approach; however, problem-based approaches structure students' activities more by asking them to solve specific (open-ended) problems rather than relying on students to come up with their own

problems in the course of completing a project.

*** Research part (methodology)**

1- Problem: The main problem that intended for this study is the obviously noticed difficulty in achieving the competencies and objectives of the chapter (logarithmic functions) in the third year secondary (life and general sciences sections)[17] and the high dependence of our students on memorization of formulas and methods of solving.

The main goal of this study is to determine the effect of a discovery and application based logarithm instruction (DABI) on students' logarithm achievement and the perceptions of students toward logarithm activities.

*** Questions**

1- Is there a significant difference between Logarithm Achievement Test (LAT) mean scores of students taught with DABI and traditionally based instruction (TBI)

2- Is there a significant mean difference between students (with DABI) in Life Sciences and General Sciences field regarding the mean scores of logarithm achievement test?

3- Is there a significant difference between the scores of the students of General sciences class (GS) and Life sciences (LS) who learned logarithm with DABI in the Students Views and Attitudes (SVA)?

4- Is there a significant mean difference between SVA mean scores of boys and girls who learned with DABI?

2- Hypotheses: In the study, hypotheses are stated in null form at significance α level of 0.05

1- $H_{(0)}$: There is no significant difference between the mean scores of the Experimental Group (EG) and Control Group (CG) in Mathematics Achievement Test MAT test.

2- $H_{(1)}$: There is a significant difference between LAT mean scores of Students taught with DABI and traditionally based instruction.

3- $H_{(2)}$: There is no significant mean difference between students in life Sciences and general sciences regarding the mean scores of (SVA).

4- $H_{(3)}$: There is no significant mean difference between (SVA) mean scores of boys and girls with (DABI).

3- Variables: In this study variables are categorized as independent and dependent variables.

1. GS and LS are the sections of the scientific classes of third year secondary students, where GS students focus on Math and physics without studying Biology, however LS students focus on Biology.

*** Independent Variable**

The independent variables in this study were gender, achievement level, field of study, and treatment. Treatment included two dimensions:-

1- Discovery and Application Based Instruction (DABI)

2- Traditionally Based Instruction (TBI)

*** Dependent Variables**

The dependent variables of students were students' logarithm achievement and SVA mean scores.

Mathematics achievement pretest marks were considered as a covariate in statistical analysis.

4- Research Design: To determine the effect of the discovery and application based logarithm instruction on students' achievement.

The research was held in the following schools in Beqaa Governorate-Lebanon: -

1- Barelias official high school LS (28) GS (9)

2- Qabbelias official high school LS (30) GS (12)

3- Al-Imam Al Jawad high school (private) LS (45) F GS (9) F

Total: 133 students

Groups	Gender		Speciality	
	Male	Female	LS	GS
CG	42	31	58	15
EG	40	20	45	15
Total	82	51	103	30

Note: Experimental groups were denoted EG, control groups were denoted CG. The students will be chosen of different averages in the MAT test, of all level marks.

5- Instruments: In this study, following measuring instruments were used.

1- Mathematics Achievement Test (MAT- Pretest)

2- Logarithm Achievement Test (LAT- Posttest)

3- Students' Questionnaire (SVA) appendix (1)

4- Interview Form

5- Teachers' questionnaire Appendix (3)

*** Interview**

Interview form consisted of 8 (semi-structured) open-ended questions.

However, four open-ended questions were added for the interviews with the participants of the experimental group. In order to understand students' attitudes toward logarithm activities and to determine differences of perception among students about treatments and logarithm topic, we did interviews with students from control groups and experimental groups. Four students from each control and experimental group were chosen and interviewed to obtain in depth information about their perception toward logarithm concept and logarithm activities administered in

experimental groups. When choosing students to do interview, the researcher chose students from different achievement levels. The selection was based on the scores of students in the MAT which was administered as a pretest.

There were two parts in interview schedule. Questions of first part were asked all of students. Questions of second part were asked only to experimental groups' students.

*** PART I**

1- What did you gain by learning logarithm?

2- What do you understand from the term logarithm of a number?

3- What does logarithm teaches you?

4- When you see a logarithm problem, how do you feel (we mean here how much the student is attracted to the work and how much he finds himself in this way of learning) ?

*** PART II**

5- What are the reasons in making error in LAT?

6- Which do you prefer between learning by listening or applying? Why?

7- What do you think about demonstrating application examples of logarithm?

8- Which was more beneficial teaching how to make operations or applying subject? Why?

Each interviewee was asked 4 or 8 questions in a period of 15-25 minutes.

6- Procedure

*** Treatment of control group (CG)**

This group will be treated in teaching logarithm in classical method, known in Lebanese curriculum in the students' book used in official schools and private school (Al-Ahlia)[18] , it is given about 3 periods for explaining.

*** Treatment of experimental group**

As we mentioned before, the students of this group will learn logarithm throughout discovery learning techniques related somehow to real life situations accompanied with the use of technology. All these sheets will be held in the class room by teacher and students since they depend on guided discovery.

For this purpose we suggest 9 activity sheets to attain the understanding of the objectives of "logarithm" far away "as much as

1. Badr,N.;Attieh,K.;Nassar,H.;Moarbes,A.; Merheb,C.;El Asmar,A.;Karroum-Mathematics-Third year secondary-Life and General sciences section-Al-Ahlia-2013-Lebanon page 201

possible" from lecturing, making the student the main player in the game of education. We will try through these activities to make the learner more interested and capable of achieving his objectives through a non-abstract and interesting way. (this performance requires about six periods).

The first sheet aimed at making connections and discovers logical interrelations between the student's prior knowledge and one of the definitions of the logarithmic function (understanding mathematics as an inverse function of the power function). This will be provided through construction and observation.

The second sheet aimed at observing the property of distribution of logarithm over multiplication. This will be held through successive examples to discover the rule not to write and prove by the teacher.

The third sheet aimed at observing the property of distribution of logarithm over division. This observation will make the student a real participant not just a bored listener.

The fourth sheet planned to be enjoyable to students were motivated by solving application examples of logarithm. Moreover, daily life problems were solved to prevent students from mindless, meaningless and irrelevant learning. In this activity, we wanted logarithm properties to be applied by students on examples from daily life. This sheet was very interesting for the students because it answers the frequent question of our students "where do we use these concepts?"

The fifth sheet aimed at providing 2 ways to discover the value of the number "e" throughout simple long calculations. In this Type equation here.activity, the learner will discover that as much as he goes forward by calculation, he will get closer to "e"

The sixth sheet aimed at the study of the behavior of the function ln at the neighborhood of zero and plus infinity. This sheet provides a simple way of observation of the required limits

The seventh sheet aimed at the study of the derivative of lnx and proving by construction that lnx is an antiderivative of $\frac{1}{x}$. By this we will be providing a second definition of the naperian logarithm as an antiderivative. This sheet surprises the learners for getting easily another definition, just by the use of his scientific calculator.

The eighth sheet planned to introduce the use of a graph calculator (it is not required to oblige

students to buy such calculators, but to use a software called "graph calculator" in the computer department of the school). This activity was very interesting for the learners. They read all the properties they need easily from their screens. They felt that they are explaining and analyzing graphically, not the lecturer. They became real participants.

The ninth sheet provides a summary over the entire chapter to collect all information provided in this chapter. In this sheet, we can – to some extent- evaluate the overall achievement.

*** Results**

The purpose of this chapter is to present the results of this study. At first, results of the achievement tests will be given. Next, results of SVA will be presented. Finally, results of open ended questions in SVA and interview results would be presented.

*** Descriptive statistics**

Basic descriptive statistics about the dependent variable in the mathematics achievement test (MAT) is given in the following table:

Variable	Number	mean	Standard deviation
CG	73	54.32	24.2
EG	60	51.66	28.7

Basic descriptive statistics about the dependent variable in the mathematics achievement test (LAT) is given in the following table

Variable	Number	mean	Standard deviation
CG	73	51.6	27.3
EG	60	62.4	24.94

By a simple comparison, we can easily see that the mean of the CG decreases from 54.32 to 51.6 even though they were dealt by classical method, this is due to the level of the (LAT) , on the other hand the mean of the scores of the experimental group increases from 51.66 to 62.4 which means a better achievement of the objectives of this lesson .

The standard deviation goes less for the EG due to the experimental working and the idea of group thinking as well as the effective sharing of a greater number of students, this made the differences less between the learners. Also applying concepts throughout daily life situations made the work more fruitful.

*** Results of testing hypotheses**

*** Test of hypothesis (H_0)**

The use of the independent groups t-test between means leads to:

t-statistics	degree of freedom	two tailed probability
0.58	131	0.5630

Then $t(131) = 0.58$ and $p = 0.5630$ at the 0.05 critical α level and so, there is no significant difference between the mean scores of the

groups (EG) and (CG) in the MAT (pretest)

*** Test of hypothesis (H_1)**

The use of the independent groups t-test between means leads to:

t-statistics	degree of freedom	two tailed probability
2.306	131	0.0198

Thus: t(131)=2.360 p= 0.0198 at 0.05 critical α level , hence there is a significant difference in the logarithm achievement test between the learners who were in (EG) and those in the (CG) .

*** Test of hypothesis (H_2)**

*** Results of (SVA) for (EG)**

This hypothesis is suggested for EG only to examine the effect of the new procedure on our students and because we already know the attitudes and the opinions of the students towards TABI because it is simply the problem

no	Logarithm prepared and applied in the classroom Learning / Teaching Activities	mean	SD
1	Allows to understand the concept of logarithm	4.42	0,91
2	Allows to understand the properties of logarithm	4.33	1.07
3	Improves the method of learning properties	4.43	1.06
4	Attracts your attention	4.20	0.97
5	Provides easy understanding for logarithmic properties	4.07	1.0
6	Provides more permanent understanding	4.35	1.02
7	Enhances the strength of thinking and interpreting	4.12	0.92
8	Helps fast memorizing and saving rules	3.72	1.28
9	Makes the course enjoyable	4.42	0.83
10	Combining subject to daily life makes learning easier	4.18	1.08
11	Embodies thread (far from abstraction)	3.92	1.06
12	Expands thought	4.0	1.09

*** Descriptive study**

Variable	N	mean	SD
EG	60	4.16	0.69

Variable	**N**	**Mean**
LS	**45**	**4.2**
GS	**15**	**4.04**

The use of the independent groups t-test between means leads to:

t-statistics	degree of freedom	two tailed probability
0.740	58	0.4624

Then, t(58) =0.740 , p= 0.4624 , so, at 0.05 critical α level there is no significant difference in the mean scores of SVA between the students of the life and general sciences sections.

*** Test of hypothesis (H_3)**

Variable (gender)	**N**	**Mean**
Male	**40**	**4.1**
Female	**20**	**4.28**

The use of the independent groups t-test between means leads to:

t-statistics	degree of freedom	two tailed probability
0.73	58	0.4681

Then, t(58) =0.73 , p= 0.4681 , so, at 0.05 critical α level there is no significant difference in the mean scores of SVA between the males and the females of the (EG)

*** Interview and questions**

Most of the students expressed that they liked DABI Appendix (2);

there were also few ones who found it difficult to understand.

One major category in student responses was about enjoyment. Students frequently expressed how they enjoyed the activities. Almost all of the students indicated that they enjoyed mathematics lessons with DABI. They found lessons very enjoyable and interesting. One student expressed that "I like logarithm. Of course sometimes I can't solve some logarithm problems but this doesn't prevent me from liking it. This might be because we know where logarithm is used and that we actually implement it." Another student replied that "I think a course about applications like DABI should be given teachers and preservice-teachers. They should learn how to make lessons funnier."

Another major category in student responses was about motivation. They frequently expressed that the activities increased their motivation toward mathematics lesson. There was one student who expressed that "when you learn it yourself, you say, I can do it, I am successful in logarithm".

Third major category in student responses was about retention. They frequently expressed that the activities were effective in terms of retention of the subject. One student said that "I will never forget the formulas for log (a.b) and log $(\frac{a}{b})$."

Similarly, another student replied that "instead of memorizing the formulas that the teacher gave us, we understand it better by discovering it on our own".

Another interesting major conclusion was increasing self-confidence of the students.

*** Teachers' questionnaire**

Analyzing the teachers questionnaire results was not difficult, most of them (48 of 54) see that there is no radical change in the objectives before 1997 and after in mathematics and particularly in logarithmic functions. They mentioned that the ways of teaching and learning remain the same and the student remained the passive (inactive) learner and the mathematics teacher stills the unique talker in the period. Appendix(3)

5- Conclusions and discussions

*** Conclusions**

The conclusions of this study can be summarized as following: -

1- The statistical analysis of the results showed that there is no significant difference between the scores of the students in the mathematics achievement test (pre-test), which means that the selection of groups was - to a large extent- fair and objective and taking into

consideration the different levels of students to get objective results.

2- The statistical analysis of the results showed that there is a significant difference between the scores of the students in the logarithm achievement test (posttest), which means that the learners who were in the guided discovery based instruction have achieved the concepts and the properties of logarithmic function, as well as they got higher scores as mentioned in the previous chapter.

3- The statistical analysis of the results showed that there is no significant difference between the scores of the (LAT) in the experimental group, concerning the students of the life sciences and the general sciences sections, this result is very important, because the students of (GS) and (LS) in some schools are given this chapter at the same time and class since it is a common chapter between the two sections, and some schools give the common chapters, where the students are collected due to the small numbers of the GS students in these schools.

4- The statistical study showed that there is no significant difference between the scores of males and females in the logarithm achievement test, which is a normal result and gives the study more reliability.

5- According to open-ended questions of SVA and interview results revealed that DABI provided permanence of logarithm subject, enjoyment, self-confidence and facilitation of the subject. It means that DABI helped students to develop their affective aspect.

6- According to open-ended questions of SVA and interview results, students using graphic calculators in logarithm activities possessed a better attitude toward mathematics and self-concept in mathematics.

7- The results of the questionnaire and interviews showed that students in experimental groups supported the effectiveness of DABI and revealed that they had positive opinions about implementation of this instructional unit.

8- It is obvious that the method we tried in teaching logarithm is not easy to be generalized for the whole program in mathematics throughout all the secondary classes but, the positive results got encourage us to search a radical change in our Lebanese curriculum jumping from classical learning to discovery learning.

*** Discussions**

DABI helped students to improve in terms of affective aspect. It may be due to factor that DABI encouraged students for full participation and emphasized connections between mathematics and daily life. In addition, it promoted students' confidence, curiosity and inventiveness in doing mathematics.

According to open-ended questions of SVA and interview results, students using graphic calculators in logarithm activities possessed a better attitude toward mathematics and self-concept in mathematics. It may be due to factor that graphics calculators provided an environment where students enjoy learning and doing mathematics.

Finally, after all results, I think that the best way to teach this chapter is to use the (DABI) method to make sure that all -or at least- most of our students are interested and have achieved the objectives, then use the classical proofs of the results in order to touch the high cognitive abilities of our students because they have to choose a scientific majors in their universities and they have to be able to deal with abstract mathematical proofs.

The books we teach with may contain some activities but they are poor and not well arranged to reach the wished results.

Remains to talk about our official exams: these exams are copies of one exam, encourage students to memorize not to discover. They are not related to life situations (except those in the SE section to some extent) and are very similar in the shape and content. These exams do not allow us to provide our society with creative thinkers even though we have a lot of intelligent students.

*** Limitations (validity)**

For this study, location and history could not be a threat, because all measuring instruments administered in the classrooms almost at the same time. Also, physical conditions were not a problem, because all the classes were in the same floor with equal conditions. Besides, in applying treatments, mathematics teacher followed the same plan and solved same exercises. In addition, while scoring pretest and posttest, researcher reviewed scoring rubric together with another mathematics teacher.

The extent to which the results of a study can be generalized determines the external validity of the study. In this research, convenience sampling was used. So, generalization of the results was

limited. Generalization can be done to subjects who have similar characteristics to that of the subjects in this study.

*** Implications**

a- Graphic calculator facilitated problem solving in a realistic context and helped to develop self-concept of students in mathematics. Therefore, calculators should be used in Mathematics applications.

b- Mathematics lessons teacher should give opportunities students to apply subject.

c- The content and teaching styles of mathematics curriculum must be changed. There must be increased focused on importance of discovering, applying and using technology in mathematics lessons.

d- Application based instruction helped students think more about this question and consequently enabled them to find out reasonable and satisfactory answers for the question that we hear always in our class rooms: ”What reasons stand behind learning this concept?”

e- The use of relevant applications of mathematics in mathematics instruction, and forming active learning environments enhance mathematics lessons.

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