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Teaching the Arithmetic Sequence through Guided Discovery Learning: A Pedagogical Experiment in Viet Nam

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ABSTRACT

"Let the student learn by discovery" has become the slogan of our country for recent years. Learning by discovery that has used by Vietnamese teacher is a term has appeared in Viet Nam in the past few years. This study proposes Guided Discovery learning to teach arithmetic sequence topic in Viet Nam high school. It is hypothesized that student. Student's outcomes of teaching arithmetic sequence topic with Guided Discovery Learning are not greater than the ones of teaching this subject with the traditional method of instruction and students' achievements after experiment are not better than students' achievements before the experiment. Two eleven -classes were involved in the trial to investigate the effectiveness of Guided Discovery Learning,. The result suggests that students have better concept retention.

Keywords: Guided Discovery Learning, discovery learning, the arithmetic sequence, Pure discovery,

Introduction

Guided discovery learning has been variously defined. Furthermore, it is common, assumed that discovery learning allows for errorful learning, that it is guided to some extent, and that is the outcome of inductive methods of instruction. It demonstrates the ability to meet the requirements innovation of teaching methods that is based on the learner-oriented perspective, helping students self-seek and discover new knowledge on previous experience and his life experiences. In Viet Nam, Guided Discovery Learning is an active method teaching which not only was studied by many researchers but also applied by teachers In recent years (Nguyen Phu Loc, 2010 [4]);Le Vo Binh, 2007 [1]).

This paper presents an experiment was to confirm that teaching the arithmetic sequence topic by guided discovery learning is more efficient than the traditional method in Viet Nam.

Discovery learning

Discovery learning is an action-based learning approach that stresses experimentation and hypothesis testing. It is a type of learning where learners construct their knowledge by experimenting with a domain and inferring rules from the results of these experiments (van Joolingen, 1999 [10]). Discovery learning is based on the assumption that education is a process, not a set of facts.

It occurs when individuals have to use the process of thought to find out the meaningfulness of something themselves (Bruner, 1961 [2]). He gives four reasons for using discovery learning as follow: (i) To make an impulse of thought, (ii) to develop inner motivation than external motivation, (iii) to learn the way of discovery and (iv) to develop thought (Bruner, 1961 [2]).

Bruner believed that the process of discovery contributes significantly to the intellectual development and that the heuristics of discovery can only be learned through the exercise of problem-solving. He proposed discovery learning as a pedagogic strategy with such important human implications that it must have applied in schools.

Several types of discovery learning are recognized as given below (Kersh, 1962A, 1964 [5-7]; Kersh and Wittrock, 1962 [8]; Kittell, 1957 [9]; Wittrock, 1963 [11]):

Pure discovery: techniques involving no direct assistance, other than encouragement, by a teacher.

Guided discovery: techniques involving minimal to moderate aid by a teacher.

Expositional learning: highly directed learning involving maximal help by a teacher and usually little or no actual discovery by the student.

Kersh and Wittrock (1962) [11] stated that guided discovery is the most motivating of the three types. The reason appears to be that the reinforcement given by a teacher in the form of encouragement and support (even if the pupil does not discover the correct answer) motivates the child to continue working and he, in turn, becomes more motivated.

In Guided Discovery Learning, the teacher devises a series of statements or questions that guide the students, step by step, making a series of exploring that leads to a single predetermined goal. In another word, the teacher initiates a stimulus, and the learner reacts by engaging inactive inquiry thereby discovering the appropriate response.

The pedagogical experiment on teaching the arithmetic sequence

Objectives of the pedagogical experiment

Investigate to find out the effectiveness and to use guided discovery learning methods currently in high school.

Hypothesis

H01: There is no significant difference between the learning outcome of students who are taught abuse Guided Discovery Learning and the students in the control group.

H02: There is no significant difference the achievements after the experiment and the ones of students before the test.

Selection of Content

Theory of the arithmetic sequence which consists of the definition of the arithmetic progressions and the formula $u_n = u_1 + (n-1)d$ is the topic for the trial treatment was selected from the Algebra and Analysis 11 that was used for high mathematics education in Vietnam.

Sample for the study

The pedagogical experiment conducted experiment according to the model "Two groups – posttest," wherein math ability of student's two groups (two classes) selected is equivalent. It has been studied at the Pacific College (primary, secondary and high school), Can Tho city. The design of the study is as Table 1 follow:

Table 1: The experimental model

Experimental class (EC)	O1	X	O2
Control class (CL)	O3	---	O4

Where

O1, O3 = Measurement (pre-test)

O2, O4 = Measurement (post test)

X = Treatment (Guided Discovery Learning)

--- = No Treatment

A summary of the design is represented in Table 2

Table 2: Design of the Study

Phase	Control group	Experimental Group
1. Pre-test (90 minuses)	the first semi-semester Achievement Test	the first semi-semester Achievement Test
2.Experimental interventions (90 minuses)	Lecture method and lecture-demonstration method	Guided Discovery Learning
3. Post Test (90 minuses)	Achievement Test	Achievement Test
Class	11.2	11.1
Total number of students (N)	22	22

The experiment was carried out in the final of the first semester of the academic year2016–2017. Before the test was conducted, mathematics learning outcomes of students of experimental class and control class were equivalent. Particularly, after finishing the first semi-semester of the academic year 2016 – 2017 (before experiment) average marks of the mathematics of students in experiment class and control class were 5.318182 and 5.409091, respectively; and according to data analysis of Excel 2013.

Table 3: Comparing the mathematics ability of experiment and control class before the pedagogical experiment

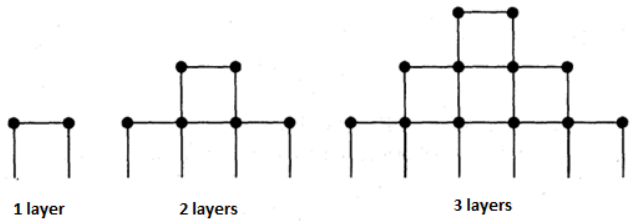
t-Test: Paired Two Sample for Means		
	Experimental class	Control class
Mean	5.318182	5.409091
Variance	2.512987	1.205628
Observations	22	22
Pearson Correlation	0.113161	
Hypothesized Mean Difference	0	
Df	21	
t Stat	-0.23385	

P(T<=t) one-tail	0.408682
t Critical one-tail	1.720743
P(T<=t) two-tail	0.817363
t Critical two-tail	2.079614

Table3 indicated that t-value is-0.23385 and P–value is 2.079614. The result is not significant at $p \leq 0.05$. Therefore, means is not different and so, mathematics learning outcomes of students in preparatory classes and control class are not different before the experiment was carried out.

Teaching methods applied in experimental class: We used "Guided discovery learning" for teaching the arithmetic sequence. In teaching process, teacher operated to guide his students to discover arithmetic sequence knowledge. Based on the models for teaching mathematical concepts by guide discovery which was outlined by Nguyen Phu Loc (2010), we designed the lesson as **Table 4** and **Table 5**.

Table 4: The lesson for teaching the definition of the arithmetic progressions

Teacher's activities (a)	**Student's activities (b)**
[1a] Make the motivation The situation: The elementary students was playing a game. In there, they have to use the matchsticks to make the flowering pyramids with different towers as figure 1.  Figure 1. To become a winner, they tried to build the tower with 1000 layer. However, how many the matchsticks will be used to rank the podium and how many the match sticks are needed for the flowering pyramids. Can you help them to calculate?	[1b] Listening and thinking Working in a pair and using the paper to solution the problem.
[2a] Using follow question to ask students to discover or find the relationships	[2b] Case 1: If the students state that the common property is each term after the first is the sum of its previous time and a constant, the teacher will introduce the sequences (1) and (2) are an arithmetic

<table>
<tr>
<td>After observing four sequences at the table, respond the follow question.
<table><tr><td>Example</td><td>Non-example</td></tr><tr><td>$2, 4, 6, 8, 10, 12, ...(1)$
$3, 7, 11, 15, 19, ... (2)$</td><td>$-2, -4, -5, -6, -9, ...(3)$
$-1, 4, 5, 7, 10, 11, ... (2)$</td></tr></table>
The sequences (1) and (2) have a common property that let be (*) but sequences (1) and (2) don't have. Let predict what it is?</td>
<td>sequence.

Case 2: If the students state that they include positive terms, the teacher says "not right" and write sequence (5) such as $-\frac{1}{2}, 0, \frac{1}{2}, 1, \frac{3}{2}$, ...into the example table and $1, 5, 7, 8, ...$into the non-example table.

The teacher did this procession until the students could discover the perfect respond. After that, the teacher continued case 1.</td>
</tr>
<tr>
<td>[3a] Making the conjecture

We call the sequence (1) which have the property (*) is an arithmetic sequence with the first term is 2, and the common difference is 2. Moreover, the sequence (2) which have the property (*) is an arithmetic sequence with the first term is 3, and the common difference is 4</td>
<td>[3b] expressing the definition of arithmetic sequence</td>
</tr>
<tr>
<td>[4a] Correct their answers and give the exact definition of an arithmetic sequence.</td>
<td>[4b] Listening and writing down the notebook.</td>
</tr>
<tr>
<td>[5a] Previewing and applying the definition of arithmetic sequence

Multiple questions 1: The next three terms of the arithmetic sequence 101, 93, 85, 77, ….Is

A. 70, 63, 56.

B. 71, 65, 59.

C. 69, 61, 53.

D. 68, 59, 50.

Multiple questions2 :The 10^{th} term of the arithmetic sequence –6, 3, 12, 21, ….Is

A. 75.

B. 66.

C. 84.

D. 93.</td>
<td>[5b] Respond the questions</td>
</tr>
</table>

Question 3: Find the 1000^{th} term of the arithmetic sequence -6, 3, 12, 21, … Question 4: Which the following sequences are an arithmetic one? Calculate its first term and common difference. a) $2, 5, 9, 14, 20, ...$ b) $25, 23, 31, 19, ...$ c) $\frac{1}{3}, \frac{2}{3}, 1, \frac{4}{3}, \frac{5}{3}, ...$ d) $u_n = 4 + 3n$	

Table 5: ***The lesson for teaching the general term of the arithmetic progressions***

Teacher's activities (a)	**Student's activities (b)**
[1a] Make the motivation Question 5: Find the 15^{th} term of the arithmetic sequence -6, 3, 12, 21, … Question 6: Find the 30^{th} term of the arithmetic sequence -6, 3, 12, 21, … Question 7: Find the 1000^{th} term of the arithmetic sequence -6, 3, 12, 21, …	[1b] Listening and thinking Students can come up with the first 30 term. Students try this themselves and compare answers with their friends and discuss why the answers do not all agree.
Sequences that were given an initial term and where each subsequent term is found by adding a constant number to the previous term are known as arithmetic sequences or arithmetic progressions. The original term is denoted by u_1 and d which is the number that is added to each tearm to generate the next term is used to denote the common difference. And this notation is used by the mathematicians.	
[2a]Do experiment » Start with u_2. What is u_2 in terms of u_1 and d? » Then move on to u_3. If we know what u_2 is, how do we find u_3? So what isu_4?	$u_2 = u_1 + d$ $u_3 = u_2 + d = u_1 + d + d$ $= u_1 + 2d$ $u_4 = u_3 + d = u_1 + 2a + d$ $= u_1 + 3d$

» What isu_{107}?	$u_{2017} = u_1 + 2016d$
[3a] Making the conjecture »» What is u_n?	[3b] expressing the general term of the arithmetic progressions $u_n = u_1 + (n-1)d$
[4a]Correct their answers and give the exact the general term of the arithmetic progressions	[4b] Listening and writing down the notebook.
[5a]Previewing the definition of arithmetic sequence Question 8: Come back the tower situation as the Figure 1. How many matches are needed for the base story of the tower? Question 9: Which is an equation for the n^{th} term of –6, -14.5, -23, -31.5, ….? A. $u_n = -8.5\,n - 7$ B. $u_n = -14.5n + 8.5$ C. $u_n = 5.5n - 2.5$ D. $u_n = -6n$ Salary: The sequence not only appears in science and technology but also perform in real life. For the instant, the salary of the worker race follows each month. Moreover, his salary will be added $70\,000\,VND$ after each month. Know that his salary at the first month is $1.500.000\,VND$ Problem 1: Let enumerate the worker salary of each month for one year. Problem 2: How about the wages of the worker in the20^{th} month?	[5b] Respond the questions

Findings

Effectiveness of Guided Discovery Learning on the learning outcome

After finishing the experiment, students of experimental and control classes were required to do the same test consisting of sixteen multiple choice question and three essay exercises. Table 6 presents the results of students.

Table 6: Test scores of experimental and control classes after the experiment

Group	Mark	0-1,9	2,0 - 3,4	3,5 - 4,9	5,0 - 6,4	6,5 -7,9	8,0-10	Average >=5,0	Sum
EC	The number of students	0	0.0	1.0	8.0	8.0	5.0	21.0	22
	Rate (%)	0	0	3	22	22	14	58	61
CL	The number of students	0	2.0	4.0	8.0	6.0	2.0	16.0	22
	Rate (%)	0	6	11	22	17	6	44	61

It is seen from Table 7 that is a statistically significant difference between the mean score of the experimental group and the control group, as indicated by the t value, $tStat = 2.347173$, $p < 0.05$. Hence, the null hypothesis (H01) stating that there is no significant difference between the learning outcome of students who are taught through Guided Discovery Learning and the students in the control group is rejected. That means that there has been a significant increase in the students in the learning outcome of students due to the experimental treatment through Guide Discovery Learning (mean = 6.590909) as compared to the control group (mean =5.636364).

Table 7: Comparing the results of experiment and control class after the Pedagogical Experiment

t-Test: Two-Sample Assuming Unequal Variances		
	EC	CL
Mean	6.590909	5.636364
Variance	1.300866	2.337662
Observations	22	22
Hypothesized Mean Difference	0	
Df	39	
t Stat	2.347173	
P(T<=t) one-tail	0.012044	

t Critical one-tail	1.684875
P(T<=t) two-tail	0.024087
t Critical two-tail	2.022691

Table 8: t-Test paired two samples for means of class before and after experiment

t-Test: Paired Two Sample for Means		
	Pre-test	Post-test
Mean	5.318182	6.590909
Variance	2.512987	1.300866
Observations	22	22
Pearson Correlation	0.628501	
Hypothesized Mean Difference	0	
Df	21	
t Stat	-4.8087	
P(T<=t) one-tail	4.71E-05	
t Critical one-tail	1.720743	
P(T<=t) two-tail	9.43E-05	
t Critical two-tail	2.079614	

A comparison of the average of scores of pre and post tests of the experimental group taught through Guide Discovery Learning

Table 8 shows that in the experimental group there was a significant increase in mean scores of science achievement from pre-test (mean = 5.318182) to posttest (mean = 6.590909), a positive gain of 123.83% in learning achievement due to experiment treatment through Guided Discovery Learning. Moreover, the absolute of calculated t-Stat exceeds the critical value (|4.8087| > 2.079614) and the p-significant at $p \leq 0.05$ (9.43E-05< 0.05). Therefore, the null hypothesis H02 is excepted, and the achievement of class after the experiment is better than the one of class before the experiment.

Conclusion

The above example demonstrates that the use of guide discovery was more effective than teaching with the traditional method. In Guided Discovery Learning, the teachers assist students to construct knowledge through inquiry or discovery by actively involving in the knowledge construction process, thus developing the thinking abilities of students.

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