

Self- Paced Instruction and Mathematics Achievement

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Abstract

Self-paced instruction attempts to bridge the gap between the felt need and the course objectives of equipping the students with mathematical tools needed in skills development. This study used a non-randomized experimental and control groups, pretest-posttest designs in two separate intact classes in College Algebra. For a period of 10 sessions, the experimental group was subjected to the proposed material – the self-paced instructional module, and the control group instead was given lectures on the same topics on exponents and radicals. t-test for uncorrelated mean was used to determine the significant difference between the pretest and posttest mean scores of the experimental and control groups. Experimental results demonstrate the efficiency and the effectiveness of the proposed method.

Key Words: Self-Paced Instruction, Module, Mathematics Achievement

1. Introduction

Teaching has come a long way in establishing itself as a profession. Teachers are internationally being recognized as professionals in their own respect. Like other professionals, the status of teaching hinges in large measure the professionalism of its members. Hence, for society to recognize and acknowledge the significance and dignity of the teaching profession, teachers have to continually improve the teaching competencies with which to guide student learning.

The center of any educative process is the learner. Without the learner, there would be no need for teaching. Formal education is based on the premise that the learning process can be directed and facilitated. Such direction and facilitation of learning, however is not a simple task. According to Bustos et al (1996), “The system of education or schooling is a macro-view of the learning process. Education is a means of transmitting the values and knowledge necessary for society’s continuation.” On the other hand, the teaching-learning process which occurs in the classroom setting is a micro-view of the educational process. There are inherently several variables worth considering when examining the teaching-learning process. Moreover, the quality of instruction largely determines the probable outcome of the teaching-learning process. As Leano (1995) pointed out, the teacher is a great factor in the teaching-learning process and therefore should have a thorough knowledge and understanding of the students which serves as essential starting point in harnessing their potentialities and achieving optimum development of their own endowments. Nocon et al (2001) wrote that, those in the field of teaching, especially in Higher Education, will certainly agree with the generalization that the mathematical ability of the average high school graduate enrolling in College is not getting any better. There seems to be a wrong emphasis somewhere. The basic mathematical skill seems to have been overlooked. According to Maceda (1997), a country can never be a real tiger in economy in a technology-driven world if the next generation is weak in Mathematics and Science. Teachers need to be retrained, textbooks need to be revised and classroom facilities need to be improved. The goal of Mathematics education is to encourage the use of precise and accurate thinking to solve problems. Intuitive reasoning is used as a guide to rigorous thinking. Rigor in Mathematics means honesty and clarity. The purpose of rigor in a beginning course is to make the concepts easily understood and used.

The researcher teaches College Algebra for two decades and found out that the performance of the students in Algebra, specifically on exponents and radicals, were relatively low. For the improvement of the teaching-learning process, the students should be given self-instructional materials that would serve as their learning modules. Vicente (2002) believes that, individualization is one of the educational tenets of our country. Some educators believe that the most important of the school objectives should be to teach all students the learning skills, attitudes, and habits that will enable them to study independently. From this significant point, a module should be developed.

A module is a self-paced instruction constructed in such a way as to facilitate the most efficient method of a user to acquire a new body of knowledge, learn new skills or be challenged on existing attitudes. Modules as instructional materials have concretized pretty well the principle of individual differences allowing each student to proceed at his own pace. Modules also attempt to bridge the gap between the felt need and the course objective of equipping the students with mathematical tools needed in skills development. With the desire to improve the quality of mathematics education, the researcher is motivated to develop and validate a self-paced instructional module in Algebra.

1.1 Objectives of the Study

The main focus of the study is to develop and validate a self-paced instructional module in Algebra. Specifically,

the study sought to determine the: (1) level of performance in Mathematics among first year students in terms of their pretest and posttest scores; (2) significant difference between the pretest mean scores of the experimental and control groups; (3) significant difference between the pretest and the posttest mean scores of the experimental group; (4) significant difference between the pretest and the posttest mean scores of the control group; (5) significant difference between the posttest mean scores of the experimental and control groups; (6) significant difference between the gain scores of the experimental and control groups.

1.2 Scope and Limitations of the Study

This study is limited to the development and validation of a self-paced instructional module in Algebra. Seventy five (75) freshmen taking up College Algebra were utilized as subjects for the two intact groups, the experimental and control groups. Hence, the researcher handled both groups. The study limited its scope on the following: (1) Development and validation of self-paced instructional module in Algebra; (2) Content areas: Laws of Exponents, Zero and Negative Exponents, Fractional Exponents, Laws of Radicals, Removing rational factor from the radicand, reducing the index of a radical, Rationalizing the denominator, Addition, Subtraction, Multiplication and Division of Radicals; and (3) Bloom's Cognitive levels: knowledge, comprehension, application, analysis and evaluation for the preparation of achievement test. This study is not a whole course sequential module. The content that was modularized is that of exponents and radicals. These topics were chosen by the researcher because the need to improve students' performance in mathematics solving was critical.

1.3 Conceptual Framework

This study rests on the concept that the performance of first year students can be affected by the manner of application activity afforded to the learners after the lesson in mathematics had been conducted. Self-paced learning techniques were used as a treatment in the experimental group and traditional learning technique was used in the control group. In mathematics, the time for students to try out what they have learned in the day's lesson is very important. It is on this part of the lesson where the students apply what they had learned and this can be a factor that will make the lesson interesting and enjoyable to them. It is necessary that students should be provided with appropriate opportunities to practice and apply the new content presented. In the self-paced learning, practice task was given after the lesson. In the traditional learning, after the teacher has conducted the lesson, the students were given practice task to apply the concept the teacher had taught them. Results of the evaluation were analyzed to determine whether such activities could improve the students' performance in the evaluation. Thus, the improvement of the students' performance in mathematics could be determined through the result of the evaluation.

2. Design of the Study

This is an experimental study, the researcher made use of the non-randomized experimental and control groups, pretest-posttest designs. A pretest were administered before the start of the experimental study. The experimental and control groups were two separate intact classes in College Algebra. For a period of 10 sessions the experimental group was subjected to the proposed material – the self-paced instructional module, but the control group instead was given lectures on the same topics on exponents and radicals. After the experiment period both groups were given the same posttest.

The design that was used in this study was,

$$\begin{array}{ccc} O_1 & x & O_2 \\ \hline O_3 & c & O_4 \end{array}$$

Where:

O = observed measures O₁ O₃ = pretest of the control and experimental group
 x = experimental group O₂ O₄ = posttest of the control and experimental group
 C = control group ----- = non randomization

2.1 Subject of the Study

The respondents of this study were the 75 male and female undergraduate students. These students belong to two separate intact classes in College Algebra. The experimental group composed of 39 students and the control group of 36 students. The group assignment was selected through a toss coin. Both groups were scheduled to meet three times a week which is equivalent to 3 hours a week. The control group was taught using the lecture method while the experimental group was taught using the self-paced instructional module. The researcher handled the two groups during the experiment period proper.

2.2 Construction and Validation of Achievement Test

The first stage in the construction of the achievement test was the construction of a table of specification. The reliability of the test was computed using the Kuder-Richardson Formula 20. It was computed to be 0.78 which shows that the test was reliable based on the scales of Blooming Evaluation Services and Testing of Indiana University that achievement test should yield a reliability coefficient of at least 0.70. Test items were analyzed to

identify the index of discrimination of each item. Items which are not discriminating enough were deleted. The test was classified according to their level of difficulty and index of discrimination. Test items in this instrument were based on the exponents and radicals. It was tried out to two hundred second year students who had finished College Algebra. It was a multiple type of test in which every item consists of four options.

2.3 Data Processing Technique

The items were subjected to analysis after the answer sheets were checked and scored. Ebel (1965) and Cabalonga (1990) enumerated the following steps to determine the difficulty and discriminating property of the test items.

1. The scores will be arranged from highest to lowest based on the scores obtained by the subjects.
2. The sub-group of the answer sheets will be separated the upper 27% and the lower 27%.
3. The number of correct responses per item of the high scoring group and low scoring group will be tallied separately.
4. The number of correct responses for each item from the high scoring group and the low scoring group will be added. The sum will be divided by the total number or cases for the two groups. The quotient will be considered as the index of difficulty for a particular test item.
5. To find the index of discrimination of the item, the number of correct responses of the low scoring group will be subtracted from the correct responses of the high scoring group. The number of cases of one group divided by the difference only. This is considered the index of discrimination expressed in decimal form.
6. The indices were compared with the accepted indices, and then item evaluation was made. The accepted indices of discrimination ranged from 0.3 and up.

2.4 Item Analysis

The test papers were checked, scored and arranged from highest to the lowest. Item analysis was employed to determine the difficulty index and discriminating index. Selection and improvement or revision of the items needed for final form of the test were done by the use of U-L Index Method. Out of 200, there were 108 test papers comprising the upper 27% and lower 27% of the respondents who were subjected to item analysis using U-L Method. Items that have levels of difficulty index ranging from 20% to 70% were retained after the tryout test. Thus, item with a discrimination index of 0.20 and above was considered acceptable. Summary of the difficulty and discrimination indices is shown in Tables 1 and 2. A short description of the summary of the difficulty index of the achievement test is shown in Table 1. It can be seen from the table that there were 2 out of 80 items with difficulty indices ranging from 0.11 to 0.25, 71 items with difficulty indices ranging from 0.26 to 0.75, 7 items with difficulty indices ranging from 0.76 to 0.90 and no item with difficulty indices ranging from 0.10 below and 0.91 above.

Table 1. Summary of the Difficulty Index of the Achievement test

Difficulty Index	No. of Item	%
0.10 and below	0	0
0.11 – 0.25	2	2.5
0.26 – 0.75	71	88.75
0.76 – 0.90	7	8.75
0.91 and above	0	0
Total	80	100

A short description of the summary of the discriminating power of the achievement test is shown in Table 2. It can be seen from the table that there were 3 out of 80 items with discrimination indices ranging from 0.10 and below, 10 items with discrimination indices ranging from 0.11 to 0.25 and 67 items with discrimination indices ranging from 0.26 to 0.75. These items met the acceptable level of discrimination index while the rest were discarded. Some items were revised or modified to complete the items. Those that were discarded were placed in the pool of item banks for future reference.

Table 2. Summary of the Discrimination Index of the Achievement test

Difficulty Index	No. of Item	%
0.10 and below	3	3.75
0.11 – 0.25	10	12.5
0.26 – 0.75	67	83.75
0.76 – 0.90	0	0
0.91 and above	0	0
Total	80	100

2.5 Preparation of Self-Paced Instructional Module

The first stage in the construction of self-paced instructional module was the review of the course syllabus in College Algebra. In developing the module, the researcher considered the different criteria in conducting and evaluating modules which are presented in journals, books, and internets. Algebra books and other related references were scanned, read, and analyzed before the actual formulation of the module. The developed module includes an overview, which discusses the contents' learning objectives, and the proper use of materials and references needed. The lessons in the module were presented following the sequence of activities below:

1. Learning Objectives. These were the objectives for a particular unit. They were expressed in behavioral terms.
2. Inputs. These contained information for the students to learn. The information was taken from the suggested reference materials.
3. Practice task. This contained a task based on the inputs that the student must complete.
4. Feedback to Practice task. This contained the correct answers to the practice task or exercise.

Content validity of the module was established by subjecting it to the comments and suggestions of faculty members who were either teaching Algebra or who had taught it for quite sometime. Some revisions were made after.

2.6 Data Gathering Procedure

The researcher gathered the data through the result of the posttest after conducting the experiment. The experimental group used the modular learning where the students were given each lesson of the module per session which needs to be read and to understand the concept and perform the given activity either in or out of the classroom. While the control group used the traditional learning, the same subject matters were taught to the two groups. The researcher gave the same set of practice task to the two groups of students after every discussion of the lesson. Books, syllabus, magazines and internets were utilized as the main source of the subject matters.

Before the start of the experiment, a test was administered to both groups to measure the ability of the students about the topic. Every lesson in the Practice task submitted were corrected, recorded, returned and discussed with the students the next meeting prior to the introduction of the new lesson for the control group while the experimental group just submitted and recorded a copy of their output individually. After the experiment, a posttest which is parallel to the given pretest, was given to the experimental and control group. Finally, at the end of the study, the Mathematics achievement of the student respondents was measured by a sixty-item achievement test of a multiple-choice type covering the lesson on Exponents and Radicals. The results of the achievement test that was validated by a group of evaluators consisting of competent teachers were checked and analyzed by the researcher. The performance of the students refers to the mean scores based on the results of the posttest. The level of performance in this test in general was judged according to the following:

Score	%	Level
51 -60	91 – 100	High
41 – 50	82 – 90	Above Average
31 – 40	76 – 81	Average
Less than 30	75	Below Average

The above criteria were based on a grading system which places 50% as a passing mark equivalent to a grade of 75%.

2.7 Statistical Treatment

The t-test for uncorrelated mean was used to determine the significant difference between the pretest and posttest mean scores of the experimental and control groups. Uncorrelated t-test or independent t-test is a test for the observed differences between the two sample means that are not correlated with each other. It was also used to determine if observed differences between the averages of two groups would be statistically significant at 5% significant level. The uses of the t-test for independent sample means are as follows:

1. to compare the difference between the average of cases or items or subjects for control and experimental groups.
2. to determine if there will be a difference between the average of the two groups.
3. to test the extent of learning in each group and to determine whether there will be significant difference between the pretest and posttest results.

3. RESULTS

This chapter presents the information on the results of the statistical analysis of data and interpretation of the research findings. It presents the achievements in Mathematics of first year students who were subjected to the two methods of teaching-learning process, the self-paced instruction and the traditional method.

3.1 Level of Performance in Mathematics among First Year Students in terms of their Pretest and Posttest Scores

The subjects of both groups were given pretest to determine their performance before the experiment proper. After the experiment, both groups were subjected to posttest to determine their performance.

Table 3. Performance Result of the Pretest and Posttest Scores of the Experimental and Control Groups

Level	Scores	Pretest		Posttest	
		Experimental (N=39)	Control (N=36)	Experimental (N=39)	Control (N=36)
High	51-60	0	0	14	2
Above Average	41-50	0	0	18	20
Average	31-40	0	0	5	11
Below Average	30 below	39	36	2	3
	Mean	23.6	23.8	47.9	41.4
	Level	Below Average	Below Average	Above Average	Above Average

Table 3 shows that the performance level of the experimental and control group in the pretest was below average while in the posttest was above average. Hence, both groups performed better after exposure on self-paced instruction for experimental group and traditional method of teaching for the control group.

3.2 Difference between the Pretest Mean Scores of the Experimental and Control Groups

A pretest was given to the students of both groups to determine if the students had an idea on the subject matters. To determine what group performed better, the t-test for uncorrelated data was used.

Table 4. t-test Result of the Pretest Mean Difference of the Experimental and Control Groups

Pretest	N	Mean	Mean Difference	Computed t- value	Tabular t-value	Decision
Experimental Group	39	23.6	0.20	0.231	1.980	Accept Ho
Control Group	36	23.8				

Alpha level = 0.05

Table 4 shows that the students of the control group achieved higher mean during the pretest with a mean difference of 0.20. The t-value is not significant because the computed value 0.231 does not exceed the critical value 1.980. Hence, the first null hypothesis – Is there a significant difference between the pretest and the posttest mean scores of the experimental and control groups?, was accepted. From the findings of the study, there is no significant difference between the pretest mean scores of the two groups.

3.3 Difference between the Pretest and the Posttest Mean Scores of the Experimental Group

The students classified as experimental group were exposed to the self-paced instruction approach of teaching. Comparison of their pretest and posttest results was needed to test the second null hypothesis.

Table 5. t-test Result of the Pretest and Posttest Mean Difference of the Experimental Groups

Experimental Group	N	Mean	Mean Diff	Computed t- value	Tabular t-value	Decision
Pretest	39	23.6	24.3	26.4*	2.021	Reject Ho
Posttest	39	47.9				

Alpha level = 0.05

Table 5 shows that the students of the experimental group achieved higher mean score during the posttest with a mean difference of 24.3. The t-value is significant because the computed t-value 26.4 has exceeded the critical value 2.021. Hence, the second null hypothesis – Is there a significant difference between the pretest and the posttest mean scores of the experimental group?, was rejected. This means that the respondents in the experimental group learned through the self-paced instruction method of teaching. From the findings of the study, there is significant difference between the pretest and posttest mean scores of the experimental group.

3.4 Difference between the Pretest and the Posttest Mean Scores of the Control Group

The respondents classified as control group were exposed to the traditional method of teaching. Comparison of their pretest and posttest results was needed to test the third null hypothesis.

Table 6. t-test Result of the Pretest and Posttest Mean Difference of the Control Groups

Control Group	N	Mean	Mean Diff	Computed t- value	Tabular t-value	Decision
Pretest	36	23.8	17.6	18.7*	2.032	Reject Ho
Posttest	36	41.4				

Alpha level = 0.05

Table 6 shows that the respondents of the control group achieved higher mean score during the posttest with a mean difference of 17.6. The t-value is significant because the computed t-value 18.7 exceeded the critical value 2.032. Hence, the third null hypothesis – Is there a significant difference between the pretest and posttest mean scores of the control group?, was rejected. This means that the students in the control group learned through the traditional method of teaching. From the findings, there is significant difference between the pretest and posttest scores of the control group.

3.5 Difference between the Posttest Mean Scores of the Experimental and Control Groups

Table 7. t-test Result of the Posttest Mean Difference of the Experimental and Control Groups

Posttest	N	Mean	Mean Diff	Computed t- value	Tabular t-value	Decision
Experimental Group	39	47.9	6.5	4.05*	1.980	Reject Ho
Control Group	36	41.4				

Alpha level = 0.05

Table 7 shows that the experimental group and the control group had a great difference in the performance in the posttest. The mean difference between the experimental and the control group is 6.5. This value is significant because the computed t-value 4.05 has exceeded the tabular t-value 1.980. Thus the fourth null hypothesis – Is there a significant difference between the posttest mean scores of the experimental and control groups?, was rejected. This means that the students in the experimental group learned better than the students of the control group. From the findings, there is a significant difference between the posttest mean scores of the experimental and control group.

3.6 Difference between the Gain Scores of the Experimental and Control Groups

Table 8. t-test Result between the Gain Scores of the Experimental and Control Groups

Gain Scores	N	Mean	Mean Diff	Computed t- value	Tabular t-value	Decision
Experimental Group	39	24.4	6.8	7.6*	1.980	Reject Ho
Control Group	36	17.6				

Alpha level = 0.05

Table 8 shows that the experimental group had higher mean score of 24.4 than the control group which is 17.6 during the practice task with a mean difference of 6.8. The t-value is significant because the computed t-value exceeded the critical value. Hence, the fifth null hypothesis was rejected. This means that the students in the experimental group performed better than the students of the control group.

4. CONCLUSION

Self-paced instruction attempts to bridge the gap between the felt need and the course objective of equipping the students with mathematical tools needed in skills development. This paper has presented a method for experimental group using the self-paced instructional module. Experimental results demonstrate the efficiency and the effectiveness of the proposed method.

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