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Programmed Learning Sequence and Instructional Module: Their Acceptability and Effectiveness in Teaching Plane Geometry

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ABSTRACT

The search for innovative teaching approaches has gained popularity in educational research. The study aimed to determine the acceptability and effectiveness of the Instructional Module (IM) and Programmed Learning Sequence (PLS) in teaching plane geometry. Quasi experimental design, specifically the Counter Balanced with Matched Group Design, was adopted. The study was conducted in a State University in the Northern Philippines, during the summer term of 2011. Two sections with more than 40 students each were the source of respondents. Students were matched based on their average grade in Math1 and Math 2 creating two matched groups of 35 subjects each. The first group was taught using IM for the first set of topics then PLS in the second set of topics. The second group was exposed to PLS first and then followed by the IM. The study noted improvement in the math achievement of the students exposed to IM and PLS. However, neither of these two methodologies could be said better than the other. In addition, these teaching methods were fully accepted by the students to use. Hence, IM and PLS are advisable to be adopted by the teachers teaching geometry classes though, some features of PLS like the integrated activities are more acceptable than IM.

Keywords - Mathematics education, programmed learning sequence, instructional module, quasi experimental design, counter balanced, matched group design, Philippines

INTRODUCTION

Instructional materials play a key role in the changes that move toward inquiry-centered, standard-based instructions. This is the reason why reinforcement, enrichment, and mastery of learning are needed. From these, a module-based instructional material evolved and was introduced in education (Villaverde, 2011).

This study focuses on the teaching strategies specifically, the modular teaching and the Programmed Learning Sequence (PLS) in relation to mathematics achievement. The Modular Teaching Approach, where students independently acquire knowledge through the devised modules, is already adopted by some institutions. This is already an accepted teaching approach and is considered to contribute significantly to students' academic performance as proven by researches.

On the other hand, the Programmed Learning Sequence (PLS) is similar to the modular approach where students independently learn. However, PLS is more manipulative than the module and is seldom introduced to teachers and students. With these, the researcher wishes to establish which of the two teaching strategies are more acceptable and effective among the students in geometry.

FRAMEWORK

Merrill (2004) concluded on his research entitled "Effects of Modular Technology Education on Junior High Students' Achievement Scores" that there is no significant difference in reading, language, arts, mathematics, science, and/or social studies achievement gain between students who have participated in a unit of modular technology education and those who have not. The results of this study did not support the claim that participation in a modular technology course can increase students' achievement in other academic subjects.

Meanwhile, Acelajado (2005) conducted a study using the modular teaching approach as intervention. Her study yielded the following conclusions: (1) The use of the modular teaching approach has made significant improvement in the learners' achievement, persistence, and confidence in mathematics, regardless of their abilities. (2) Since there is a significant difference in the posttest mean achievement scores between the High Ability Group (HAG) and the Low Ability Group (LAG), it can be inferred that performance in higher mathematics mainly depends on the learner's

mathematical ability and understanding of essential mathematical concepts. The improvement of the learners' persistence and confidence are independent of their mathematical ability. (3) The modular teaching approach in mathematics has positive effects on the respondents' achievement, persistence, and confidence levels most especially among the respondents from the low-ability group.

Programmed Learning Sequence (PLS) was first introduced as an alternative methodology in teaching individual with different learning styles. Derek Tully et al. (2006) conducted a research entitled, "Effects of Programmed Learning Sequences on the Mathematics Test Scores of Bermudian Middle School Students" where they considered the learning styles of the individual. They found out that the experimental group (PLS) scored significantly higher than its control group (traditional) counterpart based on their post-test scores on the Fractions Unit. In addition, the difference between the means of the pre-test and the post-test scores of the experimental group was significantly greater than the difference between measures of the control group.

The study conducted by Merrill (2004) and Acelajado (2005) on the effects of a modular approach in teaching in the achievement of the students showed that a modular approach in teaching could not lead to deterioration of learning; instead, a modular approach in teaching is equally effective, if not, much better than the traditional methods of teaching.

This research is related to their work considering the use of the teaching strategies; the modular teaching approach and the PLS. However, this research is different considering that the research will no longer compare the two methodologies with the traditional method, since these two teaching methodologies are already proven to be more efficient than the traditional method. In addition, the researcher used PLS in presenting Geometry lessons to students regardless of the different learning styles of the students unlike what Tully et al. (2006) did in their research.

The researcher was guided by the research design as shown in the figure below. The figure shows that the researcher utilized two (2) groups of students; pairing and matching procedure are made in order to get matched and paired students who are taken as main respondents in the study. There are two (2) sets of topics included in the study. For the first set of topics, the groups of students are exposed to the experimental treatments; IM for the first group and PLS for the second group for 10-hours. Other 10-hours are consumed for the second set of topics during the counter exposure; the first group was exposed to PLS and the second group was exposed to IM.

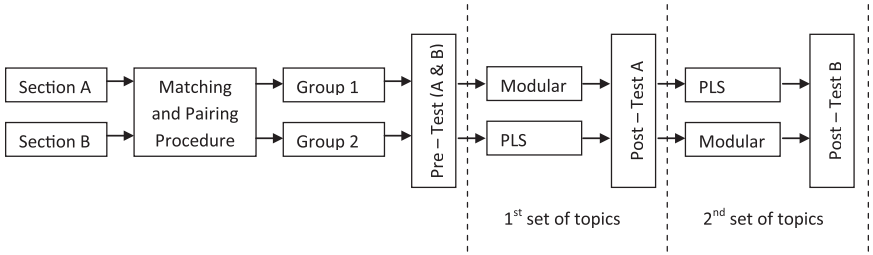

Figure 1. Schematic Diagram showing the flow of the study

OBJECTIVE OF THE STUDY

The study aimed to determine the acceptability and effectiveness of Programmed Learning Sequence (PLS) and Instructional Modules (IM) in teaching plane geometry to the students.

MATERIALS AND METHODS

Research design. The researcher adopted the quasi-experimental design, specifically, the counter-balanced with matched group design.

Locale of the Study. The study was conducted in a state university located in the Northern Part of the Philippines during the summer term of 2011.

Subjects. All the Bachelor of Elementary Education (BEED) 2 students, two (intact groups) sections enrolled in the Plane and Solid Geometry during the summer class of 2011 are considered subjects of the study. However, selected students in each group (matched group) were chosen as the primary subjects in establishing the effectiveness and acceptability of the two teaching methodologies. The matching procedure is as follows: Irregular students were not considered in the match up procedure; Average grade of each BEED 2 students in math 1 and math 2 were computed; the average grades in each group were arranged in descending order. This is the basis in identifying the pairs of students with equal performances; only students with corresponding average grades from the two groups were chosen as respondents of the study. The researcher matched 27 students in each group. The two sets of students have matched average grades in math 1 and math 2. However, after the experimental treatment, students who incurred absences during the conduct of the study were removed together with the paired students in the other group. There were only 20

student samples in each group who were retained.

Research Instruments. The average grade of the students in Math 1 and Math 2 were the basis of the student's mathematics performance. These were used in the match-up or pairing procedure to identify the sets of respondents. The grades of the students were obtained from the Mathematics and Statistics Department's Chair file copy and, in some instances, the respondents were required to submit their class cards in Math 1 and Math 2.

Two parallel exams. *The Pre-test*. Items in the Pretest were drawn from the researcher's questions file used for several years of teaching. Only good questions were included. *The Post-test*. The researcher made a set of questions parallel to the items included in the pre-test. To ensure parallelism and the same level of difficulty, the researcher opted to change only the numerical figures and did not change the sentence construction. The Assessment Module Packet developed and used by Marietta Villaverde in her study "Development and Acceptability of Performance-Based Assessment Module Packet on Selected Topics in Chemistry" was used to measure the acceptability of the materials.

Experimental Treatments

Programmed Learning Sequences (PLS) are highly-structured, visual materials that teach a specific topic, lesson or skill. These are hands-on and self-instructional resources.

The content of this PLS such text, exercises and even the presentation of the topics was patterned from the module. The additional exercises and student activities included in the PLS were lifted from other geometry books. The PLS was validated by 3 math teachers who were teaching the subject for more than 8 years. The PLS was also tried out to students enrolled in Teaching Basic Mathematics Class (Masteral Level) during the second semester of SY 2011-2012

Instructional Module. A module is a unit of curricular material, complete in itself, to which further units may be added for the achievement of larger tasks or more long-term goals

The modules were from the Geometry Book written by Ray C. Jurgensen, Richard G. Brown and John W. Jurgensen. This book has been used by the researcher in his previous geometry classes.

Analysis of Data

The following statistical tools were used: frequency count, percentage, rank, mean, t test for independent samples and t test for dependent samples.

RESULTS AND DISCUSSION

Performance in the Pre-test

The table below is the distribution of the respondents with respect to average grades in Mathematics 1 and Mathematics 2. The table reflects that the selected students in each group have equivalent Math 1 and Math 2 grade average.

The t-computed of -0.07 and the significance value of 0.944 suggests that the mean Math grades of 2.31 and 2.32 for group 1 and group 2, respectively were not different from each other. This further suggests that the two groups of students were matched and comparable. Hence, the two groups had equal mathematics performance before the experiment was conducted.

Table 1. Distribution of average grade in Math 1 and Math 2 of the Group 1 and Group 2 respondents

Average Grade	Grp_1		Grp_2	
	F	%	F	%
1.00 - 1.49	3	15	3	15
1.50 - 1.99	2	10	2	10
2.00 - 2.49	5	25	5	25
2.50 - 3.00	10	50	10	50
Total	**20**	**100**	**20**	**100**
Mean	**2.31**		**2.32**	
sd	0.58		0.57	
Tc	-0.070^{ns}			
Sig	0.944			

ns – not significant

Level of Prior Knowledge

Table 2 shows the mean Mathematics scores in the pre-test of students for the two sets of topics.

Students in group 1 and group 2 incurred 15.32 and 15.16 as average pre-test scores, respectively. The two groups exhibited equal amount of prior knowledge on the topics included in the first set. This statement is based on the t-value of 0.107 with corresponding significance value of 0.915.

There is no significant difference in the amount of prior knowledge among the students in group 1 and group 2 for the second set of topics. This is based on the pre-test mean scores of 10.42 and 11.79 for the group 1 and group 2, respectively with the t-value of -1.259 and significance value of 0.217.

The findings on these two math ability groups for the two sets of topics further implied that the two groups of respondents have the same amount of prior knowledge on the topics before the conduct of the teaching methodologies. Furthermore, these validate the previous findings that the two groups are equally matched.

Table 2. Performance of the two groups of respondents in the pre-test for the two sets of topics

Pre-Test	Set A				Set B			
	Group 1		Group 2		Group 1		Group 2	
	F	%	F	%	F	%	F	%
25 - 29	2	10	1	5	0	0	0	0
20 - 24	2	10	2	10	0	0	1	5
15 - 19	6	30	9	45	2	10	3	15
10 - 14	9	45	7	35	11	55	10	50
5 - 9	1	5	1	5	7	35	6	30
Total	20	100	20	100	20	100	20	100
Mean	15.32		15.16		10.42		11.79	
sd	5.21		3.78		2.89		3.75	
Tc	0.107^{ns}				-1.259^{ns}			
Sig	0.915				0.217			

ns – not significant

Effects of the Treatment

Performance in the Pre-test and Post-test

Exposure of students using instructional modules has resulted to an increase in the achievement scores from 15.32 to 23.63 in the set A topics and from 11.79 to 19.53 in the set B topics. These observations show that instituted treatment could improve the Mathematics achievements of the students. This statement is based on the t-computed of -8.56 and -0.6.92 together with significance value of <0.001 and <0.001, respectively. Hence, the instructional module is effective in improving mathematics achievement.

Table 3. Test of difference showing the differences on means in the pre-test and post-test in the two sets of topics for the instructional module treatment

Modular	Mean	SD	T-value	Sig
Set A				
Pre-Test	15.32	5.21	-8.595*	<0.001
Post-Test	23.63	5.36		
Set B				
Pre-Test	11.79	3.75	-6.919*	<0.001
Post-Test	19.53	3.34		

* - significant

Exposure of students using PLS resulted to an increase in the achievement scores from 15.16 to 24.16 in the set A topics and from 10.42 to 20.26 in the set 2 topics. These observations proved that the instituted treatment could improve the mathematics achievements of the students. This statement is based on the t-computed of -10.09 and -7.62 together with significance value of <0.001 and <0.001, respectively. Hence, the use of PLS in the classroom is effective in improving mathematics achievement.

Table 4. Test of difference showing the differences in means in the pre-test and post-test in the two sets of topics for the programmed learning sequence treatment

PLS	Mean	SD	T	Sig
Set A				
Pre-Test	15.16	3.78	-10.092*	<0.001
Post-Test	24.16	4.62		
Set B				
Pre-Test	10.42	2.89	-7.620*	<0.001
Post-Test	20.26	5.81		

* - significant

Performance of Module group and PLS group

For the first set of topics, students exposed using the PLS in the classroom obtained higher scores of 24.16 in the achievement compared to the mean achievement scores of 23.63 for students exposed using the module. Similar observations for the second set of topics were noted. Students exposed using the PLS in the classroom obtained higher scores of 20.26 in the achievement compared to the mean achievement scores of 19.53 for students exposed using the module.

However, the average post test mean scores for set 1 and set 2 topics of the students exposed to modular and PLS shows no significant differences. These statements are based on the t-computed of -0.324 and -0.479 with corresponding significance values of 0.748 and 0.635, respectively. Hence, the two teaching methodologies are both equally effective in improving the achievement of the students and neither of the two could be more effective than the other.

Table 4. Distribution of post-test scores and t-test showing the differences on means between the two treatments (Modular and PLS) in the two sets of topics

Post-Test	Set A				Set B			
	Modular		PLS		PLS		Modular	
	F	%	F	%	F	%	F	%
30 - 35	4	20	3	15	3	15	0	0
25 - 29	1	5	6	30	1	5	1	5
20 - 24	11	55	9	45	8	40	11	55
15 - 19	4	20	2	10	5	25	7	35
10 - 14	0	0	0	0	3	15	1	5
Total	20	100	20	100	20	100	20	100
Mean	23.63		24.16		20.26		19.53	
sd	5.36		4.62		5.81		3.34	
Tc	-0.324^{ns}				0.479^{ns}			
Sig	0.748				0.635			

ns – not significant

Acceptability of the Treatments

In general, the student subjects perceived that the use of modules and PLS in the classroom is acceptable. The over-all mean perception mean scores of 4.55 for the module and 4.65 for the PLS are both in the "highly acceptable" level.

The Use of Instructional Modules

Students found the use of instructional modules inside the classroom as highly acceptable especially in guiding and motivating students to learn, in ensuring relevance to topics, and providing enrichment resources. They also observed that using modules were more acceptable among students with necessary skills to use the materials. These statements are based on the acceptability statements "The material can be used to guide students", "The material can motivate learning", "Instructional events in the material are relevant to the objective", "Students have pre-requisite skills to use the materials" and "Various resources are tapped to widen access of knowledge and to enrich learning" with corresponding mean scores of 4.76, 4.74, 4.72, 4.71 and 4.68, in the same order. These mean scores have obtained the highest acceptability statement.

Although, the following statements "Objectives are clearly stated", "Objectives are attainable and measurable", "Provide sufficient information", "The material provides progression and consecutive depth of ideas" and "The material is presented with a specific format and adapted in overall house style" obtained the lowest mean scores of 4.24, 4.32, 4.35, 4.35 and 4.38 respectively, these statements still are considered moderate as a high level of acceptability.

The Use of Programmed Learning Sequence (PLS)

Students found the use of PLS in the classroom highly acceptable along the statements "The material can motivate learning", "Students have pre-requisite skills to use the materials", "The material can be used to guide students", "The material involves the student's active learning through appropriate activities" and "The material utilizes practical application". These statements have obtained the highest mean scores as follows: 4.88, 4.76, 4.76, 4.68 and 4.68. Further, students can claim that PLS could motivate and guide students to learn, it could provide active and appropriate learning activities with practical applications. Also, these materials could only be best given to students with the necessary knowledge in using the materials or a thorough orientation should be done before the PLS methods.

There were only four (4) statements that obtained mean scores corresponding to moderately acceptable level. These are the statements "The material is presented with a specific format and adapted in overall house style", "The material provides progres-

sion and consecutive depth of ideas", "Are attainable and measurable" and "Features value-laden learning activities" with corresponding mean scores of 4.35, 4.36, 4.45 and 4.47.

General Notations on the Use of the Two Methodologies

There are some statements wherein the use of PLS inside the classroom was perceived "highly acceptable" but it is perceived "moderately high acceptability" in using modules inside the class like objectives are clearly stated; content could provide sufficient information; and there is a systematic sequencing of the lesson.

There is also a statement wherein students perceive the use of a module to be more acceptable than the use of PLS. The statement "one of the contents features value laden learning activities."

Acceptability Statement	Module			PLS		
	Mean	sd	Description	Mean	sd	Description
A. Objectives	***4.36***	***0.55***	***Moderately Acceptable***	***4.54***	***0.50***	***High Acceptable***
1. Are clearly stated	4.24	0.85	Moderately Acceptable	4.56	0.75	Highly Acceptable
2. Are attainable and measurable	4.32	0.68	Moderately Acceptable	4.45	0.62	Moderate Acceptable
3. Are expressed in terms of competencies which knowledge, skills and attitudes	4.52	0.62	Highly Acceptable	4.61	0.61	Highly Acceptable
B. Content	***4.51***	***0.49***	***High Acceptable***	***4.54***	***0.49***	***High Acceptable***
1. Provides topics in the course syllabus	4.59	0.70	Highly Acceptable	4.61	0.70	Highly Acceptable
2. Is relevant to the learning activities	4.56	0.66	Highly Acceptable	4.61	0.93	Highly Acceptable
3. Provide sufficient information	4.35	0.81	Moderately Acceptable	4.50	0.66	Highly Acceptable
4. Features value-laden learning activities	4.53	0.56	Highly Acceptable	4.47	0.56	Moderately Acceptable
C. Organization	***4.52***	***0.37***	***Highly Acceptable***	***4.56***	***0.44***	***Highly Acceptable***

Acceptability Statement	Module			PLS		
	Mean	sd	Description	Mean	sd	Description
1. The material is simple and easy to follow	4.50	0.62	Highly Acceptable	4.65	0.60	Highly Acceptable
2. Instructions are clear and concise	4.61	0.56	Highly Acceptable	4.67	0.54	Highly Acceptable
3. There is systematic sequencing of the lesson	4.39	0.50	Moderately Acceptable	4.53	0.56	Highly Acceptable
4. The material provides progression and consecutive depth of ideas	4.35	0.69	Moderately Acceptable	4.36	0.60	Moderately Acceptable
5. The material is presented with a specific format and adapted in overall house style	4.38	0.70	Moderately Acceptable	4.35	0.77	Moderately Acceptable
6. The material provides adequately study aids such as questions, problems and explorations	4.67	0.60	Highly Acceptable	4.68	0.64	Highly Acceptable
7. Instructional events in the material are relevant to the objective	4.72	0.46	Highly Acceptable	4.64	0.60	Highly Acceptable
D. Materials and Resources	***4.69***	***0.32***	***Highly Acceptable***	***4.70***	***0.36***	***Highly Acceptable***
1. Various resources are tapped to widen access of knowledge and to enrich learning	4.68	0.47	Highly Acceptable	4.67	0.48	Highly Acceptable
2. Materials provided are fitted to the instructional event	4.68	0.47	Highly Acceptable	4.68	0.53	Highly Acceptable
3. Students have pre-requisite skills to use the materials	4.71	0.46	Highly Acceptable	4.76	0.43	Highly Acceptable

Acceptability Statement	Module			PLS		
	Mean	sd	Description	Mean	sd	Description
E. Effectiveness	***4.68***	***0.39***	***Highly Acceptable***	***4.75***	***0.42***	***Highly Acceptable***
1. The material can be used to guide students	4.76	0.55	Highly Acceptable	4.76	0.55	Highly Acceptable
2. The material involves the student's active learning through appropriate activities	4.56	0.61	Highly Acceptable	4.68	0.59	Highly Acceptable
3. The material utilizes practical application	4.68	0.53	Highly Acceptable	4.68	0.53	Highly Acceptable
4. The material can motivate learning	4.74	0.45	Highly Acceptable	4.88	0.33	Highly Acceptable
over-all	***4.55***	***0.30***	***Highly Acceptable***	***4.62***	***0.34***	***Highly Acceptable***

Strengths/Weaknesses of the Treatments

A simple interview to all the students subjected under the two experimental conditions was conducted to further assess and explain the result. Likewise, giving open-ended questions to students was done to elicit students' observations relative to the conduct of the experimental methodologies. Here are the common strengths/weaknesses encountered by the students during the conduct of the experimental methodology that have had contributory effects to the students' performance.

In using instructional modules

The following statements are common observations of students while using the instructional modules. The instructional modules test honesty of the students; force the students to study harder; help the students to work independently; give the students time to review all his/her answers before checking; train students to read and follow correctly the instructions; but provide exercises that are routinary; thus these become boring.

In using Programmed Learning Sequence (PLS)

The following statements were common observations of students while using the PLS. This teaching material makes students accomplish the task not minding

the time; is enjoyable and interesting; has more challenging and fun activities; tests honesty of the students; forces the students to study harder;changed their attitude towards Mathematics, from negative to positive; gives new insight in making instructional materials; helps the students to work independently; makes activities and materials reusable by other students; makes activities self-corrected; students can correct their own answer without asking others; has attractive and appealing materials; is like learning through a game and not boring; has unique teaching method, "It is our first time to encounter this method"; makes students accomplish the activity without complaints; topics are reinforced through a series of activities; students are forced to answer an item, because answers will be revealed right after; has a simple presentation of the topics, however student learn through a series of manipulative activities; and makes the class noisy while performing the PLS.

CONCLUSIONS

The following are the conclusions drawn from the findings:

The two groups of respondents have statistically-equal performance before the start of the experimental treatment. Thus, the two groups have the same amount of prior knowledge on the topics. Furthermore, these have also confirmed the previous findings that the two groups are equally matched.

The two groups of students exposed to the two teaching methodologies exhibited improvements in the pre-test and post-test. In addition, the two groups of students have exhibited no differences in their post-test scores. Hence, the use of instructional modules and Programmed Learning Sequence (PLS) in teaching plane geometry is effective. The use of instructional modules in the class resulted to an improvement in Math performance and comparable to the class using the PLS.

The student-subjects perceived that the use of instructional modules and PLS in the classroom is acceptable. Students found the use of instructional modules inside the classroom as highly-acceptable especially in guiding and motivating students to learn, in ensuring relevance to topics, and providing enrichment resources.

PLS could motivate and guide students to learn, it could provide active and appropriate learning activities with practical applications. Also, these materials could only be best given to students with the necessary knowledge in using the materials or a thorough orientation should be done before the PLS approach begin.

There were some statements wherein the use of PLS inside the classroom was perceived "highly acceptable" but it was perceived "moderately acceptable" in the used of modules. The PLS was perceived more acceptable in stating clear objectives, providing a content that were sufficient enough information, and providing a more

systematic sequencing of the lesson than of the IM.

RECOMMENDATIONS

Since the teaching methodologies resulted in an improvement in the pre-test/ post-test scores, teachers teaching geometry classes or mathematics courses are advised to devise their own instructional modules or programmed learning sequences. In addition, this study may be replicated to other subject areas or to other fields of discipline to test if the same result will be observed.

Since the two teaching methodologies resulted to comparable Math performances among the students exposed and considering other research findings using instructional modules and programmed learning sequence could have result equal or better than the traditional teaching method, devising instructional modules or programmed learning sequence should be recommended to teachers, especially those teaching the soon-to-be teachers.

It is observed that both teaching methodologies are fully-accepted by the students. However, most of the students gave good remarks on the use of PLS especially the PLS notes, and activities like pick a stripe, flip chute and task card. The teachers should then try to inject or to integrate such activities in their class discussions to minimize, if not eradicate boredom to students.

It is also noted that students exposed to PLS methods resulted a changed in attitude towards mathematics, from negative to a positive outlook. In addition, students in PLS class claimed they were active for the whole class. Hence, the teacher should try to expose students with a negative attitude toward the subject to PLS mode of teaching.

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