Structured Approach vs. Self-Paced Modular Approach in Teaching Trigonometry

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Abstract *- The study aimed to determine which approach in the teaching of Mathematics allowed students to achieve a higher mathematical performance and to establish the learning styles of the students to showed greater confidence on a written posttest - the self-paced modular approach or the structured lecture demonstration based approach. The instruments used in the study are Trigonometry Achievement Test (PTAT) designed by the researcher and the Grasha - Reichmann Student Learning Style Survey. Hence. the result shows on the test of significant difference on the respondents learning styles and level of performance established independent learning conditions and demonstrate remarkably higher mathematical performance, respectively. In the light of the statistical analysis and the findings of the study, it could be generalized that SPMA made the students learning styles more independent because they prefer to work at their own pace. Hence, SPMA help them also improve their level of performance in relation to plane trigonometry regardless of their mathematical abilities compared to structured approach. Along these lines, the subsequent recommendations are presented for consideration: The teachers should use collective learning style inventories so that students remain interested throughout their mathematics course. And should use SPMA in teaching trigonometry and other disciplines in the field of mathematics.*

Keywords: *Self-Paced Modular Approach, Structured Approach, Learning Styles, Academic Performance*

INTRODUCTION

Mathematics is often viewed as a difficult topic despite its importance in daily life [9]. Such perception is, in part, due to the abstract nature of mathematics. From the time when mathematical concepts are abstract, students are faced with the difficulty of understanding and establishing the relationship between their knowledge and intuition about concrete structure and theoretical nature of mathematics. Another important problem associated with the students' learning difficulty is the methods and approaches employed in the delivery of the subject content. Most teachers emphasize how highly difficult mathematics is but fail to impart to their learners how mathematical skills are importance for their future achievements.

Trigonometry is an unspeakable part of mathematics in higher education. It needs various topics in arithmetic and geometry as any source of creativeness and understanding of the foundations, that are important in the development of notions and manner of teaching trigonometry. Accordingly, it is necessary for students to know the basic concepts on analytical part of trigonometry. Moreover teaching Mathematics subject like plane trigonometry to students who do not have a very strong background in mathematics is always challenging experience to the teacher. This experience is also awfully rewarding when these students begin enjoying the excursion, which leads to mastering the concepts not by simply memorizing.

Likewise, the role of a teacher in a mathematical setting is to assist the students in seeing the big picture, construct accurate knowledge, and framing the details to help illuminate the end result. Just like any other subject, understanding content is the ultimate goal of teaching mathematics to students. Developing mathematical understanding does not merely mean getting high scores in different assessments as quizzes and tests, or being able to solve drills in mathematics books, but rather, it is manifested in the students' ability to relate and communicate to previously acquired knowledge and be able to identify its practical purposes.

On the idea that SPMA has responded enthusiastically to the change of the classroom into

places of rich and active learning environment, various authors reveal varied reactions that are virtually treated as logical and of primary importance.

Modular approach as self-directed learning activity packets which are self instructional package, self-paced, student directed, and place the responsibility for learning on the students [15]. These activity packets provide students with an opportunity to develop their self-esteem and an increased level of achievement in the content area of the course. Consequently, this approach allows students to work through the material in a systematic, efficient, and timely manner. While the end results are achieved when the students work through the procedural sequence.

Additionally, George and Alexander as well pointed out that the self-directed learning activity packet is a scheme of communicating between a student and/or small group of students and the instructor [4]. With this method the teacher sheds the role of presenter, demonstrator, driller and questioner, and now takes on the role of facilitator, initiator, monitor, coach, and coordinator.

Subsequently, the SPMA helps the learners to learn or acquire skills, knowledge and information using materials which provide sufficient reinforcement, and enrichment. It also allows the learner to work at a rate style and level situated to his capacity. At this level, the student plays the major role in developing one's own ways of learning to learn.

As a whole, SPMA allows students the opportunity to move through the mathematical concepts at their own pace with multiple chances to "replay" the presentation of the concepts with the supplement of the software. Thus, this approach proved to be more favorable than the students taught by structured approach. Also, SPMA creates interest and motivation in the non math major students in mathematics because it also promoted positive changes in their mathematical performance as well as in their learning styles.

Hence, the self-paced modular approach (SPMA) in trigonometry shall be introduced to enable the students experience the real and concrete meanings of trigonometry and lay some foundations for more advanced work for successful performance and self confidence towards mathematics. This transformation suggested that there's a need to change both the curricular content and the structured teaching approach in the traditional classroom that involves renewed effort to focus on: seeking solutions, exploring patterns and formulating conjectures. Accordingly, student learning is not a haphazard affair but it is controlled by factors such as teaching methods and approaches together with a range of teacher and class influences.

This paper shall advance the role of SPMA in trigonometry as an attempt in humanizing the students' mathematics conceptual understanding and examine its effect on the students learning styles and the learner's achievement and self confidence towards mathematics particularly the non-math major students.

Theoretical - Conceptual Background

This study is premised on Weiner's (1980) attribution theory. It is concerned with how individuals interpret events and how this relates to their thinking and performance. A person seeking to understand why another person did something may attribute one or more causes to that performance.

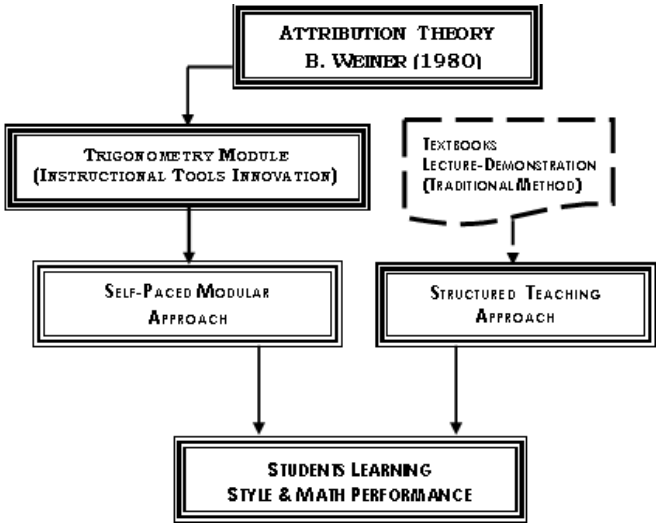

Figure 1: *Schematic Diagram of the Theoretical-Conceptual Framework of the Study*

Weiner focused his attribution theory on achievement [14]. He identified ability, effort, task difficulty, and luck as the most important factors affecting attributions for achievement. Thus, controllability contrasts causes one can control, such as skill/effectiveness, from causes one cannot control, such as aptitude, mood, others' actions, and luck. Attribution theory has been used to explain the difference in motivation between high and low achievers. According to attribution theory, high achievers will approach rather than avoid tasks related to succeeding because they believe success is due to high ability and effort which they are confident of.

SPMA affords students opportunities to display their mathematical thinking, reasoning, and problem solving. Educationalist should create instructional activities using modular style to increased learner's proficiency in mathematics. Moreover, SPMA is design not only to help the learner's mathematical way of thinking, but also mean to enhance textbook used by the teacher in the classroom. Thus learning to solve the problems requires great deal of practice with different kinds of problems that demand thought.

In a mathematics classroom environment utilizing a SPMA, mathematical situations are so well formulated depending on students, dept of content understanding and thereby encouraging them to focus on and develop different methods and approach in arriving at the answers. One distinct feature show their solution processes and give justification for their answers [2].

The important feature of this SPMA is that students are asked to study the instructional content and take test on the content until they are able to demonstrate mastery and not only to produce their correct answers but also to show their solution processes and give justification for their answers.

SPMA promises solution to may educational problems resistance from teachers and administrators to use of instructional module in the classroom is not usual. This reaction can arise from the belief or fear of the teachers, because they thought that the ultimate aim of SPMA is to reduce the human element on lecture–demonstrations or instruction. However, most educationalist would counter to education will always require human intervention from instructors or facilitators.

Consequently, SPMA will require teachers to move away from lecturing and monitoring their students' readiness and checking for understanding with tasks which are closed and with single and unique response. This instructional material serves as a key factor in ensuring that the students are at par with the advocacy of the renewed mathematics arena. Furthermore, there has been a long debate over the reason why students dropped out of their schooling which at enrolment they had every attention of completing. One of the main reasons is that the students have difficulty of relating the learned mathematical skills in their everyday activities. Most of the students don't accept mathematical reasoning as belonging to them, as being important part of their concept of self. SPMA eliminates this dilemma, since the fundamental view stresses that the students is the determinator in the whole instructions process. Hence, an instructional module is a component of a learning process in the student learning, studying and experiencing while moving towards the mastery of subject content area.

SPMA applied to employs empirical methods in analysis, design, and repeated tryout and revision to validate the effectiveness of the instructional materials to the non math major students. In order to better understand the creation and design of instructions, that learners can exhibit observable changes in behavior, knowledge and skills which can contributed to the use of self-paced module in the teaching instruction.

Effectively synthesizes and aims to "provide insight into understanding that various ways in which philosophy shapes instructional design practice" Hence learning essentially involves a change in abilities, attitudes, beliefs, capabilities, knowledge, mental models , and patterns of interaction or skills[13].

The purpose of SPMA is to assist learners in acquiring higher order thinking skill (HOTS) especially in problem solving. This would prepare them to understand and solved problems. The learners are also motivated to develop self-discipline, self-confidence and critical thinking, as well as teachers' awareness of difference among students' increase. It is generally believed that the learners' learning styles towards the content area influence their success in the course. In other words, the students, favorable learning styles result to good achievement in a course.

However, local researchers are in concurrence to the advocacy that critical reasoning and analytical thinking through active-interactive involvement should be the focus of classroom instructions. Inocian suggested that the students should continuously be provided with relevant activities that would give adequate exposure for the development of their higher thinking skills, especially on analysis, synthesis and evaluation [6].

Furthermore, Paja cited Gunsberg and Opper who advocated the promotion of this interest and learning through interactions of current cognitive structure and new experiences to arouse interest and stimulate the subsequent development of understanding [8] . Meaning, mathematics teachers must understand that the learners are not nearly as excited about problem solving as their teachers.

Teachers' threatening and authoritarian attitudes could lead to fearsome classroom climate in which the learner might hesitate to ask questions or answer the

teachers' questions. Furthermore, learners' fearing their mathematics teacher might have a conditioned reaction to mathematics as well.

For this rationale the SPMA help the learners to motivated and develop self-discipline and critical thinking, as well as teachers, awareness of differences among students' increase. It is generally believed that students learning style towards a course influence their success in that course. In other words, favorable learning style results to good achievement in a course.

OBJECTIVES OF THE STUDY

This paper shall advance the role of SPMA in trigonometry as an attempt in humanizing the students' mathematics conceptual understanding and examine its effect on the students learning styles and academic performance.

METHODS

This quantitative study made use a descriptive-comparative design. The Pretest-Posttest Control Group design was employed for this study. The research requires two groups with one group being the experimental group and the others is the control group. The experimental group is exposed to the SPMA while the control groups left without the module.

Respondents

The respondents of the study are ninety eight (98) non math major first year students as shown below from the College of Arts and Sciences, Cebu Normal University, Cebu City, who are enrolled in Trigonometry for the second semester, Academic year 2009–2010. The experiment which lasted for ten (10) weeks considered two groups of 49 respondents each section.

Table 1. Respondents of the Study

Respondents	TREATMENT	
	Structured Approach	*SPMA*
B.A COMMUNICATION	8	10
B.A. ENGLISH (LITERATURE)	13	9
B.A. PSYCHOLOGY	11	15
B.A. FILIPINO	9	8
B.A. POLITICAL SCIENCE	8	7
	N = 49	N = 49

Students would be equally distributed into two learning groups as shown in table 1 above. One learning group is under SPMA, the other one is under the structured approach.

Instrument

This study utilized the following instruments such as: (1) Modules in Trigonometry; (2) Researcher -made test in Plane Trigonometry*: Plane Trigonometry Achievement Test (PTAT)* , a 30-item test which was used to measure the respondents' pretest and posttest achievement on the modularized topics. Both tests are of moderate length, not too short to be inconclusive of achievement, nor too long to cause fatigue among non math major students, which is a cause for validity deterioration; (3) GRASHA - REICHMANN STUDENT LEARNING STYLE SURVEY**,** an instrument that aims to determine the students learning styles towards the course.

Grasha and Reichmann's learning style scale focus more on students' preferences in the learning environment and it has six different students' learning styles such as: independent, avoidant, collaborative, dependent, competitive and participant. The questionnaire is a 60 items self-evaluation inventory scored using five (50 point Likert scale), with the average score for each style ranked according to its percentile position in comparison with the general norm; however, only three(3) preferences (low, moderate and high) are identified for each style.

RESULTS AND DISCUSSION

This section presents the gathered data, discusses the results and provides implications for the analysis of the research. The data are exhibited in the order of the problem statement.

Profile of the Respondents' Learning Style

To determine the profile of the respondent's learning styles in plane trigonometry before and after the exposure to the following?

1. Self - paced modular approach, and
2. Structured approach?

The respondents' mean scores are shown in Table 2, which the SPMA and structured approach recorded that the respondents had a mean value of 4.14 and 4.16, respectively on collaborative learning style, which means that they were rated "high". They were both also recorded a rating of high on competitive learning style because both the respondents mean score were 3.17 and 3.18 correspondingly.

Table 2. Learning Style of the Students Before and after Exposure to Structured Approach

Learning Styles	Before Exposure		After Exposure	
	Mean Scores	Description	Mean Scores	Description
Independent	3.61	Moderate	3.72	Moderate
Avoidant	2.41	Moderate	2.61	Moderate
Collaborative	4.14	High	4.16	High
Dependent	3.99	Moderate	3.86	Moderate
Competitive	3.17	High	3.18	High
Participant	4.10	Moderate	4.17	Moderate

Consequently, the results above displayed that collaborative and competitive learning styles are dominant in sample group before and even after the exposure to structured approach. From this reason, collaborative learning fosters the development of critical thinking through discussion, clarification of ideas, and evaluation of others' ideas and to enhance critical- thinking and problem- solving skills of the students. This involves creating and managing meaningful learning experiences and stimulating students' thinking through real world problems. They would like also to be a center of attention to receive appreciation from their accomplishment in class. Because they prefer teacher – centered instructional material.

Johnson and Johnson [8] made mentioned that there is persuasive evidence that cooperative teams achieve higher levels of thought and retain information longer than students who work quietly as individuals. They also added that in a competitive environment, students judge their abilities to master content, skills, and knowledge relative to their competitors.

Table 3. Learning Style of the Students Before and after Exposure to SPMA

Learning Styles	Before Exposure		After Exposure	
	Mean Scores	Rank	Mean Scores	Rank
Independent	3.81	Moderate	3.90	High
Avoidant	2.58	Moderate	2.45	Moderate
Collaborative	4.09	High	4.15	High
Dependent	3.96	Moderate	3.84	Moderate
Competitive	2.97	High	2.92	High
Participant	4.06	Moderate	4.09	Moderate

However, Table 3 discloses that before the respondents' exposure to SPMA they recorded a score of 4.09 for collaborative learning style and 2.97 for the competitive style, both with descriptive rating of high. On the other four learning styles, students scored "Moderate". Thus, after the exposure to the self-paced module it was found out that the respondents are more independent with a mean score 3.90.

This means that on SPMA students who like to believe for themselves and they prefer to work at their own pace but will listen to the ideas of others in the classroom and feel confident in their learning abilities. According to Smith and MacGregor collaborative learning styles represents a significant shift away from the typical teacher-centered or lecture-centered milieu in college classrooms[12]. In collaborative classrooms, the lecturing/ listening/note-taking process may not disappear entirely, but it lives alongside other processes that are based in students' discussion and active work with the course material. However, teachers who use collaborative learning approaches tend to think of themselves less as expert transmitters of knowledge to students, and more as expert designers of intellectual experiences for students-as coaches or mid-wives of a more emergent learning process.

Johnson and Johnson emphasized that an effective classroom must have the right mix of collaborative learning and competitive learning along with individualistic learning[7]. They also highlight that collaborative learning style is consists of five elements such as: (1) students must have "positive interdependence" in that each student believes that their fate is in fact linked to the fate of the cooperating students; (2) students must have "promotive interaction" in that they are forced to work together and cannot accomplish the task at hand alone; (3) each student must be held accountable; (4) students must be taught an interpersonal and small-group skills;(5)students must work through "group processes" in that the group discusses how well they are doing and what they can do to improve.

Sarasin [11] revealed that the teacher should be willing to change their teaching strategies and techniques based on the appreciation of the variety of student learning styles. Hence, the teacher should also try to ensure that their methods, materials, and resources fit the ways in which their students learn and maximize the learning potential of each student.

Respondents' Level of Performance: A Comparison of Two Approaches in Teaching Trigonometry.

The profile in the level of performance of the respondents in plane trigonometry on the SPMA and structured approach was determined on the result of their pretest administered before the exposure to both approaches. The respondents' were expected to get a mean score of 50% or 15 correct answer of the 30 items researcher made test.

The second research question which on the respondents' levels of performance in the pretest and posttest with the use both approaches in teaching plane trigonometry is likewise expounded.

It was hypothesized that at 0.05 level significance, both approaches would have a significant difference in their actual mean and hypothetical mean, because the absolute computed value of the structured approach and self-paced modular approach z_c = 14.03 and z_c = 15.67 respectively are greater than the tabular value of $z_{tabular}$ = 1.645 before the conduct of the experiment.

Table 4. Plane Trigonometry level of performance of the SPMA and Structured approaches.

Group	Competencies	No. of Items	a.m.	h.m.	S.D.	z_c - test Value	Description
Structured approach	-*Measurement of Angles* -*Triangles* - *Circle* - *The Coordinates of Special Arguments in the Unit Circle* - *Negative Arguments Identities*	30	9.87	15	2.56	14.03	*Below Average*
Self-paced modular approach		30	8.37	15	2.96	15.67	*Below Average*

Table 4 illustrates of the respondents of the structured approach and SPMA at the beginning of the unit which was below average. As a result, respondents were not fully equipped with the basic concepts and competence to learn and likewise were not very exposed to quite difficult problems in plane trigonometry before the exposure to both approaches. Thus the below average level of performance was expected. Accordingly, the student's way of perceiving, thinking, feeling, and doing may change as a result of a learning experience. Given that learning is an individual process, the teacher cannot do it for the student and the student can only learn from their personal experiences.

Significant Mean Difference

From a systematic perspective the adoption of SPMA in teaching trigonometry in the classroom has tended to focus on either problems related to teacher strategies and instructional materials.

The third research question dealt on significant difference between posttest of the students' level of performance that expose to SPMA and structured approach in the same learning content.

Part of the research of this study is to find out whether or not that there is a significant difference in the students' mathematical performance of the SPMA and structured approach. As a result, Table 5 displays that the obtained computed t - value is 1.79 at *0.05* level of significance which is smaller than the critical value.

Table 5. Pre-test Plane Trigonometry Achievement Profile of the SPMA and structured approach

Group	n	Mean	SD	Computed Value t - Value
Structured approach	49	9.37	2.56	1.79*
Self-paced modular approach	49	8.37	2.96	

**Not Significant* *df = 96* *t – Value@.05 = 1.99*

This implies that there is no significant difference between SPMA and structured approach during a pretest. It shows that the respondent of both approaches could be treated equal distinctive mathematical background in trigonometry.

However, in Table 6 shown below the calculated *t – value* is 2.3 at 0.05 level of significance is greater than the table value 0f 1.96. it implies that there is a significant difference between mean score of SPMA and structured approach. This pointed out that the set of students who are exposed to SPMA is much higher on the level of mathematical performance than the mean score of the structured approach of 15.67 and 13.80 respectively. because the non math major using SPMA performs significantly better and grasp better learning on the concept being tested and more effective than the respondents who were taught using structured approach in teaching trigonometry.

Table 6: Post-test Trigonometry Achievement Profile of the Self-paced modular approach and structured approach

Group	n	Mean	SD	Computed Value t - Value
Structured approach	49	13.80	4.15	2.36*
Self-paced modular approach	49	15.67	4.09	

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These outcomes support the perception of Pareek and Rao [10] that modular instruction creates interest in the respondents, who they demonstrated remarkably higher mathematical performance than the respondents taught using structured approach.

Findings

Statistically, the following findings indicated the meaningful difference between the two groups: the structured approach and SPMA as follows:

The learning styles before and after the exposure of the students to structured approach and SPMA showed remarkably high on both Collaborative and Competitive learning styles. It means that the structured approach and self-paced modular approach are similar in their learning styles. However, it displays in the SPMA the respondents are more independent compared to structured approach after the exposure to SPMA. This established that the students prefer to reflect and analyze the content of the module for themselves to develop their confident in their learning abilities. Thus, it proves that in strengthening lesser - preferred learning styles will helps students to expand the scope of their learning to become more versatile learners, and adapt to the requisites of the "real world [11].

The entry performance of the students in the structured approach and the SPMA in solving difficult mathematical problems on the same learning content were both below average. Thus, there was no significant difference between the structured approach and the SPMA actual mean performance and the hypothetical mean. The two groups cannot be treated equally.

The students' mathematical performance in the structured approach and the SPMA had made a significant difference in mean score in the pretest and posttest achievement scores. Thus, the students exposed to SPMA demonstrated remarkably higher mathematical performance than the respondent taught using structured approach.

CONCLUSION AND RECOMMENDATION S

In the light of the statistical analysis and the findings of the study, it could be generalized that SPMA made the students learning styles more independent because they prefer to work at their own pace. Hence, SPMA help them also improve their level of performance in relation to plane trigonometry regardless of their mathematical abilities compared to structured approach.

It is recommended that the Mathematics teachers should use collective learning style inventories in designing class delivery approach to different student learning preferences within the context of the module.

Allow teachers to explore their creativity in the presentation the content of the module so that students remain interested, focused, and excited throughout their mathematics course.

Mathematics teachers need to be educated on the preparation of SPMA in helping student establishes a positive attitude toward mathematics and to become more confident of their own abilities toward mathematics.

Use SPMA in teaching plane trigonometry and other discipline in the field of mathematics.

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