THE IMPACT OF ACTIVITY-BASED MATHEMATICS PROCESS SKILLS MODEL ON HIGH SCHOOL STUDENTS' ACHIEVEMENT IN MATHEMATICS

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Abstract

The purpose of this study is to investigate the impact of activity-based mathematics process skills on high school students in mathematics. The design adopted for the research study was one of the quasi-experimental designs, non-equivalent control group design. The subjects were 80 Grade Ten students from BEHS (1) in Myitkyina Township, 100 Grade Ten students from BEHS (1) in Waingmaw Township, 75 Grade Ten students from BEHS (Namati) in Namati Town and 72 Grade Ten students from BEHS (1) in Moegaung Township. The instruments used in the study were pretest and posttest. The experimental groups were taught with activity-based mathematics process skills model while the control groups were taught the same concept using formal method. Students' mathematics achievement and mathematics process skills on posttest were compared using one-way ANCOVA. The results showed that there were significant differences between high school students who were taught with activity-based mathematics process skills model and those who do not receive it in performing mathematics process skills in all selected schools.

Keywords: Mathematics, Process, Mathematics Process Skills, Activity-based Mathematics Process Skills, Model**.**

Introduction

Mathematics is one of the branches of science that contributed greatly to the advancement of science and technology. Learners must possess mathematics process skills such as problem solving, reasoning, communication, connection, and representation in order to apply, combine and adapt their mathematical knowledge to new situations in their lives and works. These process skills form the basis of the functional skills standards for mathematics and apply at all levels. Enhancing mathematics process skills will provide the tools that learners will need to tackle situations involving mathematics in life. Activity Based Mathematics Instruction (ABMI) is guided by the progressive philosophy of education as propounded by John Dewey. The National Council of Educational Research and Training (NCERT, 2005) emphasizes that mathematics learning should be facilitated through activities from the very beginning of school education. The major concern of this study is to investigate the effectiveness of activity-based mathematics process skills model at the high school level.

Statement of the Problem

In mathematics instruction, the students need to use the 5 Cs as important 21st century skills for learning will enable them to participate actively in all lessons such as Collaboration, Communication, Critical thinking and problem solving, Creativity and innovation and Citizenship. In Myanmar, the present teaching strategy emphasizes on lecture method that focuses on memorized facts which leads to rote learning (MOE, 2013). This is one of the problems that the students are facing in mathematics instruction.

Purposes of the Study

The main purpose of this study is to investigate the effectiveness of activity-based mathematics process skills model at the high school level. The specific objectives of the study are;

- To develop a model for enhancing mathematics process skills through activities for the high school students.
- To investigate the impact of the activity-based mathematics process skills model and constructed activities on high school students' mathematics process skills achievement.

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- To make suggestions and recommendations based on the findings for the effectiveness of mathematics teaching at the high school level.

Research Hypotheses

In order to achieve the objectives of this study, two research hypotheses are formulated.

1. There is a significant difference in the posttest scores of high school students who are taught with the activity-based mathematics process skills model and those who are not.
2. There is a significant difference in each of the mathematics process skills achievement of high school students who are taught with the activity-based mathematics process skills model and those who are not.

Scope of the Study

This study is geographically restricted to Kachin State. Participants in this study are 80 Grade Ten students from BEHS (1) in Myitkyina Township, 100 Grade Ten students from BEHS (1) in Waingmaw Township, 75 Grade Ten students from BEHS (Namati) in Namati Town and 72 Grade Ten students from BEHS (1) in Moegaung Township. This study is restricted to five content areas: Quadratic Functions; Absolute Value Functions; Probability; Similarity and Trigonometry from Grade Ten mathematics textbook prescribed by Basic Education Curriculum and Textbook Committee, Ministry of Education, Myanmar. Activities used in this study are games, practical activities, math lab, exhibition, projects, ICT in math classroom, math quiz, cooperative learning or small group learning and use of teaching aids. The impact of the developed model is examined in terms of students' mathematics process skills achievement.

Definition of Key Terms

Mathematics: Mathematics is the study of quantity, structure, space and change; it has historically developed, through the use of abstraction and logical reasoning, from counting, calculation, measurement, and the study of the shapes and motions of physical objects (Hess, 2013).

Process: A process is a chain of activities to reach a specific aim to get a desired result (Zubair, 2012)

Mathematics Process Skills: Mathematics Process Skills are defined as the skills that can be acquired through the processes of problem solving, reasoning and proof, communication, connection and representation (NCTM, 2011).

Activity-based Mathematics Process Skills: In this study, activity-based mathematics process skills mean the skills for problem solving, reasoning, communication, connection and representation those can be acquired through different kinds of mathematics activity.

Model: Model is an instructional strategy that can be used to accomplish particular material and justify instructional goals (Zubair, 2012).

Significance of the Research

The process standards extend thinking/learning skills: problem-solving, reasoning and proof, communication, mathematical representation and connections (Kennedy & Tipps, 2000). This may be a challenging task for educators to show how the mathematics process skills can be developed through mathematics lessons. How to integrate these skills in the mathematics lessons is one end of the problem and how these planned activities are helpful in developing the mathematics process skills in students can be another end of the problem. For these reasons, there is a need to develop a model for enhancing activity-based mathematics process skills at the high school level.

Review of Related Literature

Philosophical Background of the Research

Progressivism, Cognitivism and Constructivism are presented as the philosophical background of the research.

Dewey (1916) stated that education is the process of the reconstruction of experience, giving it a more socialized value through the medium of increased individual efficiency. Today's teachers need to consider teaching learning activities in the teaching learning process to achieve the intended learning outcomes. Teaching mathematics through activities can provide the students the opportunities for the development of 21st century skills. Progressivist teachers make school interesting and useful by planning lessons that provoke curiosity. In a progressivist school, students are actively learning. The students interact with one another and develop social qualities such as cooperation and tolerance for different points of view. Moreover, students solve problems in the classroom similar to those they will encounter in their real situation.

A key concept of cognitivism is that learning constructs mental maps in the brain and learning process is the means by which these mental structures are understood. Cognitivism defined learning as an internal, active, creative process. Teachers need to assess the learner's abilities to discover whether he or she is ready to learn (Gage & Berliner, 1992).

Constructivism is an educational theory that emphasizes hands-on, activity-based teaching and learning (Ozomon & Craver, 1986). The purpose of constructivist teaching and learning is to enable students to acquire information in ways which make that information most readily understood and usable.

Theoretical Background of the Research

Paget's Cognitive Development Theory, Bruner's Theory of Constructivism and Vygotsky's Sociocultural Theory are described as the theories affecting the teaching model for enhancing activity-based mathematics process skills.

Piaget believed that the development of a child occurs through a continuous transformation of thought processes. Piaget has identified four primary stages of development: sensorimotor, preoperational, concrete operational and formal operational. In general, the knowledge of Piaget's stages helps the teacher understand the cognitive development of the child as the teacher plans stage-appropriate activities to keep students active. Teachers should give children first-hand experiences with the natural world in order to help them. They should let them interact with each other and encourage them to talk and think about their experiences in order to stimulate the growth of logical thinking and the development of language to express their thoughts. So, these ideas are considered for constructing teaching learning activities

According to Bruner, instruction must be concerned with the experiences and contexts that make the student willing and able to learn, instruction must be structured so that it can be easily grasped by the student and instruction should be designed to facilitate extrapolation and or fill in the gaps (going beyond the information given). The purpose of mathematics teaching is to enable students to master the knowledge structure of mathematics in a comprehensive way. Mathematics teachers should actively create positive learning conditions in the classroom, and guide students to discover and learn through hands-on activities, thinking and representation.

For Vygotsky, who focused on the importance of social cultural dimensions and language as characteristics of schooling and learning (Moll, 1990), the social system in which children develop is crucial to their learning. Parents, teachers and peers interact with the child and mediate learning through socially organized instruction. Peer collaboration is also an important idea of the

Vygotskian perspective. Peer groups are commonly used for learning in field such as mathematics, science and language arts. Therefore, Vygotsky' sociocultural theory is considered for developing teaching learning activities in this study.

Background Teaching Models of the Research

Five teaching models are taken into consideration in the proposed model. Main ideas of each model are presented as follows. Glaser's basic teaching model is the fundamental teaching model among the various teaching model. This model is suitable for all levels of education i.e., elementary, secondary, higher etc. It consists of four main components such as instructional objectives, entering behaviors, instructional procedure and performance assessment with feedback loop.

Flander interaction analysis model captures the verbal behavior of teachers and students that is directly related to the social–emotional climate of the learning environment. The term "interaction" means an action – reaction or a mutual or reciprocal influence which may be between individuals. The improvement of pupils' interaction and social skills is one of the most important aims of education. To enhance communication skill, one of mathematics process skills, these ideas of interaction analysis model should be taken into account.

Dr. Talyzina's neocybernetic model is composed of the following: instructional objectives, input level or entering behavior, selection and/or structuring of knowledge technological devices or multi-media presentation of materials, acquisitional steps or step-by-step psychological theory, teaching algorithm, feedback phase and regulation or corrective actions stage (Khin Zaw, 2001a).

Polya created his famous four-step process for problem solving, which is used to help students in problem solving process. He developed the four steps for problem solving; understand the problem, plan the solution process, carry out the problem solution steps and looking backwards. These four steps should be practiced in every mathematics classroom to develop students‟ problem solving skills and ability in mathematics.

Moreover, the multimodal model by Dr. Khin Zaw (2001b) is a vital theoretical construct in the modern pedagogy. This model consists of channel capacity, brain resilience, redundancy, unitilizing/symbolizing modes and diffusing/resynthesizing mode. These modes are essential in the teaching learning process.

Proposed Model for Activity-Based Mathematics Process Skills at the High School Level

The development of the proposed model includes four phases. They are: (1) Preactive Phase, (2) Interactive Phase, (3) Postactive Phase and (4) Feedback Phase.

Preactive Phase

Step (1) Identification of Content

A teacher should select the intended content from prescribed mathematics textbook.

Step (2) Identification of Learning Outcomes

After selecting the content, the teacher has to identify the learning outcomes that are related to the selected learning content.

Step (3) Preparation of Teaching Learning Activities

Teachers have to prepare activities which may contribute to making the learning permanent, creating positive attitudes towards the class, attracting interest for the class and enhancing mathematics process skills.

Step (4) Selection of Teaching Strategies and Methods

The selected teaching strategies and methods should be student-centered.

Teachers have to select innovative teaching methods that provide positive mathematical learning experiences could help to enhance students' mathematics process skills.

Step (5) Selection of Teaching Aids

Selecting relevant teaching aids is the perquisite step in the preactive phase. Teachers have to explore the resources considering questions: who are the participants? what materials are required? what facilities are needed to conduct the activity?

Step (6) Decisions about How to Assess

Teacher has to decide how to assess and which tools will be used to check the intended learning outcomes are received or not.

Interactive Phase

Step (1) Letting Students Know Learning Outcomes

By letting student know learning outcomes, they will clearly understand beforehand what they are going to learn from the lesson.

Step (2) Giving Activity/ Task

The second step of the interactive phase is giving students teaching learning activities. Mathematics teachers may use one or more teaching learning activities according to selected content and targeted learning outcomes.

Step (3) Discussing Mathematical Ideas in Small Group

Discussing mathematical ideas in small group is one of the best practices that encourage students to be actively participated in the teaching learning process. It creates the environment that engages students who might not otherwise be engaged in their own learning in meaningful ways.

Step (4) Using a Pattern of Relationship to Analyze the Condition

Students have to use the ideas of small group discussion and pattern of relationship to analyze the condition. Using these ideas and patterns, students have to prepare for the presentation.

Step (5) Presentation to the Whole Class

It is the final step of the interactive phase. Students' presentation to the classroom is an important element in delivering positive learning experiences.

Postactive Phase

Step (1) Summary of the Learning Outcomes

In the first step of the postactive phase, teacher and students will discuss the key concepts and main points of the lesson.

Step (2) Reflection on the Lesson

At the end of the lesson, teacher should reflect on the lesson with the students and analyze its effectiveness.

Step (3) Assessment

In this step, the teacher may assess students' performance through observation, questioning, writing student learning journal and giving them extended exercises.

Feedback Phase

The teacher has to continue to the feedback phase when the students do not achieve the expected learning outcomes. Feedback guides the teachers to adapt and adjust their teaching strategies, instructional materials and teaching learning activities.

The Activity-based mathematics process skills model is presented in Figure 1.

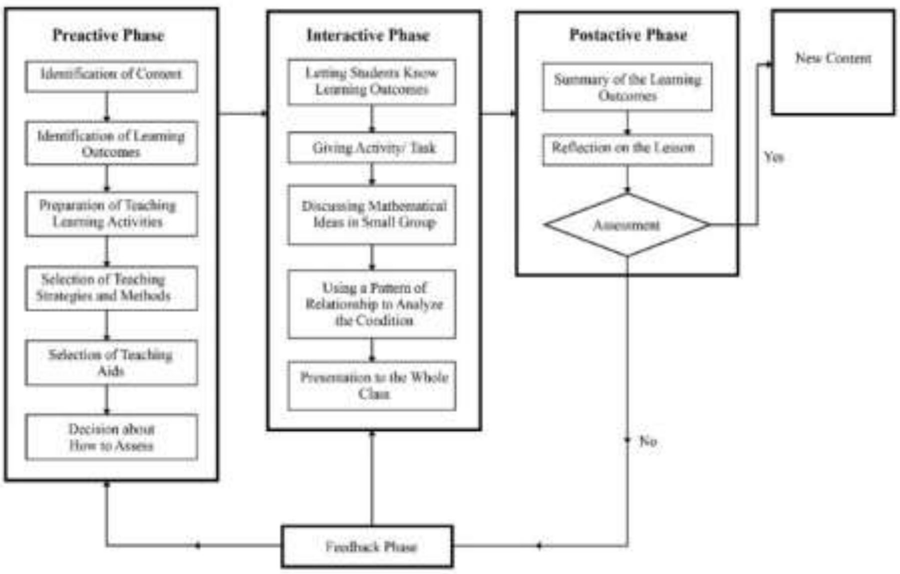

Figure 1 Activity-based Mathematics Process Skills Model

Method

Quasi-Experimental Research Design

The design adopted in this study is one of quasi-experimental research designs, viz., non-equivalent control group design.

Population and Sample

Among the four districts in Kachin State such as Myitkyina, Monyin, Banmaw and Putao District, two districts were randomly selected. Three townships and one town were also chosen from these two districts. One school was randomly chosen from each township and town.

Instruments

The main instruments to collect the data for quasi-experimental design are a pretest and a posttest.

Pretest

This test includes four chapters from mathematics textbook: Introduction to Coordinate Geometry; Exponents and Radicals; Logarithms; and Functions. This pretest includes three sections. Section A consists of 10 multiple choice items, section B consists of short questions and section C consists of long questions. The total score is 50 marks, and the allocated time is one hour and thirty minutes for this pretest.

Posttest

Posttest covers Chapter 5; Quadratic Functions, Chapter 6; Absolute Value Functions, Chapter 7; Probability, Chapter 8; Similarity and Chapter 10; Trigonometry of Grade Ten mathematics textbook. It consists of multiple-choice items, short question items and long question items. The total score for the test is 50 marks.

Pilot Study

Before starting the main study, for the validation of the tests, pilot study was conducted with Grade Ten students from No (1) Basic Education High School Shwegu, Shwegu Township, Kachin State. The internal consistency reliability of the pretest is tested by Cronbach's Alpha and the posttest is also tested by Cronbach's Alpha. The Cronbach's Alpha internal consistency reliability is .714 for pretest and .752 for posttest.

Research Procedure

At the beginning of the experimental study, the two intact groups were assigned: the experimental group and the control group randomly. Then, a pretest was administered to both groups to analyze the initial level of basic mathematics knowledge. After administering pretest, the experimental group was given the treatment by the proposed model and the control group was taught by formal instruction. After the treatment, a posttest was administered to both experimental and control groups to investigate the impact of proposed model on students' mathematics process skills. And then, the findings are presented based on the experimental and control groups' scores.

Data Analysis

Quantitative data from pretest and posttest were analyzed by applying inferential statistics: Analysis of Covariance (ANCOVA). Analysis of covariance (ANCOVA) is used as a means of increasing the power of a statistical test. ANCOVA is used for controlling extraneous variables. ANCOVA adjusts posttest scores for initial differences on some variable and compare adjusted scores (Mills & Gay, 2016). To be able to determine whether there are significant differences between the experimental group and the control group, the posttest scores of the groups are analyzed by using ANCOVA.

Findings

Research findings for pretest, posttest and mathematics process skills are presented in this section.

Research Findings of Pretest

Table 1 One-way ANCOVA Results for Pretest Scores of Grade Ten Students in S1

Source	Type III Sum of Squares	*df*	Mean of Squares	*F*	Sig (2-tailed)
Corrected Model	2.812[a]	1	2.812	1.381	.244
Intercept	74415.313	1	74115.313	36387.061	.000
Group	2.813	1	2.813	1.381	.244 (ns)
Error	158.875	78	2.037		
Total	74277.000	80			
Corrected Total	161.687	79			

Note. S1 = No. (1) Basic Education High School, Myitkyina; ns = not significant.

The results in Table 1 show that there was no significant difference between the pretest scores of the experimental group and those of the control group in S1.

Table 2 One-way ANCOVA Results for Pretest Scores of Grade Ten Students in S2

Source	Type III Sum of Squares	*df*	Mean of Squares	*F*	Sig (2-tailed)
Corrected Model	275.560[a]	1	275.560	53.602	.000
Intercept	96596.640	1	96596.640	18790.136	.000
Group	275.560	1	275.560	53.602	.000***
Error	503.800	98	5.141		
Total	97376.000	100			
Corrected Total	779.360	98			

Note. S2 = No. (1) Basic Education High School, Waingmaw; ****p* < .001.

The results in Table 2 show that there was significant difference between the pretest scores of the experimental group and those of the control group in S2.

Table 3 One-way ANCOVA Results for Pretest Scores of Grade Ten Students in S3

Source	Type III Sum of Squares	*df*	Mean of Squares	*F*	Sig (2-tailed)
Corrected Model	0.137[a]	1	0.137	0.138	.712
Intercept	67392.137	1	67392.137	67630.365	.000
Group	0.137	1	0.137	0.138	.712 (ns)
Error	72.743	73	0.996		
Total	66753.000	75			
Corrected Total	72.880	74			

Note. S3 = Basic Education High School, Namati: ns = not significant.

The results in Table 3 show that there was no significant difference between the pretest scores of the experimental group and those of the control group in S3.

Table 4 One-way ANCOVA Results for Pretest Scores of Grade Ten Students in S4

Source	Type III Sum of Squares	*df*	Mean of Squares	*F*	Sig (2-tailed)
Corrected Model	0.683[a]	1	0.683	0.264	.609
Intercept	65657.627	1	65657.627	25418.104	.000
Group	0.683	1	0.683	0.264	.609 (ns)
Error	180.817	70	2.583		
Total	66066.000	72			
Corrected Total	181.500	71			

Note. No. (1) Basic Education High School, Moegaung: ns = not significant.

The results in Table 4 show that there was no significant difference between the pretest scores of the experimental group and those of the control group in S4.

Research Findings of Overall Posttest

The following table show the one-way ANCOVA results for mathematics achievement on posttest of Grade Ten students in S1, S2, S3 and S4.

Table 5 One-way ANCOVA Results for Overall Posttest Scores of Grade Ten Students

School	Tests of Between-Subjects Effects					Observed Mean		Adjusted Mean	
	Source	*df*	*F*	*p*	*η2*	EG	CG	EG	CG
S1	Pretest	1	0.773	0.382	.010	42.60	31.90	42.56	31.94
	Group	1	204.200	.000***	.726				
	Error	77							
S2	Pretest	1	0.958	0.330	.010	43.28	33.48	43.13	33.63
	Group	1	353.586	.000***	.785				
	Error	97							
S3	Pretest	1	1.045	0.310	.014	42.34	30.55	42.36	30.54
	Group	1	546.284	.000***	.884				
	Error	72							
S4	Pretest	1	0.170	0.682	.002	39.82	31.59	39.81	31.60
	Group	1	136.642	.000***	.664				
	Error	69							

Note. S1 = No. (1) Basic Education High School, Myitkyina; S2 = No. (1) Basic Education High School, Waingmaw; S3 = No. (1) Basic Education High School, Namati; S4 = No. (1) Basic Education High School, Moegaung; EG = Experimental Group; CG = Control Group; ***$p < .001$.

The results presented in Table 5 show that there was a significant difference between the posttest scores of the experimental group and control group in S1, S2, S3 and S4 without considering the extraneous variables on these scores.

Research Findings of Students' Mathematics Process Skills on Posttest

Quantitative research findings of students' mathematics process skills on posttest in each selected school were presented in this section.

(i) Quantitative Research Findings of Students' Problem-Solving Skill on Posttest

Table 6 One-Way ANCOVA Results for Problem-Solving Skill on Posttest

School	Tests of Between-Subjects Effects					Observed Mean		Adjusted Mean	
	Source	*df*	*F*	*p*	*η2*	EG	CG	EG	CG
S1	Pretest	1	0.111	0.740	.001	8.73	6.48	8.73	6.47
	Group	1	37.219	.000***	.326				
	Error	77							
S2	Pretest	1	0.333	0.565	.003	8.76	6.88	8.77	6.87
	Group	1	66.266	.000***	.406				
	Error	97							
S3	Pretest	1	0.118	0.732	.002	9.00	7.30	9.00	7.30
	Group	1	30.230	.000***	.296				
	Error	72							
S4	Pretest	1	0.215	0.644	.003	8.74	6.71	8.75	6.70
	Group	1	63.024	.000***	.447				
	Error	69							

Note. S1 = No. (1) Basic Education High School, Myitkyina; S2 = No. (1) Basic Education High School, Waingmaw; S3 = No. (1) Basic Education High School, Namati; S4 = No. (1) Basic Education High School, Moegaung; EG = Experimental Group; CG = Control Group; ***$p < .001$.

According to the results in Table 6, there were significant differences in the problem-solving skill on posttest between experimental group and control groups in S1, S2, S3 and S4.

(ii) Quantitative Research Findings of Students' Communication Skill on Posttest

Table 7 One-Way ANCOVA Results for Communication Skill on Posttest

School	Tests of Between-Subjects Effects					Observed Mean		Adjusted Mean	
	Source	***df***	***F***	***P***	***η2***	**EG**	**CG**	**EG**	**CG**
S1	Pretest	1	0.008	.927	.000	8.40	6.08	8.40	6.08
	Group	1	30.267	.000***	.282				
	Error	77							
S2	Pretest	1	0.413	.522	.004	8.70	6.64	8.71	6.63
	Group	1	86.458	.000***	.471				
	Error	97							
S3	Pretest	1	2.988	.088	.040	8.51	5.90	8.52	5.89
	Group	1	86.123	.000***	.545				
	Error	72							
S4	Pretest	1	0.013	.909	.000	8.03	6.29	8.03	6.29
	Group	1	27.196	.000***	.283				
	Error	69							

Note. S1 = No. (1) Basic Education High School, Myitkyina; S2 = No. (1) Basic Education High School, Waingmaw; S3 = No. (1) Basic Education High School, Namati; S4 = No. (1) Basic Education High School, Moegaung; EG = Experimental Group; CG = Control Group; ***$p < .001$.

According to the results in Table 7, there were significant differences in the communication skill on posttest between experimental group and control groups in S1, S2, S3 and S4.

(iii) Quantitative Research Findings of Students' Connection Skill on Posttest

Table 8 One-Way ANCOVA Results for Connection Skill on Posttest

School	Tests of Between-Subjects Effects					Observed Mean		Adjusted Mean	
	Source	***df***	***F***	***P***	***η2***	**EG**	**CG**	**EG**	**CG**
S1	Pretest	1	0.022	.883	.000	8.63	6.85	8.63	6.85
	Group	1	33.726	.000***	.305				
	Error	77							
S2	Pretest	1	9.736	.002	.091	8.74	7.00	8.63	7.11
	Group	1	56.497	.000***	.368				
	Error	97							
S3	Pretest	1	1.325	.254	.018	8.60	5.78	8.61	5.77
	Group	1	97.344	.000***	.575				
	Error	72							
S4	Pretest	1	0.255	.615	.004	7.76	6.21	7.77	6.20
	Group	1	38.524	.000***	.358				
	Error	69							

Note. S1 = No. (1) Basic Education High School, Myitkyina; S2 = No. (1) Basic Education High School, Waingmaw; S3 = No. (1) Basic Education High School, Namati; S4 = No. (1) Basic Education High School, Moegaung; EG = Experimental Group; CG = Control Group; ***$p < .001$.

According to the results in Table 8, there were significant differences in the connection skill on posttest between experimental group and control groups in S1, S2, S3 and S4.

(iv) Quantitative Research Findings of Students' Skill of Reasoning and Proof on Posttest

Table 9 One-Way ANCOVA Results for Skill of Reasoning and Proof on Posttest

School	Tests of Between-Subjects Effects					Observed Mean		Adjusted Mean	
	Source	***df***	***F***	***p***	***η2***	**EG**	**CG**	**EG**	**CG**
S1	Pretest	1	0.022	.883	.000	8.50	6.70	8.50	6.70
	Group	1	40.138	.000***	.343				
	Error	77							
S2	Pretest	1	0.612	.436	.006	8.46	6.56	8.45	6.58
	Group	1	61.682	.000***	.389				
	Error	97							
S3	Pretest	1	0.060	.808	.001	7.86	5.85	7.86	5.85
	Group	1	59.344	.000***	.452				
	Error	72							
S4	Pretest	1	0.000	.983	.000	7.53	6.38	7.53	6.39
	Group	1	19.699	.000***	.222				
	Error	69							

Note. S1= No. (1) Basic Education High School, Myitkyina; S2 = No. (1) Basic Education High School, Waingmaw; S3 = No. (1) Basic Education High School, Namati; S4 = No. (1) Basic Education High School, Moegaung; EG= Experimental Group; CG= Control Group; ***p < .001.

According to the results in Table 9, there were significant differences in the skill of reasoning and proof on posttest between experimental group and control groups in S1, S2, S3 and S4.

(v) Quantitative Research Findings of Students' Representation Skill on Posttest

Table 10 One-Way ANCOVA Results for Representation Skill on Posttest

School	Tests of Between-Subjects Effects					Observed Mean		Adjusted Mean	
	Source	***df***	***F***	***p***	***η2***	**EG**	**CG**	**EG**	**CG**
S1	Pretest	1	1.271	.263	.016	8.35	5.80	8.36	5.79
	Group	1	39.466	.000***	.339				
	Error	77							
S2	Pretest	1	2.276	.135	.023	8.62	6.40	8.47	6.55
	Group	1	30.888	.000***	.242				
	Error	97							
S3	Pretest	1	2.812	.098	.038	8.37	5.73	8.37	5.72
	Group	1	104.019	.000***	.591				
	Error	72							
S4	Pretest	1	.016	.900	.000	7.76	6.00	7.76	6.00
	Group	1	44.334	.000***	.391				
	Error	69							

Note. S1= No. (1) Basic Education High School, Myitkyina; S2 = No. (1) Basic Education High School, Waingmaw; S3 = No. (1) Basic Education High School, Namati; S4 = No. (1) Basic Education High School, Moegaung; EG= Experimental Group; CG= Control Group; ***p < .001.

According to the results in Table 10, there were significant differences in the representation skill on posttest between experimental group and control groups in S1, S2, S3 and S4.

Discussion

Mathematics is a powerful equipment needed for many jobs in the increasingly complex and technological society. The lack of mathematics process skills might cause the difficulties among students while learning mathematics. Myanmar students are also facing this difficulty. Therefore, this study was conducted as a new contribution to mathematics teaching and the proposed model could be enhanced students' mathematics process skills. This study mainly aimed to develop a model for enhancing mathematics process skill at the high school level and to investigate the impact of that model in order to give suggestions and recommendations for the effectiveness of mathematics teaching in Myanmar.

There were significant differences between the two groups in all selected schools on the overall mathematics achievement of Grade Ten students. It can be interpreted that the use of the proposed model had a significant effect on students' mathematics achievement. For mean scores of problem-solving skills, communication skill, connection skill, the skill of reasoning and proof, representation skill, it was found that there were significant differences between the two groups in all selected schools. According to these findings, it can be interpreted that the proposed model makes the students enhance mathematics process skills such as problem solving, communication, connection, reasoning and proof, and representation.

Students' performance had significant differences in overall mathematics achievement and in the achievement of mathematics process skills in terms of the statistical results. Therefore, it can be concluded that the proposed model has positively contributed to the improvement of mathematics teaching methodology at the high school level and could encourage the enhancement of students' mathematics achievement and mathematics process skills.

The results of quantitative study were consistent with the findings of previous related studies. Firstly, these findings support Thompson's findings: This study suggests the use of preparation, practice, and performance model work to validate the effectiveness of the standard-based instruction as an effort for a systematic change in the education of mathematics and science (Thompson, 2009). Secondly, it supports Yupadee Panarach' finding: the students' mathematics achievement after receiving the mathematical learning model using activity-based learning was higher than the criteria of 60 percent at .05 level of significance. Overall, their level of work commitment and attitudes toward mathematics were considered high (Yupadee, 2021). Finally, it supports Harjinder Kaur and Anurag Sankhian's finding: activity-based method helps in the improvement of achievement motivation and academic achievement in mathematics as compared to the traditional method (Harjinder & Anurag, 2017). According to the findings of the present study prove that the proposed model has positive influence on students' achievement in mathematics process skills. It is sure that the proposed model can enhance students' mathematics achievement and mathematics process skill. It is also sure that the present study could contribute a new teaching model for mathematics at the high school level in Myanmar.

Suggestions

Mathematics teachers should create classroom environment with the opportunities for students to apply and adapt a variety of appropriate strategies to solve problems, to make and investigate mathematics conjectures, to discuss their thinking as well as evaluate thinking and strategies of other students, to construct mathematical ideas through connecting their previous ideas, and to create and use multiple representation in expressing mathematical ideas. Mathematics teachers should apply modern active teaching methods which encourage students enhance mathematics process skills and they also should use relevant teaching learning activities which develop 21st century skills. Mathematics teachers should collaborate with students, asking questions or thinking aloud when a student or a group of students is not making progress. They should scaffold base on knowledge and skills of individual students. They should provide resources and time for students to gather data, detect patterns, make and justify conjectures. They should ask probing questions if data or strategy seems to be unconnected or inappropriate to the inquiry. They should organize pooling of data, as appropriate. They should guide students as they apply their chosen strategy. They should facilitate the purposeful sharing of different problem-solving strategies for the same problem. They should direct students to use multiple strategies to solve the same problem, when appropriate.

Conclusion

As a conclusion of this study, it was seen that the proposed model and learning activities enhance students' academic achievements and mathematics process skills. This study also demonstrated that proposed model may be utilized more than formal learning in teaching mathematics. Finally, it is expected that the proposed model will lead to positive results on the academic success levels of students in case of its implementation in the mathematics curriculum.

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