

**A STUDY OF TEACHER'S MATHEMATICS PEDAGOGICAL
CONTENT KNOWLEDGE (MPCK) AND ITS EFFECT ON
STUDENTS' ATTITUDE TOWARDS MATHEMATICS AND
SCHOLASTIC ACHIEVEMENT IN MATHEMATICS OF
SECONDARY LEVEL STUDENTS OF NEGALAND**

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Abstract

Traditionally mathematics classes are grave and solemn and often appear intimidating students and make them reticent about using it. The most important factor impinges students' attitude towards and scholastic achievement in mathematics is teacher's Mathematics Pedagogical Content Knowledge (MPCK) that may confidently eradicate students' anxiety towards mathematics. Mathematics teachers got the soul authority to change the situation in a desirable direction that may confidently enhance students' attitude towards mathematics. The study is fashioned to create a scalable intervention to measure the relationship between teachers' MPCK and students' attitude towards and scholastic achievement in mathematics. To address this issue students of Nagaland (NL) constitute the population. A sample of 200 students was selected from tenth standard. A 25-items self-developed standardised questionnaire ($r = 0.86325$) was used to measure the students' attitude towards mathematics (15-items) and 10 mathematics questions from tenth level Nagaland Board of School Education (NBSE) syllabus. The obtained data were analysed and interpreted by using descriptive statistics, t-test, one-way ANOVA, and Scheff's Post-hoc test. The result reveals there is significant relationship among and between all the independent variables of attitude towards mathematics (i.e. teacher's Mathematics Pedagogical Content Knowledge, Creation of Learning Environment by the Mathematics Teachers according to Students' SES and demographic constructs, and Student Characteristics) except between teachers' MPCK and student Characteristics. And there is significant difference and influence of intersection among and between attitude

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towards mathematics and scholastic achievement in mathematics of secondary level students of Nagaland.

Keywords: MPCK, Attitude towards mathematics, Scholastic achievement in mathematics, Mathematics anxiety.

Introduction

“Students under achievement in mathematics are just not a concern for particular country but have become a global concern over the years “(Pisa, 2003)

A subject of vicarious and ethereal beauty, mathematics disciplines our mind in a desirable direction that develops power of clear thinking quickness of mind and perseverance. There is a common believe/myth in society that a well versant, in-depth common and specialised content knowledgeable mathematics teacher is the best person to teach mathematics. Research indicates that it takes more than a good instructor to teach mathematics. “Good mathematics teacher involves good teachers, an effective mathematics environment, and a curriculum that is more than a mile wide and an inch deep” (Nancy Protheroe). But what’s about “Knowing to teach mathematics”? Actually mathematics education is a science and separate discipline of education like pure mathematics. Several studies and researches so far has been undertaken to trace out the factors that influence students’ scholastic achievement in mathematics. Among them teachers’ Mathematics Pedagogical Content Knowledge (MPCK) and students’ positive attitude towards mathematics are the most important and surely a forceful determinant impinges students’ scholastic achievement in mathematics. Those who can bridge the gap between pure mathematics and mathematics education under congenial learning environment can develop students’ positive attitude towards mathematics and that can enhance the scholastic achievement in mathematics. In reality for a mathematics teacher Subject Matter Knowledge (SMK), Generic Pedagogical Content Knowledge (GPCK) including knowledge of blended learning, knowledge of student characteristics and their acceptance and creation of Learning Environment (LE) are the core components of specialised cognitive and affective abilities to teach mathematics. “Mathematics Pedagogical Content Knowledge (MPCK) is an amalgam of SMK in mathematics, Generic Pedagogical Content Knowledge (GPCK) & knowledge of blended learning, knowledge of student characteristics and students’ acceptance as per their biographical and demographical aspects and knowledge of creating congenial learning environment”. In a nut-shell that could be declared as Mathematics Pedagogical Content knowledge (MPCK) which impinge students’ attitude towards the subject and achievement.

A target is essential for attitude. Attitudes are highly composite and can affect learning comprehensively and influence performance and performance in turn

influences attitudes including attitudes. There are three parts of attitudes towards mathematics. Viz: -

1. The emotional part signifies students' feelings confronted with mathematics.
2. The cognitive part depicts students' beliefs about mathematics.
3. The operative part behaviour student exhibit when they have to do mathematics.

There are three factors impinging students' attitude towards and scholastic achievement in mathematics. Viz: -

1. The teacher' Mathematics Pedagogical Content Knowledge (MPCK) is an amalgam of Subject Matter Knowledge (SMK) in mathematics, Generic Pedagogical Content Knowledge (GPCK) and knowledge of blended learning, knowledge of student characteristics and students' acceptance as per their SES and knowledge of creating congenial mathematics learning environment both inside and outside of school premise.
2. The student characteristics (i.e., mathematical achievement, readiness and educational motivation, confidence, self-efficacy, self-concept, self-judgment, self-reaction, and mathematics phobia and anxiety).
3. The creation of congenial environment by the mathematics teacher acquainted with classroom management, the availability, provision and use of TLMs, and SES of the parents, demographic aspects.

Table 1.1: Represents the factors impinging the students' achievement in Mathematics.

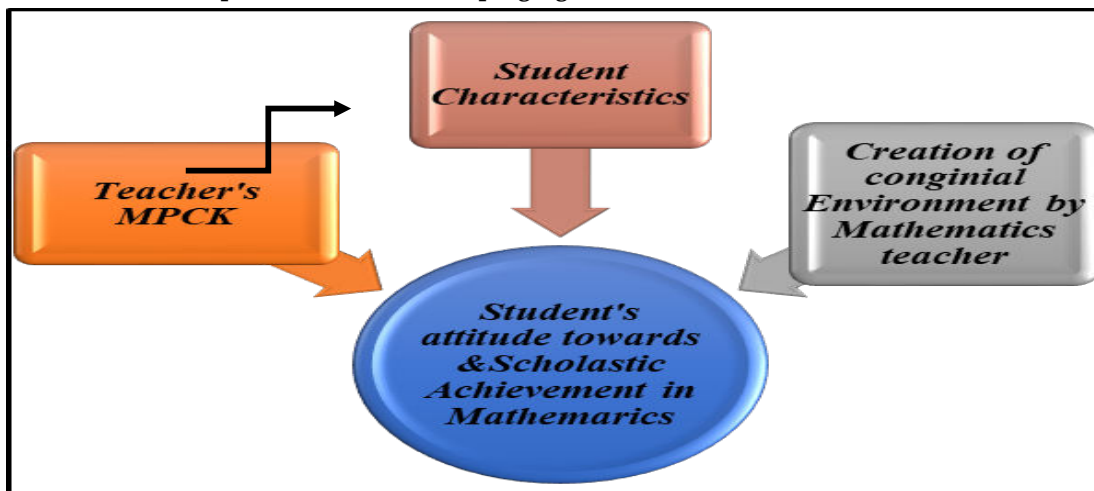
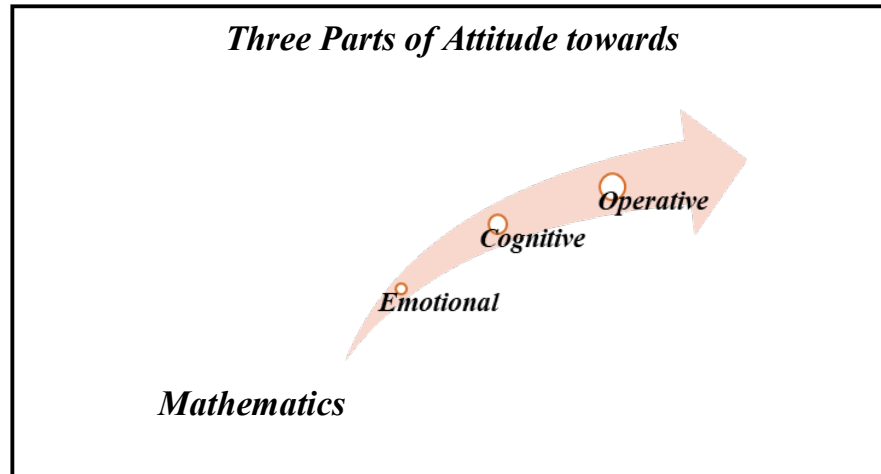


Table 1.2: Represents the three Attitude & parts of attitude towards maths



According to Aiken, (1970), "attitudes affect achievement and achievement in turn affects attitudes". It is therefore an irrefutable fact from the aforesaid discussion that the successfulness of development attitude toward and scholastic achievement in mathematics is contingent on myriad of factors all impinge on the learning of mathematics. Here the most important factor is the teacher; the teachers' Mathematics Pedagogical Content Knowledge (MPCK) and attitude towards mathematics and amount of confidence and support mobilized for their students accounts the degree of attitude towards mathematics enhanced.

"Adequate preparation in science and mathematics enables students to develop socially and intellectually and to participate fully in technological society as informed citizens" (Clark, 2006). However, the minority students less frequently study in this field. The low number of Naga students in mathematics related profession has become a socio-political debate. Nagaland has a minor chunk of tribal population, not deprived and marginalized groups with respect to education. However, the students' mathematics education/ higher education did not perform as expected. There are strong based numerous reasons could be traced out which create barrier for academic achievement in mathematics and that contribute to unequal participation of Naga tribes in mathematics education comparing with the other non-tribal students. In a nutshell those intrinsically interrelated affective factor could be categorized as external, internal, socio-economic and psychological, of course all factors do not apply to all racial and ethnic groups.

Table 1.3: Represents the barrier for academic achievement in mathematics.

BARRIER FOR ACADEMIC ACHIEVEMENT IN MATHEMATICS	
1	The external constraints are related to issues at levels of policy, planning and implementation.
2	The internal constraints are with respect to school system, content, curriculum, pedagogy, medium of instruction, and politically appointed inefficient officers etc.
3	The third set of problem related to social, economic and cultural background of tribal students.
4	Psychological aspect relates to first generation learner (i.e. only for Nagaland), motivation, self-esteem, self-efficacy, confidence and mathematics anxiety of the students.

2. Material and Methodology

2.1 Population and sample

In the present investigation all the students of Nagaland were the population of this study. Based on random sampling technique the researcher selected 200 students from four schools and the schools were selected by purposive sampling from Peren, Dimapur and Kohima districts of Nagaland,

2.2 Tools used in the study

To collect data from sample groups the researcher used standardised self-developed 15-items questionnaire for attitude towards mathematics and 10 questions for scholastic achievement in mathematics. Assessment is made on five points Likert's-format scale.

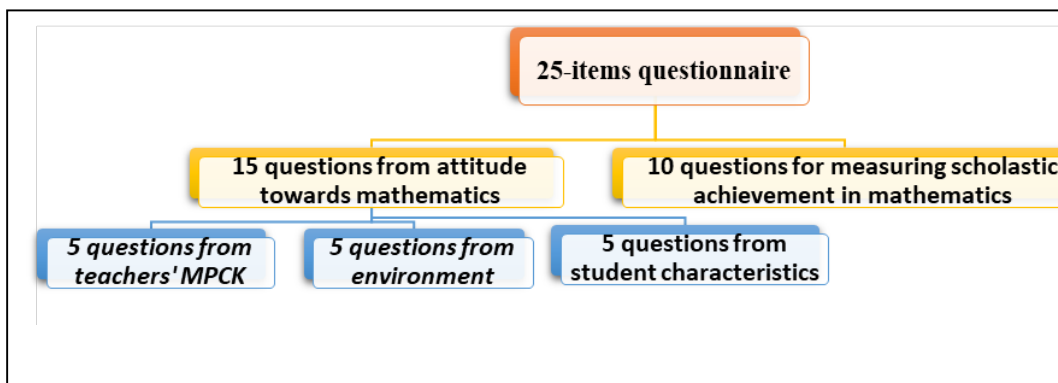


Table 2.1: Represents the hierarchy of questionnaire.

2.3 Statistical technique used

The data pertaining to the criterion variables of attitude towards mathematics (i.e., teachers' MPCK, environment of school, home and society, and student

characteristics) and scholastic achievement in mathematics have been examined by One-way ANOVA for each variable, and Scheff's Post-hoc test to examine the significant difference among groups.

To determine the relationship among and between the independent variables, Pearson's Product Moment Method of Correlation was used.

2.4 Scope and delimitation

- the study was conducted only for the year August and September 2017.
- the study was conducted only for Class-X students of Nagaland.
- the study was conducted only for the subject Mathematics, not for other subjects.
- attitude towards mathematic and scholastic achievement in mathematics tests were conducted separately.
- Teacher's MPCK was assessed from students' perception about the teacher.
- only selected personal and institutional variable has been taken into consideration for the present study.
- the study has been delimited to students' perception about their teachers' MPCK, their attitude towards mathematics and scholastic achievement in mathematics.

Further the findings have been subjected to limitations of tools and statistical treatment used.

2.5 Objectives of the study

- to determine whether or not there is presence of correlation among and between all the independent variables of attitude towards mathematics i.e., teacher's Mathematics Pedagogical Content Knowledge (MPCK), creation of learning environment by mathematics teacher and student characteristics.
- to determine whether or not there is presence of correlation among and between attitude towards mathematics and scholastic achievement in mathematics of secondary level students of Nagaland.

2.6 Hypothesis of the study

H₀₁: There is no significant difference and influence of interaction among and between all the independent sub-variables of attitude towards mathematics i.e., teachers' Mathematics Pedagogical Content Knowledge (MPCK), creation of learning environment by mathematics teacher and student characteristics.

H₀₂: There is no significant difference and influence of intersection among and between the attitude towards mathematics and scholastic achievement in mathematics of secondary level students of Nagaland.

3. Statistical Analysis and Graphical Representation

Under descriptive statistics mean, and standard deviation against the score of independent variables (i.e., teachers' MPCK, creation of learning environment by mathematics teacher, and student characteristics) and dependent variables (i.e., attitude towards mathematics and scholastic achievement in mathematics) are presented in the below mentioned table.

Table 3.0: Represents size of the sample, mean and SD of different variables.

	MPCK of teachers	Learning environment	Student characteristics	Attitude towards mathematics	Achievement in mathematics
N	200	200	200	200	200
M	16.065	14.2	14.19	44.46	24.56
SD	2.8953	2.2640	2.5151	4.4077	7.4650

From the table-3.0, it is revealed that mean score of MPCK of teachers perceived by the students is very much higher than that of the creation of learning environment by mathematics teacher (i.e., 16.065>14.02) and it is almost same with knowledge of student characteristics by the teacher (14.20 = 14.19). Though the mean score of Naga tribal students' attitude towards mathematics is high (i.e., 44.46) but their scholastic achievement is comparatively very low (i.e., 24.56).

H₀₁: There is no significant difference and influence of interaction among and between all the independent sub-variables of attitude towards mathematics i.e., teachers' Mathematics Pedagogical Content Knowledge (MPCK), creation of learning environment by mathematics teacher and student characteristics.

Table 3.1: Represents the ANOVA of independent variables under attitude towards mathematics.

Ind. Variable	Variation	∑ of Square	df	Mean Square	F	P
MPCK of teachers	Between groups	466.2633	2	233.1317	35.26371	0.00001
Learning Environment	Within groups	3946.935	597	6.611281		
Student characteristics	Total	4413.198	599			

** P<0.05 Table F, df (2,597) = 3.01 The result is significant at P < 0.05

The computed value of F-statistics i.e., 35.26371 is much higher than the critical/table value of F, df (2,597) = 3.010815 at 0.05 levels of significance i.e., P= 0.00001<0.05. Hence it should be taken as quite significant. Consequently, the null-

hypothesis H_{01} is rejected means, there is significant difference and influence of interaction among and between all the independent sub-variables of attitude towards mathematics i.e., teachers' Mathematics Pedagogical Content Knowledge (MPCK), creation of learning environment by mathematics teacher and student characteristics. Hence at least one significant difference definitely exists between the group means.

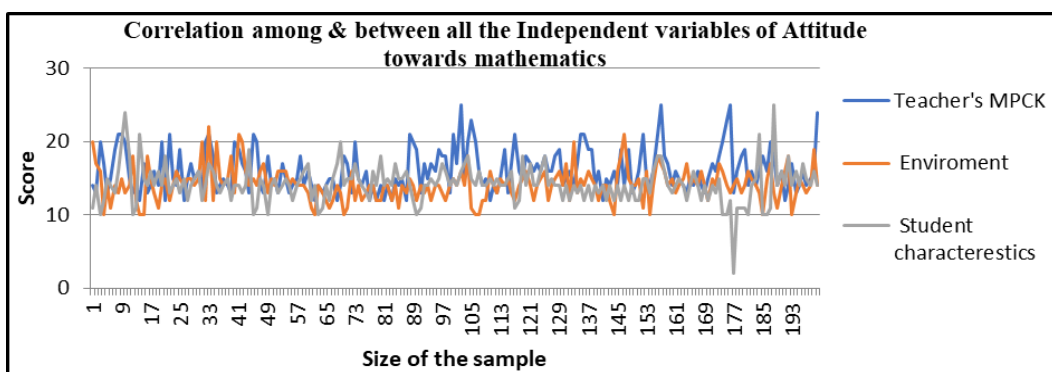
The attitude towards mathematics' independent variable's mean score for MPCK, creation of learning environment by mathematics teacher and Knowledge of Student characteristics are 16.065, 14.20, and 14.19 respectively. To find out which of these paired mean had a significant difference, the Scheffe's post-hoc test was applied.

Table 3.1.1: Represents Scheffe's Post-hoc test for significance difference of attitude towards mathematics

INDEPENDENT VARIABLES OF MPCK			TS : F_s	Scheffe's Critical value
MPCK of teachers	Learning environment	Student characteristics		
16.065	14.20	xx	52.5423	F-critical x df(n) = 3.010815 x 2 = 6.021630
16.065	xx	14.19	0.0016	
Xx	14.20	14.19	53.1073	

** Significant at 0.05 level

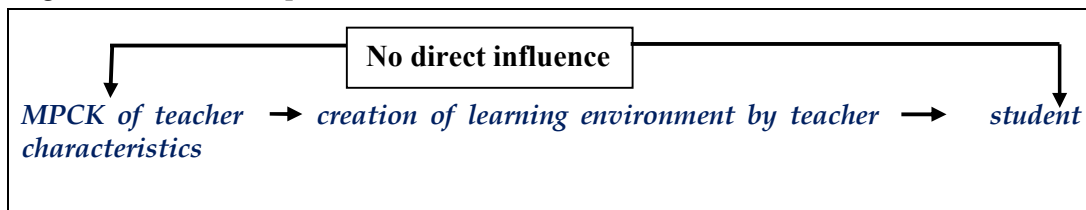
The table-3.1.1 shows that the significant paired means difference in attitude towards mathematics between MPCK & creation of learning environment by mathematics teacher and creation of learning environment by mathematics teacher & student characteristics are 52.5423 and 53.1073 respectively which are more than the Scheffe's critical value of 6.021630 at 0.05 level of confidence and no significant paired mean difference in attitude towards mathematics between MPCK and student characteristics is 0.0016 as it is less than the Scheffe's critical value of 6.021630 at 0.05 level of confidence.



Graph 3.1: Representing the correlation among and between the independent variables of attitude towards mathematics.

Reasons: The reasons behind the facts are as follows,

Actually Mathematics Pedagogical Content Knowledge (MPCK), creation of learning environment by mathematics teacher and student characteristics are intrinsically interrelated, one influences the other. Teacher characteristics are enhanced under the influence of MPCK, which can create the congenial mathematics learning environment of the students and have tremendous impact on student characteristics. It happens logically without step jumping means unless a teacher endowed with MPCK able to create the learning environment and motivate the students extrinsically, student characteristics would remain unchanged. As tribal Nagas are hunting gathering group and first hand learner hardly they are motivated towards any other criteria except physiological needs/ deficiency needs or d-needs; they are the physical needs/requirements for human survival and that is the root cause for not having any significant relationship between MPCK and student characteristics.

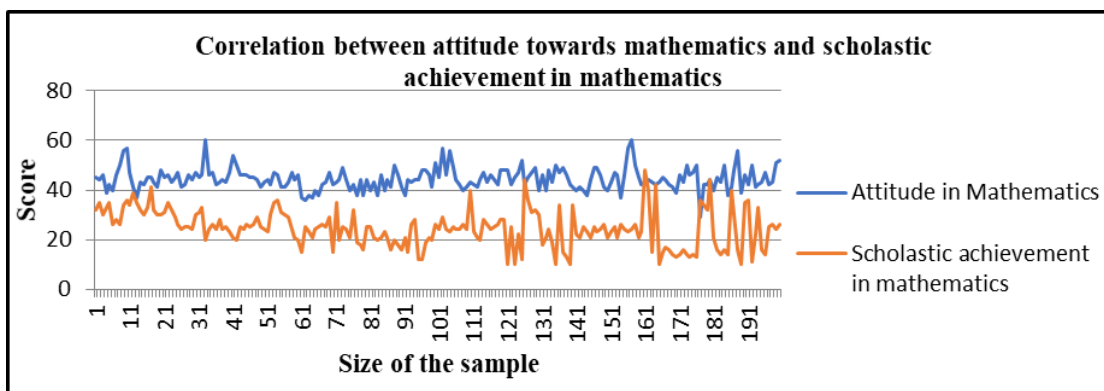


H₀₂: There is no significant difference and influence of intersection among and between the attitude towards mathematics and scholastic achievement in mathematics of secondary level students of Nagaland.

Table 3.2: Represents the significance of difference between secondary level student's attitude towards mathematics and scholastic achievement in mathematics.

Variables	't'	Sig	MD	SED	95% CI of Difference
Attitude towards maths	32.463	0.00001	19.9	0.613	18.699<19.9<21.101 (Rejected as not contained "0")
Achievement in maths					

From table-3.2, the "t" difference between secondary level students' attitude towards mathematics and scholastic achievement in mathematics is 32.463, which is statically significant as the P-value is less than 0.05 (P=0.00001<0.05 for two tailed) and as 95% CI of difference not containing Zero, there is statistical significance between the mean of two variables. Hence the formulated null hypothesis is rejected i.e.; **there is significant difference and influence of intersection among and between attitude towards mathematics and scholastic achievement in mathematics of secondary level students of Nagaland.** The difference between means in the population likely to be between 18.699 and 21.101



Graph 3.2: Representing the correlation among and between attitude towards mathematics and scholastic achievement in mathematics.

Reasons:

The lumen of the light of existing mathematics education from grass root level to higher secondary level is seriously dimmed. Among numerous reasons most critical reasons behind the significant difference between attitude towards mathematics and scholastic achievement in mathematics are, as follows:

1. Tribalism hinders the transparency in every inch of educational parameters in Nagaland that obstacle and decay the progress of mathematics education.
2. Easy earning, easy living and stupid illegal thinking trivialize the power of logical critical thinking of the people (necessary for mathematics education), that impinges students' inclination towards easy achievement and deemed it prudent not to dedicate towards mathematics education.
3. Mathematics education in Nagaland is badly hampered by the government policy i.e. there is provision for passing High School Leaving Certificate Examination with the help of sixth subject [Music, Information Technology (Vocational), Introductory Information Technology, Home Science, Foundation of Information Technology, Environmental Education, Book Keeping and Accountancy, and Travel and Tourism] and without passing in mathematics means if a student pass compulsorily in English and in any four subjects among second language, mathematics, science, social sciences, and sixth subject he/she declared pass. As a result, from middle school standard students start neglecting mathematics.
4. It has become a ritual to change the mathematics and science books of Class-IX and Class-X grade in Nagaland. In eight years four times those books have been changed with lower degree of knowledge and

information, gravity of the contents declined by lips and bounds. It seems that text books are teacher centered not student centered, the reason behind the facts may be diversified but the immediate blow is from non-availability of qualitative local mathematics and science teachers. Many schools run without mathematics and science teachers, several commerce graduates are appointed and they are compelled to take mathematics. It is somewhat like compromising education behind the smoke screen.

5. Low ratio of higher secondary schools with mathematics education in Nagaland, insists the secondary students to opt for either arts or commerce due to non-availability of science stream and of facilities therein. That restricts the development of positive attitude towards mathematics. Even there is dearth of secondary schools in rural areas of Nagaland, higher secondary education with mathematics is far away and day dream for the students of those areas.
6. Mathematics phobia, high anxiety towards mathematics, non-availability of regular needs and supplementary material and nonmaterial elements for classroom instructional practices and on top of that average poor socioeconomic status of the parents crippled the mathematics education in Nagaland.
7. In Nagaland existing available mathematics teachers both in secondary and higher secondary levels though scanty are mostly from other states, instead of providing red-carpet, tremendous practice of red-tapism always keep those teachers behind the smoke screen and forceful deprivation of their legitimate rights and step motherly treatment from diversified agents jeopardize those mathematics teachers' professional ethics and under those shrewd and fine unseen rigging made a class differences among and between the non-local mathematics/science teachers and local students and administration. This is one of the most important root cause hindering mathematics education of both secondary and higher secondary level students of Nagaland.
8. In Nagaland, the teachers those who work with their hands and heart and produce significant wealth are denied access to the financial benefits and in the avenue of promotion and status, on the other hand local beneficiaries not only denigrate educational productivity but also reflects before the mass their own weakness and lack of individual knowledge and skills.
9. Mathematics is used almost in all subjects known as academia. The value of learning mathematics failed to provide a healthy example before the society as manufacturing units are almost nil in Nagaland as there is no

ease of business due to prolonged Naga political crises even after 50 years of getting statehood.

10. Overall educational attainment and status of teachers' training in Nagaland is worse; several fraud-star tribal teachers with fake certificates have been serving in different schools. Though detected and published through media yet no legal action has been taken so far and many of them even granted promotion.
11. Teachers recruitment has been totally stopped since long back, there are several schools run by either no or disqualified mathematics and science teachers. There is evidence of serious lack of specialized teachers for mathematics even in secondary level schools in Nagaland, and against the post vacancies of mathematics teachers' mare arts and commerce graduates were recruited to cope up with the local unemployment problem, neither they are efficient nor are dedicated to teach mathematics, their condition is like a chicken who can't fly like an eagle. That spoils the back bone of tribal secondary level students' mathematics education in Nagaland.
12. There are localization (Rural/Urban) disadvantages associated with the availability of mathematics laboratory, ICT laboratory, CAL laboratory, libraries and other amenities both in the secondary and higher secondary level schools of Nagaland.

Results

Effective teaching is at par excellence attribute of quality education. It is beyond doubt that overall educational system largely depends upon active, resourceful and competent teachers. An effective teacher not only imparts the entire educational curriculum allotted to him/her in the best and effective manner but also ensures the optimum development of the students. At present effectiveness of teachers become imperative to empower the students to face global challenges. "There are many factors, which influence the effectiveness of a teacher viz. Intelligence, attitude towards teaching, experience, academic qualification, personality, mental health etc. (Raghu, 1994)".

There are three factors impinging students' attitude towards and scholastic achievement in mathematics. In the light of the above findings it could be concluded that there is significant difference in teacher's Mathematics Pedagogical Content Knowledge (MPCK) & creation of learning environment by mathematics teacher and student characteristics & creation of learning environment by mathematics teacher. And there is no significant difference between teacher's MPCK & student characteristics. There is significant difference between attitude towards mathematics and scholastic achievement in mathematics.

Discussion

Mathematics is a subject which disciplines the mind in a desirable direction and there is three parts of positive attitude towards mathematics (the emotional part, the cognitive part and the operative part) and is the prerequisite of a student in learning mathematics. There is a correlation between students' attitude towards and scholastic achievement in mathematics. Through several studies it is revealed that students with similar abilities differ in scholastic achievement. It is due to positive attitude towards the subject. Therefore, developing positive attitude towards mathematics is an important goal of mathematics curriculum. In a general observation students having positive attitude towards mathematics achieve more in comparison with those students who have negative attitude towards mathematics. Therefore, it is an irrefutable fact from the aforesaid discussion that the successfulness of development attitude toward and scholastic achievement in mathematics is contingent on myriad of factors all impinge on the learning of mathematics. Here the most important factor is the teacher; the teacher's MPCK, and amount of confidence and support he/she mobilizes for their student's, besides that environment of home, school and society & knowledge of student characteristics that garner students' attitude towards mathematics.

Suggestions

In order to improve the quality of mathematics education in Nagaland the following measures are to be taken. There should be,

1. Student-centered education with dynamic-methods
2. Make the curriculum dynamic not dogmatic
3. To provide need based job oriented courses
4. Make the teachers feel worthy
5. Improving pre-service and in-service teacher's training
6. Orientation course for teachers' MPCK to eradicate students' anxiety towards mathematics
7. Dichotomy created by the system of education should be reviewed for solution
8. Monitoring of one school by another
9. Use of ICT
10. Examination reform

Conclusion

Teacher's mathematics pedagogical content knowledge is one of the most important factors that impinges student's attitude towards mathematics and scholastic achievement in mathematics provided the environment of the home, school and society and student characteristics are congenial. But the result reveals there is

significant difference between attitude towards mathematics and scholastic achievement in mathematics of the secondary level students of Nagaland.

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A Study on Teachers' Mathematics Pedagogical Content Knowledge (MPCK) and its effect on ..

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