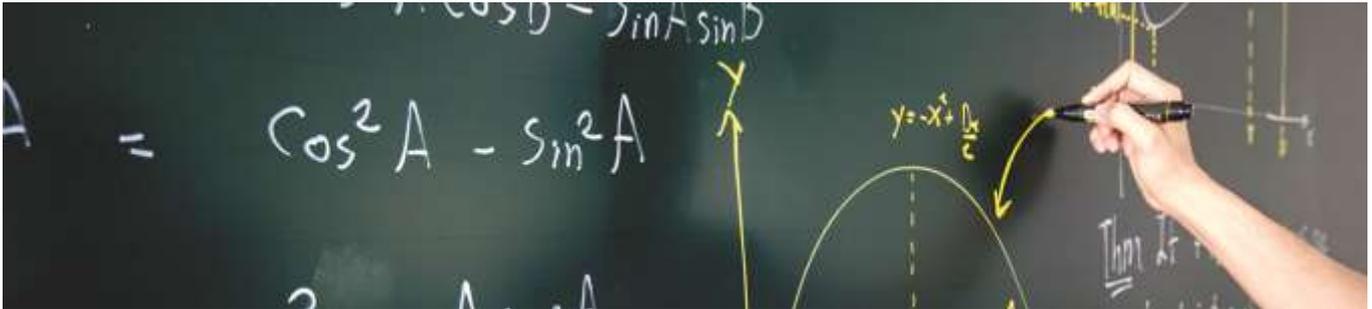


“A study on the relationship between students’ perception towards their teacher’s mathematics pedagogical content knowledge and anxiety towards Mathematics”



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ABSTRACT

Teaching is a multidimensional process encompasses with a myriad of separable dimensions or instructor/constructor attributes to contribute but many a time difficult to quantify. From psychological perspective there is a general myth that mathematics is an enigmatic subject. The most important factor impinges students learning mathematics is teacher’s Mathematics Pedagogical Content Knowledge (MPCK) that may confidently eradicate students’ anxiety (SA) towards mathematics. These two variables are intrinsically interrelated but distinct entities. Some prime factors like teachers mathematics content knowledge, generic pedagogical and psychological knowledge, and teachers’ personal experiences which may garner students learning in mathematics and to trivialise the level of anxiety. This study is fashioned to create a scalable intervention about the indispensable role of teachers endowed with MPCK and SA in mathematics. To address this issue students of Kolkata (India) constitute the population of this study. A sample of 200 secondary level students was selected. A-36 items self-developed questionnaire ($r=0.8935$) was used to measure students’ perception about their teachers MPCK. A-12 items questionnaire of Fennema-Sherman was taken to measure students’ anxiety towards mathematics. The obtained data were analysed and interpreted using descriptive statistics, t-test and one-way Analysis of Variance (ANOVA).The result shows there is significant relationship between teachers MPCK and anxiety towards mathematics.

Key words:

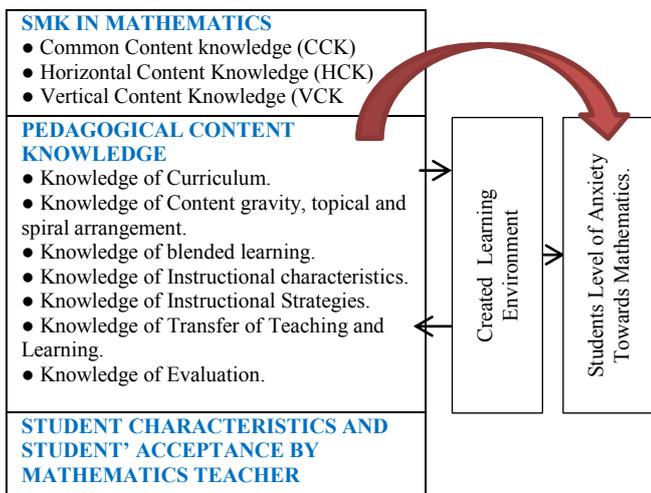
Pedagogy,
 Generic Pedagogical knowledge,
 Mathematics Pedagogical Content Knowledge,
 Mathematics Anxiety.

I. INTRODUCTION

Mathematics is a subject which disciplines our mind in a desirable direction. “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). Research indicates that it takes more than a good instructor to teach mathematics. 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. But what about “Knowing to teach mathematics”? Actually mathematics education is a science and separate discipline of education like pure mathematics. Those who can bridge the gap between pure mathematics and mathematics education under congenial learning environment can eradicate the students’ anxiety towards mathematics. In reality for a mathematics teacher Subject Matter Knowledge (SMK), Pedagogical Content Knowledge (PCK) 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, PCK & 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’ psychological construct like anxiety.

MPCK= SMK IN MATHEMATICS + PCK & KNOWLEDGE OF BLENDED LEARNING + KNOWLEDGE OF STUDENT CHARACTERISTICS & STUDENTS’ ACCEPTANCE BY TEACHER + KNOWLEDGE OF CREATING THE CONGENIAL LEARNING ENVIRONMENT.

I would like to highlight the exclusive existing reasons (those could be considered under the domain of MPCK that impinge the level of students’ anxiety towards mathematics of secondary level, with the help of below mentioned table.



CCK is mathematical knowledge and skills used in general settings, not necessarily unique to teaching. HCK is interdisciplinary subject matter knowledge and skills used in general settings as mathematics is entwined with almost all the subjects known as academia. VCK is the knowledge and skills that conjugate and correlate among and between several topics and sub-topics of mathematics. PCK is the fusion of several multidimensional teaching aptitudes and attributes acquired and empowered through myriad of interrelated variables i.e., knowledge of curriculum, knowledge of content gravity and student potentiality of learning (KCGSPL), blended learning and understanding of students cognitive and affective abilities, strength or lacuna: judicious uses of micro skills of teaching:

instructional strategies, ability to transfer of teaching and learning and use of CCE. Actually PCK is that exclusive knowledge domain of teaching that differentiates the expert teacher in a subject area from the subject expert. In short PCK is the way of formulating and representing content, comprehensible to others. Teacher must have two distinct knowledge of students i.e., knowledge of student characteristics and their co-ordeal acceptance by their teachers as per socio-economic status for diagnostic and remedial teaching. It is a challenging job for a mathematics teacher to have both the knowledge of students either to minimise or eradicate the phobia and anxiety towards mathematics in a congenial learning environment. SMK, PCK, knowledge of blended learning and Students’ Knowledge about acceptance under congenial LE are related to teachers’ professional competency and those variables are intrinsically interrelated but distinct entities and the intersection of those is the altar of teacher’s Mathematics Pedagogical Content Knowledge (MPCK). That ultimately influence students level of anxiety towards mathematics, is represented by the below mentioned Venn-Diagram.

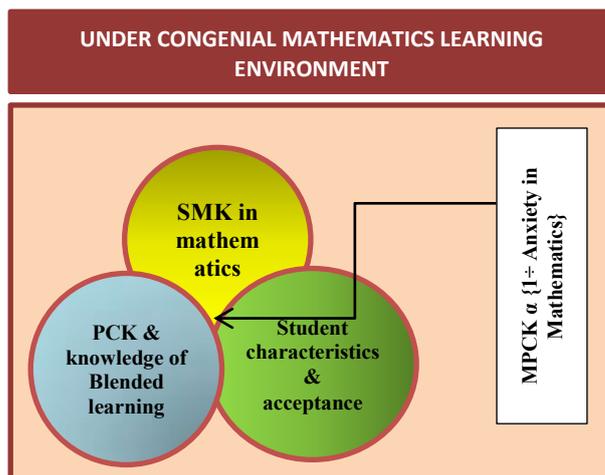


Table No. 1.0: Represents the Venn-diagram of the intersection of independent variables (SMK, PCK & Blended learning, and Knowledge of student characteristics & acceptance) and i.e., Mathematics Pedagogical Content Knowledge (MPCK).

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II. MATERIAL & METHODOLOGY

2.1 Population and sample

In the present investigation all the secondary level students of West-Bengal were the population of the study.

Based on stratified random sampling technique the researcher selected 200 (100 male and 100 female) class- X students from eight co-education schools of Kolkata (Schools were selected purposively).

2.2 Tools used in the study

To collect the data from sample groups the researcher used two tests as follows:

- The Fennema-Sherman Mathematics Anxiety Scale (MAS) comprises 12-items under four categories with both positive and negative statement: Thinking about mathematics (4-items), Taking mathematics test (3-items), Learning mathematics lesson (2-items), and solving mathematics problem (3-items). Assessment is made under five points Likert’s-format scale.

- A self-develop Mathematics Pedagogical Content Knowledge (perceived by students) scale comprises of 36-items under four categories with all positive statement: Subject matter knowledge in mathematics (9-items), Pedagogical content knowledge (9-items), Knowledge about students (9-items) and learning environment (9-items). Assessment is made under five points Likert’s-format scale.

2.3 Statistical technique used

To examine the significance difference between MPCK and Anxiety towards Mathematics t-test was used. The data pertaining to the criterion variables of MPCK have been examined by One-way ANOVA for each variable, 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 of the study

- the study was conducted only for academic year 2016 and January 2017.
- the study was conducted only for class-X standard students.
- the study was conducted only for the subject mathematics, not for other subjects.
- only selected personal & institutional variable were taken into consideration for present study.
- the study was delimited to their predictors of anxiety towards mathematics and mathematics pedagogical content knowledge perceived by the students.
- Further the findings was subjected to limitations of tools used and statistical treatment used.

2.2 Objectives of the study

- To determine the level of mathematics anxiety of secondary level students of Kolkata.
- To determine whether or not there is presence of correlation between mathematics anxiety and teachers’ mathematics pedagogical content knowledge perceived by the secondary level students of Kolkata.
- To determine whether or not there is presence of correlation among and between all the independent sub-variables of MPCK i.e., subject matter knowledge, pedagogical content knowledge including blended learning, knowledge of students characteristics under congenial learning environment.

2.5 Hypotheses of the study

H₀₁: There is no significant difference between mathematics pedagogical content knowledge perceived by the secondary level students of Kolkata and their anxiety towards mathematics.

H₀₂: There is no significant difference and influence of intersection among and between all the independent variables of MPCK i.e., subject matter knowledge in mathematics, Pedagogical Content Knowledge and blended learning, knowledge of student characteristics and acceptance, and congenial learning environment created by teacher.

III. STATISTICAL ANALYSIS AND GRAPHICAL REPRESENTATION.

Through descriptive and inferential statistics researcher analysed the collected data for the study. Descriptive analysis is as follows

VARIABLES ↓		VERY LOW ANXIETY	LOW ANXIETY	MODERATE ANXIETY	HIGH ANXIETY	VERY HIGH ANXIETY	R = -0.8974
	N →	06	28	90	36	40	
ANXIETY	MEAN	18.50	26.46	35.66	45.97	53.75	
	SD	2.43	2.63	2.95	2.29	1.95	
MPCK	MEAN	156.83	137.57	116.32	108.47	89.65	
	SD	2.32	8.14	4.73	4.51	6.00	

Table-3.1: Represents the descriptive statistics of collected data on the level of anxiety towards mathematics and corresponding Teachers’ Mathematics Pedagogical Content (MPCK).

Table-3.1, Reveals when the mean level of teachers’ MPCK decreases from 156.83 to 89.65 then students’ anxiety towards mathematics increases from very low anxiety to very high anxiety (i.e., 18.50 to 53.75), and there exist a strong negative correlation i.e., **-0.8974** between teachers’ MPCK and students’ level of anxiety towards mathematics, means these two variables act in inverse proportion.

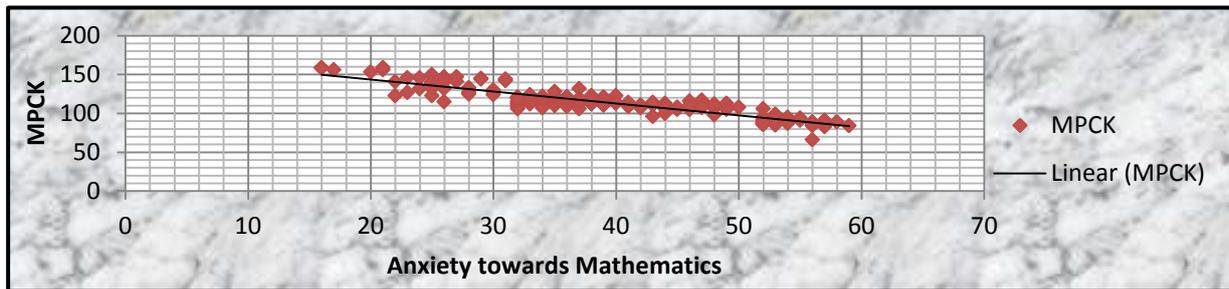
H₀₁: There is no significant difference between teachers’ MPCK perceived by the secondary level students of Kolkata and their anxiety towards mathematics.

VARIABLE	N	MEAN	SD	MD	SED	“t”	Sig.	95% CI of Difference
MPCK	200	113.77	17.04	74.44	1.3953	53.351	0.00001	71.705<74.44<77.175 Not containing “0” hence significant.
ANXIETY	200	39.33	9.95					

Table-3.2: Represents the significance of difference between the mean of MPCK of teachers, perceived by the students and their anxiety towards mathematics.

From the table-3.2, the “t” difference between teachers’ MPCK perceived by students and anxiety towards mathematics is 53.351, which is statistically significant as the P-value is less than 0.05 ($P=0.00001 < 0.05$, for 2-tailed), and this result is seconded by 95% CI of difference as it does not contain zero. Hence the formulated null-hypothesis is rejected. It means H_{01} is rejected i.e., **There is significant difference between teachers’ MPCK perceived by the secondary level students of Kolkata and their anxiety towards mathematics.** The difference between the means in the population likely to be between 71.705 and 77.175.

The below mentioned graphical representation reveals, there is a strong inverse correlation between students’ anxiety towards mathematics and teachers’ MPCK.



Graph table no.1: Represent the correlation between Anxiety towards mathematics and MPCK of the teachers perceived by the students.

H_{02} There is no significant difference and influence of intersection among and between all the independent variables of MPCK i.e., subject matter knowledge in mathematics, Pedagogical Content Knowledge and blended learning, knowledge of student characteristics and acceptance, and congenial learning environment created by teacher.

SUB-VARIABLES OF MPCK	N	MEAN	SD	∑ of S	df	M.Sq.	F**	Sig.	
SMK	200	28.77	4.38	Between groups	82.935	003	27.645	1.279	0.280
PCK & B.L	200	28.70	4.65						
STDN.	200	28.43	4.95						
L/ ENV.	200	27.95	4.60						
				Within groups			17207.411	796	21.617
				Total			17290.346	799	

** $P < 0.05$ Table F, $df(3,796) = 2.61$ & $P < 0.01$ Table F, $df(3,796) = 3.80$

Table-3.3: Represents the significance of difference among and between all the sub-variables of teachers’ MPCK.

[SMK= Subject Matter Knowledge, PCK & B.L= Pedagogical Content Knowledge and Knowledge of Blended Learning, STDN. = knowledge of student characteristics and acceptance, and L/ ENV. = congenial learning environment created by teacher]

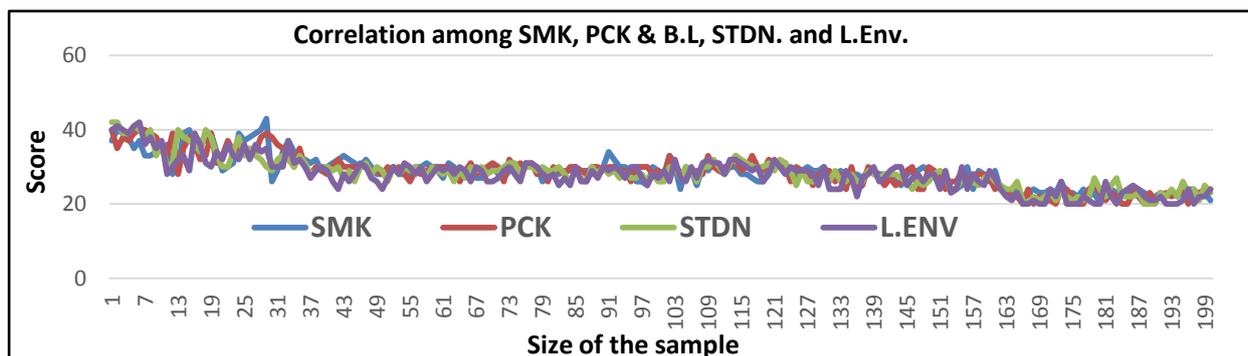
From the table-3.3, the computed value of F, i.e. 1.279 is lower than both the critical value of F at 0.05 and 0.01 levels of significance. Hence it should be taken as not significant. Consequently the null-hypothesis H_{02} is accepted it means, **there is no significant difference and influence of intersection among and between all the independent variables of MPCK i.e., subject matter knowledge in mathematics, Pedagogical Content Knowledge and blended learning, knowledge of student characteristics and acceptance, and congenial learning environment created by teacher.**

The below mentioned table represent the Pearson Correlation among and between the independent sub-variables of MPCK.

Pearson Correlation between sub-variables.	Value	Pearson Correlation between sub-variables.	Value
SMK and PCK & B.L	0.808847	PCK & B.L and STDN.	0.838304
SMK and STDN.	0.809381	PCK & B.L and L/ENV.	0.805431
SMK and L/ENV.	0.786924	STDN and L/ENV.	0.842361

Table-3.4: Represents Pearson Correlation among and between the independent sub-variables of SMK, PCK, STUDENTS, and L.Env.

From the table-3.4, the result reveals that there exist a strong positive correlation among and between those above mentioned independent sub-variables and the below mentioned graphical representation reveals that these four independent sub-variables are intrinsically interrelated though they are distinct entities.



Graph table 2: Representing the correlation among and between the sub-variables of MPCK.

IV. RESULTS

MPCK is the prerequisite of a mathematics teacher in instructional process. That may garner the student’s positive attitude towards mathematics that only may lower down the level of mathematics anxiety. In the light of the above findings it could be concluded that students under better and greater MPCK-able teachers, reflect lower level of anxiety towards mathematics. Because empowered mathematics teachers, empower the students in mathematics as they are well versant about how to do, what to choose to do, when delivering instruction in their classrooms determine what content students learn and which students learn that content.

In the light of above findings it could be concluded that there are no significant differences among and between the means of independent variables of MPCK (i.e., Subject matter knowledge in mathematics, Pedagogical content knowledge and knowledge of blended learning, Knowledge of student characteristics and acceptance by them and congenial learning environment created by teacher) perceived by the students. There are strong positive correlations among and between the independent sub-variables of distinct entities and are intrinsically interrelated.

V. DISCUSSION

At present design of education “teachers are less instructor but more constructor, they are less born but more made”. No mathematics lesson, no matter how well planned, can be successful if the elements of MPCK are not in place. The gap between student differences and heterogeneous instructional practices are manageable to minimise by dint of MPCK of teachers, as in a classroom situation homogeneous instructional approach goes for heterogeneous groups of students.

“Students are the best observer and judger of teacher”. Their participation and involvement in instructional process signifies the concerned mathematics teacher’s subject matter knowledge, skills and potentiality in teaching and learning process. In professional teacher training college they are trained with multi faced behaviour and characteristics of students and their needs and aspirations and interests. Our future education tremendously converging towards digitised, personalised, and blended learning (where blended learning is a proper subset of e-learning) with the inclusion of ICT tools in education, which got tremendous impetus in teaching and learning process without denying the value of printed version, specially inclined towards Project based learning (PBL) in mathematics and Assessment for learning (AFL) under the umbrella of ET. In professional teacher training college mathematics teachers are made equipped with all the latest cells of MPCK and their execution is the prerequisite either to erase or eradicate students’ anxiety towards mathematics and may help students to embrace mathematics.

VI. CONCLUSION

Mathematics anxiety is the outcome of low-esteem and fear of failure and is associated with believes, it encompasses tension, nervousness, fear and worry. It is manageable under the impression and guidance by an active, resourceful, and competent mathematics teacher empowered with MPCK. All the independent sub-variables of MPCK are intrinsically interrelated but distinct entities.

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