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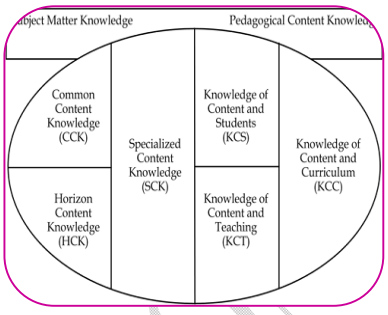
QUALITY INSTRUCTION THROUGH MATHEMATICAL KNOWLEDGE FOR TEACHING (MKT): A STUDY ON MKT OF PRIMARY SCHOOL TEACHERS OF FIJI



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ABSTRACT

Teachers' mathematical knowledge plays a central role in the teaching of mathematics, whereby in this study framed as 'Mathematical Knowledge for Teaching.' Studies have shown that teachers' sound knowledge of MKT have immensely contributed to students' higher achievement in mathematics(Hill.et.al 2005).The objectives of the study is to examine the current status of MKT among Primary School Mathematics Teachers of Fiji schools in terms of its components; Knowledge of Content and Students (KCS), Knowledge of Content and Teaching(KCT), Common Content Knowledge(CCK), and Specialized Content Knowledge(SCK), with respect to teachers' teaching locations. The study engages descriptive survey with Stratified Random Sampling technique, and sample size of 360 Primary School Teachers. The research tool uses 'a test on MKT' to gauge the levels of teachers' MKT with one-way Analysis of Variance. The relevance of the study is to propose to the Ministry of Education in Fiji, the significant areas of support that are needed for primary school teachers with teaching mathematics in order to bring about higher student performance. The findings of the study are discussed in detail in the paper.

KEYWORDS: *Mathematical Knowledge for Teaching(MKT), Common Content Knowledge(CCK), Primary School Teachers, Specialized Content Knowledge(SCK); Knowledge of Content and Teaching(KCT), Knowledge of Content and Students(KCS)*

INTRODUCTION:

Research on teachers' knowledge of teaching has been on-going for the last decade as it has helped to influence teachers' perception, interpretation and decision making about teaching in general and mathematics teaching (Kersting 2008), in terms of content and pedagogical aspects of teaching(Ono &Fereira 2010). Studies have also proven that teachers' sound knowledge of MKT have immensely contributed to students' higher achievement in mathematics(Hill.et.al 2005) and teachers' quality instruction (Borko et.al.1992).It has also developed teachers' cognitive skills to identify students' errors and make quick judgements derived from the wealth of knowledge one has acquired **(**Son.J.W.(2013). Therefore from the above discussion, it can be concluded that MKT can positively contribute to students' learning and classroom instruction.

MATHEMATICAL KNOWLEDGE FOR TEACHING

Mathematics Knowledge For Teaching (MKT) includes the teachers' knowledge needed 'in' teaching and 'for' teaching mathematics as defined by Schneider and Plasman (2011),to bring about effective teaching and indirectly improve student learning. Ball et al(2008) elaborates MKT as a framework that

weave in multiple knowledge components in the teaching of mathematics, thus more refinement of content knowledge and pedagogical content knowledge.

The MKT concept has been initially derived from Shulman's (1986) experimental model and further modified by Hill et al(2008) and had been considered as one of the most exceptional re-organised structures of the teachers' Pedagogical Content Knowledge, within the area of mathematics education.

Shulman's Model highlighted the two major components in teaching mathematics, as Procedural Content Knowledge and Subject Content Knowledge which was later extended by Hill et al (2008) and rephrased as Mathematical Knowledge for Teaching(MKT). Subject Matter Knowledge, further includes Specialised Content Knowledge(SCK), Common Content Knowledge(CCK), and Horizon Content Knowledge(HCK).

Pedagogical Content Knowledge on the other hand, includes Knowledge of Content and Teaching(KCT), Knowledge of Content and Students(KCS),and Knowledge of Content and Curriculum(KCC).

SCK covers knowledge of content limited to teaching mathematics which includes teaching resources, representations and making connections, and using mathematical language for teaching. CCK gives way for teachers to focus on mathematical knowledge that is needed to solve problems in multi-contexts, and HCK, includes how teachers can relate mathematics topics across the curriculum, and also mapping mathematical concepts with other levels or grades.

However, Pedagogical Content Knowledge includes KCT, which includes making connections of mathematical concepts and ideas with various pedagogical approaches which brings about effective teaching with meaningful learning in students. KCS focuses on teachers' understanding on mathematical content and interacting with how students think, and addressing students' misconceptions. KCC, directs teachers to connect mathematical content with teaching resources.

KCC and HCK are normally embedded within the four highlighted components.

The use of MKT as a modified Shulman's model is seen as a more holistic model that could measure teachers' MKT from a more wider perspective, and it provides a direct relationship between teachers' Procedural Content Knowledge with student learning.

NEED AND IMPORTANCE OF THE STUDY

The low student achievement rate in Mathematics for Primary students, as according to the one of the local newspapers in Fiji, The Fiji Times, dated December 3rd 2016, the former Education Minister had identified subject delivery by teachers as one of the main contributors to the unfavourable results in Year 6 and Year 8 National Examination results as the pass rate for Mathematics for Year 6 in 2016 was only 29 per cent. The Minister further highlighted the urgency to address new teaching approaches in primary mathematics.

In addition, there is no known study conducted in Fiji about MKT on Primary School Teachers in Fiji. Since Fiji is categorised under "Small Island States' as the population is about 90 000, finding of such studies, according to Sanga(2012), could be used as building blocks of local and international literature in mathematics education.

RESUME OF THE RELATED LITERATURE

Raiula T.N. &Kumari.S.N.V.(2018),revealed that the level of MKT of male teachers in Fiji's primary schools is significantly higher than female teachers.

Slavit.D.,&Lesseig.K.(2017),revealed that inquiry based instructions, which is closely associated with MKT, help teachers to tackle problems using multiple approaches, construct one's own mathematical problems, and helps in scaffolding and rehearsals.

Mitchell.R. et al. (2014) revealed that teaching experience and teacher qualification contribute positively to MKT, however, female teachers' MKT is significantly higher than male teachers.

Guddadanveri. P.S.(2014) revealed that teaching approaches such as co-operative learning would help students actively participate and through interaction with peers and teachers brings about great motivation and meaningful learning, and indirectly resulted to higher student achievement.

Malik. S.K.et al.(2013revealed that teachers' knowledge of constructivist instructional approach, which is closely associated with MKT, promotes student-centred learning which brings about active student dialogue, freedom of expression is accommodated resulting in higher achievement for students as compared to traditional method of teaching.

Son.J.W.(2013), revealed in MKT, teachers' cognitive skills could help in identifying student errors that could be helpful in teacher's instruction. Findings showed that errors could be integrated into instruction and bring about positive attitudes in teaching.

Hill et al.(2005) revealed that teachers with MKT have acquired high quality instruction, not specifically on MKT, but also contribute to general knowledge about teaching. Quality teachers' MKT positively contribute to quality mathematics content knowledge, resulting to higher student achievement.

After a critical analysis of the related literature findings, the following research gaps have been identified by the researchers; studies that incorporate all components of MKT in a study, and considering MKT components in different contexts.

To fill up this research gap, the present study, titled " Quality Instruction Through Mathematical Knowledge For Teaching (MKT): A study on MKT of Primary School Teachers of Fiji" was undertaken.

Operational Definitions of The Terms

Mathematical Knowledge for Teaching (MKT)

Mathematical Knowledge For Teaching refers to what mathematical techniques and skills that teachers require to teach mathematics, and can be divided into two categories; Pedagogical Content Knowledge (PCK) according to Hill et al.,(2008), includes Knowledge of Content and Students(KCS),which refers to knowing about the students and mathematics; and Knowledge of Content and Teaching(KCT), knowing about teaching and mathematics.

The other category; subject matter knowledge includes Common Content Knowledge(CCK), mathematical skills and knowledge which can be used in realistic situations and Specialised Content Knowledge(SCK), refer to mathematical skills and knowledge , more confined to teaching. The other two components of MKT; Knowledge at the Mathematical Horizon(KMHZ), and Knowledge of Content and Curriculum(KCC) are usually embedded in the other categories of MKT.

In the present study, the researcher expounded on Hill et al.'s model of the levels of MKT with its related components for Primary School Mathematics Teachers in Fiji which was measured by administering a 'Test on Mathematics Knowledge for Teaching' which was prepared by the researchers by covering the following:

(i) Common Content Knowledge,
(ii) Knowledge of Content and Teaching,
(iii) Knowledge of Content and Students and
(iv) Specialised Content Knowledge

PRIMARY SCHOOL MATHEMATICS TEACHERS

In the present study, Primary School Mathematics Teachers refer to teachers in Fiji serving in different schools as various locations throughout the country, and are basically divided into four main Divisions namely; Central, Northern, Western, and Eastern Division whereby the schools are further categorised as remote, rural, semi-urban and urban schools. According to Ministry Of Education Report(2011), rural schools are classified under 10 to 20km from a town boundary; and remote are greater than 20km away; for this study, the researcher has categorised semi-urban, 4km to 9km from town boundary; and urban, 3km within town boundary.

Primary School Mathematics Teachers are employed and supervised by the MOE with a minimum qualification of Primary Teacher Certificate and are required to teach all the subjects recommended by MOE.

OBJECTIVES OF THE STUDY

1. To compare the level of MKT among Primary School Mathematics Teachers in Fiji and its components according to location.
2. To compare the level of Mathematical Knowledge for Teaching Components among Primary School Mathematics Teachers with respect to location.

To study this objective the following hypothesis was formulated.

HYPOTHESIS OF THE STUDY

H_1: Primary School Mathematics Teachers in remote, rural, semi-urban and urban schools differ significantly in Mathematical Knowledge for Teaching

H_2:Primary School Mathematics Teachers in remote, rural, semi-urban and urban schools differ significantly in Mathematical Knowledge for Teaching Components.

METHODOLOGY

The population covers all Primary School Mathematics Teachers in Fiji, which has a total of 5778 teachers. The Sample was obtained using Krejcie and Morgan(1970) Sample size table, with a sample of 360 teachers.

Descriptive survey was used with Stratified Random Sampling technique, taking a stratus from each Education District is selected The research tool was validated using Content Validity and the reliability of the tool was calculated using Cronbach's Alpha.

ANALYSIS OF DATA AND RESULTS

The collected data were analysed using SPSS from administering the tool ' A Test on Mathematics Knowledge for Teaching.'

Objective 1

To compare the level of MKT among Primary School Mathematics Teachers in Fiji and its components according to location.

To compare the level of MKT, with respect to location, the reliability of the data was calculated using Cronbach's Alpha. The details is given in Table 1.1

Table 1.1: Reliability Details of Data with respect to Location

Cronbach's Alpha	N of Items
.803	4

Hypothesis 1

H_1: Primary School Mathematics Teachers in remote, rural, semi-urban and urban schools differ significantly in Mathematical Knowledge for Teaching.

The null hypothesis is stated as:

H_0: Primary School Mathematics Teachers in remote, rural, semi-urban and urban schools do not differ significantly in Mathematical Knowledge for Teaching.

The hypothesis was tested using one-way 'Analysis of Variance'(ANOVA) with the level significance fixed at 0.05 level. The details are given on Table 1.2

Table 1.2: ANOVA Details of Level of MKT among Remote, Rural, Semi-urban and Urban Primary School Mathematics Teachers of Fiji

Source of Variation	Sum of Squares	df	Mean Square	F-value	P-value	Result
Between Groups	2.748	3	.916	2.566	.054	NS
Within Groups	128.183	359	.357			
Total	130.931	362				

From Table 1.2 it is evident that there is no significant difference in MKT, among teachers of remote, rural, semi-urban and urban Primary School Mathematics Teachers, hence the level of MKT is equal among Primary School Mathematics Teachers teaching in different teaching locations in Fiji.

Objective 2

To compare the level of Mathematical Knowledge for Teaching Components among Primary School Mathematics Teachers with respect to location.

Hypothesis 2

H_2: Primary School Mathematics Teachers in remote, rural, semi-urban and urban schools differ significantly in Mathematical Knowledge for Teaching Components

The null hypothesis is stated as:

H_0: Primary School Mathematics Teachers in remote, rural, semi-urban and urban schools do not differ significantly in Mathematical Knowledge for Teaching Components

The hypothesis was tested using one-way 'Analysis of Variance'(ANOVA) with the level significance fixed at 0.05 level. The details are given on Table 1.3

Table 1.3: ANOVA Details of Level of MKT Components among Remote, Rural, Semi-urban and Urban Primary School Mathematics Teachers of Fiji

		Sum of Squares	df	Mean Square	F-value	P-value	Results
CCK	Between Groups	42.501	3	14.167	1.885	132	NS
	Within Groups	2698.546	359	7.517			
	Total	2741.047	362				
KCT	Between Groups	109.436	3	36.479	3.782	.011	S
	Within Groups	3463.016	359	9.646			
	Total	3572.452	362				
KCS	Between Groups	103.836	3	34.612	2.831	.038	S
	Within Groups	4388.412	359	12.224			
	Total	4492.248	362				
SCK	Between Groups	67.743	3	22.581	1.485	.218	NS
	Within Groups	5458.257	359	15.204			
	Total	5526.000	362				

From Table 1.3 it is evident that there is no significant difference in CCK, among remote, rural, semi-urban and urban Primary Teachers, hence the level of CCK is equal among Primary School Mathematics Teachers in different teaching locations in Fiji.

It can also be revealed from the Table that there is no significant difference in SCK, among remote, rural, semi-urban and urban Primary Teachers, hence the level of SCK is equal among Primary School mathematics Teachers in different teaching locations in Fiji.

However, it is also evident from the Table that there is a significant difference in KCT, among remote, rural, semi-urban and urban Primary School Mathematics Teachers.

It can also be revealed from the Table that there is a significant difference in KCS, among remote, rural, semi-urban and urban Primary School Mathematics Teachers.To compare the differences, individual means are identified as given in Table 1.4

Table 1.4: Mean and Standard Deviation of MKT Components

		Mean	Std. Deviation	Std. Error
KCT	Remote	12.4167	2.99177	.35258
	Rural	13.3194	2.78743	.32850
	S/Urban	11.9000	3.54253	.33777
	Urban	12.9817	2.89949	.27772
	Total	12.6088	3.14144	.16488
KCS	Remote	12.0139	3.51853	.41466
	Rural	12.6528	3.08179	.36319
	S/Urban	11.9273	3.85210	.36728
	Urban	13.1743	3.35781	.32162
	Total	12.4628	3.52272	.18489

To find out which group differences in terms of KCT and KCS, are significant a Post hoc test was done.

Table 1.5: Post hoc Test Results for KCT with respect to Teaching Locations

	Teaching Locations Compared	Mean Difference	Std. Error	P-value	Results
KCT	REM and RUR	.90278	.51764	.387	NS
	REM and S/U	.51667	.47082	.752	NS
	REM and URB	.56498	.47167	.698	NS
	RUR and S/U	1.41944*	.47082	.029	S
	RUR and URB	.33779	.47167	.916	NS
	S/U and URB	1.08165	.41975	.086	NS

*Significant at 0.05 Level

From Table 1.5 it is evident that KCT of teachers teaching in rural schools is significantly higher than teachers teaching in semi-urban schools.

Table 1.6: Post hoc Test results for KCS with respect to Teaching Location

	Teaching Locations Compared	Mean Difference	Std. Error	P-value	Results
KCS	REM and RUR	.63889	.58271	.274	NS
	REM and SU	.8662	.53000	.870	NS
	REM and URB	1.16042*	.53097	.029	S
	RUR and SU	.72551	.53000	.172	NS
	RUR and URB	.52153	.53097	.327	NS
	S/U and URB	1.24704*	.47252	.009	S

*Significant at 0.05 Level

From Table 1.6 it can be revealed that KCS of teachers teaching in urban schools is significantly higher than teachers teaching in semi-urban schools.

It is also evident from the Table that KCS of teachers teaching in urban schools is significantly higher than teachers teaching in remote schools.

MAJOR FINDINGS

- There is no significant difference in MKT, among teachers of remote, rural, semi-urban and urban Teachers, hence is equal among Primary School Mathematics Teachers in different teaching locations in Fiji.

- There is no significant difference in CCK and SCK Components of MKT among teachers of remote, rural, semi-urban and urban schools hence equal among Primary School Mathematics teachers in different teaching locations in Fiji.
- There is a significant difference in KCT and KCS components of MKT among Primary School Mathematics teachers of remote, rural, semi-urban and urban schools.
- KCT of teachers teaching in rural schools is significantly higher than teachers in semi-urban schools
- There is no significant difference in KCT between Primary Schools Mathematics Teachers in; Remote and rural schools, Remote and semi-urban schools,Remote and urban schools,Urban and rural schools, and Urban and semi-urban schools.
- KCS of teachers teaching in urban schools is significantly higher than teachers in semi-urban schools
- KCS of teachers teaching in urban schools is significantly higher than teachers in remote schools.
- There is no significant difference in KCS between Primary School Mathematics Teachers teaching in Rural and remote schools, semi-urban schools, and Urban and rural schools.

EDUCATIONAL IMPLICATIONS

In order to improve the level of Knowledge of Content and Teaching of teachers, and Knowledge of Content and Students in semi-urban and remote schools the Ministry of Education needs to:

- Support semi-urban and remote teachers in providing Professional Development sessions on Knowledge of Content and Teaching and Knowledge of Content and Students
- Invite resource personnel to run workshops for semi-urban and remote teachers on Knowledge of Content and Teaching and Knowledge of Content and Students
- Provide partnership with teacher education institutions and provide professional support for teachers in semi-urban and remote schools in carrying out combined projects in areas of Knowledge of Content and Teaching and Knowledge of Content and Students
- Form clusters and teachers' network for semi-urban and remote schools to allow teachers to share ideas on Knowledge of Content and Teaching and Knowledge of Content and Students
- Organise modelled lessons from mentor teachers on Knowledge of Content and Teaching, and Knowledge of Content and Students
- Provide incentives for action researches for teachers in semi-urban and remote schools in the area of Knowledge of Content and Teaching, and Knowledge of Content and Students
- Provide support resource materials that would support teachers in semi-urban and remote schools with Knowledge of Content and Teaching, and Knowledge of Content and Students

CONCLUSION

Mathematical Knowledge of Teaching playa a significant role in teacher instruction. Therefore if well addressed at the primary school level, there would be positive changes as teachers' cognitive level of teaching task preparations and quality of teacher instruction would positively contribute to students' understanding of mathematical concepts which further bring about students' higher achievement in mathematics. Teachers would not only acquire quality instruction on Mathematical Knowledge for Teaching, but would also contribute to general knowledge about teaching.

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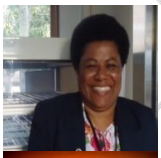

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