SECONDARY SCHOOL MATHEMATICS TEACHERS' UTILIZATION OF PEDAGOGICAL KNOWLEDGE AND THEIR TEACHING EFFECTIVENESS

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ABSTRACT

The study explored mathematics teachers' understanding of pedagogical knowledge and how it works out in teaching and learning. The sample consisted of 162 Senior Secondary School years two (II) students (87 boys and 75 girls) randomly selected and six secondary school teachers purposefully selected from 5 Local Government Areas of Ekiti State, Nigeria. Two instruments were used for the study-an interview schedule and a researcher designed questionnaire. Data were analyzed using frequency counts, regression and multiple regressions. Results indicated that teachers' pedagogical knowledge correlated significantly with practice. Furthermore, a significant correlation was established between teachers' preparation and teacher characteristics with practice in mathematics. Recommendations were made to meet current demands for teacher effectiveness in mathematics teaching.

Keywords: Mathematics, Teaching Methods, Pedagogical Knowledge

1. INTRODUCTION

The teaching and learning of mathematics have some major setbacks due to lack of teachers' pedagogical knowledge. It is only recently when substantive progress has been made in understanding mathematics teachers' knowledge and how it plays out in practice and how it can be developed. Researchers (Fennema 1992, Odili, 2009) have arranged two major works that expand the field's conception of the nature and complexity of the knowledge that teachers bring to the classroom to teach the students. Odili (2009) further disclosed two levels of teachers' knowledge:

- The pedagogical level-the discovery method and the spontaneous dialogue between students and teacher; and,
- The content mastery/the uncommon mastery of the subject matter.

Researchers (Given, 1971; Popoola, 1997& Farmer, et al 2003) offer a detailed empirical and theoretical explanation of the multiple levels of knowledge, planning, and decision-making entailed in the teaching of mathematics and how it pays to be competent in

pedagogical knowledge. The studies further describe the teachers' professional vision as an important factor too. All these support mathematical knowledge a teacher must have for effective teaching and learning and also show the extent of the character of knowledge that enables teachers to interact effectively with students over substantial mathematics concepts in the classroom. The study of teachers' knowledge was revitalized in the mid-1980s when pedagogical content knowledge was introduced .Pedagogical content knowledge is a kind of knowledge known to anticipate specific student understanding and misunderstanding in specific instructional contexts, and showing strategies (method) ready to employ when students demonstrate misunderstanding or understanding.

The concept is critically important and found to play a central role in classroom/laboratory teaching practices. This points to a form of knowledge that a teacher is required to possess to be considered competent in his/her teaching. Researchers (Ball, 1996; Herington 2003) have strong belief that what is needed for competent teaching in any domain is a combination of sound subject matter knowledge and general pedagogical training that a teacher must have for effective teaching and learning to take place. This belief is part of the support structure for a wide range of programmes in higher institutions aimed at taking mathematics and science teachers in various mathematical and scientific fields and getting them into the classroom rapidly. Belief has been defined as the lenses through which an individual looks when interpreting the world and as such affects the way one interacts with the world [Philipp, 2007; Carpenter & Lehrer 1999].

Teachers hold interpretive lenses through which they filter experiences in their classrooms that inform the way they teach in the classroom environment. Research has established that teacher beliefs about how to teach mathematics are linked to their pedagogical knowledge and consequently, student learning in the classroom (Philipp, 2007; Thompson, 1992; Wilson & Cooney, 2002). Traditionally, the teaching of mathematics is about telling, or providing clear, step-by-step explanations of procedures while students learn by listening and practising these procedures. Research literature (Hiebert, 2003; Chapmman 1996), had noted the deficiencies of this traditional approach which is a contrast to the pedagogical knowledge reform (NCTM, 2000) advocated in a constructivist view of teaching and learning which emphasises students' conceptual understanding and discourse in the mathematics classroom.

Within this context of reform in mathematics education, a challenge for teacher preparation in terms of pedagogical knowledge preparation programs is the limited amount of time used to impact the experiences that nudge teacher's mathematics pedagogical knowledge and increase their efficacy for teaching mathematics. What teacher might have learnt will suffice to prepare them for the challenges in teaching in the classroom. Hence, an understanding of the true basis of pedagogical competency knowledge is essential as an antidote to such quick fixes for bolstering teacher knowledge more adequately. Teacher understanding of fundamental mathematics pedagogical knowledge and competencies required to face the challenges of teaching is the focus of this paper.

The purpose of the study was to examine the understanding of mathematic teachers' pedagogical knowledge and how it works out in mathematics instruction. Specifically, the study investigated the influence of teacher's pedagogical knowledge in the practice of teaching. It further examined the relationship between teachers' pedagogical knowledge and the practice,

teacher's preparation, teachers' characteristics and the contributions of teacher's pedagogical knowledge variables on the practice among others.

1.1 HYPOTHESES

- There is no significant relationship between teachers' pedagogical knowledge and the practice of teaching in mathematics.
- There is no significant relationship between teachers' preparation and the practice of teaching mathematics.
- Teachers' characteristics have no significant influences on their practice of teaching.
- Teachers' 'pedagogical knowledge makes no significant contribute to their practice of teaching mathematics.

2. METHODOLOGY

Descriptive research designs of the ethnographic and survey types were used for the study. Fifteen public secondary schools were randomly selected from a population of two hundred and twenty two senior secondary schools from 5 local government areas out of 16 LGAs. 162 (87 boys and 75 girls) senior secondary school II students were randomly selected. The schools were selected on the basis of their status (senior school of 15 years of establishment and functionality). Thus, the public schools in the LGAs were grouped accordingly before the balloting procedure was employed in the selection of the six schools used for the study. Six secondary school mathematics teachers were also interviewed and given a questionnaire to complete for this study. They were strategically selected from a pool of mathematics teachers in the state using principal's assessment in their respective schools as a basis.

Interview was used to determine the teacher's level of pedagogical knowledge and understanding, which probed into their past and present experiences in the hope of understanding how they developed the kinds of knowledge they needed for teaching mathematics. Part of the requirement was for each teacher to submit a written typical lesson plan to determine how well a teacher actually prepares for a lesson.

Another instrument used in the study was a self-designed questionnaire structured in 4-point Likert Scale on teachers' pedagogical knowledge on the practice in mathematics meant for students on their opinion on the teachers. The instruments were validated by 2 experts of mathematics education with a reliability coefficient of 0.88 for teacher's questionnaire and 0.91 for the student's questionnaire and found adequate for the study. Questions and hypotheses were raised and generated at 0.05 level of significance. Frequency counts, correlation and multiple regressions were used for the study. The results of the study are as stated in the tables:

3. RESULT

3.1 RESEARCH QUESTION 1:

What is teachers' pedagogical knowledge in the practice of teaching mathematics? When the teachers were asked about their pedagogical knowledge and preparation for teaching;

the majority of them expressed dissatisfaction with the way they prepared for teaching. They expressed the importance of the knowledge of the concepts in mathematics as pre-requisite to practice and found themselves still unprepared for teaching because most times teachers rush to the classroom without going through what is to be taught to the students and therefore, find it unable to answer some of the questions posed by students. Some of them found the knowledge of the concepts important, and so need to go through them before going to teach in the class.

3.2 RESEARCH QUESTION 2

What is the influence of teacher's pedagogical knowledge of the practice of teaching mathematics?

Table 1: Influence of Teachers' pedagogical knowledge variables on the practice in Mathematics

Variable	Agree		Disagree	
	F	%	F	%
Method	150	92.59	12	7.41
Motivation	134	82.72	28	17.28
Materials	148	91.36	14	8.64
Inducing persevere	117	72.22	45	27.78

Table 1 shows the teacher's pedagogical knowledge variables on the classroom practice. Teacher's method of teaching has the highest influence on the practice and is found to be 150 or 92.59%. This is closely followed by teacher's instructional material with 148 or 91.36%. Teacher's motivation used in teaching is found to have the least influence with 134 or 82.72%, while inducing persevere is found to be 117 or 72.22%. The overall responses show that teacher's pedagogical knowledge influences the practice of teaching mathematics.

Hypothesis 1: There is no significant relationship between teachers' pedagogical knowledge and the practice of teaching in mathematics?

Table 2 shows the relationship between teacher's pedagogical knowledge and the practice in teaching.

Table 2: Teachers' pedagogical knowledge and the practice in Mathematics

Variable	N	r-cal	r-table
Teacher's pedagogical knowledge	87	0.665	0.217
Practice in Teaching	75		

Table 2 shows that r-calculated is 0.665 greater than table value of 0.217 at 0.05 level of significance. Hence hypothesis one is rejected. It implies that there is a strong and positive

relationship between teachers' pedagogical knowledge and the practice in teaching mathematics.

Hypothesis 2: There is no significant relationship between teacher's preparation and the practice of teaching in mathematics?

Table 3 shows students' rating of their teachers' preparation for practice in teaching.

Table 3: Pearson correlation summary of teachers' preparation and the practice in mathematics

Variable	N	r-cal	r-t
Teacher's preparation	87	0.624	0.217
Practice in Teaching	75		

Table 3 shows that r-calculate (r=0.624) is greater than table value of r = 0.217. Hence, the hypothesis is rejected. Therefore, there is significant positive relationship between teachers' preparation and the practice in mathematics.

Hypothesis 3: There is no significant influence of teachers' characteristics and the practice of teaching?

Table 4: Pearson correlation summary of teachers' characteristics and the practice

Variable	N	r-cal	r-t
Teacher's characteristics	87	0.472	0.217
Practice in Teaching	75		

Table 4 shows that r-cal (0.472) is greater than r-table (0.217) at 0.05 level of significance. The hypothesis is rejected. This means that there is significant relationship between teachers' characteristics and the practice.

Hypothesis 4: Teachers 'pedagogical knowledge will not significantly contribute to practice of teaching in mathematics?

Table 5: Multiple Regression showing beta weight of Teachers' pedagogical knowledge

Variables	Regression Coefficient B	Explained Variables R	Beta Weight	T	Sig
Method	0.224	0.015	0.278	3.437	0.000
Motivation	0.036	0.027	0.023	1.205	0.214
Materials	0.125	0.032	0.123	2.854	0.13
Inducing persevere	0.043	0.037	0.032	0.011	0.214
Constant	68.65	0.603		7.507	0.000

Dependent variable: Practice
The following Regression equation can be derived from table 5.
$Y = A + B_1 X_1 + B_2 X_2 + B_3 X_3 + B_4 X_4$
whereX_1=Method
X_2=Motivation
X_3=Material
X_4=Inducing persevere
B (1-4) =the regression weight model derivable from A=Constant.

Table 5 is the regression relationship between dependent variable and independent variables of the form $Y = 68.6+0.224\ B_1+0\ .036B_2 + 0.125B_3+0\ .043\ B_4$. The table shows the most important independent variables that contribute to the explained variation in the teacher's pedagogical knowledge in the practice of teaching. Teacher's method of teaching has a beta weight of .278 or 27.8%, which has the (best predictor) highest relative contribution to the practice in mathematics. This is closely followed by the material used by teacher for practice with a beta weight of 0.123 or 2.3%. Inducing persevere has a beta weight of 0.032 or 3.2%, while motivation has a beta weight of 0.023 or 2.3%. In terms of magnitude of the weight of the regression coefficient, method of teaching turns out to be the most important, powerful and strong contributor of teacher's practice. The least predictor is inducing persevere Hence, the method of teaching of teachers contribute significantly to the practice of teaching.

Table 6: F-test analysis of teacher's knowledge and the practice in mathematics

Source of variation	Sum of squares	Df	MSS	R	R square	Adjusted R square	Standard Error	F	Sig
Regression	68.3	4	4.10	0.678	0.633	0.514	1.312	18.3	0.00
Residual	296.5	157	1.865						
Total	364.8	161							

The analysis of variance further shows the F-ratio (18.32) significant at 0.05 levels. Table 3 indicates variables of teacher's pedagogical knowledge jointly contribute to the practice in mathematics, which has multiple correlation of 0.633 with the practice. This implies that teacher's pedagogical knowledge account for 63.3% variation. This shows that other factors other than the one used in the study accounted for 36.7% of the teacher's pedagogical knowledge. The coefficient of correlation R is .678.It implies that strong and positive relationship exists between variables of teacher's pedagogical knowledge and the practice. The regression model is significant in terms of goodness of fit ($Fc = 18.3$, $P < 0.0\ 5$, $Ft = 2.37$).

4. DISCUSSION

The study shows that teachers' pedagogical knowledge correlates significantly with the practice, going with the interview of teachers and the responses of the students. Hence, teachers and students view pedagogical knowledge as that type of knowledge from where you draw ideas on the practice of teaching –how to relate to students, manage a class, prepare tests and even the content knowledge. Teachers in this study believed that content and pedagogical knowledge can

be developed through formal courses and other ways. Students believed that their teachers can study more and prepare for practice of teaching.

The study investigated the status of teachers' pedagogical knowledge and how it can influence the practice in mathematics. The findings revealed that, there is a significant correlation between teachers' pedagogical knowledge and the practice. Dayal, et al (2007) & Eisenberg (1997) corroborated this by saying that mathematical act builds on the basis of mathematical understanding. This calls for different types of knowledge and ways of handling mathematics. This suggests that a broad range of pedagogical knowledge is considered in understanding how teachers can teach in the class. This finding supports the earlier statement of the mathematics educators (Agbarevo, 2006; Chapman, 1990 and Popoola, 1997) who stated that teacher's characteristic behaviour, such as attitude, interest, mode of teaching are a combination of factors that enable teachers to teach well in the classroom.

Further analyses observed from the respondents are pointers to affecting the teachers' practice. Because of teachers' pedagogical knowledge of mathematics, a teacher should plan his instruction very well, show interest and enthusiasm in his work can be flexible in dealing with the students in order to bring out the best practice in teaching.

Finding also indicated that teacher preparation is significantly correlated with the practice of mathematics in the classroom. This means that teachers' knowledge is influenced by his preparation in the subject. Teachers' adequate preparation of subject and good delivering of lessons is essential in the practice. In support of this finding, Okorie, (1979); Fenmema and Franks (1992) and Krantz, (1999) observed that the teacher should plan his instructions very well, show interest and enthusiasm in his work. He should be flexible in dealing with the students in order to bring the best out of them when teaching mathematics (Brawner et.al, 2000).

5. CONCLUSION

The relationship between teachers' pedagogical knowledge and how it works in practice is critical for success in teaching and fostering positive practice in mathematics. However, the results of the present study emphasize the importance of teachers' pedagogical knowledge for the teaching practice. This finding supports the earlier statements of mathematics educators (Agbarevo, 2006; Chapman, 1990 & Popoola, 1997) who state that teacher's characteristic behaviour such as attitude, interest, mode of teaching are a combination of factors that enable teachers to teach well in the classroom. To boost teachers' pedagogical knowledge in mathematics, a teacher should plan his instruction very well, show interest and enthusiasm in his work and be flexible in dealing with the students in order to bring out the best practice in teaching.

5.1 RECOMMENDATIONS

Significant relationship established between mathematics teachers pedagogical knowledge, preparation and characteristics, underscores the need to prepare teachers accurately for the job. To this end it is recommended that:

- The Federal Government should resuscitate the moribund Teachers Vacation course (T.V.C) programme. It will serve as a vehicle for extending the activities of ASEI

(Activity, Student, Experimentation and Improvisation) movement and PDSI (Plan, Do, See, Implement) approach to the state and Local Government levels.

- The work of the National Mathematics Centre (NMC) should be broadened by creating regional centres for teachers in-service training in mathematics education and the use of new educational technologies should be set up with technical assistance from funding agencies for improvisation and developing educational software.
- The Didactics of mathematics should be introduced as a new course or an area of knowledge in mathematics Teacher Education programme in all teacher training institutions and universities.

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