ASSESSMENT OF PROFESSIONAL STANDARDS FOR TEACHING MATHEMATICS IN SECONDARY SCHOOLS

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Abstract
The study assessed by determining secondary schools mathematics teachers compliance or non- compliance to Professional Standards of Teaching Mathematics (PSTM). Descriptive survey design was adopted for the study. The population of the study consisted of 40 (29 male and 11 female) mathematics teachers within Bauchi metropolis area of Bauchi State. Stratified random sampling was used to select 40 (30 male and 10 female) mathematics teachers. Adaptation of National Council of Teachers of Mathematics [NCTM, 1991] Professional Standards for Teaching Mathematics (PSTM) was made as an instrument for data collection. A Cronbach's Alpha of 0.89 was obtained as the reliability of the PSTM items. Hypothesis was tested at $\alpha = 0.05$ level of significance. The data was analyzed using percentages, charts and Chi- Square test. Results from the study showed that higher percentage (96.7 % and 90 %) of male and female mathematics teachers select task that engaged students in mathematics class; there is no statistically significant difference ($\Psi^2 = .006$, $df = 1$, $\rho = .938$) between male and female mathematics teachers on the compliance or non compliance to the PSTM. Orientation lectures on PSTM to newly employed mathematics teachers and effective supervision on the compliance to PSTM by Head of Department (HOD) in mathematics in each school; Mathematics Associations like Mathematics Association of Nigeria (MAN) in collaboration with Federal and State Ministries of Education Inspectorate Division to organized workshops and seminars on the need for compliance to PSTM were the recommendations made from the study.

Keywords: Assessment, Professional Standards for Teaching Mathematics, and Secondary schools

Introduction

Assessment as used in the context of this study refers to the direction for action on the level of secondary school mathematics teachers compliance or non- compliance to the Professional Standards for Teaching Mathematics (PSTM). The PSTM expresses the vision of the National Council of Teachers of Mathematics (NCTM) for teachers who are well prepared to teach mathematics. The PSTM describe a set of principles accompanied by elaborations and illustrations that can be used to judge what is valuable and appropriate in mathematics teaching (NCTM, 1991). The PSTM consists of 6 standards (Reforms) that can support teaching and learning of mathematics for the improvement of students' performances. NCTM spelt out the PSTM as:

Standard 1: Worthwhile Mathematics Tasks.

Standard 2: Teacher's Role in Discourse.

Standard 3: Student's Role in Discourse.

Standard 4: Tools for Enhancing Discourse.

Standard 5: Learning Environment.

Standard 6: Analysis of Teaching and Learning.

Review of literature on perception of mathematics by students is important for one to establish the basis for any reform in the field of teaching and learning mathematics. Ernest (as cited in Johanne, 2006) found a wide spread of public image of mathematics as difficult, cold, abstract and in many cultures largely masculine. Sewel (1981) experienced in her research that half of her interviewers walked away without answering her questions when they understood that they were about mathematics. Previous studies had also shown that poor methodology of teaching contributes to the problems students encounter in learning mathematics and other related courses to it (Blanco, 2001; Leongson and Limjamp, 2005; Vankus, 2005; Okigbo and Okeke, 2011). Aliyu (2015) attributes students' failure in mathematics to mathematical phobia. Oyetunde (2010) reports that teacher is the most important factor in quality education. With this, employment of qualified and experienced mathematics teachers in schools (Amoo, 2001; Abuul and Imoka, 2012) is hoped to improve teaching and learning of mathematics in schools. Ambali (2014) called for a review on the pattern of instruction teaching, methodology, curriculum and assessment to ensure academic excellence in mathematics. All these were acknowledging on the bit to improve teaching and learning of mathematics.

However, Dickey (1997) observed that,

"*today's mathematics teachers are experiencing major changes not only in the mathematics content they teach, but also in the way they teach. Nearly all of these teachers came through school when mathematics consisted of a collection of facts and skills to be memorized or mastered by a relatively homogeneous group of students taught using a lecture approach. Now teachers are called on to teach new, more challenging mathematics to a very diverse audience using active learning approaches designed to develop understanding. This is an enormous challenge that coalesced with the publication of the National Council of Teachers of Mathematics (NCTM)* ***Curriculum and Evaluation Standards for School Mathematics***" (p.1)

there is need to assess the secondary school mathematics teachers compliance or non–compliance to PSTM that are intended to guide teachers towards excellence in teaching and active learning approaches designed to develop teacher and student understanding in mathematics. To what extend do teachers comply with these standards of teaching and learning mathematics? What aspect of the PSTM secondary school mathematics teachers show non–compliance to? Determining in percentages secondary school mathematics teachers' compliance or non- compliance to PSTM (Standards 1-6) is the main objective of the study.

Specifically the study assessed by determining compliance or non-compliance of mathematics teachers on:-

i. Selecting tasks that engage students in mathematics class.
ii. Deepening students' understanding through asking questions, listening, and monitoring.

iii. Engaging students to be active and interactive through listening, responding and questioning.
iv. Engaging students on the use mathematical models.
v. Creating a learning classroom environment that fosters the development of mathematics through making connection of present lesson to previous lesson.
vi. Engaging in ongoing analysis of teaching and learning through guiding students in mathematics class on solving problems.
vii. Difference between male and female secondary school mathematics teachers on compliance or non-compliance to PSTM.

Hypothesis

The following hypothesis was tested at $\alpha = 0.05$ level of significance.

Ho: Male and Female secondary school mathematics teachers do not differ on compliance or non- compliance to PSTM.

Post Graduate (10) students in Education from Faculty of Technology Education, Abubakar Tafawa Balewa University, and Bauchi were the research assistant. The criterion for the selection of the assistant was based on willingness of the student to assist and above all the assistant must be a trained teacher with minimum of 5 years teaching experience in secondary school.

Methodology

Descriptive survey design was adopted for the study. The population of the study consisted of 40 (29 male and 11 female) mathematics teachers within Bauchi metropolis area of Bauchi State. The population was characterized by both junior and senior secondary school mathematics teachers with various qualifications (National Certificate in Education (NCE); Bachelor of Science Mathematics (BSC. Mathematics); Bachelor of Science Education Mathematics (BSC.ED/Mathematics); Bachelor of Education Mathematics (B.Ed . Maths); Higher National Diploma in Education/mathematics (HND); Masters of Education Mathematics (M.ED. Mathematics).

Stratified random sampling was used to select 40 (30 male and 10 female) mathematics teachers whose teaching experience range from 2- 30 years.

Table1a. List of schools based on gender from which the sample was selected

Name of school	Male	Female	Total
Government Technical Bauchi.	7	2	9
Government Day Secondary School Miri.	6	2	8
Federal Government Girls College Bauchi.	4	1	5
International Staff School ATBU,Bauchi.	4	1	5
Kofar Wambai Secondary School , Bauchi	4	2	6
Sa'adu Zungur Secondary School Bauchi.	5	2	7
Total	30	10	40

Table1b. Qualification based on gender of the sample population

Qualification	M.Ed Maths	Graduate	HND	NCE	Total
Gender Male	1	19	3	7	30
Female	1	3	1	5	10
Total	2	22	4	12	40

Adaptation of National Council of Teachers of Mathematics [NCTM , 1991] Professional Standard for Teaching Mathematics (PSTM) was made. The PSTM was structured in to sections (A and B) **Appendix I & II**. Section A is the observatory check list containing 6 items. While section B is the questionnaire items consisting of 6 items. The items were structured in terms of positive and negative responses. Items 3 and item 6 were the only negative response items while the rest were positive responses. The idea of combined positive and negative response items was to produce items scores with consistent meaning. Agree item from the questionnaire response was interpreted as compliance while disagree stands for non- compliance to the item statement. Face validity of the modified PSTM items for the data collection was obtained from secondary school principal and senior lecturer in mathematics education. The items were later subjected to pilot testing. A Cronbach's Alpha of 0.89 was obtained as the reliability of the items. The PSTM emphasizes teaching that help students develop mathematical power. The PSTM consists of 6 standards for the teaching of mathematics. Each item on the standard illustrates effective practices for teaching and learning of mathematics which includes teacher roles in implementing the standard.

Two Phases were adopted for the administration and collection of the data.

Phase 1: This involved data collection through structured observation of the teacher during the actual act of teaching in the mathematics classroom **(Appendix I**). The role of the observer is to adopt a passive, non–intrusive role, merely noting down the incidence of the factors being observed (Cohen, Manion and Morrison, 2005).

Phase 2: This involved administration and collection of the questionnaire on PSTM items to the mathematics teacher to indicate level of compliance or non- compliance to each of the 6 items on the questionnaire (**Appendix II**).

Method of Administration and collection of the data involving in the 2 phases required that each assistant is to observe and administer the questionnaire to 4 mathematics teachers. The time allocated was two weeks. Period of 30 minutes (maximum of 10 minutes for each item) was allowed for the observation. During the first week, the assistant is expected to observe and record the observation on first 3 items on the observatory list items. While the remaining 3 items on the list (item 4, 5 and 6) to be observed during the second week. It was after the second observation the questionnaire item was administered to each of the observed mathematics teacher.

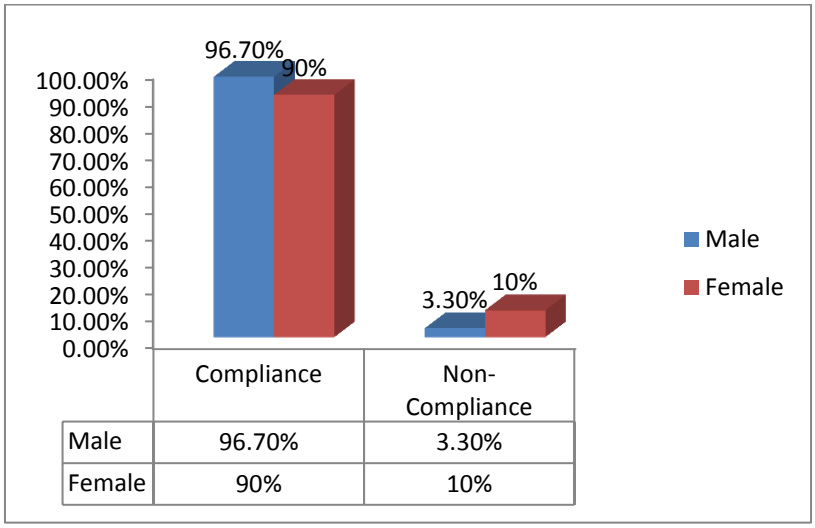
The idea of combining the two methods for data collection was to ensure valid and reliable information were gathered during interpretation of the data. The observatory item report and the corresponding item on the questionnaire where harmonized through comparison before decision is reached on the mathematics teacher compliance or non- compliance to the PSTM.

The data was analyzed using percentages, charts and chi- square test.

Presentation of Results

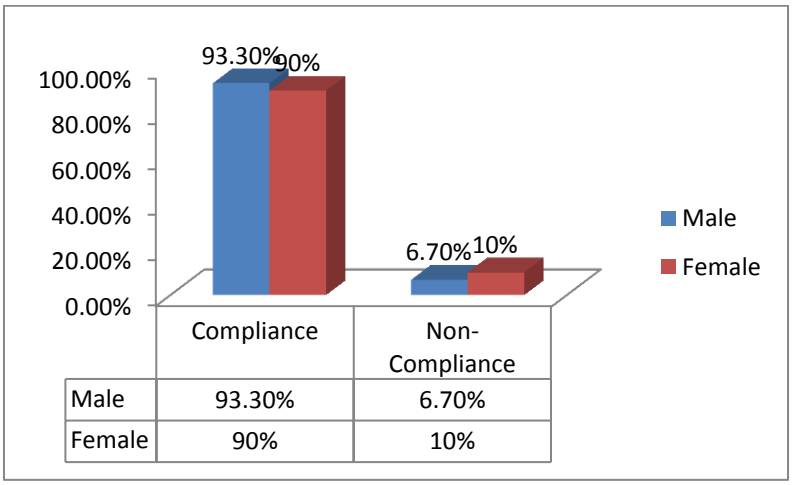
Results obtained from the data were tabulated and hypotheses tested were presented in this section. The results were the product harmonization on combination of the questionnaire response and the observatory responses combined to come up with a single result on each item. It was the single result for each group that was analyzed using Statistics Product and Service Solutions (SPSS).

Fig1. Level of Compliance and Non – Compliance on selecting tasks that engage students in mathematics class



The Figure 1 above shows the result obtained on achieving objective 1 of the study.

Fig 2. Deepening students understanding



The result obtained on the level of compliance or non- compliance of mathematics teachers on deepening students understanding through asking questions, listening, and monitoring was shown on Figure 2 above.

Table 2. **Engaging students to be active and interactive**

Gender	Compliance	Non-Compliance
Male	93.30%	6.70%
Female	90%	10%

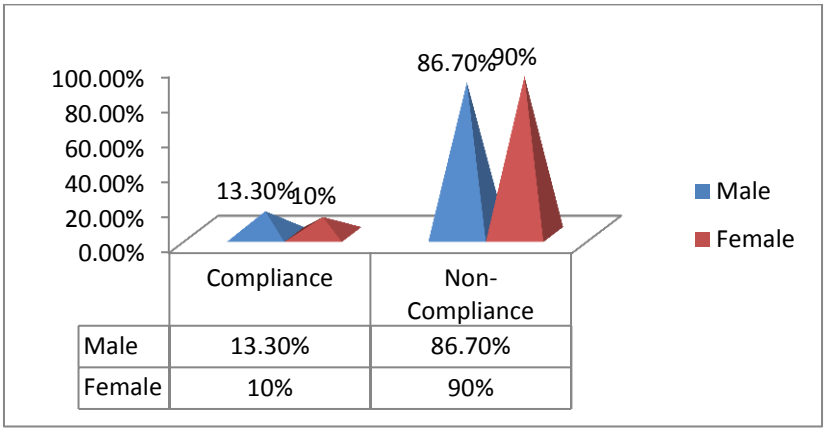
Table 2 above is the result obtained on engaging students in mathematics class to be active and interactive through listening, responding and questioning.

Table 3. **Engaging students on the use mathematical models**

Gender	Compliance	Non-Compliance
Male	90%	10%
Female	90%	10%

Table 3 shows the result obtained on encouraging students to use mathematical models in mathematics class.

Fig 3. Creating a learning classroom environment that fosters the development of mathematics



Result obtained on creating a learning classroom environment that foster the development of mathematics through making connection of present lesson to previous lesson, was shown on Figure 3 above.

Fig 4. Level of compliance and non- compliance on engagement on ongoing analysis of teaching and learning

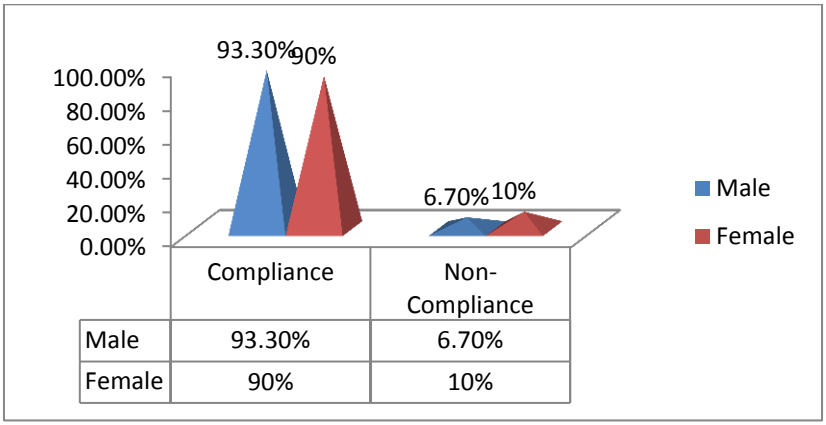


Figure 4 above, shows the result obtained on the level of compliance and non- compliance on engagement on ongoing analysis of teaching and learning through guiding students in mathematics class on solving problems.

Table 4a. Gender Response Cross Tabulation

Response			Compliance	Non -Compliance	Total
Gender	Male	Count	117	63	180
		Expected Count	116.2	63.8	180.0
	Female	Count	38	22	60
		Expected Count	38.8	21.2	60.0
Total		Count	155	85	240
		Expected Count	155	85.0	240.0

Table 4b. Chi- Square Tests

	Value	df	Asymp.Sig(2-tail)	Exact Sig (2-Sided)	ExactSig(tsided)
Pearson Chi-Square	.055 [a]	1	.815		
Continuity Correction [b]	**.006**	**1**	**.938**		
Likelihood Ratio	.054	1	.815		
Fisher's Exact Test				.876	.466
Linear- by Linear Association	.054	1	.816		
No of valid cases [b]	240				

a. 0 cell (0 %) have expected count less than 5. The minimum count is 21.25
b. Computed only for a 2X2 table.

Table 4a and Table 4b above shows the result of chi- square test computed for a 2X2 table. Table 4a is the result showing the gender response cross tabulation while Table 4b shows the Ho tested at α =0.05 level of significance. From the result Ψ^2 =.006, df = 1, ρ = .938

Findings

- Higher percentage (96.7 % and 90 %) of male and female mathematics teachers select task that engaged students in mathematics class.
- More than 89.9 % (male and female) mathematics teachers complied with PSMT on deepening students' understanding in mathematics class.
- Teachers' roles are related to students' roles.
- 90 % (male and female) of the mathematics teachers engaged students with mathematical models as teaching tools.
- Higher percentages (86.7 % and 90 %) of male and female mathematics teachers fail to link their lesson with previous lesson.
- 93.3 % and 90 % of male and female mathematics teachers engaged on guiding students in mathematics class on problem solving.
- There is no statistically significant difference between male and female mathematics teachers on the compliance or non compliance to the PSTM.

Discussion

In discussing the results from the study, certain limitation such as the extent of difference in compliance and non-compliance to PSTM between Junior and senior secondary school mathematics teachers must be acknowledged.

Result from Figure1 shows the level of compliance and non- compliance of the secondary school mathematics teachers to PSTM. The result was used to achieve objective i of the study. From the result, 96.7 % and 90 % of the male and female mathematics teachers respectively complied with the standard 1 of the PSTM. While the percentage of non – compliance stood at 3.3 % and 10 % for male and female mathematics teachers respectively. Finding from this, shows higher percentages (96.7 % and 90 %) of male and female mathematics teachers select task that engaged students in mathematics class.

To achieve Standard II of the PSTM which correspond to objective ii of the study, the result obtained from the analysis was shown on Figure 2. From the result, 93.3 % and 90 % of both male and female mathematics teachers complied with the Standard II of the PSTM. While only 6.7 % and 10 % of the male and female mathematics teachers are not in compliance. Finding from this shows that more than 89.9 % (male and female) mathematics teachers complied with deepening students' understanding in mathematics class through asking questions, listening, and monitoring of students.

Result on Table 2 was used in achieving objective iii of the study. From the result, only 6.7 % and 10 % of the male and female mathematics teachers did not comply with Standard 3 of the PSTM. Simple analysis from this shows relationship between objective ii and objective iii of the study. Finding from this analysis shows that teacher's roles are related to student's roles (a teacher who succeeded on deepening students understanding would equally succeed on engaging the students to be active and interactive in mathematics class).

Result on Table 3, shows the extent of compliance and non-compliance of mathematics teachers with the Standard 4 of the PSMT. From the result, 90 % of both male and female mathematics teachers complied with PSTM by engaging students on the use of mathematical model while non –compliance stood at 10 %. Finding from this showed that 90 % (male and female) of the mathematics teachers engaged students with mathematical models as teaching tools.

Result on Figure 3, shows the level of compliance and non- compliance to Standard 5 of the PSTM. From the result, only 13.3 % and 10 % of male and female mathematics teachers complied. Finding from this showed that higher percentages (86.7 % and 90 % of males and females) mathematics teachers fail to link their lesson with previous lesson.

Jamar (1991) observed that mathematics is sequential in nature. In teaching mathematics there is need for teachers to link the topic with students' previous knowledge.

To achieve objective vi of the study, result on Figure 4 was used. From the result, 93.3 % and 90 % of the male and female mathematics teachers engaged ongoing analysis of teaching and learning through guiding students in mathematics class. Indeed, this corresponded to compliance to Standard 6 of the PSMT. Finding from this showed that 93.3% and 90% of male and female mathematics teachers engaged on guiding students in mathematics class on problem solving.

On determining the objective vii of the study, the Ho was tested at $\alpha = 0.05$ level of significance, and the result was shown on Table 4a and Table 4b respectively. The Table 4a showed the gender responses cross tabulation computed for observed and expected counts on compliance and non- compliance to PSTM for both male and female mathematics teachers. However, result on Table 4b showed that the Chi- Square test computed revealed $\Psi 2 = 0.006$, df= 1, $\rho = .938$. From the result, the Ho was not rejected at $\rho > 0.05$. Finding from this showed that there is no statistically significant difference between male and female mathematics teachers on the compliance or non-compliance to the PSTM.

Conclusion

The study assessed secondary school mathematics teachers' compliance or non- compliance to PSTM as set up by NCTM in 1991. The PSTM consisted of 6 standards to be observed and complied by mathematics teachers for effective teaching and learning of mathematics in schools. Findings from the study showed that with the exception of standard 5, higher percentages of mathematics teachers were in compliance to the PSTM. The non- compliance to standard 5 of the PSTM as found in the study may contribute to secondary school students' poor understanding of some mathematics topics which are sequential in nature like Sine and Cosine rules. However, only further study could verify this. There is need for further study on implication of mathematics teachers not linking topics with students' previous knowledge (which contradicts standard 5 of PSTM).

Recommendation

Orientation lectures on PSTM to newly employed mathematics teachers, and effective supervision on the compliance to PSTM by Head of Department (HOD) in mathematics in each school is recommended. It is also recommended that Mathematics Associations like Mathematics Association of Nigeria (MAN) in collaboration with Federal and State Ministries of Education Inspectorate Division should organize workshops and seminars on the need for compliance to PSTM.

References

Abuul, S.I., & Imoka, B.I. (2012). Effects of self-directed learning approach on students' interest in trigonometry. *Benue Journal of Mathematics and Mathematics Education, 1*(2), 22-29.

Aliyu, A. (2015, September 8). Why students fail mathematics. Daily Trust. Retrieved November 12, 2016, from www.daily trust.com.ng/.../43827- why

Ambali, A. (2014, September 8). Real deal mathemtics education for sustenable development. World Stage Group. Retrieved November 12, 2016, from worldstagegroup.com/..../readnews.php?/..

Amoo, S. (2001). Secondary school mathematics teachers characteristics and teaching effectiveness. *Journal of Primary Science, 2*(1), 29-35.

Blanco, J. L .(2001). Errors in the teaching/ learning mathematics of the basic concepts of geometry. *International Journal for Mathematics Teaching and Learning,* 11(2): 305-325. Retrieved January 17, 2015, from http://ejournalsersco.com/direc

Cohen, L., Manion, L., & Morrison, K. (2005). *Research Methods in Education.* NewYork: Taylor & Francis e-Library.

Jamar, I. (1991). *Education for all by the year 2000: Mathematics for all.* Department of Education, Bayaro University , Kano.

Johanna, R. R. (2006). The Image of Mathematician. *Philosophy of Mathematics Education Journal, 19*(1), 2-17. Retrieved from http://www.people.ex.ac.uk/PErnest/pome19/index.htm

Leangson A.J., & Limjamp AA (2005). Assessing the mathematics achievement of college freshman using piaget's logical operations. *International Journal for mathematics Teaching and Learning*,5(4): 116-124. Retrieved October 19 , 2016, from www.cimt.org.uk/journal/index.htm

National Council of Teachers of Mathematics. (1991). *Professional Standard for Teaching Mathematics.* Michigan State University: MARS. Retrieved November 10, 2016, from toolkit for change.org/toolkit/documents/551-92-nmctm-teaching standards.pdf

NASSP BUlletin (1997). *Challengesd of mathematics teaching today: How can school leaders help?,* Dickey, ME: Author.

Okigbo C.E. , and Okeke CO (2011). Effects of games and analogies on students' interest in mathematics. *Journal of the Teacher Association of Nigeria,* 46(1):101-112.

Oyetunde, T. O. (2010). Educational standards in Nigeria: The state of the arts. In I. S. T.O. Oyetunde, S. J. Aliyu, P.M. Haggai ,&M. J.Musa(Eds.), *Improving educationalstandards in Nigeria. Perspective, challenges andstrategies*(pp.30-41). ABU: UnivPress(Nig): ISBN:978-2949-72-8.

Sewel, B. ((1981). Use of mathematics by Adults in Daily life. *Advisory Council for Adults and Continuing Education (ACACE).* Leicester, U.K .

Vankus, P. (2005). History and present of didactical games as a methods of mathematics teaching. *Acla, didactica Universitatis Comenianae Mathematics.*, 53-68.

Appendix I

Section A. Observatory Check list: Tick in the most appropriate Compliance (C) or non-compliance (NC)

1. The teacher posed worthwhile mathematical tasks to the students.	C	NC
2. The teacher role in the mathematics class includes asking questions, listening to students questions and monitoring students.		
3. The role of students in mathematics class includes asking questions and listening to the teacher.		
4. The teacher uses mathematics models (Teaching aids) during the lesson.		
5. The teacher creates a learning environment that fosters the development of lesson.		
6. The engage in ongoing analysis of teaching and learning.		

Appendix II

Section B. Professional Standard for Teaching Mathematics Questionnaire

Directions: There are no correct or incorrect responses. Read each item carefully. Please think about how you feel about each item. Darken the circle that most closely corresponds to how the statements best describes your feelings. Use the following response scale to respond to each item. Agree (A) and D (Disagree)

1. As mathematics teacher, I posed worthwhile mathematical tasks to my students.	A	D
2. My role as mathematics teacher includes asking questions, listening to students questions and monitoring students.		
3. The role of students in mathematics class includes listening only.		
4. I encourage the use of mathematics models by students in my mathematics class.		
5. I create a learning environment that fosters the development of mathematics		
6. Do not have to engage in ongoing analysis of teaching and learning.		