



Effective Teaching and Evaluation of Mathematics by Secondary School Mathematics Teachers in the North West Region of Cameroon

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

The study set out to examine the extent to which secondary school mathematics teachers implement the principles of effective teaching and evaluation of mathematics as put forward by the National Council of Teachers of Mathematics – NCTM; principles which when effectively implemented will enable learners to construct knowledge thereby doing away with mathematics phobia, and consequently performing better in mathematics. The study adopted a descriptive survey research design. The population of the study was made up of 600 public and private secondary school mathematics teachers serving in the North West Region of Cameroon. Using the Taro Yamane's formula, 240 mathematics teachers selected through simple random sampling, constituted the sample of the study. Two research questions and two hypotheses guided the study. A questionnaire whose Cronbach alpha reliability was found to be 0.87 was used to collect relevant data. The data collected was analysed using mean to answer the research questions and t-test to test the hypotheses at the 0.05 level of significance. The findings of the study revealed that the level of implementation of the principles of effective teaching and evaluation of mathematics by secondary school mathematics teachers in the North West Region of Cameroon is significantly low. Furthermore, male and female mathematics teachers do not differ significantly in their implementation of the principles of effective teaching and evaluation of mathematics. It was

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recommended among other things that secondary school mathematics teachers should embrace the NCTM principles of effective teaching and evaluation of mathematics with finesse and incorporate them within their instructional programs and practices.

Keywords: Effective teaching; mathematics teaching principles; mathematics evaluation; mathematics teachers' practices; secondary schools.

1. INTRODUCTION

Mathematics is a Greek word, which refers to things that we gain knowledge of [1]. It is generally regarded as a science and also as a language that helps to develop our abilities to count, measure and describe the shapes of varied objects. It thus deals with reasoning and quantitative calculations that are logical. Wikipedia asserts that mathematics is generally recognized as the foundation on which every nation strives to emerge and become prosperous and seek to attend economic independence. Thus the importance of developing the mathematical competence of all learners at all levels of education cannot be overemphasized. This is certainly the *raison d'être* for making mathematics compulsory and one of the leading core subjects in secondary schools in Cameroon. The compulsory nature of mathematics is certainly not unconnected to the vital role it plays in this contemporary society. Mathematics is a core science that studies and explains relationships related to quantities, numbers and measurements [2]. It is a tool for the advancement of any science-based disciplines including among others engineering, space science, graphics, technology, medicine and industry [3]. The aforementioned is indicative of the fact that the importance of mathematics cannot in any way be underestimated in every human enterprise. Mathematics plays numerous important roles in varied domains of human life, four of which are: indispensable tool for the attainment of economic prosperity, key for the acquisition of core skill in life, a language full of beauty, and a field of education [4].

Mathematics is generally regarded as an indispensable subject having a great impact on every activity of individuals and nations alike. It is considered a foundational discipline and bedrock for understanding most scientific concepts [2]. No wonder this subject is considered as one of the key subjects which has a direct link with other subjects especially in primary and secondary school curricula globally. In particular, its link with science and technology

cannot be overemphasized [5]. The subject cuts across primary and secondary levels of education in Cameroon. Although mathematics still remains one of the most difficult subjects in secondary schools as perceived by learners, there is a general feeling that this subject is difficult not only by its very nature but also as a result of teachers' instructional practices [6]. As a result of this impression and teachers' instructional practices, majority of students still dread mathematics no matter the approach used [7], [8].

The process of students obtaining mathematical knowledge in the traditional teaching/learning approach is described as the 'copy method' [9]. However, students who memorize facts or procedures without understanding are often not too sure of where, when or how to make use of what they are familiar with and such learning is often quite fragile [7]. This traditional view of mathematics can also constrain the scope of the mathematical content and pedagogy covered by the curriculum. Traditional mathematics classes mostly consist of three segments [10]: Previous day's work is corrected in the first segment. This is followed by the presentation of new materials by the teacher, very often solving one or two new mathematical problems followed by a few students solving similar problems on the chalkboard. The third segment requires students to work on assignments, very often at home, against the next lesson. These segments suggest that most learners in a secondary school mathematics classroom spend most of the time watching the mathematics teacher solve problems at the board and then working alone on traditional problems provided very often by the textbooks or by the teacher. Thus activities in the traditional classroom often involve students copying what the teacher has established. Moreover, most students in the traditional framework view mathematics as consisting mainly of memorizing rules, and are hardly guided to involve themselves in creative activities and construction of knowledge.

An important theoretical foundation on which the teaching and learning of mathematics can be

understood is constructivism. The term 'constructivism' appears to have different meanings for different people. This term was originally used to describe a theory of learning [11]. Recently, the term constructivism has become more associated with the theory that the world is naturally complex with no objective reality, and that much of what we know is constructed from our beliefs and the social environment in which we live [7]. This view suggests that knowledge should be actively constructed and not passively received from the environment as is the case with mathematics. Mathematics should not be viewed as objective knowledge [12]. Rather, it should be perceived as involving active construction of knowledge by individuals, shared with others. In a constructivist perspective, assessment and evaluation are integral parts of both development work and the teacher's instructional activities and not separate components that can be discussed in isolation [13]. Mathematics can thus be seen as both an interactive and a constructive activity. Summarily, constructivism can be considered as a move toward learning in which learners have or are endowed with opportunities to construct their own knowledge, create new knowledge or assemble knowledge in order to make sense of what is being taught or learned. This is generally achieved through building internal links to the ideas and facts being taught and learned. One however wonders to what extent secondary school mathematics teachers in Cameroon apply the principles of effective teaching and evaluation; principles which when effectively implemented, will enable learners to construct knowledge thereby doing away with mathematics phobia, and consequently performing better in the subject [14].

Statistics from the Cameroon General Certificate of Education Board (CGCEB) reveal that there has been consistent undesired performance and massive failure of students in mathematics at the General Certificate of Education Ordinary Level (GCE O/L) (See Appendix A). The statistics suggest that up to 2016, achievement in mathematics at the GCE O/L in Cameroon had not exceeded 25% for at least the previous 12 years. From experience as a marker at the GCE O/L, the present state of affairs is not any better. The current constant poor performances of students at the General Certificate of Education (GCE) at the Ordinary Level (O/L) suggest that the way students acquire mathematical knowledge and skills should be re-organized [6]. Explicit principles and targets for the effective

teaching/learning and evaluation of mathematics in secondary schools have been outlined [14], [15], [16]. These principles include:

- Focusing learning through the establishment of mathematics goals; the effective teaching of mathematics should not only include the establishment of clear goals for learning, but should also situate goals as indicators of progress within the learning environment, and further use these goals to guide decisions taken within the teaching/learning process.
- Employing activities that promote reasoning and problem solving; the effective teaching of mathematics should engage students in solving and managing tasks that promote logical mathematical reasoning and problem solving and further provide multiple entry points and a wide range of solution strategies.
- Using and connecting mathematical representations; the effective teaching of mathematics should engage learners in creating connections among mathematical representations in a bit to deepen their understanding of mathematical concepts, steps and procedures. These connections should also be used as tools for problem solving.
- Facilitating meaningful mathematical dialogue; the effective teaching of mathematics should facilitate dialogue among learners. This will permit them to build reciprocated understanding of mathematical concepts and ideas by exploring and comparing varied student approaches and points of view.
- Asking purposeful questions; the effective teaching of mathematics should make use of purposeful questions not only to assess but also to advance and promote students' reasoning and sense making about vital mathematical concepts, ideas and relationships.
- Building procedural confidence from conceptual understanding; the effective teaching of mathematics should build confidence with procedures on a foundation of conceptual understanding so that learners, over time, develop skillful procedural flexibility as they solve societal, contextual and mathematical problems.
- Supporting productive struggle in learning mathematics; the effective teaching of mathematics should constantly provide

learners with individual and collective opportunities and the desired support to engage in productive efforts as they grapple with mathematical concepts, ideas and relationships.

- Educating and using evidence of student thinking; the effective teaching of mathematics should very often use evidence of student thinking to appraise progress in the direction of mathematical understanding and as a consequence, to adjust teaching continually in ways that support and extend students' learning.
- Encouraging student inquiry and cooperative learning; the effective teaching of mathematics should consistently provide opportunities for students of varying abilities to work together in groups thereby supporting one another and also using inquiry learning to construct their understanding of mathematics.
- Providing continuous assessment and offering corrective feedback; the effective teaching of mathematics obliges teachers not only to continuously check the progress of students' understanding but to also constantly give detailed positive feedbacks in order to guarantee that students correctly assimilate new mathematical knowledge.

Educators and the mathematics community in Cameroon fear that the reason why students are not meeting desired successes academically can largely be attributed to the fact that they hardly experience instructional practices which are consistent with the aforementioned recommended principles. When teachers of mathematics are unswerving in the implementation of the principles, learners are more apt in developing and extending a rich and conceptual understanding of the different mathematical concepts, ideas and processes, as well as mathematical skills and procedural fluency [14]. Unfortunately, Teacher Training Colleges and Faculties of Education in Cameroon seem not to lay as much emphases as required on the NCTM principles in the course of training mathematics teachers. Studies however indicate that much emphases on these principles lead to improved students' performances.

One such study examined the instructional practices of 'star teachers' in mathematics [17]. Star teachers are those who are exceptionally

successful, with their students consistently scoring higher in end of course and national exams; the community sees them as outstanding; principals rate them highly than the other teachers; even other teachers judge them as outstanding; in fact the learning community view them as superior teachers [18]. The researchers concluded that those considered as star teachers were better than the other teachers because they demonstrated instructional practices that are consistent with NCTM's principles.

Another study also examined the mathematics instructional practices of star teachers, comparing them to the practices of teachers not so identified [19]. They concluded that those considered as star teachers demonstrated instructional practices which were very much in line with the NCTM Principles, more frequently than those not considered as stars. When teachers' instructional practices are consistent with NCTM's standards, learners have a propensity to succeed more during mathematics evaluations [20]. It can therefore be plausible to conclude that if mathematics teachers embrace the NCTM principles with flair and integrate them within their teaching/ learning programs and practices, then student's success rate in mathematics would undoubtedly increase.

1.1 Objectives of the Study

1. To determine the extent to which mathematics teachers in the North West Region implement the principles of effective teaching and evaluation of mathematics in secondary schools.
2. To determine how male and female mathematics teachers differ in their implementation of the principles of effective teaching and evaluation of mathematics in secondary schools in the North West Region.

1.2 Research Questions

1. To what extent do mathematics teachers in the North West Region implement the principles of effective teaching and evaluation of mathematics in secondary schools?
2. How do male and female mathematics teachers differ in the extent to which they implement the principles of effective teaching and evaluation of mathematics in

secondary schools in the North West Region?

1.3 Hypotheses

Ho₁: The extent of implementation of the principles of effective teaching and evaluation of mathematics in secondary schools by mathematics teachers in the North West Region is not significant.

Ho₂: Male and female mathematics teachers do not differ significantly in their implementation of the principles of effective teaching and evaluation of mathematics in secondary schools in the North West Region.

2. METHODOLOGY

The study adopted the descriptive survey research design. Through the simple random sampling technique and by employing the Taro Yamane's formula, 240 mathematics teachers drawn from a population of over 600 mathematics teachers in both public and private secondary schools in the North West region, constituted the sample of the study. A self designed structured questionnaire utilizing a four point Likert scale was used to collect relevant data. Section A solicited demographic information from the respondents. Section B had 10 items on the effective principles of teaching mathematics as posited by NCTM. The items were personalized to permit the respondents to carry out self evaluation. According to NCTM, the extent to which these principles are implemented during mathematics lessons, determine the effectiveness of teaching / learning and evaluation that take place. These items were disguised with the usual mathematics teachers' classroom practices, giving a total of 15 items. Mathematics teachers were requested to indicate the extent to which they implement these principles during mathematics lessons.

The questionnaire was vetted by three experts; one specialised in mathematics education, the second in measurement and evaluation, and the third expert specialised in educational psychology. The instrument was then pilot tested using 21 mathematics teachers who were within the population, but not part of the sample. Cronbach alpha was used to determine the reliability – internal consistency of the questionnaire. Thus the reliability of the instrument was found to be 0.87. The instrument was used to collect data using the simple random sampling technique during the North West Mathematics Teacher's Association (MTA)

Meeting. The responses ranging from Very Large Extent (VLE), Large Extent (LE), Low Extent (LE) to Very Low Extent (VLE) were weighted 4, 3, 2, and 1 point(s) respectively for positive items. The scoring was reversed for negative item.

The data collected was analysed using mean to answer the research questions and t-test to test the hypotheses at a 0.05 level of significance. The benchmark or norm for making decisions was set as follows: $35 \leq$ Very High extent ≤ 40 , $25 \leq$ High extent < 35 , $15 \leq$ Low extent < 25 and $10 \leq$ Very low extent < 15 . The limits are obtained by multiplying midpoints and end points (that is 4, 3.5, 2.5, 1.5, 1) on the four-point Likert scale (that is, 4, 3, 2, 1) by the total number of questionnaire items (that is 10) in each section.

3. FINDINGS

Research Question 1: To what extent do mathematics teachers in the North West Region implement the principles of effective teaching and evaluation of mathematics in secondary schools?

Table 1 indicates that the item mean scores range from 1.68 to 2.50. It further indicates that the total mean score of mathematics teachers' responses on the extent of implementation of the ten principles of effective teaching and evaluation of mathematics is 22.10 out of 40. This means that the level of implementation of the principles of effective teaching and evaluation of mathematics by secondary school mathematics teachers in the North West Region is low.

Research Question 2: How do male and female mathematics teachers differ in the extent to which they implement the principles of effective teaching and evaluation of mathematics in secondary schools in the North West Region?

Table 2 shows that the mean implementation score for male mathematics teachers is 22.12 while that of female mathematics teachers is 22.04. Thus although male teachers have a slightly higher implementation score, the extent of implementation of the principles of effective teaching and evaluation of mathematics by both male and female secondary school mathematics teachers in the North West Region is low.

Ho₁: The extent of implementation of the principles of effective teaching and evaluation of mathematics in secondary schools by mathematics teachers in the North West Region is not significant.

Table 1. Extent of implementation of the principles of effective teaching and evaluation of mathematics

S/N	Questionnaire item	Number of respondents				Item Score (X)	Item mean score (X/240)
		VHE (4)	HE (3)	LE (2)	VLE (1)		
1	Establish mathematics goals to focus learning	19	61	76	84	495	2.06
2	Implement tasks that promote reasoning and problem solving	32	59	94	55	548	2.28
3	Use and connect mathematical representations	47	19	104	70	523	2.18
4	Facilitate meaningful mathematical discourse	15	22	98	105	378	1.68
5	Pose purposeful questions	11	96	93	40	558	2.33
6	Build procedural fluency from conceptual understanding	38	60	106	36	580	2.42
7	Support productive struggle in learning mathematics	19	79	124	18	579	2.49
8	Elicit and use evidence of student thinking	9	24	111	96	426	1.78
9	Encourage student inquiry and cooperative learning	38	74	97	31	599	2.50
10	Offer continuous assessment and provide corrective feedback.	57	32	95	57	570	2.38
Total Mean Score / 40							22.10

Table 2. Extent of implementation of the principles of effective teaching and evaluation by male and female mathematics teachers

Gender	N	Mean	Std. Deviation	Extent of Implementation
Males	191	22.12	3.48	Low Extent
Females	49	22.04	3.54	Low Extent
Total	240	22.10	3.48	

Table 3. One Sample t-test for extent of implementation of the principles of effective teaching and evaluation of mathematics

	Test Value = 25					
	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence interval of the difference	
					Lower	Upper
Extent of Implementation	-12.887	239	.000	-2.896	-3.34	-2.45

Table 4. t-test for equality of means of male and female mathematics teachers' responses

		t-test for Equality of Means						
		T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
Gender Differences in Implementation	Equal variances assumed	.142	238	.887	.080	.559	-1.021	1.180
	Equal variances not assumed	.141	73.624	.888	.080	.564	-1.045	1.204

For null hypothesis one, the one-sample t test was significantly different from 25 with $t(239) = -12.89$, $p < 0.05$ and confidence interval ranging from 21.66 (i.e. $25 - 3.34$) to 22.55 (i.e. $25 + 2.45$). Therefore, the null hypothesis that the extent of implementation of the principles of effective teaching and evaluation of mathematics in secondary schools by mathematics teachers in the North West Region is not significant was rejected at the 0.05 alpha level. Therefore the level of implementation of the principles of effective teaching and evaluation of mathematics by secondary school mathematics teachers in the North West Region is significantly low.

Ho₂: Male and female mathematics teachers do not differ significantly in their implementation of the principles of effective teaching and evaluation of mathematics in secondary schools in the North West Region.

Table 4 indicates that the mean difference in the implementation scores of male and female mathematics teachers is 0.80. It further indicates that the t-value is 0.14 with a degree of freedom of 238. This gives a p-value of 0.89 which is not significant ($p > 0.05$) at the 0.05 level of significance. Therefore male and female mathematics teachers do not differ significantly in their implementation of the principles of effective teaching and evaluation of mathematics in secondary schools in the North West Region.

4. DISCUSSION OF FINDINGS

4.1 Extent of Implementation of the Principles of Effective Teaching and Evaluation of Mathematics

The findings of this study reveal that the level of implementation of the principles of effective teaching and evaluation of mathematics by secondary school mathematics teachers in the North West Region of Cameroon is significantly low. This is a possible justification for the constant poor performances recorded by secondary school students in mathematics at the GCE O/L. This is because when teachers of mathematics are consistent with each of the principles of effective teaching and evaluation, students are more apt to develop a rich and conceptual understanding of the different mathematical ideas and processes, as well as skill and procedural fluency [14]. Furthermore, some researchers investigated the mathematics instructional practices of those considered as 'star teachers' [19]. The researchers concluded

that star teachers demonstrated those instructional practices that are aligned with NCTM's principles. Thus the low level of implementation of the principles of effective teaching and evaluation of mathematics is a pointer to the fact that mathematics students in secondary schools in the North West Region have not fully developed conceptual understanding of the different mathematical ideas and processes, as well as their skills and procedural fluency.

4.2 Gender Differences in the Implementation of the Principles of Effective Teaching and Evaluation by Mathematics Teachers

The finding of the study indicates that although male teachers have a slightly higher implementation score, the extent of implementation of the principles of effective teaching and evaluation of mathematics by both male and female secondary school mathematics teachers in the North West Region is low. It further indicates that male and female mathematics teachers do not differ significantly in their implementation of the principles of effective teaching and evaluation of mathematics in secondary schools in the North West Region. This is an indication that the extent of implementation of the principles of effective teaching and evaluation of mathematics is independent of gender. It has been demonstrated that when teachers' instructional practices are aligned with NCTM's standards, students tend to meet greater success on mathematics evaluations [20]. Thus there is need for both male and female mathematics teachers to equally align their instructional practices with NCTM standards to enable students achieve better especially at the GCE O/L examinations.

5. CONCLUSION

The study assessed the extent to which mathematics teachers in the North West Region of Cameroon implement the principles of effective teaching and evaluation of mathematics in secondary schools as stipulated by the National Council for Teachers of Mathematics (NCTM). The study was also interested in finding out the disparities which may be associated to the levels of implementation of the NCTM principles by male and female mathematics teachers. The unacceptable constant poor performances registered by students in

mathematics at the GCE Ordinary Level provoked this study. These poor performances made many stakeholders to raise doubts if mathematics teachers in Cameroon were effectively implementing the NCTM principle; principles which when well implemented according to NCTM, will enable learners to construct knowledge thereby doing away with mathematics phobia and consequently performing well at Ordinary Level Mathematics. The findings of the study confirmed that the level of implementation of the principles of effective teaching and evaluation of mathematics by secondary school mathematics teachers in the North West Region of Cameroon is significantly low. It further revealed that male and female mathematics teachers do not differ significantly in their implementation of the principles of effective teaching and evaluation of mathematics. As a result of the findings, some steps in the form of recommendations need to be taken in order to redress the disturbing performances in mathematics at the GCE Ordinary Level.

6. RECOMMENDATIONS

The following recommendations were put forward as a follow-up to the findings of this study intended to help mathematics learners to improve on their achievement in mathematics.

- Secondary school mathematics teachers should embrace the NCTM principles of effective teaching and evaluation of mathematics with finesse and incorporate them within their instructional programs and practices.
- Teacher training colleges and faculties of education in universities should develop practical courses on the implementation of NCTM's principles of effective teaching and evaluation of mathematics. These principles should be clearly demonstrated during microteaching and teaching practice exercises.
- The Teachers' Resource Center (TRC) and the North West Mathematics Teacher's Association (MTA) should organise seminars on the effective implementation of the NCTM's principles of effective teaching and evaluation of mathematics. These organs should also put in place a monitoring mechanism to ensure that mathematics teachers are effectively implementing these principles.

CONSENT

As per international standard or university standard, participant's written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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APPENDIX A

Success Rate (%) in Mathematics Compared with GCE O/L Success Rate from 2005 to 2016 in Cameroon

Year O/L Candidates	Total N ^o of GCE O/L Candidates	GCE O/L Success Rate (%)	Success Rate in Mathematics (%)
2016	102857	62.17	8.90
2015	99069	48.93	11.80
2014	86724	45.7	9.40
2013	81675	47.7	15.32
2012	79384	42.8	14.56
2011	65678	43.1	18.49
2010	60875	58.2	15.00
2009	55890	53.7	20.46
2008	50419	48.1	15.35
2007	44676	55.9	18.38
2006	40613	51.5	23.99
2005	35530	45.7	16.83

Source: GCE Board examination statistics booklets of listed years

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