Bearing/Distance Problems in Mathematics: Teachers' Construction Efficacy in the Secondary School in Plateau State, Nigeria

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Abstract: In Nigeria, most teachers among other things lack the necessary teaching skills, and mastery of subject matter for effective teaching of mathematics at the secondary school level. These deficiencies have often resulted in high and repeated failure rates in national and standard mathematics examinations. The present study investigated the ability of mathematics teachers to construct practical and realistic word problems in bearing and distance toward mitigating the deficiencies. The research methods adopted were exploratory and descriptive surveys due to the need to explore and analyze the abilities using quantitative techniques. Sample consisted of 292 (35.48%) mathematics teachers who took part in the in-service training workshop organized by the Mathematical Association of Nigeria (MAN) in Plateau state, Nigeria. Purposive sampling technique was used to select the sample that involved the workshop participants only. The instrument 'construction of practical and realistic word problems in bearing and distance test (CPRWPBDT)' was used for data collection while the analysis was carried out using simple percentages, mean scores and one-way ANOVA. The findings of the study among other things revealed that the mathematics teacher participants constructed practical and realistic word problems in bearing and distance within 91.67% completion rate, 70.45% of the problems constructed were within the context, at least 75% rate of correctness with little difficulties/errors was observed in sketching (65.90%), and reality (40.90%). The variations observed within the participants in the construction of the problems were statistically not significant. Thus it was recommended among other things that mathematics teachers should undergo regular in-service workshop training to help in developing essential skills themselves for constructing practical/realistic word problems in bearing and distance; and should avoid unnecessary errors for meaningful teaching and learning of bearing and distance.

Keywords: *In-service teachers, bearing/ distance, mathematics teaching, secondary school.*

Introduction

A number of researches have revealed that the performance of students in the senior school certificate examination (SSCE) in mathematics in Nigeria is below the expected standard as a result of lack of sufficient qualified teachers to handle the subject well, the use of ineffective instructional strategies, and the presentation of poorly prepared candidates for national standard examinations in mathematics and so on (Bot, 2011; Cai et al., 2009; Eniayeju, 2010; Federal Ministry of Education [FME], 2006; Sunardi & Pambudi, 2018; Uloko & Imoko, 2007; West African Examinations Council [WAEC], 2013, 2014, 2015, 2016, 2017). Consequently, suggestions have been offered toward mitigating the problem including the use of a variety of mathematical games and puzzles; the use of novel, interesting methods and strategies; regular revision of past examination questions; and solving of practical/realistic word problems (Binda, 2005; Bot, 2013; Bot & Dareng, 2013; Bot & Timku, 2014; National Mathematical Centre [NMC], 2009; WAEC, 2013, 2014, 2015, 2016, 2017). In spite of these suggested measures, the problem still persists thereby raising concern for stakeholders (Arigbabu et al., 2012; Bot, 2013; FME, 2006; Sunardi & Pambudi, 2018). Thus it is necessary to search for better means of tackling the problem in the interest of national development in Nigeria since mathematics serve as the foundation laying stone, and a crucial means of producing educated citizens for the country.

A critical consideration of the senior school mathematics curriculum in Nigeria of which some new relevant topics were added recently from further mathematics curriculum such as logic, matrices and calculus; the compelling demands of

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standard mathematics examination questions; and the complexities involved in mathematics instruction as a whole, it becomes highly probable that if mathematics teachers keep abreast of new teaching methods, strategies and techniques through periodic professional in-service training and personal development on handling some selected difficult concepts from the curriculum, it will help to promote effective teaching of mathematics, and enhance the training and preparation of students for external standard mathematics examinations in the senior secondary school in Nigeria. The reason being that in-service professional training and development of teachers generally has many advantages. These include the fact that it helps the teachers to update their knowledge and teaching skills; to cultivate and increase their critical thinking and reasoning; to increase their effectiveness in classroom instructional delivery; it provides the mechanism for teachers to be able to face new educational challenges and changes in the dynamic society; it enhances their self-confidence, attitude, interest, beliefs, motivation and professional practice, and it provides a better means of training teachers to be able to select and effectively utilize various instructional materials for teaching and learning including new technologies to mention a few (Borg, 2011; Boyd et al., 2008; Clotfelter et al., 2007; Izci & Goktas, 2017; Nyamwange et al., 2017; Omar, 2014; Sari, 2007).

Nonetheless, at the senior secondary school level in Nigeria, bearing and distance is one of the most important topics in the mathematics curriculum that teachers need to periodically update their knowledge and skills through the appropriate and approved teacher re-training workshops and personal professional development activities. Also, the complex and increasing demand of the knowledge of bearing and distance in survey, geology, oceanography, aerospace and so on make it imperative for secondary school mathematics teachers to acquire more training and re-training to be able to build better capacity for more useful and productive teaching and learning output. Bearing simply represents the clockwise angular movement between two places or points. The reading begins from North Pole in a clockwise direction and ends at the North Pole. Also, it represents measurement of the movement of an angle in a clockwise direction relative to the north line. For example, in dealing with bearing based on points symbolism or representation from the mathematics curriculum, the bearing of point say 'x' can be described as the line joining the center of the compass through 'x' measured in degrees clockwise from the north direction. This suggests that bearing is a concept that deals with points, movements, angles, distance, directions and locations. This is to a large extent that it is taken and treated as bearing and distance in both junior and senior secondary school mathematics curriculum in Nigeria. It is applied in many subject areas including navigation for showing directions, geography for locating landmarks, survey to locate places/points, mathematics for calculating longitude and latitude and so on and so forth (Arigbabu et al., 2012; Praczyk, 2007).

Additionally, bearing and distance is characterized by a clockwise measurement with the base at the North direction, ending in the North line, that is, North to North reading; the total angle in the reading is made of 360^0 represented by a 3-digit figure like 023^0 and 189^0; the calculation is based on sketching and drawing of a vivid triangle (Arigbabu et al., 2012).

Most mathematics teachers find the concept of bearing and distance among other major topics in the school mathematics curriculum difficult to teach practically based on real life situations, and pose, create, construct relevant, meaningful and challenging problems as well due to poorly mastered subject and complex nature of bearing and distance (Awotunde & Bot, 2003; WAEC, 2014, 2015, 2016, 2017). These challenges have persisted over time unresolved but could be reduced drastically by ensuring that mathematics teachers are involved in functional professional in-service training especially on teaching methodology and novel content knowledge acquisition in the subject.

In addition, bearing and distance is one of the most difficult topics from the secondary school mathematics curriculum in Nigeria which most teachers often skip teaching until and unless a very good teacher is hired or it is avoided entirely, and many students experience difficulty learning and understanding it due to poorly acquired mathematics knowledge at the background. This affects their performance in general mathematics examinations since most of the time, the students are said to attempt solving the questions given haphazardly without careful, serious concentration and effort (Bot & Dareng, 2013; Bot & Timku, 2014; WAEC, 2014, 2015, 2016, 2017). Thus it is absolutely necessary in the present circumstance for mathematics teachers to acquire robust and frequently update their knowledge of bearing and distance concept owing to the need to help their students to be able to prepare adequately for their local school assessment and national standard mathematics examinations and pass same successfully with good acceptable grades. This invariably will help reduce the negative comments about the inability of most students to solve geometry questions dealing with bearing and distance. It will also help them avoid making unusual errors including misunderstanding of concepts, terms and symbols; sketching diagrams poorly; and interpreting results poorly (WAEC, 2015, 2016, 2017, 2018; Wonu & Zalmon, 2017). Beyond these advantages, the training and retraining of mathematics teachers to update their knowledge periodically is important and necessary considering the fact that bearing and distance problems varies in construction and requires different solution approaches, metacognitive skills and strategies which may be challenging to most students and some teachers as shown by the nature of the following examples:

1. A ship leaves a certain port and travels 20km on a bearing of 040^0, and then 50km on a bearing of 285^0. Calculate (a) Its distance from the port (b) The bearing of the port from the ship.

2. A ship from a port travels for 60km on the bearing of 110^0. It continuous to travel and changes direction for another 40km on a bearing of 080^0. How far is the ship from the starting point?
3. A Tailor leaves a certain shop and moves 25m on a bearing of 245^0. At the same time, a carpenter leaves the same shop and moves 15m on a bearing of 110^0. How far apart are the two men?

To be able to attempt these and other similar or related problems, a lot of problem solving skills and strategies albeit heuristics, critical thinking and logical reasoning are required including numerical, manipulative, process, computational, creative cum artistic and basic operational skills and techniques. The entirety of these cognitive activities and probably many more constitute the basic requirements for successful problem solving whether they are routine or non-routine. Unfortunately, many students lack these skills thus making them to experience difficulties with bearing and distance, and mathematics tasks generally (Akinoso, 2014). Therefore, except concerted effort is made to provide proper training to mathematics teachers especially through in-service training workshops who in turn would teach to impart the proper skills to their students, the students would continue to face many challenges with their problem solving tasks.

Gleaning from the points raised over the challenges associated with the solution of bearing and distance problems and the difficulty it could pose to students when engaged in training due to their poorly cultivated background knowledge; the issue of insufficient qualified teachers and utilization of poorly conceived teaching methods and strategies; and also given the need to produce highly mathematically sound, meticulous, cultured and educated students, it is important for mathematics teachers, irrespective of their teaching qualifications and classroom experiences, to be couched properly through regular in-service training programmes to be able to think, reason better and critically, generate, analyze, solve and encourage better practical and or realistic solutions of word problems.

Practical word problems connote bearing and distance problems that a teacher can identify and construct within the immediate school environment familiar to students as opposed to standard, and imaginary restricted problems from recommended textbooks. They make the learning of mathematics relevant, realistic, less abstract, attractive, captivating, interesting, motivating, and above all they make the subject closer to and within the reach of students in tandem with the tenets of constructivism theory (Bot & Dareng, 2013; Bot & Timku, 2014; Sembiring, 2010; Sunardi & Pambudi, 2018; Zascerinska et al., 2013). Beyond these advantages, practical problems in mathematics are supposed to help create opportunity for the teacher and students to discuss the modalities for solving them together formally in the class. This is one of the principles underlying effective teaching and learning that is emphasized in the theory of constructivism that individuals learn by building their own knowledge, and essentially by connecting new ideas and experiences to existing understanding in the cognitive structure (Bransford et al., 1999; Takele, 2020). This cannot happen without the teacher having to mobilize students and learning resources together to create and foster the ability of solving practical problems from the beginning that would be supplemental to regular classroom exercises. In other words, teachers must use their ingenuity to initiate, create practical supplemental problems with students and guide them properly in solving them to build new knowledge, and to promote meaningful learning and understanding. Nonetheless, available literature disclosed that there is a dearth of research on the construction, analysis, and evaluation of practical and realistic word problems by teachers towards effective implementation of the new secondary school mathematics curriculum in Nigeria and elsewhere in the world; hence this study was conceived and anchored on the need to fill this gap.

Statement of the Problem

In Nigeria, a lot of mathematics teachers are said to lack necessary teaching skills and mastery of the subject matter for effective teaching to take place in the classroom. These and other deficiencies have severally contributed to the problem of poor training of students and their preparation for mathematics examinations resulting in high and repeated failure rates in such examinations. The problem has been a major concern to stakeholders who at the same time are curious to see it mitigated in the interest of helping to prepare their children to be able to pursue different carriers in life given that mathematics is a major requirement for further education in Nigeria and elsewhere in the world. It is a truism that to be able to teach mathematics most effectively and efficiently not only in the secondary school in Nigeria with the Nigeria Certificate in Education (NCE) as the minimum qualification required but in most other countries in the world, a sufficient understanding and mastery of subject matter and content knowledge, principles, good rapport, dedication, confidence, genuine interest, motivation, commitment and frequent in-service albeit on-the-job teacher training are required among other numerous things. Unfortunately, most mathematics teachers lack these important qualities and hardly receive in-service training frequently to update their knowledge, teaching skills and so on. These deficiencies make it very difficult for them to carry out their teaching job satisfactorily. To overcome the deficiencies, therefore, they need to be provided with and encouraged as well to attend and actively participate in regular in-service training on teaching some of the more difficult topics which include bearing and distance from the mathematics curriculum. For this reason, this study focused mainly on the in-service professional training of mathematics teachers on construction of practical and or realistic word problems in bearing and distance in mathematics.

Objectives of the study

The objectives of the study are twofold namely to find out the extent to which mathematics teachers attending in-service workshop training on mathematics teaching methodology are able to construct, analyze and synthesize practical and realistic word problems dealing with bearing and distance; and to investigate the probable difficulties or errors that could be encountered in the process of constructing the problems.

Research Questions

The research questions raised to guide the study were as follows:

1. What are the types of practical and realistic word problems in bearing and distance that mathematics teachers attending in-service workshop training on teaching methodology are able to construct?
2. What difficulties and or errors do mathematics teachers on in-service workshop training on teaching methodology make in constructing practical and realistic word problems for teaching the concept of bearing and distance in mathematics?
3. How do the difficulties and or errors vary in constructing practical and realistic bearing and distance word problems by mathematics teachers on in-service workshop training on teaching methodology?

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance in the study:

1. There is no significant variation in constructing practical and realistic word problems for teaching bearing and distance by mathematics teachers on in-service workshop training on teaching methodology.
2. There is no significant variation in the difficulties and or errors in constructing practical and realistic word problems in bearing and distance by mathematics teachers on in-service workshop training on teaching methodology.

Methodology

Research Goal

This research was carried out based on the need to explore, describe and explain the ability cum variability of secondary school mathematics teachers on in-service workshop training on innovative teaching pedagogies to construct practical and realistic word problems for teaching bearing and distance word problems. Also, the study examined the probable variance in the difficulties and typical errors associated with their construction ability, skills and competences. Thus exploratory, descriptive and quantitative methods were employed as research design.

Population Sample and Data Collection

The population consisted of 823 mathematics teachers from selected secondary schools in Plateau state, Nigeria. Sample was made of 292 (35.48%) mathematics teacher participants on in-service workshop training in three zones namely north, central and south Plateau state. The workshop was provided by the Mathematical Association of Nigeria, Plateau state chapter held 2nd-11th, March 2020 in the zones on different dates with each set of the workshop training taking three consecutive days.

The sample was chosen using purposive sampling technique since only those that participated in the workshop were used in the study. Each participant was nominated by their respective school principals thus making the sample a subject of research interest with required minimum teaching qualification and many years of teaching experience as well in the secondary school.

The researcher designed 'construction of practical and realistic word problems in bearing and distance test' tagged CPRWPBDT, and used it as data collection instrument. The CPRWPBDT had one simple important direction to the participants 'look round at the environment including the classroom where a school is located carefully; construct two important word problems on teaching the concept of bearing and distance'.

The CPRWPBDT was neither an achievement nor performance test since it contained only one direct instruction on what should be done by the participants; hence it was only face-validated for content validity by two mathematics education experts, and also one expert in testing and measurement evaluation before it was considered fit to be administered. The feedback indicated that it was free of ambiguity in terms of content, simple in terms of instruction clarity, understandable and answerable within the context of the topic bearing and distance. Based on these attributes from experts' evaluation, the CPRWPBDT was considered valid and reliable for data collection.

The method of the workshop training was think-pair-share and submit, where the participants were grouped following initial class interactive discussions and couching on the tenets of effective teaching, preparation for effective teaching of mathematics, qualities of effective mathematics teachers, and effective lesson planning on teaching bearing and distance. Sample of questions from the lesson plans used in the training are: Find the bearing of (i) X from Y (ii) Y from X, using a given diagram; and illustrate the following using diagrams (i) The bearing of N from M is SSW (ii) The bearing

of B from A is N260E (iii) The bearing of P from Q is 0570. Participants received training on the nature and applicability of these type of word problems, identification of the variables, planning how to solve them, sketching, drawing, analyzing and interpreting the solution and so on. Following the training intervention were few oral evaluation questions which the participants responded satisfactorily. Thereafter, the participants were administered the CPRWPBDT first at the individual level to study. Second, they were made to seat in groups ranging from seven to ten individuals per group to construct the two required problems individually being the study goal. Third, each group was made to brainstorm on what to do, how to do it from their individual reasoning and thinking; and later worked together as a group to construct the two required problems and submit same based on their agreement. The time allowed was 30mins. Fourth was class presentations by selected group representatives, and fifth was class discussion of presentations presided by a facilitator.

The two problems constructed by each individual participant at the second stage of the think-pair-share and submit based on the administered CPRWPBDT were collected and scored for each participant. Firstly, frequency count was utilized to obtain the scores relative to rates of submission, use of context, correctness of expressions, units, symbols and representation, and difficulties/errors in percentage. Secondly, each of the two problems was scored 50 marks on an interval scale with a maximum score of 100 percent for each participant following a planned essay marking method and accuracy format cum marking scheme.

Analyzing of Data

The data collected was analyzed using descriptive, and inferential statistics mainly percentage and mean for analyzing the research questions, and one-way analysis of variance (ANOVA) for testing the hypotheses at 0.05 level of significance. The choice of percentage and mean as fitting for analysis of the research questions at the first level was due to the need to examine the frequency, rate and the level with which the respondents were able to construct the tasks required within contexts in terms of classified types, completion, correctness, difficulties and the typical errors. The choice of one-way ANOVA on the other hand as fitting for testing the hypotheses at 0.05 level of significance was due to the fact that the data second level was scored for correct and accurate construction on an interval scale as the sample population was drawn and observed independently with construction efficacy as dependent variable and problems direction as the independent variable.

Results

The results of the study are presented using tables followed by brief explanations.

Table 1. Presentations of Constructed Practical/Realistic Problems on Bearing and Distance

Zone	Topic	Groups Formed	Problems Expected	Problems Submitted	Presentation
North	Bearing/ Distance	9	18	14 (77.78%)	7 (77.78%)
Central	Bearing/ Distance	8	16	16 (100%)	8 (100%)
South	Bearing/ Distance	7	14	12 (85.72%)	7 (100%)
Total		24	48	42 (87.50%)	22 (91.67%)

Table 1 revealed that groups totaling 24 were formed from the three zones north, central and south but 22 (91.67%) groups completed the tasks (42 problems submitted being 87.50%) and presented it during whole class interaction. This means within time limit, 42 out of 48 problems were initiated, constructed and presented for discussion. Groups from the north and south failed to submit a complete set of the problems implying that the teachers could not work within time limit to complete their work.

Table 2. Practical/Realistic Bearing/Distance Word Problems Constructed from Contexts

	Topic	Problem	Number within Context	Number Outside Context
1	Bearing and Distance	1	14 (63.64%)	8 (36.36%)
2	Bearing and Distance	2	17 (77.27%)	5 (22.73%)
Total		2	31 (70.45%)	13 (29.55%)

Table 2 revealed that for the two (2) practical and realistic word problems in bearing and distance required, 31 (70.45%) were done within the contexts in real life, and 13 (29.55%) were constructed outside contexts in real life. This suggests approximately 30% of the participants could not construct good practical and realistic word problems covering bearing and distance from real life situations.

Table 3. Correctness of Practical and Realistic Word Problems in Bearing and Distance Relative to Expression, Units, Symbols, Demand and Representation

Topic	N	$\bar{x}$	Std.	Problem	Correctness	Percentage	Remark
Bearing/Distance	292	37.73	3.87	1	E15, U20, S17, D19, R12	75.45%	Very Good
Bearing/Distance	292	41.37	2.56	2	E19, U20, S19, D19, R14	82.73%	Very Good

Key: E= Expression, U=Units, S=Symbols, D=Demand, R=Representation

In Table 3, the correctness of the practical and realistic bearing and distance word problems 1 and 2 was very good since the percentages are more than 75% each relative to using good and relevant expressions, units, symbols, demand and appropriate representation. However, the correctness of constructing problem 2 (82.73%) is better than problem 1 (75.45%) probably due to better thinking, reasoning and reviews. Also, the construction of problem 2 with a mean score of 41.37 and a standard deviation of 2.56 is better than problem 1 with a mean score of 37.73 and a standard deviation of 3.87. Nevertheless, combining the construction of problems 1 and 2, the mean score for the correctness is 79.10 with a standard deviation of 3.21. This implies a good performance on the average.

Table 4. Difficulties/Errors in Constructing Practical/Realistic Bearing/Distance Problems

Dimension	Difficulties/Errors	Percent (%)	Remark
Expression	Reckless and careless omission of units, unnecessary use of arbitrary letters outside context, lack of 3-digit figures, use of 60° instead of 060°, incomplete sentences - some without question marks, misuse of commas, full stop, misuse of capital letters and small letters, wrong spellings e.g. class-room instead of classroom, unwanted shortcut e.g. dist instead of distance, cal instead of calculate, lack of spatial reasoning e.g. using km for short distances from hostel to dining hall, one group to another in same hall, use of unfamiliar acronyms e.g. GCP, FCE	22.73% (100-77.27)	Very Good
Context	wrong location and movement within the context, use of places outside the class, school and community against the instruction, e.g. Qua'an pan, langtang, namu, kwande, Barkinciyawa, vague and out of context problems e.g. a farmer with a piece of land 40km from point A on a bearing of 60° to B and he move…	26.91% (100-73.81)	Very Good
Reality	Lack of spatial reasoning and imaginative thought in distances and use of units e.g. km for short distances within school like from hostel to dining hall and classroom, use of unfamiliar acronyms to represent object, places make it abstract	40.90% (100-59.10)	Good
Notation	Improper use of notations in some cases e.g. 60° instead of 060°, N60°E instead of N060°E, 085°NE instead of N085°E or 085°, 105°SE instead of S105°E	13.64% (100-86.36)	Very Good
Sketching	Wrong sketching and illustration e.g. no angular movement indicated, poor representation e.g. he for student as if it were unisex, a student - how far is he instead of how far is the student.	65.90% (100-34.10)	Very Poor

Table 4 revealed that teachers encounter some difficulties as well as make minor errors in many aspects in constructing practical and realistic word problems for teaching bearing and distance. Majority has to do with sketching (65.90%) and reality (40.90%) which were conceived and done poorly.

Table 5. ANOVA on Construction of Practical/Realistic Word Problems in Bearing/Distance

	Sum of Squares	df	Mean Square	F	Sig
Between Groups	6.400	1	6.400	.800	.397
Within Groups	64.000	8	8.000		
Total	70.400	9			

From Table 5, the variations in constructing practical and realistic word problems in bearing and distance is not statistically significant since p=0.05<0.397 at $F_{(1, 8)}$ with $F_{cal.}$=0.800. This suggests that taking one constructed problem after another in bearing and distance, there exists the likelihood of similarity in ability of mathematics teachers to initiate and generate them from situations in real life.

Table 6. ANOVA on Difficulties/Errors in Practical/Realistic Word Problems in Bearing/Distance

	Sum of Squares	df	Mean Square	F	Sig
Between Groups	14.400	1	14.400	.983	.351
Within Groups	117.200	8	14.650		
Total	131.600	9			

Table 6 revealed that the variations of the difficulties or errors in constructing practical and realistic word problems in bearing and distance is not statistically significant given that at 0.05 level of significance, p=0.05<0.351 at $F_{(1, 8)}$ with $F_{cal.}$=0.983. This means that from one problem to another constructed in bearing and distance, teachers are most likely to encounter similar difficulties and make similar errors in solving them but the difficulties and the likely errors are not supposed to be a major concern because of the insignificance.

Discussion

This study was mainly premised on promoting skillful and effective mathematics teaching and learning perceived to be poorly carried out by mathematics teachers; the need to improve the performance of students in mathematics said to be below the expected standard in the senior school certificate examination conducted by WAEC; and the need to mitigate the problems by initiating, providing and solving practical and realistic word problems among other things (Bot, 2011; FME, 2006; Uloko & Imoko, 2007; WAEC, 2013, 2014, 2015, 2016, 2017). The focus of the study on bearing and distance was because of its importance in applying mathematics to many subject areas, courses and disciplines such as navigation, astrology, survey, exobiology, geography, cartography and physics but many teachers find it difficult to construct and teach suitable and relevant problems from real life to make the learning less abstract and beneficial to their students.

It is generally believed that the training an individual gets further on-the-job at any given level of engagement or education is capable of impacting positively on the way and manner which a profession or assignment is carried out. Similarly, the knowledge mathematics teachers possess initially and through further training should form the basis of understanding and hence teaching of mathematics effectively (Tuna, 2013). In order to promote effective teaching of mathematics in the secondary school, therefore, further training on-the-job is direly required of teachers. In like manner, effective teaching of bearing and distance can be enhanced significantly when the teachers are exposed to the concepts holistically especially on how to evolve with and solve real life situations albeit practical problems from surrounding and immediate school environment as against imaginary textbook problems being used haphazardly. Except this measure is taken genuinely through in-service training provision for teachers, it would be a difficult task to achieve. Thus in this study, specific attention regarding construction of bearing and distance problems was paid to the types and dimension, analysis, difficulties and the typical errors associated with the process.

Consequent upon this, the findings of the study revealed that mathematics teachers can construct from the surrounding and immediate school environment practical and realistic word problems in bearing and distance to a large extent after workshop training giving their tasks completion rate of 91.67% (Table 1), and where for instance 70.45% of the problems were within context (Table 2). However, Table 3 revealed that in spite of this feat, the correctness vary from one problem to another with problem number two (2) constructed better than problem number one (1) [i.e. 82.73% against 75.45%] in terms of good relevant use of expressions, units, symbols, questioning or demands and proper representation.

In a similar vein, Table 4 revealed that mathematics teachers can construct practical and realistic word problems in bearing and distance but not without some difficulties and minor errors in the process especially in sketching (65.90%) and relating the problems to real life or in reality (40.90%). In other words, teachers make some mistakes while initiating, posing, analyzing and solving practical problems which affect their students during examination. This concurs with the remarks of the chief examiners for WAEC (2015, 2016, 2017, 2018), and Wonu and Zalmon (2017) that difficulties and errors occur in solving the examination questions involving bearing/distance by candidates such as misunderstanding of concepts, terms and symbols; poor sketching, drawing and labelling diagrams; and poor interpretation of results. This unfortunate development has been attributed solely to students' weaknesses due to their negative disposition and poor mathematics background for years in the secondary school in Nigeria, but it is evident as the findings of this study would show that mathematics teachers cannot be exonerated and bulwarked. This implies that students' errors and difficulties in mathematics generally are not the result of their effort only but how and what they are taught by their teachers in class that affects them during examination. If the subject is taught very well by a good teacher and the knowledge is grasped properly, students will not experience any sort of weakness but if the subject is poorly taught by a teacher with poor subject matter and content knowledge, it will definitely reflect on the performance of students. Moreover, teachers are said to impact on students' performance from their subject matter knowledge, knowledge of content and teaching, and knowledge of content and students since these form the basis of their instructional practices (Lee et al., 2018). However, some teachers do have insufficient knowledge to deal with various mathematics problems which creates misconceptions, misunderstanding and mistakes among students being

prepared for assessment and examination in mathematics. Thus it is no wonder that Lee et al. (2018) underscored the importance of professional development for teacher pedagogical knowledge and subject matter versus content knowledge development toward effective problem solving.

Table 5 revealed that the variations in construction of practical and realistic word problems in bearing and distance is not statistically significant; and Table 6 revealed that the variations of the difficulties and or errors involved is not statistically significant as well. This simply implies that given opportunity for construction of more practical and realistic word problems in bearing and distance, not much differences will manifest in the use of good and relevant expressions, symbols, units, questioning demand and representation; and similar level of difficulties and or errors will be obtained in the process irrespective of the types and dimensions of the problems constructed. However, with several reviews, there is likelihood for the difficulties and errors to reduce drastically with large amount of constructed problems. This suggests that mathematics teachers need more in-service workshop training to be able to conceptualize and build better problem solving and construction skills and competences in order to construct error-free problems. This is in tandem with the suggestions of Fresko and Ben-chaim (1986) that there should be frequent in-service training of mathematics teachers to update their knowledge who in turn will use the updated knowledge and skills to help students learn and achieve better results in mathematics. Also, it is in tandem with Boyd et al., (2008), Clotfelter et al., (2007), Obioma (2008) and Omar (2014) that teachers need to be exposed to more and frequent in-service training because of the benefit to them and their students in terms of improved teaching, learning and performance and by implication disposition. It is also in agreement with other researches which largely stressed the need to encourage teachers to participate actively in workshops training on mathematics regularly because of the gigantic impact on students' performance from teacher interaction with one another besides having increased knowledge of subject matter, confidence and competence to utilizing new student-centered approaches (Ramatlapana, 2009; Sifuna & Kaine, 2007).

Furthermore, mathematics teachers require more of in-service workshop training in agreement with Nabie et al. (2018) to develop the ability to reduce the abstract nature, reduce the level of difficulty and make the subject less boring for students. According to the authors, this will help promote students' cognitive skills growth in order to be able to squarely respond to conceptual problem situation including the ability to explore, connect and relate mathematics to different situations and disciplines. Akkoc and Akbas-Gul (2010) contended that trained teachers who understand the concept of bearing and distance for instance will be able to assist their students to understand and apply the knowledge without the students experiencing difficulties and developing misconceptions unduly. Also, for students to keep building knowledge, develop new ideas and experience according to the theory of constructivism, they need knowledgeable and experience teachers (Takele, 2020), and so also, for teachers to apply student-centered approaches in teaching in the present circumstance for improved performance, they need in-service training (Musyoka, 2011). In all of these, in-service training of mathematics teachers is needed and as demonstrated in the findings of this study that there is no significant variations in problems initiation, posing and construction including difficulties and errors due the concept of bearing/distance, it is important therefore that mathematics teachers receive such training on regular basis to be more effective in handling mathematics most especially in teaching of preconceived abstract and difficult-to-teach concepts including bearing and distance in the secondary school.

Conclusion

The importance of mathematics in the development of any nation cannot be overemphasized. Similarly, the need for mathematics teachers to regularly train and acquire more knowledge on effective means of teaching for improved achievement and performance of students cannot be overemphasized in the quest for scientific and technological development of Nigeria and its citizens. Consequent upon the findings of this study, the construction of practical and realistic word problems by mathematics teachers is essential in promoting effective and efficient mathematics instruction toward enhanced conceptual development, achievement and improved performance among students. In particular, the study demonstrated that mathematics teachers can construct at least two practical and realistic word problems in bearing and distance with at least 70.45% within contexts and at least 75% correctness in the use of good and relevant expressions, units, symbols, and appropriate representation. The correctness varies from one problem to another due to better thinking and reasoning skills utilized, and potential reviews that could be made. However, this was not without some difficulties encountered and minimal errors committed in the process especially in sketching and illustration. Constant in-service workshop training of mathematics teachers is, therefore, necessary to eliminate some of these limitations and overall achieve the goal of teaching and learning of bearing and distance.

Recommendations

Based on the findings from the study, the following recommendations are made:

1. Mathematics teachers should be exposed to regular in-service workshop training to develop essential skills and competences in constructing practical and realistic word problems in bearing and distance by the government and recognized mathematics associations in Nigeria. The mathematical association of Nigeria

should increase its effort in organizing more of such workshops for mathematics teachers to be supported by the government.

2. Mathematics teachers should avoid errors and or any difficulties associated with constructing practical and realistic word problems in bearing and distance for effective teaching and learning to take place in their classrooms.

3. Since the variations in constructing bearing and distance word problems and the errors and or difficulties involved in attempting the solutions are not statistically significant, there is dare need for mathematics teachers to continue engaging in constructing more related problems with clear sketching and solution processes, strategies and techniques. This will help improve their competences and boost their interest and motivation in teaching mathematics.

4. One of the main concerns of mathematics teachers is to see to the improvement of students' achievement and overall performance towards meeting state and national expectations. Thus mathematics teachers should be encouraged by their principals and government with proper funding to undergo regular in-service training to be able to improve on their knowledge, skills, principles and techniques of constructing and resolving practical and realistic word problems in other aspects of mathematics in the secondary school.

Limitations

The present study is not without some limitations which could be addressed in a further research study. The sample was restricted to mathematics teacher participants on in-service training workshop which represented only 35.48% of the entire population studied. Thus purposive sampling technique was used instead of random sampling thereby making the sample less representative. A researcher-designed instrument with clear direct instruction on what respondents were expected to do within the immediate environment rather than based on their broad knowledge of the contents of bearing and distance was employed for data collection. This must have placed a limitation on the ability of some of the teacher participants albeit sample to use their wide proficiencies in constructing and investigating the questions from diverse background in mathematics skills, experience and knowledge. Also, only two practical problems were used in the study owing to insufficient time. This could have affected the outcome of the study since it is possible some teacher participants could require sufficient time to be able to answer mathematics application questions outside their place of primary assignment. Additionally, there is a dearth of research studies on pedagogy underpinning effective mathematics instruction related to the teaching and learning of bearing and distance in the secondary school. This makes it difficult for the use of up-to-date literature on the subject matter.

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