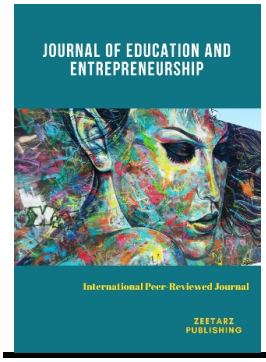

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The Use of Mathematical Games and Secondary School Students' Achievement in Mathematics in Fako Division, South West Region of Cameroon

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Abstract

This study investigated the effect of mathematical games on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon. The target population comprised of 4,224 form five students from the Secondary schools in Fako Division. The accessible population was made up of 188 students and the sample size of the study was made up of 100 students from two colleges using the multistage sampling technique. The statistical analyses and findings revealed that mathematics teachers do not use mathematical games to teach mathematics in secondary schools in Fako Division of the South West Region in Cameroon. It was recommended that mathematics teachers in Cameroon should use mathematical games such as tic-tac-toe, dots and boxes, playing cards, dice games, ludo games and so on to teach mathematical concepts that are difficult and abstract so as to enhance socialization amongst learners, class participation, arouse and sustain interest, and achievement in class and public examinations in mathematics and the mathematical sciences.

Keywords: Mathematical Games, Students' Achievement, Fako Division, Cameroon.

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Mathematics is the science of structure, order, and relation that has evolved from counting, measuring, and describing the shapes of objects. It deals with logical reasoning and quantitative calculation. Since the 17th century it has been an indispensable attachment to the physical sciences, social and management sciences and technology, to the extent that it is considered the underlying language of science. It is for this reason that mathematics is universally called the *Queen* and *Servant* of the sciences so it must be taught well (Nekang, 2011).

Instructional materials are ingredients that make teaching and learning of mathematics pleasant and satisfying. Today's successful teacher of mathematics is able to communicate ideas, build students curiosity through the use of instructional materials. Mathematics is an abstract logical science therefore mathematics teachers have special need for instructional materials which lend reality to abstract ideas. Mathematics teachers think in terms of tangible and visual representation such as sketches, models to concretize ideas. Such materials like mathematical games generate and sustain interest in mathematics teaching and learning if well selected and used (Nekang, 2011; Harbor-Peters, 2001).

Mathematics has not secured its rightful position in the mind of students due to the lack of interest as a result of poor tuition and aversions (the teaching and learning processes which may lead to failure). Eba (1985, p.29) stated that mathematics has been a threat to students because of problems associated with its instruction. Eba rightfully said that:

> *The main reason why so many students hate mathematics, and why so many fail in it, is because of poor tuition. In many cases, teachers teach mathematics in a rather abstract way because of inadequate preparation, poor teaching methods and lack instructional materials.*

Agbor-Etang cited in Nsuh (1991), acknowledged the existence of problems in the teaching of mathematics in Cameroon when he observed that some of the main problems in science teaching are in mathematics teaching. Agbor-Etang added that these problems affect both the future professional mathematicians and are also of great concern to the physicist, statistician, engineer, economist and sociologist. Harbor-Peters (2001) defined instructional method as a path followed in communicating knowledge with the view of securing the best individual result. This has to do with the manner in which mathematical knowledge is communicated to the students. Since there are individual differences of the learners, there is the need for a teacher to vary his/her methods of presenting similar ideas in order to dispel boredom and generate interest. The following instructional strategies (anti-aversions) have also been developed and examined:- delayed formalization, target task, project, use of computer, improving mathematical readability, use of andragogical inquiry, use of games and simulations, ethno-mathematical approach, use of concept maps, use of problem-solving strategies and models, and so on (Harbor-Peters, 2001).

The concept of mathematical games as a teaching technique

Harbor-Peters (2002) defined instructional game as a structured activity with set rules for play in which two (2) or more students interact under clearly designed instructional objectives. In a typical game, participants make decisions as if they are in actual situation. There is something enjoyable, however serious, involving competition for specified objectives and observing rules. Games require strategies, tactics and initiative from players (students). Hence, there must be a winner. Games are valuable for encouraging social skills, stimulating mathematical discussion, developing strategies for learning new concepts,

reinforcing skills and concepts as an aid to symbolization and logic, and for helping the development of mathematical understanding.

Rutherford (2015) opined that people of all ages love to play amusing and inspiring games that may arouse their interest to learn and discover new ways of doing things. Mathematical games help students to explore elementary number concepts such as the counting sequence and series, number and numeration, basic number operation, one-to-one correspondence, and computation strategies. Engaging mathematical games can also encourage students to explore number combinations, place value, patterns, arithmetic processes and other important mathematical concepts. Also, mathematical games help students to deepen their mathematical understanding, reasoning, and applications such in sets and logic, measurement, geometry, trigonometry, graph, probability and statistics. Teachers should provide frequent opportunities for students to play games, and then let the mathematical ideas show up as students discover new patterns, relationships, and strategies.

The greatest strength of games in mathematics teaching and learning is in the ability of a game to provide drill and practical application. Thus, students learn and perfect their mathematical skills in play-way which removes aversion. Aversions in mathematics consist of the teaching and learning processes which may lead to fears and failure. Examples of mathematical games are: Dice or ludo game and coin game for probability; Geoboard games for geometric concepts, for angles, identifying and differentiating polygons, describing and locating coordinate points; Coordinate game for Cartesian plane and coordinates; Card game for elementary number concepts, arithmetic processes especially addition, simplifying algebraic expressions, ordering fractions, geometric concepts, probability and randomness and so on (Nekang, 2016).

The values of Mathematical Games in Teaching and Learning

1. Games provide enjoyment and recreation and at the same time, stimulate mathematical thinking. Playing games encourages strategic mathematical thinking as students find different strategies for solving problems and deepen their understanding of numbers.
2. They are used to ascertain the previous experience students have and the extent to which concepts have developed. Games present opportunities for practice, often without the need for teachers to provide the problems. Teachers can then observe or assess students and work with individuals or small groups of students.
3. To strengthen the knowledge of colour, size, shape and thickness before counting starts in primary one.
4. To reinforce what has been taught in class. Games have the potential to allow students to develop familiarity with the number system and with “benchmark numbers” (such as 10s, 100s, and 1000s) and engage in computation practice, building a deeper understanding of operations.
5. A motivating factor especially for slow learners, below average students and dyscalculics. Dyscalculia is an impairment of the ability to solve mathematical problems, usually resulting from brain dysfunction. Games support a school-to-home connection. Parents can learn about their children’s mathematical thinking by playing games with them at home.
6. The kind of concentration and skill needed often lead to discovery and creativity, for example, geometrical shapes.
7. To satisfy the love of meeting a challenge.

8. Use to refresh one's thinking when they are played for enjoyment, amazement, delight and recreation.
9. To create beauty for example, a student can make a pattern of triangles or numbers or construct a sequence of shapes: 1, 1+3, 1+3+7, 1+3+7+13, … (mathematics as an aesthetic).
10. When played repeatedly, games support students' development of computational fluency. (Harbor-Peters, 2001; Rutherford, 2015; Nekang, 2016).

Fluency requires a balance and connection between conceptual understanding and computational proficiency. Computational methods that are over-practiced without understanding (algorithmic learning) are forgotten or remembered incorrectly which also leads to failure. Conceptual understanding without fluency can inhibit the problem-solving process [National Council of Teachers of Mathematics (NCTM), 2000). Developing computational fluency in mathematics should be a role, principle, and duty for all the teachers and stakeholders of mathematics and the mathematical sciences. Mathematical games provide opportunity for meaningful practice, and problem-solving. Recent researches about how students develop fact mastery indicate that drill techniques and timed tests do not have the power that mathematical games and other experiences have. Appropriate mathematical activities like meaningful practice and problem-solving are the major foundations to develop mathematically proficient students who can demonstrate computational fluency. Computational fluency includes efficiency, accuracy, and flexibility with strategies (Russell, 2000).

The Demerits of Mathematical Games in Teaching and Learning

1. It is time consuming.
2. It can be a source of aversion. Make sure the game matches the mathematical objective.
3. It can make a class noisy. Keep the classroom discussion to a controllable noise level.
4. Avoid being passive. The number of players or members of a group should not exceed five, this is for participation reasons.
5. Weak students may become weaker. Rotate the role players else weak students will be left out (Harbor-Peters, 2001; Nekang, 2016).

Sometimes teachers use games solely to practice number facts. These games usually do not engage children for long because they are based on students' recall or memorization of facts. Some students are quick to memorize; others need a few moments to compute a related fact. When students are placed in situations in which recall speed determines success, they may infer that being "smart" in mathematics means getting the correct answer quickly instead of valuing the process of thinking. Consequently, students may feel incompetent when they use number patterns or related facts to arrive at a solution and may begin to dislike mathematics (mathematicsphobia) because they are not fast enough (Rutherford, 2015).

Statement of the Problem

There is a general impression that mathematics is difficult by its very nature. Students believe that mathematics is highly structured and that it is so abstract that its study requires special intellectual talents. Some see the subject as something mysterious that is to be feared and even believe that mathematicians are mad. The inherent notion held by many Africans, particularly Cameroonians is that mathematics is a very difficult subject that is capable of making one mad. This may be the centre of the phobia (mathematicsphobia) which students exhibit for mathematics and the mathematical sciences and which has claimed many

casualties over the years. The nature of mathematics is such that it demands a lot of thinking from its learners; critical thinking, postulational and analytical thinking which require a lot of time. Nevertheless, not many students possess the patience to think properly. They lack the perseverance required in solving mathematical problems. Also, mathematics is a language of size and order and it is symbolic in nature which make students consider it a difficult subject. Unfortunately, mathematics has not secured its rightful position in the mind of students in Cameroon due to the lack of interest as a result of poor tuition, aversions, and the fact that students have developed negative attitude towards mathematics. The problem of this study therefore is: To what extent does the use of mathematical games affect secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon.

Objectives of the Study

The study sought to investigate the use of mathematical games affect secondary school students' achievement in mathematics. Its objectives are to determine (1) the effect of the tic-tac-toe mathematical game on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon; (2) the effect of the dots and boxes mathematical game on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon; (3) the effect of the playing card mathematical game on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon; (4) the effect of the dice mathematical game on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon.

Scope of the Study

Geographically, the study was delimited to selected secondary schools in Fako Division, in the South West Region of Cameroon. The secondary schools considered in the study were public schools, confessional schools and lay private schools in Fako division. Content wise, the study was delimited to the use mathematical games and their effects on secondary school students' achievement in mathematics. Specifically, the use of the tic-tac-toe, dots and boxes, playing cards, and dice mathematical games and their effect on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon.

Methodology

The following are the steps or procedures used to investigate the extent to which the uses of mathematical games affect secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon.

Research Design

A research design describes how data relating to a given problem should be collected and analyzed. Cooper and Schindler (2001) defined research design as a blue print for the collection, management, and analysis of data. The research design used for this study was the survey research design. This research design was used because it involved just a portion of students from two schools chosen through a multistage sampling technique. The researcher used form five students because it is believed that they have spent at least four years in secondary school and would have likely passed through more than one Mathematics teacher. According to Nworgu (1991), a survey research is one in which a group of people or items is studied by collecting and analyzing data from only a few people or items considered to be representative of the entire group. The survey plan or survey design is specifies how such data will be collected and analyzed.

Area of the Study

This research was carried out in Fako Division of the South West Region of Cameroon. The South West Region is one of the two Anglophone (English speaking) Regions of Cameroon and its capital is Buea with an area of 25,410km2 with a population of 1,481,433 inhabitants. The South West Region is divided in to six administrative divisions, viz: Fako, Ndian, Lebialem, Koupe-Manenguba, Meme and Manyu. The divisions are further divided into subdivisions. Fako division is made up of six sub-divisions (Tiko, Muyuka, Buea, Limbe 1, 2, 3) and covers an area of 2093km2. Fako Division has a total population of 534,854 (Statoids, 2004). Fako Division was considered the area of interest for the researcher because of its multiplicity of schools from primary to tertiary.

Population of the Study

The target population of this study comprised of 4,224 form five students from the secondary schools in Fako Division. The accessible population was made up of 188 students and the sample of the study was made up of 100 students from two colleges drawn using the multistage sampling technique.

Sample and Sampling Technique

The questionnaires were administered to 100 form five students of the two selected secondary schools in Fako Division. The systematic sampling technique was used to select the respondents who took part in the research from the two selected secondary schools. According to Amin (2005), systematic sampling is one in which every k^{th} element of the sampling frame is selected. As such, the researcher used the class lists in each of the form five classes to draw the required sample. A roll call was first conducted to ensure that all the respondents in the class were present. In a situation where some students were absent, a re-ordering of the respondents was done following the order of names on the class list. The first respondent was drawn by a simple random sampling technique between the first and second students on the class list. The rest were obtained by selecting the corresponding respondents who occupy the appropriate number positions on the list till the 50 respondents were gotten. This technique was used by the researcher to minimize bias such that each respondent had a fair chance of taking part in the study.

Method of Data Collection and Analysis

The questionnaire constructed was based on the objectives of the study. The 4-point Likert type scale was used to construct the questionnaire items with each item having four options (Strongly Agree, SA=4, Agree A=3, Disagree, D=2 and Strongly Disagree, SD=1). The questionnaire was face and content validated. The technique used for administration in this study was the direct delivery technique. With permission from the Principals of the selected institutions, the Vice Principals and Deans of Studies assisted greatly in the effective administration of the instrument. Students were met in class and were reminded of the anonymity of their responses, the objectivity and sincerity while filling the questionnaires. Besides, they were advised to work independently. All the necessary explanations concerning the questionnaire were made to the respondents at the beginning of the exercise. The respondents were then given enough time to fill their copies after which they were collected, giving a return rate of 100%. The statistical method that was used to analyze the data collected for the study were descriptive statistics (mean scores and standard deviations) to answer the research questions and the Chi-square (x^2) test of independence to test the hypotheses.

Results

Research Question one: What is the effect of the tic-tac-toe mathematical game on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon?

Decision Level: $\bar{x} = \frac{4+3+2+1}{4} = \frac{10}{4} = 2.5$

Respondents agree or accept with the opinion expressed in the item if the mean score is 2.5 and above. Otherwise, they disagree or reject.

Table 1: Opinion of respondents on the tic-tac-toe mathematical game

Item	SA	A	D	SD	$\bar{x}$	s	Dec
1. My mathematics teacher always teach in class while demonstrating with the use of tic-tac-toe.	10	15	25	50	1.85	1.02	D
2. My mathematics teacher always teach us how to use tic-tac-toe in class.	06	18	22	54	1.76	0.95	D
3. My mathematics teacher know how to teach with the use of tic-tac-toe.	12	18	22	48	1.94	1.07	D
4. I always ask to use tic-tac-toe to explain mathematical concepts in class.	15	11	24	50	1.91	1.10	D
5. My mathematics teacher always use tic-tac-toe to explain mathematical concepts in class.	11	15	22	52	1.85	1.05	D
6. My mathematics teacher always use tic-tac-toe for addition and subtraction in class.	09	19	21	51	1.86	1.03	D
TOTAL	**63**	**96**	**136**	**229**	**11.17**	**6.22**	
AVERAGE					**1.86**	**1.03**	**D**

Where, $\bar{x}$ = Mean score, s = Standard Deviation, Dec. = Decision, and A = Accepted

The findings show that mathematics teacher always teach in class without demonstrating with the use of tic-tac-toe mathematical games, they do not teach the learners how to use the game, they do not use tic-tac-toe mathematical games to explain mathematical concepts and for problem-solving in class ($\bar{x}$ = 1.86 ± 1.03). From the statistical analysis, since the calculated value (x^2 = 236.24) is greater than the critical value (x^2= 31.53) with df = 18 at $p \leq 0.05$ level of significance, we reject the null hypothesis (Ho_1) and conclude that the tic-tac-toe mathematical game has a significant effect on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon. This implies that the use of the tic-tac-toe mathematical game can greatly influence students' socialization, achievement and interest in mathematics in Fako Division in the South West Region of Cameroon while the absence or nonuse of the game can negatively affect performance.

Thota et al. (2004) stated that the friendliness of Tic-tac-toe (TTT) games makes them ideal as a pedagogical tool for teaching the concepts of socialization amongst the students. The

game is a very good brain exercise for mathematics students because it involves looking ahead and trying to gain increased responsibility of the next action especially in problem-solving.

Research Question two: What is the effect of the dots and boxes mathematical games on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon?

Table 2: Opinion of respondents on the tic-tac-toe mathematical game

Item	SA	A	D	SD	$\bar{x}$	s	Dec
1. My teacher comes to class with dots and boxes whenever he needs it to teach.	12	19	24	45	1.98	1.06	D
2. My mathematics teacher draws dots and boxes on the board while teaching some concepts.	34	28	18	20	2.76	1.13	A
3. My mathematics teacher always explains why dots and boxes are used to teach.	21	26	16	37	2.31	1.18	D
4. My mathematics teacher teaches well with the use of dots and boxes.	22	26	22	30	2.4	1.14	D
5. My mathematics teacher sends students to the board or in front of the class to go and explain concepts with the use of games.	27	30	28	15	2.69	1.03	D
6. With the use of dots and boxes, it has help me to improve on my performance in mathematics.	25	24	18	33	2.41	1.19	D
TOTAL	**141**	**153**	**126**	**180**	**14.55**	**6.73**	
AVERAGED					**2.43**	**1.12**	

Where, $\bar{x}$ = Mean score, s = Standard Deviation, Dec. = Decision, and A = Accepted

The findings show that mathematics teachers go to class without dots and boxes but they draw dots and boxes on the board while teaching some concepts. Mathematics teacher hardly sends students to the board or in front of the class to go and explain concepts with the use of games. The use of dots and boxes has not helped learners to improve on their performance in mathematics ($\bar{x} = 2.43 \pm 1.12$).

From the statistical analysis, since the calculated value ($x^2 = 52.32$) is greater than the critical value ($x^2 = 31.53$) with df = 18 at $p \leq 0.05$ level of significance, we reject the null hypothesis (Ho_2) and conclude that the dots and boxes mathematical games have a significant effect on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon. This implies that the use of the dots and boxes mathematical games can greatly influence students' practice, achievement and interest in mathematics in Fako Division in the South West Region of Cameroon while the absence or nonuse of the games can, to a very great extent, negatively affect performance. Dots and boxes is a good mathematical game in which learners need to practice a 'plan ahead' strategy especially when assisted by an instructor. Teachers always want to emphasize planning ahead in various decision making and problem-solving (Moursund, 2007).

Research Question three: What is the effect of the playing card mathematical game on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon?

Item	SA	A	D	SD	$\bar{x}$	s	Dec
1. Our school has a mathematical laboratory.	04	16	19	61	1.63	0.90	D
2. My mathematics teacher always takes us to the laboratory when he wants use playing cards to teach some mathematical concepts.	05	10	24	61	1.59	0.87	D
3. When explaining some concepts that use games, my mathematics teacher uses playing cards to explain the concepts.	06	15	24	55	1.72	0.93	D
4. My teacher uses playing cards to teach topics like probability.	11	15	21	53	1.84	1.05	D
5. My mathematics teacher knows how to explain concepts with the use of playing cards.	05	15	20	60	1.65	0.91	D
6. Playing cards have helped me to understand probability so well and I cannot face problems when answering questions.	15	20	35	30	2.20	1.10	D
7. With the use of mathematical game, it has help me to improve on mathematic	14	29	12	45	2.12	1.13	D
TOTAL	**60**	**120**	**155**	**365**	**12.75**	**6.89**	
AVERAGE					**1.82**	**0.98**	
D							

Table 3: Opinion of respondents on the playing card mathematical game

Where, $\bar{x}$ = Mean score, s = Standard Deviation, Dec. = Decision, and A = Accepted

Findings show that schools do not have mathematical laboratories so mathematics teachers hardly use playing cards to teach some mathematical concepts like probability. Playing cards have not helped learners to improve on mathematics problem-solving since playing card games are hardly used to teach mathematics ($\bar{x} = 1.82 \pm 0.98$).

From the statistical analysis, since the calculated value ($x^2 = 357.6$) is greater than the critical value ($x^2 = 35.48$) with df = 21 at $p \leq 0.05$ level of significance, we reject the null hypothesis (Ho_3) and conclude that the playing card mathematical game has a significant effect on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon. This implies that the use of the playing card mathematical game can greatly influence students' participation, achievement and interest in mathematics in Fako Division in the South West Region of Cameroon while the absence or nonuse of the games can negatively affect performance. Moursund (2007) believes that a two-person game environment facilitates face-to-face communication and companionship in the players which is highly needed in higher thinking processes and problem-solving. The use of "fair" coin, six-sided die, and a deck of card can generate a random sequence of integers and randomness in probability.

Research Question four: The effect of the dice mathematical game on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon.

Table 4: Opinion of respondents on the dice mathematical game

Item	SA	A	D	SD	$\bar{x}$	s	Dec
1. My mathematics teacher always teach us with the use of dice in explaining some concepts.	14	17	26	43	2.02	1.08	D
2. When given an example that contains dice, my mathematics teacher always explains it with the use of the dice mathematical game.	13	18	24	45	1.99	1.08	D
3. Dice mathematical game has helped me to understand the concepts of probability so well.	12	17	24	47	1.94	1.06	D
4. Mathematical games have helped me to improve on my performance in mathematics.	20	27	26	27	2.4	1.09	D
TOTAL	**59**	**79**	**100**	**162**	**8.35**	**4.31**	
AVERAGE					**2.09**	**1.08**	**D**

Where, $\bar{x}$ = Mean score, s = Standard Deviation, Dec. = Decision, and A = Accepted

Findings reveal that mathematics teachers hardly teach with the use of dice to explain some concepts. Dice mathematical games have not helped learners to understand the concepts of probability and have not helped them to improve on their performance in mathematics problem-solving. From the statistical analysis, since the calculated value (x^2 = 74.24) is greater than the critical value (x^2= 23.34) with df = 12 at $p \leq 0.05$ level of significance, we reject the null hypothesis (Ho_4) and conclude that the dice mathematical game has a significant effect on secondary school students' achievement in mathematics in Fako Division in the South West Region of Cameroon. This implies that the use of the dice mathematical game can greatly influence students' achievement and interest in mathematics in Fako Division in the South West Region of Cameroon while the absence or nonuse of the games can negatively affect performance.

The use of dice and other mathematical games in practicing number concepts can improve skills and help reduce anxiety at school. Teachers and parents should not over dwell on it or force these games on the learner(s) since it might make the learner(s) more anxious and may result in mathematisphobia. Learning is easier when kids are happy and relaxed. Mathematical games are important in that they intrinsically motivate and create fun. They should be used as a vehicle to explore joy and fun when teaching and learning problem-solving (Moursund, 2017; Nekang, 2016).

Conclusion

The statistical analyses and findings revealed that mathematics teachers do not use mathematical games to teach mathematics in secondary schools in Fako Division of the South West Region in Cameroon. The absence of motivating teaching strategies and methods is highly responsible for the lack of interest, negative attitude and poor performance in mathematics at all levels of education in Cameroon. The use of mathematical games may be a good way to avert aversions (fear and failure) and the phobia (mathematicsphobia) caused

by difficult topics, the problems of curriculum and policy, gender issues, teacher competency, and the modes of task presentation (Harbor-Peters, 2001).

Recommendations

- Mathematics teachers in Cameroon should use mathematical games such as tic-tac-toe, dots and boxes, playing cards, dice games, ludo games and so on to teach mathematical concepts that are difficult and abstract.
- Teachers should be trained on the creation and use of mathematical games at all levels of education.
- The government and other stakeholders should make available the finances, instructional packages and conditions necessary for the teaching, learning and application of mathematics and the mathematical sciences in technological development and to improve all aspects of life in the contemporary society in Cameroon.

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