EFFECT OF CONCEPT MAPPING ON STUDENTS' ACHIEVEMENT AND INTEREST IN ELEMENTARY PROBABILITY IN CAMEROON

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ABSTRACT

This study investigated the effect of concept mapping on two groups of form five (final year secondary school) students' achievement and interest in elementary probability. It also sought to find out the effects of concept mapping on the achievement of male and female students in probability. A 17-item-essay type Achievement Test in Elementary Probability (ATEP) and a 13-item Probability and Statistics Interest Inventory (PSII) were administered on 154 subjects before and after teaching. The internal consistency of ATEP ($\alpha = 0.70$) and the reliability coefficient of PSII ($\alpha = 0.64$) were computed using the Cronbach Alpha (α) formula. The subjects were randomly drawn from two schools in Bui Division, in the North-West Region of Cameroon. The study lasted for two weeks. Data were analyzed using means and standard deviations to answer the three research questions and a two-way (2x2) analysis of covariance (ANCOVA), to test the two hypotheses stated at $p \leq .05$ level of significance. Results showed that concept mapping enhances students' achievement and interest in probability and statistics in Bui Division in Cameroon. It was recommended among others that concept mapping techniques should be used by all mathematics teachers at all levels of instruction from primary to tertiary. Also, that students should apply the knowledge of concept mapping in other subjects, topics of mathematics, in summarizing their notes or other works and during examinations especially when answering essay-type questions and in self-evaluation.

Keywords: Concept mapping, Achievement, Interest, Elementary Probability, Gender, Mathematics Education, Cameroon.

INTRODUCTION

The tasks of the Mathematics pedagogic offices of the Teachers' Resource Centers (TRCs), the Mathematics Teachers' Association (MTA), the South West Association of Mathematics Teachers (SWAMT), Female Mathematics and Science Association of Teachers (FEMSAT), and the Cameroon General Certificate of Education (CGCE) Board are in running in-service programs, workshops, seminars and symposia on the use of new teaching methods, strategies, textbooks, and teaching aids. In spite of the efforts put forward by the various bodies and the government, performance and interest in mathematics and the mathematical sciences in class and public examinations are still very poor. Some of the factors responsible for this very poor performance include students' lack of interest, curiosity, and commitment to study, inadequate support and encouragement from parents and the government and some aversive aspects. Many fingers of blame are still being pointed at teachers' use of poor and inappropriate teaching methods such as lecture and descriptive methods and the absence of teaching strategies and instructional materials as the principal causes for high failure rate. Also, direct information dissemination methods make students to lose interest, thus perform poorly in mathematics and the mathematical sciences.

Another reason why so many students hate mathematics and why so many fail in it is because teachers teach mathematics in a rather abstract way (Balogun, 1997; Nekang, 2004; 2007). Agbor-Etang cited in Nekang (2004) acknowledged the existence of problems in the teaching of mathematics when he observed that some of the main problems in science teaching are in mathematics teaching. He added that these problems affect both the future professional mathematicians and are also of great concern to the physicists, statisticians, engineers, economists and sociologists. Lo-oh (2005) found that the possible causes of mathematical learning difficulties in Cameroon were the lack of interest, poor academic background, parental influence, societal influence, poor learning environment, poor teaching, attention deficits, lack of mathematical equipment and adolescent problems. Lo-oh's findings also revealed that the different areas of students' mathematical learning difficulties in Cameroon were the understanding of word problems, doing basic arithmetic, understanding steps in mathematics and understanding arithmetic facts. The very poor results recorded in class and public mathematics examinations in Cameroon are testified by the table below.

Table 1: GCE O/L Mathematics Results from June 1997-2007.

	June 1997	**June 1998**	**June 1999**	**June 2000**	**June 2001**	**June 2002**	**June 2003**	**June 2004**	**June 2005**	**June 2006**	**June 2007**
Registered	17928	17839	19810	19330	21503	23199	26977	30412	31870	36993	39961
Sat	12874	13146	17062	17214	19258	19971	23104	28487	30837	36250	39158
Absent	5054	4693	2748	2116	2245	3228	3873	1925	1033	743	803
Passed	2560	1779	3701	3919	3978	3324	4192	10379	5190	8696	7198
Failed	10314	11367	13361	13295	15280	16638	18912	19206	26680	28297	31961
% Passed	**9.89**	**13.53**	**21.69**	**22.77**	**20.66**	**16.64**	**18.14**	**36.43**	**16.83**	**23.99**	**18.38**

[Courtesy: Cameroon General Certificate of Education Examination (CGCE) Board, Bamenda Agency & Nekang and Agwagah, 2007].

Though the mathematics results are so poor, Torto (2003) and Nekang (2004) hold that male candidates perform better than their female counterparts.

To reiterate the gender issue, Torto (2003) conducted a gender comparison of the Science, Mathematics and Technology (SMT) results for June 1995 in Uganda and the June 1996 GCE O/L results in Cameroon. Torto came to the conclusion that with the exception of additional Mathematics where the few girls who participate do well, boys outperform girls in the SMT subjects in Uganda. For the situation in Cameroon, Torto stated that the percentage pass for Biology was 57.35% (Boys =65.50%, Girls = 49.20%); Chemistry was 49.20% (Boys =53.70%, Girls = 44.70%); Physics was 26.00% (Boys =37.20%, Girls =14.80%); Mathematics was 23.80% (Boys =32.80% Girls = 14.80%); and Further Mathematics was 27.90 %(Boys =43.70%, Girls = 21.10%). Torto concluded that the number of students passing SMT subjects has declined over the years in Cameroon. In the "A" level examinations taken at the end of upper secondary, the success rate of girls is again lower. In 1993, the percentage of girls with Grade A in Mathematics and Further Mathematics was 0.4% and 0% respectively as against 4.0% and 3.3% of boys (Torto, 2003). Since this researcher knows no recent gender comparison of SMT results in Cameroon, the researcher like Torto believes that the situation is still the same. The above analyses are in line with the opinion of Harbor-

Peters (2001) that boys have some qualities, which favour their higher achievement and interest in mathematics than girls. According to Harbor-Peters, the gender issue in mathematics has been a source of aversion. Mathematics has been male-stereotyped, especially as mathematics is regarded as abstract and difficult and has attributes which boys are attracted to. Boys are good at risk bearing and handling of difficult situations. Even some teachers feel more comfortable making a boy than a girl understand mathematics. The homely, more reserved, girls are kept away from such difficult tasks (p. 19).

Gwanyama (1992, p.56), had earlier dismissed the myth that mathematics is a subject suitable for boys only, when he said, "… the male and female students taught by the professional mathematics teachers benefited equally".

Agbor-Etang as cited in Nekang (2004, p.30) gave a summary characteristic of good and successful mathematics teachers when he said:

> The ten characteristics of a good mathematics instructor are that he knows his subject matter, is competent and presents well-prepared lectures, relates mathematics to life, encourages students question and opinion, is enthusiastic about mathematics, is approachable, friendly and available, is concerned for students progress, has a sense of humor, is warm kind and sympathetic, and uses teaching aids effectively.

Similarly, Harbor-peters (2002, p.36) explained the teachers' competence in mathematics contents in relation to students' achievement and as a source of interest in mathematics learning when she said that:

> A competent mathematics teacher teaches with confidence and commands the admiration of his/her students. This generates interest in the learner. Every student has a model teacher he/she cherishes and admires. The thought of such a teacher inspires his/her students to want to learn. This generates interest in them. It is therefore necessary that teachers should have mastery of the contents they teach.

Harbor-peters went further to say that mathematics should be charming, fascinating as well as attractive to the learners, the teachers and the users. This means that various structures must be properly put in place (instructional strategies and material, attraction and retention of mathematics teachers). Harbor-peters concluded that since mathematics students of today may become mathematics teachers of tomorrow, they need to be attracted to learn and study mathematics. Similarly, Cockeroft's (1982) asserted that:

> There is no area of knowledge where a teacher has more influence over the attitudes as well as the understanding of his pupils than his professional life. A teacher of mathematics may influence for good or ill the attitudes of mathematics of several thousand young people and

> decisively affect many of their career choices. It is therefore necessary that mathematics should be taught to pupils, but also well taught. All pupils should have the opportunity of studying mathematics in the company of enthusiastic and well-qualified mathematics teachers (p.11).

Elementary probability is a branch of mathematics which deals with the possibilities or chances of events occurring under stated conditions. Probability is a daily observable fact used in life. Some of these frequent events include the tossing of a coin by referees to choose which team to kick off a match, the pool stackers making forecasts of winning teams in football matches, fortune tellers making prophecy to their clients, weather forecasters making predictions of the likelihood that it may rain on a particular day and so on.

Theoretical or mathematical probability is the case of calculating the probability of throwing a head when a coin is tossed or getting a three (3) when a die is thrown or selecting the sex of a child. Empirical or experimental probability is based on the actual event taking place (David-Osuagwa, Anemelu and Onyeozili, 2004). This shows that elementary probability is very important in the contemporary society, though the subject report of the chief examiners of the Cameroon GCE O/L mathematics examination for 2008 showed that elementary probability is one of the problematic topics in the syllabus.

Mathematics educators believe that instructional methods still need a lot of review and amelioration. This believe matches with the argument raised by Jonassen (1996), that students show some of their best thinking when they try to represent something graphically, and that thinking is a necessary condition for learning. Similarly, Pankratius (2002) said that concept mapping was found to be a key to organizing an effective knowledge base. Ausubel in 1968 advanced a theory, which differentiates meaningful learning from rote learning. He believed that students must relate new knowledge (concepts and propositions) to what they already know, and that learning proceeds in a top-down or deductive manner. Ausubel's theory of learning claims that those new concepts to be learned can be incorporated into more inclusive concepts or ideas (advanced organizers) for example, verbal, phrase or a graphic. Ausubel's theory consists of three phases, presentation of an advanced organizer, presentation of learning task or material and strengthening the cognitive organization.

According to Kinchin (2000), concept maps have been said to provide a "window into students' minds". The power behind concept mappings derives from the belief of many researchers and psychologists (Novak and Gowin, 1994; Lawson, 1994 and Buzan 1995) that concepts are ultimately understood through their relations with other concepts. It is therefore a tool for assisting and enhancing many of the types of thinking and learning that we are required to do at school. The use of concept maps as an instructional strategy may go a long way to enhance the achievement and also to arouse the interest of mathematics learners. Teachers who utilize concept mapping for organizing and planning their instruction and who teach their students concept mapping techniques promote learning (Novak and Gowin, 1994).

STATEMENT OF THE PROBLEM

Concept mapping however, is an effective teaching strategy that has been extensively used in mathematics and other subjects out of Cameroon. Since the use of concept mapping had been found effective in enhancing students' achievement in organic chemistry, ecology and genetics, and algebra in Nigeria and in essay writing in Oxford University, there is therefore the need to investigate the effects of concept mapping in mathematics in Cameroon. The problems investigated in this study, posed as a question is: How does concept mapping affect students' achievement and interest in elementary probability in Bui Division in Cameroon?

METHODOLOGY

The target population of the study was the 1200 form five students in the 23 government, mission and lay-private mixed colleges in Bui Division. A total of 154 form five students were drawn from two colleges, using purposive and simple random sampling techniques.

DESIGN OF THE STUDY

The design of this study was the non-equivalent, non-randomized control-group, pretest-posttest Quasi-experimental design. The design according to Ali (1996) is considered appropriate because it establishes a cause-effect relationship between the independent and dependent variables. This design was also adopted because it was not possible to have a complete randomization of the subjects. Thus, intact classes were used as experimental and control groups. The independent variables were teaching method and sex while the dependent variables were achievement and interest.

INSTRUMENTS FOR THE STUDY

Two instruments, an Achievement Test on Elementary Probability (ATEP) and a Probability and Statistics Interest Inventory (PSII), were used for data collection. Five experts, three in mathematics education and two in measurement and evaluation validated the instruments. Try-out tests were administered to ascertain the reliability of the instruments. The instruments were administered simultaneously to twenty (20) form five students in a college in Bui Division. The sample used for trial testing did not constitute part of the study. The Cronbach Alpha (α) formula was used because ATEP consisted of essay type questions. The internal consistency of ATEP was computed at $\alpha = 0.70$. Similarly, the Cronbach Alpha (α) formula was used to establish the reliability of PSII because the items were continuously scored. The reliability coefficient of PSII was $\alpha = 0.64$

CONDUCT OF THE STUDY

The teacher-effect factor was controlled by the fact that two trained teachers were used (research assistants) in the implementation of the instruments under the supervision of the researcher. Teaching started immediately after the pretest in each of the schools. One research assistant used the lesson prepared for the concept mapping technique to teach students in the experimental group. The other research assistant used a traditional lesson to teach students in the control group. Teaching lasted for two week, that is, four periods of forty minutes each (i.e. 40 x 4 x 2= 320 minutes or 5 hours 20 minutes).

The pretest (ATEP and PSII) were given to the two classes (groups) at the same time. This was to avoid the students discussing the test items and also, to avoid leakages. The post-test was carried out at the end of the second week of instruction. The same set of tests used for the pretest was administered to the students as the post-test. The same procedure and conditions used for conducting the pretest were adopted for the post-test.

METHOD OF DATA ANALYSIS

Mean scores and standard deviations were used for analyzing data to provide answers for the research questions. The hypotheses were tested at $p \leq 0.05$ level of significance using a two-way (2 x 2) Analysis of Covariance (ANCOVA). The pretest scores were used as covariates to the post-test scores.

RESULTS AND DISCUSSION

The table below gives information sought to answer research question one which was stated thus: How does the use of concept mapping instructional strategy affect form five students' achievement in elementary probability in Bui Division in Cameroon.

Table 3: The Mean Achievement Scores and Standard Deviations (SD) of ATEP Scores of the Subjects.

	Number	Pre-ATEP		Post-ATEP		
Group	**of Subjects**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain**
Experimental	69	2.29	21.83	54.15	19.09	21.86
Control	85	33.40	20.88	46.78	25.92	13.38
Difference in mean		-1.11			+7.37	

The data shows that the two groups were originally at almost the same level of achievement with a mean achievement score of 32.29 and standard deviation 21.83 for experimental and a mean of 33.40 and standard deviation 20.88 for the control group. For the post-ATEP, the experimental group obtained a higher mean achievement score of 54.15 with a standard deviation of 19.09. The control group obtained a mean achievement score of 46.78 with a standard deviation of 25.92. The difference in the post-ATEP mean scores for the two groups was 7.37 in favour of the experimental group. The mean gain scores for the two groups were 21.86 and 13.38 for experimental and control groups respectively. This signifies that the experimental group benefited more in the lessons. Hence, the concept mapping instructional strategy enhanced students' achievement in elementary probability in Bui Division in Cameroon.

The table below gives the data used to answer hypothesis one which was stated thus: There is no significance difference in the post-test mean achievement scores of the two groups of students (experimental and control) taught elementary probability using concept mapping instructional strategy and those taught using the traditional method in Bui Division in Cameroon.

Table 4: A two-way (2 x 2) ANCOVA Table of Subject Scores in ATEP.

Source of Variation	Sum of Squares	df	Mean Squares	F	Fcv	level
Method	1643.70367	1	1643.70367	22.65	3.91	5%
Residual	10959.48382	151	72.57936305			
Total	12603.18749	152				

The table shows that the $F_{calculated}$ = 22.65 is significantly greater than the $F_{critical}$ = 3.91 with degrees of freedom 1 and 151 for method and residual respectively and at $p \leq .05$ level of significance. Judging from the data available at the $p \leq .05$ level of significance, we reject the null hypothesis (Ho_1) and state that there is a significance difference in the post-test mean achievement scores of students taught elementary probability using concept mapping instructional strategy and those taught using the traditional method in Bui Division in Cameroon, in favor of those taught using the concept mapping instructional strategy. The justifications for this finding is that the increase in students' ability to connect new information to existing relevant concepts in the learner's cognitive structure through concept mapping will lead to an increase in their ability to solve elementary probability problems involving higher thinking processes. These include problems that have to do with application, analysis, synthesis and evaluation .The study therefore support the assertion that students' achievement in mathematics would greatly improve, if relevant instructional methods and strategies are used to teach mathematics and the mathematical sciences in Cameroon.

The finding of this study is in line with that of Ezeudu (1995) that the use of concept mapping has a significant effect on students' achievement in organic chemistry in Nigeria. Esiobu and Soyibo (1995) also found that the effect of concept mapping techniques on students' achievement was significant in Ecology and Genetics in Nigeria. Buzan (1995) averred that the use of concept mapping techniques improve on students working time with higher score. Novak and Gowin (1994) came to a conclusion that teachers who utilize concept mapping for organizing and planning their instruction and who teach their students concept mapping techniques promote learning. They went ahead to say that this is because teachers and students can better understand the conceptual organization of both the discipline and their own understanding of the subject. Similarly, Pankratus (2002) stated that concept mapping was found to be a key to organizing an effective knowledge base. This claim was verified and proven true in this study since good organization of probability concepts favored students in the experimental group to achieve better and showed more interest than their control group colleagues.

The table below gives information to answer research question two which was stated thus: How does the use of concept mapping instructional strategy affect form five students' interest in elementary probability in Bui Division in Cameroon?

Table 5: Post-PSII Scores, Mean Interest Scores ($\overline{X}$) and Standard Deviations (SD) for Experimental and Control Groups.

ITEMES	**EXPERIMENTAL GROUP**						**CONTROL GROUP**					
Positively Cued	SA(4)	A(3)	D(2)	SD(1)	$\overline{X}$	SD	SA(4)	A(3)	D(2)	SD(1)	$\overline{X}$	SD
1	17	28	6	2	3.13	0.76	25	34	12	2	3.12	0.78
2	21	26	5	1	3.26	0.72	24	28	7	3	3.17	0.82
3	16	28	7	2	3.09	0.77	15	36	16	3	2.90	0.77
4	7	13	24	11	2.29	0.93	6	29	34	5	2.48	0.76
5	9	12	21	12	2.33	1.00	6	16	28	12	2.09	0.94
6	4	17	21	10	2.28	0.88	3	17	35	17	2.08	0.80
12	18	27	6	2	3.13	0.76	19	32	16	3	3.05	0.77
13	16	28	8	2	3.04	0.77	18	31	16	4	3.04	0.87
					2.83						**2.74**	
Negatively Cued	SA(1)	A(2)	D(3)	SD(4)	$\overline{X}$	SD	SA(1)	A(2)	D(3)	SD(4)	$\overline{X}$	SD
7	10	12	21	10	2.58	1.00	9	10	28	25	2.96	0.99
8	8	21	13	12	2.54	0.99	14	26	24	10	2.41	0.93
9	7	19	23	8	2.56	0.88	13	22	28	10	2.48	0.94
10	3	3	19	25	3.32	0.84	1	0	29	43	3.56	0.58
11	16	7	20	9	2.58	1.10	12	13	30	17	2.72	1.01
					2.68						**2.84**	

The table shows a mean interest score of 2.83 for the positively cued items and 2.68 for negatively cued items for the experimental group. The mean interest score of the control group is 2.74 for positively cued items and 2.84 for negatively cued items. Higher positivity and lower negativity mean interest scores for the experimental group portrays higher interest for probability and statistics. Whereas, lower positivity and higher negativity mean interest scores for the control group portray lower interest for probability and statistics. Judgment is made with reference to the mean post-PSII = $\frac{(1+2+3+4)}{4}$ = 2.5, for both positively and negatively cued items. From the table, the post-test mean interest scores of items 1, 2, 3, 10, 12 and 13 (i.e. 3.13, 3.26, 3.09, 3.32, 3.13 and 3.04 respectively for the experimental group and 3.12, 3.17, 2.90, 3.56, 3.04 and 2.87 respectively, for the control group) show that all the respondents agree that probability and statistics lessons are exciting; that their concepts are related to day-to-day life; that it guides us in decision-making and in tackling everyday experiences; that it should not be scrapped from the GCE syllabus; that teacher demonstrations and instructional games (Ludo, playing cards, tossing a coin and game of raffle) make probability enjoyable more than all other topics in mathematics; and that teacher demonstrations and instructional games are helpful in understanding probability concepts.

Responding to items 4, 5 and 6 (with post-test mean interest scores of 2.29, 2.33 and 2.28 respectively, for the experimental group and 2.48, 2.09 and 2.08 respectively, for the control group), respondents indicated that they rarely take problems in probability and statistics to their teachers; that they solve test and examination problems in any order depending on the easiness of the problems and that they do not always perform better in probability and statistics assessments compared to other topics in mathematics. In other words, they perform as well in probability and statistics as in other topics. From items 7 and 11 (whose post-test mean interest scores are both 2.58 for the experimental group and 2.96 and 2.72 respectively for the control group), respondents feel that though probability and statistics concepts are abstract, they are related to scientific investigations; and that there is no preference for algebra to probability. In other words, their achievement and interest for probability and statistics is same as for algebra and other topics in mathematics.

Finally, responding to items 8 and 9, subjects in the experimental group believe that the language of probability and statistics is not difficult to understand (mean interest score, $\overline{X}$ = 2.56) and that the symbols, methods and materials used for teaching are not confusing (mean interest score, $\overline{X}$ = 2.54). Their counterparts in the control group feel that the language of probability and statistics is difficult (mean interest score, $\overline{X}$ = 2.48) and that their symbols, methods and materials used for teaching are confusing (mean interest score, $\overline{X}$ = 2.41). The general mean post-PSII score for the experimental group liking probability and statistics ($\overline{X}$ = 2.83) is, higher than that of the control group ($\overline{X}$ = 2.74).

Also, the mean post-PSII score of the experimental group hating probability ($\overline{X}$ = 2.68) is lower than that of the control group ($\overline{X}$ = 2.84). This shows a higher post-treatment interest for probability and statistics by the experimental group. This interest for probability and statistics in favor of the experimental group should be due to the concept mapping instructional strategy used. This study also support the assertions that students' interest in Mathematics would improve to a great extend if relevant instructional methods, good strategies and appropriate materials are used. There is therefore the need for the concept mapping instructional techniques to be used at the early stages of education to arouse and sustain the interest of children in mathematics and the mathematical sciences. The interest will obviously guarantee performance in the sciences. Agwagah (1993) feels that interest is something that develops within a period of time and that students' interest in mathematics can be affected positively or negatively as a result of the techniques used in the teaching process.

The table below gives information necessary to answer research question three which was stated thus: What gender differences exist in the post-test mean achievement scores of form five students taught elementary probability using concept mapping instructional strategies in Bui Division in Cameroon?

Table 6: Mean Achievement Scores and Standard Deviations of Subjects due to Methods and Gender.

		MALE		FEMALE		Difference in Post- ATEP
GROUP	TYPE OF TEST	MEAN	SD	MEAN	SD	Males vs Females
Experimental	PRE-ATEP	36.56	22.20	27.87	20.54	
	POST-ATEP	57.52	15.52	51.57	21.14	5.95
Control	PRE-ATEP	39.07	21.45	27.61	17.09	
	POST-ATEP	49.45	23.25	43.55	22.85	5.90

Observe from the able that the male subjects in the control group obtained a higher mean achievement score, $\bar{x}$= 49.45 while their female counterparts in the same group had $\bar{x}$ = 43.55 (a difference of 5.90). Also, the male subjects in the experimental group obtained a higher mean achievement score, $\bar{x}$ = 57.52 whereas their female counterparts in the same group obtained only $\bar{x}$ = 51.57 (a difference of 5.95). Hence, male subjects achieved more than the females counterparts in the two groups with males in the experimental group achieving better than those in the control group. According to the mean achievement scores obtained, the subjects could be classified as follows: Males (experimental group, $\bar{x}$ = 57.52) $>$ Females (experimental group, $\bar{x}$ = 51.57) $>$ Males (control group, $\bar{x}$ = 49.45) $>$ Females (control group, $\bar{x}$ = 43.55). Since males and females in the experimental group showed more improvement than their counterparts in the control group, it indicates that the concept mapping instructional strategy is effective irrespective of gender.

The table below gives the necessary information to test hypothesis two which was stated thus: There is no significant difference in the post-test mean achievement scores between male and female students taught elementary probability using concept mapping instructional strategies in Bui Division in Cameroon?

Table 7: A tow-way (2 x 2) ANCOVA table of subjects' scores showing gender as a variable.

Source of Variation	Sum of Squares	Df	Mean Square	F_{cal}	F_{cv}	Level
Gender	2175.418478	1	2175.418478	10.25	3.91	5%
Residual	32690.35546	151	216.4924203			
Total	34865.77394	152				

The table shows that the $F_{calculated}$ = 10.05 is significantly greater than $F_{critical}$ = 3.91 with degrees of freedom 1 and 151 for gender and residual respectively. Judging at the $p \leq .05$ level of significance and using the data available, we reject hypothesis (Ho_2) and conclude that there is a statistically significant difference in the post-test mean achievement scores between male and female students taught elementary probability using concept mapping instructional strategies in Bui Division in Cameroon. Also, from the table, we observe that the female students in the experimental group achieved better in the post-ATEP ($\bar{x}$ = 51.57) than their counterparts in the control group ($\bar{x}$ = 43.55). The difference in achievement can only be attributed to the concept mapping instructional strategy since students in the two groups (experimental and control) were at almost the same level of achievement in pre-ATEP ($\bar{x}$ = 27.87 and $\bar{x}$ = 27.61 for experimental and control group respectively). Therefore, concept mapping techniques which have been found to enhance achievement in elementary probability can be conveniently used by mathematics teachers for both sexes at all levels in Cameroon.

Ezeugo and Agwagah (2000) came to the conclusion that students exposed to the concept mapping techniques achieved more in Algebra than those who were not; and that male students in the experimental group achieved more than the female students. Torto (2003), on analyzing the UCE examination for Uganda in 1995 and the O/L GCE result statistics for Cameroon in June 1996 also stated that male candidates performed better than their female counterparts. Harbor-Peters (2001) opined that boys have some qualities, which favour their higher achievement and interest in mathematics than girls. Oakes, cited in Odogwu (2002) stated that only fifteen percent of the scientists, engineers and mathematicians in the United States of America are women. This according to Oakes is because academically qualified girls choose not to take science and mathematics courses in high school. Odogwu said that this choice is related to the findings of Hyde, Fennema and Lamen that boys do better than girls on mathematical problems involving story problems and spatial relation problems. A similar view had been stated by Maccoby and Jacklin (1973) that spatial ability continues to be the area in which the strongest and most consistent sex differences are found. These studies differ from that conducted by Aiyedum (2000) on senior secondary one (SS1) students' achievement in mathematics in Kwara state in Nigeria. He found out that there is no significant difference in the performance of male and female students, though male students' average performance was slightly higher.

CONCLUSION

From the data analyzed and results obtained it could be concluded that the use of concept mapping as instructional strategy enhances students' achievement in elementary probability in Bui Division in Cameroon. It enhances students' interest in probability; male students achieved better than female students on the overall study; and that students in the experimental group showed greater interest on PSII and achieved more than those in the control group. Thus, concept mapping has significant effects on students' achievement and interest in probability and statistics in Cameroon.

EDUCATIONAL IMPLICATIONS OF THE STUDY

The results of this study have some implications for mathematics teachers, teacher education institutions, curriculum developers, authors and textbook writers. The study indicates greater students' achievement of mathematics content area taught using concept mapping instructional techniques. By implication, the use of concept mapping instructional strategies greatly improves students' achievement and arouses their interest in mathematics. Therefore, if mathematics teachers adopt concept mapping techniques during mathematics lessons, students' achievement and interest in the subject may be improved to a very great extend in Cameroon.

Since the use of concept mapping (an innovation) produces greater results, there is the need for mathematics teachers to be given adequate training on the effective use of the techniques. Hence, concept mapping instructional techniques should be included in the methodology for mathematics students of all teacher training institutions and faculties in Cameroon.

Also, curriculum developers should create the awareness of these techniques to teachers by including them in the mathematics curriculum. Authors and textbook writers should by examples and illustrations provide proper application of these techniques in different aspects and topics in mathematics and mathematical science textbooks in Cameroon.

RECOMMENDATIONS

The following recommendations are made based on the study.

a. Concept mapping instructional techniques should be used by all mathematics teachers at all levels of education from primary to tertiary. Since interest is developed at the early stages of education, this strategy may yield greater performance throughout the child's schooling, if the strategy is used effectively at the primary level and early years of secondary.
b. Concept mapping techniques should be taught in teacher training colleges and in faculties of education to ensure adequate training of teachers with the use of modern methods and strategies. Seminars and in-service programs should be organized by all mathematics associations, examinations boards, the delegations of education and the regional pedagogic offices for teachers in the field to be acquainted with the use of concept mapping techniques for teaching, evaluating and for documenting students' mathematics achievement and interest.
c. The ministries of education through their departments of research and examination should sensitize teachers on the effects of concept mapping techniques by use of the media. Teachers should select good instructional materials and use them appropriately in the teaching of mathematics especially on topics like probability and statistics that show some abstraction.
d. Students should apply the knowledge of concept mapping in other subjects, topics of mathematics, in summarizing their notes or other works and in examinations especially when answering essay-type question and in self-evaluation. Educators should equip themselves with practical applications of concept maps in assessing students in classroom

situations, by asking them to construct concept maps of what they had learned; and as a hypertext design tool.

REFERENCES

Agwagah, U. N. V. (1993). Instruction in Mathematics Reading as a Factor in Students' Achievement and Interest in Word Problem Solving; *Unpublished PhD Thesis*, U. N. N

Aiyedum, J.O (2000). Influence of Sex Difference of Students on their Achievement in Secondary School Mathematics. In Obodo, G.C. (ed.) *abacus: The Journal of the Mathematical Association of Nigeria 25* (1),102-113.

Ali, A. (1996). Fundamentals of Research in Education. Awka: Meks Publishers (Nig).

Ausubel, D (1968). Educational Psychology: A Cognitive View. New York: Hol Rinehart, and Winston.

Balogun, F. U. (1997). *Communicative Competency in Mathematics Education in Africa.* Lagos: Everlead printing and publishing Company.

Buzan, T (1995). *The Mind Map Book* (Ed.). London, UK: BBC Books.

Ezeudu, F. O. (1995). The Effects of Concept Mapping on Students' Achievement, Interest and Retention in Organic Chemistry. *Unpublished PhD Thesis, University of Nigeria Nsukka.*

Ezeugu, N. C. and Agwagah, U. N. V. (2000). Effect of Concept Mapping on Students' Achievement in Algebra: Implication for Secondary Mathematics Education, in the 21st Century". *ABACUS, 25* (1), 1–12.

Gwanyama, O. S. (1992). Teacher Qualification as a Factor in Mathematics Achievement of Male and Female Secondary Students in Bui Division of Anglophone Cameroon. *Unpublished M.ED Dissertation, University of Nigeria, Nsukka*; August.

Harbor-Peters, V.F.A. (2002). Generating and Sustaining Interest in Mathematics Classroom. In Animalu, A.O.E and Harbor-Peters, V.F.A (eds.) *Proceedings of The Workshop for Re-training Mathematics Teachers at the University of Nigeria Secondary School* (9th-11th, December). Enugu: Snaap Press.

Jonassen, D. H. (1996). *Computers in the Classroom*: Mind tools for Critical Thinking. Eagle woods, NJ: Merrill/Prentice Hall.

Kinchin, I.M (2000). Using Concept Maps to reveal Understanding: a two-tier analysis. School Science Review, March 2000, 81: 41-46.

Lawson, M. J. (1994). Concept Mapping. In T. Husen and T. N. Postlethwaite (eds.); *The International Encyclopedia of Education* (2nd Ed.) Vol. 2, 1026–1031. Oxford: Elsevier Science.

Maccoby, E.E and Jacklin, C.N. (1973). Sex Difference in Intellectual Functioning in a Pluralistic Society. *Proceedings of the 1972 International Conference on Testing Problems Educational Testing Service Princeton New Jersey 87*

Nekang, Fabian Nfon (2004). Effect of Concept mapping on Students' Achievements and Interest on Elementary Probability in Bui Division of Cameroon. Unpublished Med project of the Department of Science Education of the University of Nigeria, Nsukka.

Nekang, Fabian Nfon (2007). Mathematics Education in Cameroon: Issues, Expectations and the way forward. *Journal of Research in Education, 4* (2), 53-56.

Nekang, F. N. and Agwagah, U.N.V. (2007). Teachers' Role, Believes and Gender Differences on Problem Solving in Mathematics and the Mathematical Sciences. *Journal of Educational Research and Development, 2* (4), 52-62.

Novak, J. D. and Gowin, D (1994). *Learning How to Learn*. Cambridge, England: Cambridge University Press.

Odagwu, H.N. (200). Female students' perception and Attitude to Mathematics. A Bane to their SMT Education. In Sadiku, J.S (ed.) *abacus: The Journal of the Mathematical Association of Nigeria, 27* (1), 18-14.

Pankratius, W. (2002). School Improvement in Maryland: Project Better/Science: August, Online

Torto, Rita (2003) Extracurricular and out of School Factor affecting Girls' Participation and Performance in SMT Subject: (Home/ Community Factor; Distance from School; Safety; Time Use), Online.

APPENDIX A
AN ACHIEVEMENT TEST ON ELEMENTARY PROBABILITY (ATEP)
CLASS: Form 5 TIMES ALLOWED: 45 Minutes

INSTRUCTIONS: *Answer all questions. All necessary working must be shown, giving your answer at each stage. Simplify your answers as much as possible.*

A. A single die is tossed once, what is the probability that:

1. A number less than 3 appears?
2. A number greater than or equal to 3 appears?
3. A number less than 7 appears?

4. A number greater than 6 appears?
5. A prime number appears:

B. An unbiased die marked 1 to 6, is rolled twice. Find the probability of:

6. Rolling two sixes.
7. The second throw being a six, given that the first throw is a six.
8. Getting a score of ten from the two throws.
9. Throwing at least one six.
10. Throwing exactly one six.

C.

(i) A box contains five red balls, three white balls and two green balls. A ball is taken out of the box at random. Determine the probability that it is:

11. Red.
12. White.
13. NOT green.

(ii). If the three balls are taken out in succession, using tree diagrams, determine the probability that they are drawn out in the order: green, red, and white if each ball is:

14. Replaced.
15. Not replaced.

(iii). A bag contains white balls and black balls. The probability of picking out a white ball is 3/5. What is

16. The probability of picking out a black ball?
17. The number of black balls if the bag contains 15 balls?

APPENDIX B
PROBABILITY AND STATISTICS INTEREST INVENTORY (PSII)

INTRODUCTION

Below is a list of statements to ascertain your disposition towards probability and statistics. Please, respond to whether you Strongly Agree (SA), Agree (A), Disagree (D) or Strongly Disagree (SD).

Indicate your sex: Male (M) or Female (F)

S/N	Items	SA	A	D	SD
1	I like probability and statistics because their lessons are very exciting.				
2	I like probability and statistics because their concepts are clear and related to day-to-day life				
3	I like probability and statistics because it guides us in decision-making and in tackling everyday experiences.				
4	I always take problems on probability and statistics and other related topics to my teacher.				
5	I solve problems on probability and statistics first when writing a test or an examination.				
6	I perform better in probability and statistics compared to other topics in Mathematics				
7	Their concepts are abstract and unrelated to scientific investigations				
8	The symbols, methods and materials used for teaching are confusing				
9	Their language is very difficult to understand				
10	It is the worse topic in mathematics. It should be scrapped from the GCE syllabus				
11	I prefer studying Algebra to Probability and Statistics.				
12	Teacher demonstrations and instructional games (luddo, playing cards, tossing a coin, game of raffle) are enjoyable more than all other topics in Mathematics				
13	Teacher demonstrations and instructional games are helpful in understanding concepts.				