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Effects of Cooperative Small Group Learning (CSGL) on Prospecting Primary Teachers' Performance and Attitude in Mathematics: The Case of Chipata College of Education

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Abstract: ***This study was guided by the research hypothesis; "There issignificant improvement in performance when Cooperative Small Group Learning (CSGL) is used in the teaching and learning of mathematics and when it is not used". It arose from the fact that primary school student teachers'performance is not desirable and they graduate from colleges of education without experiencing innovations in the teaching of mathematics to uplift standards and performance at primary school level. Two classes were purposively selected of which one was a control class and the other was an experimental class. Both classes had common tasks in their classrooms and a common test. Primary data was collected through a common test, a standard questionnaire for students, one-to-one students' interviews and from lecturers' interviews. Other data came from observing interactiveclassroom activities, presentations and photos. The mean, the standard deviation, the Chi–square test and the z-test showed positive results in performance in favor of the research hypothesis. The class that experienced the CSGL outperformed the control class. Factor analysis, manual coding and observations positively showed that students' attitude was enhanced in the class that experienced the CSGL strategy, especially when they were able to use it in their own classes.The fact that the strategy worked using two topics; (1) equations and inequations. (2) ratio and proportion, the author thinks that it can work using other topics in different contexts.***

Keywords: cooperative, interaction, innovative, experimental, control

1. Introduction

Education is a very powerful instrument for social change and transformation and innovative teaching practice is the only way to enhance the quality of our education in Zambia. Teacher education colleges and Universities attempt to teach future teachers everything they need to know to be effective teachers over their entire career. The author agrees withHiebert, J. (2007), who feels that this goal has not been realistic and argues that a new model for teacher preparation is needed.

An alternative model for teacher education is the Cooperative Small Group Learning (CSGL) which in terms of the social constructivist paradigm, learning is a social process which is neither limited to an individual, nor it is passive. Meaningful learning only takes place once an individual is engaged in social activities (Jackson et al., 2006). The model has enhanced student performance using, [1] ratio and proportion and [2] equations and in equations. It has also greatly influenced their attitude in the teaching and learning of Mathematics generally. The level of teaching effectiveness is a question that plagues higher education for a number of decades (Braskamp, and Ory; 1994). "That which produces beneficial and purposeful student learning through the use of appropriate procedures", which is an aspect that this paper is seeking to address except it is from the primary education.

2. Literature Review

Literature reviewed indicates that CL holds great promise as a supplement to textbook instruction by providing learners with opportunities to practice mathematics skills and mathematical language to discuss concepts and make connections to other skills and disciplines (Veenman, et al, 2002).

According to Bruner, J.S. and Vygotsky, L. (1978), the social nature of learning, citing that other people should help a child to develop skills through the process of scaffolding is emphasized.

Teaching mathematics by showing learners that everyone has the equal chance to offer something will allow the learner to have more respect for each other (Park, 2010).

Learners should be provided opportunities to work together cooperatively in small groups on significant problems that arise out of their experiences and frames of reference to help old knowledge with new knowledge(Southwest Consortium For the Improvement of Mathematics and Science Teaching, 1999).

According to Kalajaiye A.O. (1994) it is generally agreed that skill in computation is desirable at the primary school level, but that the world trend was to avoid learning facts by mere repetition until they become almost mechanical.
The primary school is the beginning of formal education. It is at this level that the first introduction to a subject field is gained formally. Therefore, the primary school should

provide the foundation on which later mathematical knowledge will rest (Kalajaiye, 1994).

Extensive research has compared cooperative learning with traditional classroom instruction using the same teachers, curriculum, and assessments. On the average:

- Students who engage in cooperative small group learning learn significantly more, remember it longer, and develop better critical-thinking skills than their counterparts in traditional lecture classes.
- Students enjoy cooperative learning more than traditional lecture classes, so they are more likely to attend classes and finish the course.
- Students are going to go on to jobs that require teamwork. Cooperative learning helps students to develop the skills necessary to work on projects too difficult and complex for any one person to do in a reasonable amount of time. According to Manden, D. (2011), use of cooperative activities involving pair and small groups of learners in a classroom establishes a democratic form of teaching; it enhances both the individual and the community. Each student is able to share his/her ideas and learn to listen and respect each other. He further notes that it influences collaborative spirit among students by minimizing competition leading to conflicts in todays' world.
- Hundreds of research studies of team-based learning in higher education have been conducted, with most of them yielding positive results for a variety of cognitive and affective outcomes. Analyses of the research support the following conclusions: Individual student performance was superior when cooperative methods were used as compared with competitive or individualistic methods. The performance outcomes measured include knowledge acquisition, retention, accuracy, creativity in problem solving, and higher-level reasoning. Other studies show that cooperative learning is superior for promoting metacognitive thought, persistence in working toward a goal, transfer of learning from one setting to another, time on task, and intrinsic motivation For example, students who score in the 50th percentile when learning competitively would score in the 69th percentile when taught cooperatively.

3. Problem Definition

Prospecting primary teachers enter the college without any theories about mathematics education. They literally depend on lecturers' traditional way of teaching for their performance, attitude and delivery in schools. Their performance in Mathematics has been generally poor.

It is believed that most teachers teach the way they were taught themselves. The traditional method of teaching at CCE has left students none innovative. No wonder mathematics results persist to get poorer year in and year out at colleges of education as well as in primary schools. It is because colleges keep offloading to the market, teachers who are inefficient and who use stereotyped methods of teaching, making the subject described as dull and dry. This creates a gap in acquisition of knowledge and calls for an investigation. Therefore, I wish to explore CSGL as the teaching strategy that can miraculously open up both student teachers and lecturers' minds to profitably improve in performance and attitude in the teaching and learning of Mathematic.

It is felt that primary education is as primary as the name suggests, 'more important than anything else,' according to Cambridge Advanced Learners Dictionary. Therefore, if the student teachers can improve their performance while appreciating CSGL and go into the field to implement it, we would be closer to achieving the mathematics teachers' tasks which the Cockcroft committee (2002), viewed as:

- Enabling each pupil develop within his/her capabilities the mathematical skills and understanding required for adult life, for employment and for further study and training, while remaining aware of difficulties which some pupils will experience in trying to gain such an appropriate understanding.
- Of providing each pupil with such mathematics as may be needed for his/her study of other subjects and of helping each pupil to develop so far as possible his/her appreciation and enjoyment of mathematics itself

4. Methodology

Research design

This study used a quasi-experimental design in which both qualitative and quantitative research methods for data collection and analysis were used in order to enhance the reliability and validity of the research results.

Study area

The research was conducted at Chipata College of Education (primary teachers' college) in the eastern part of Zambia. It was chosen because it is where I am lecturing. I had all the tips on poor performance in Mathematics at this college as shown in table 1.1. The allocated time on the time table was the time I utilized to implement the CSGL strategy. Further, the time allocated to observe students on teaching practice is the period I also utilised to monitor my participants. All these minimised my expenditure on the study.

Study population and sample

- In this study the researcher was interested in 74 participants out of one-hundred sixty-six (166) who were third year student teachers at Chipata College of Education. The experimental class consisted of twenty (20) males and eighteen (18) females while the control class comprised of twenty (20) males and sixteen (16) females. They were of
- Mixed sex and ages ranged between 21 to 32 years. They all had completed grade twelve and had at least a grade six or better in mathematics. They came from all parts of Zambia. Four fellow lecturers participated in the study.

Sampling procedure

The study used purposive sampling to come up with participants from the population. This method was used to obtain a more representative sample. Like for (Crawshaw& Chambers, 1984), it was the only practical method to arrive at solutions to their urgent problems.

Research instruments

The outcomes of this research were provided by naturally occurring data found in the classroom, such as the test scores

(Appendix 3) and lesson presentations. Others were accessed through one to one interviews, standard questionnaire where items on Lickert scale were included (Appendix 2), videos, audio recordings, photos and observations as the area of focus dictated.

Data collection

- To address issues of bias in the data collection, triangulation (using multiple sources of data) was used. It is agreed in research that researchers should not rely on any single source of data (Mills, 2011). Table 3.1 shows the source of data for each research question. For example, the research questions are in column one and the three sources of data are in row one. Therefore research question one on performance had data collected using all the three sources, students' test, student survey and classroom activities.

Table 1: Triangulation Matrix

Research Questions	DATA SOURCE		
	1	2	3
Q1. Performance	Student test	Student survey	Classroom activities
Q2. Attitude	Student survey	Lecturer survey	Classroom activities
Q3. Curriculum	Lecturer survey		

- To control the focus of my study and to head off any potential obstacles to implementation, I sort for permission from the Principal, my Head of Section (HOS), my fellow lecturers and the students. This created cooperation among the stake holders. The two classes, of which one class was the control group and the other as an experimental group, were the participants from which data was collected. The four fellow lecturers also contributed useful information to this research going by the lecturers' interview schedule.

5. Findings and Data Analysis

Introduction

The findings of this study are anchored on the effectiveness of the CSGL strategy on performance, attitude and related curriculum in the teaching of the two topics earlier mentioned. The data was analysed by using SPSS software and Excel because these can perform a wide variety of statistical procedures (allow production of graphs and tabular statistics) and information for easy comparison of results and their significance. Measures included the mean/s, the standard deviation, the Z-score test, chi- square test and factor analysis. Other qualitative data was manually analysed.

Classroom observations as they performed tasks were natural. A standard questionnaire (appendix1) was administered to twenty–one (21) students in the experimental class of which only fifteen (15) were returned, which was fair. Lecturers were aurally interviewed using an interview guide (appendix 2). Eleven (11) students were observed in their classrooms (during teaching practice) using an observation schedule (appendix 6). One to one interviews were also done with the students. They wrote a common test although the control class underwent the traditional (lecture) method of teaching only while the experimental class experienced the CSGL strategy but they wrote a common test.

Effectiveness of the CSGL on performance

The study required that we respond to research objective one which is: to find out the effectiveness of the CSGL on student teachers' performance.

A presentation on direct proportion

- Used real packets of sugar and their costs to establish that as the number of packets increased, the cost also increased.
- Solved an example question by using the unitary method.
- Gave an Example to be worked in pairs: Find how many kg of meat that can be bought from K100 if 3kg were bought for K30.30. Encouraged them to use any other method of their choice.

Findings

Some groups found wrong solutions (less than 3kg). Some pairs used two different methods but got the same solutions. None failed completely.

The pair that found a solution less than 3kg lacked the mathematical process skill of prediction because they never thought that the answer needed to be more than 3 kg as per real life situation. When I asked them using 3 sweets cost K3, would K5 buy more or less than 3 sweets? Quickly they said more. Then I asked if this question was any different from the task one. After a while they realised the answer was to be more than 3kg, but how to work it out was a challenge. These students did not poses the concept of diret proportion that if as one quantity increases/decreases,the other also increases/decreases in the same ratio.

A follow up on the presentation

- Students shared why 0.909 was not correct- that the amount, K100 was higher than K30.30 and so a higher number than 3kg would be a better solution. They also shared how the two methods were done.
- They identified the two different methods as unitary and ratio methods.
- Students agreed that answers could never be different for the two methods.

All the above enhanced student performance which saw increased achievement and development of higher processing skills.

In the test, in the experimental class, 3 left a similar question unanswered (were absent during the presentation) while 32 correctly used the two methods and 3 used the proportion method only. Compared to the control class, only 12 used the two methods correctly, 13 used the same proportion method, 6 did not attempt it and 5 found different solutions to the two methods. I paid particular attention to the pair that got a wrong answer in class and both of them correctly answered the similar question in the test.

Implication

Buying and selling is first taught in grade 3. A teacher who has basic knowledge on increases/decreases in quantities can as well start to orient the pupil on this in grade 3. This entails that up to when they meet the topic on proportion

(grade 6), they will have the basics and it would not prove difficult. Now look at how the very teacher to be, struggles with this. There is need for innovative strategies in the teaching of Mathematics in colleges of education as we prepare them to go and teach our innocent children.

Meanwhile, in the control class it was usual business of talk and chalk. Same tasks were given but as to whether they were done in class or not, lay in the hands of the students. However a mention was made to do all tasks and if they could not do they could ask friends. They were encouraged just like their friends in the other class to revise all work done.

Findings from a common test

The test (appendix 3), comprised of two method questions (not part of the analysis), and eight other questions on the two topics which were analysed by comparing the two classes.

The mean and standard deviation

In order to process these results to show the effectiveness of the CSGL strategy, these tests were done using SPSS as shown in table 4.6.

Table 2: SPSS mean and standard deviation

	Condition under went	N	Mean	Std. Deviation	Std. Error Mean
Score of participant	Experimental	38	62.47	11.489	1.864
	Control	36	41.78	14.842	2.474

The information in the table shows that the experimental group did better because it had a higher average than the control group (although it may be affected by extreme measures). The standard deviation however, tells more about the scores; how they are spread around this mean. Clearly, it shows that scores in the experimental group were much closer to the mean than the scores in the control group. It also entails that most students scored between 51 and74 percent ($\pm$ 1 *standard deviation*) in the experimental group while most students in the control group had between 27 and 57 percent (also,$\pm$ 1 $standard\ deviation$). Equally the standard error of the experimental class was lower. This shows a positive effect of the CSGL strategy of teaching the two topics.

The Z – test: Testing the difference between the two means of large samples.

The aim of this test was to determine whether there was a difference in the average scores of the students that received the CSGL treatment (the experimental class)and those who did not (the control class).

Determination of the result used , $\propto$ = 0.05, and table value 1.645 for single tailed.

The formula is:

$Z = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n1+} + \frac{s_2^2}{n_2}}}$ where $\bar{X}_1$ and $\bar{X}_2$ are the means of the experimental class and the control classes respectively. S_1 and S_2 are their standard deviations and n_1 and n_2 are theirsample sizes. All these are in table 4.3**.** Therefore, the calculated value of z is 7.326 (see calculations in appendix 1) and 7.326 >1.645

Therefore, we can conclude that there is enough evidence that there is significant improvement in scores in the experimental class than in the control class. In this case, in cooperating the CSGL strategy proved better than lecturing only. We reject H_o and accept H_1.

The Chi- square test

For further verification of the test results, SPSS chi-square test was done. Chi-square is a statistical test commonly used to compare observed data with data we would expect to obtain according to the hypothesis. Were the deviations (differences between observed and expected) the result of chance, or were they due to other factors. How much deviation occurred, must conclude that something other than chance was at work, causing the observed to differ from the expected.

Table 3: SPSS Treatment received. 'Did they pass? Cross tabulation

			Did they pass?		
			Yes	No	Total
Treatment received	Experimental	Count	31	7	38
		Expected Count	25.7	12.3	38
		Std. Residual	1.1	-1.5	
	Control	Observed Count	19	17	36
		Expected Count	24.3	11.7	36
		Std. Residual	-1.1	1.6	
Total		Count	50	24	74
		Expected Count	50	24	74

Table 4: Chi-square test

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	9.575[a]	1	0.002		
Continuity Correction[b]	8.127	1	0.004		
Likelihood Ratio	9.843	1	0.002		
Fisher's Exact Test				0.003	0.002
Linear-by-Linear Association	9.445	1	0.002		

N of Valid Cases	74				
a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.65.					
b. Computed only for a 2x2 table					

The Chi-square value, 9.575 is greater than 0.05 as the level of significance. This reveals that there was an association between the treatment received and whether they passed or not. The conclusion is that CSGL caused the observed count to differ from the expected count shown in table 4.5.

Selected items from the test

With regard to the tasks that were given in the classrooms, six similar questions [2. 4, 5, 7, 9, 10(iii)] appeared it the test. Then next was to find out about the performance in these questions in both classes. Tables 4.6 and 4.7 show the number of students who did, correct solution, wrong solutions and those who did not attempt in the experimental and the control classes respectively. Their graphical representations are also shown in figure 1

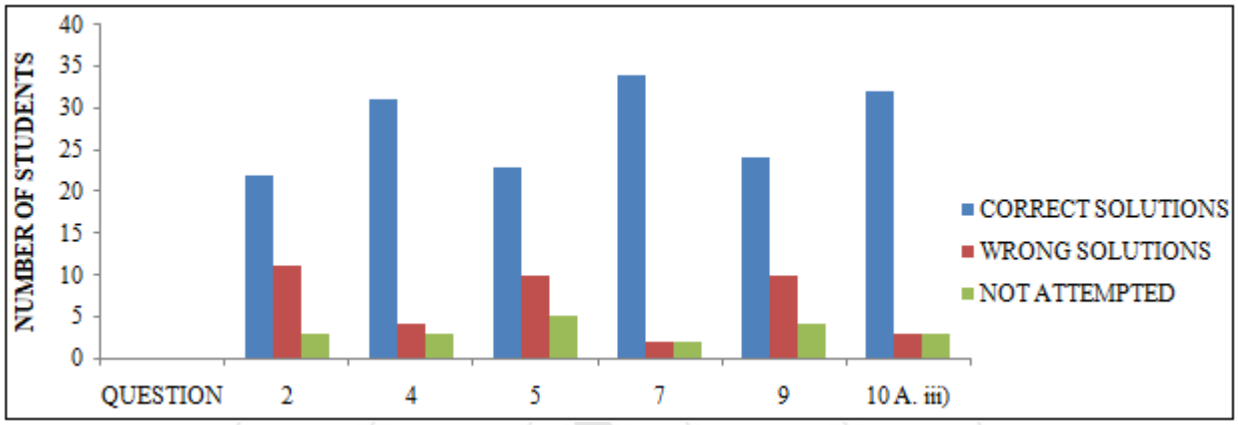

Figure 1: Graphical presentation of experimental class performance in six questions

Most students in this class obtained correct solutions for all the six questions and very few did not attempt. These who did not attempt are day scholars who rarely attend classes especially in the morning. A minimal number got wrong solutions and it was mainly miscalculations in equation and in equation questions. It is on record that most students do not have the right concepts of working with variables.

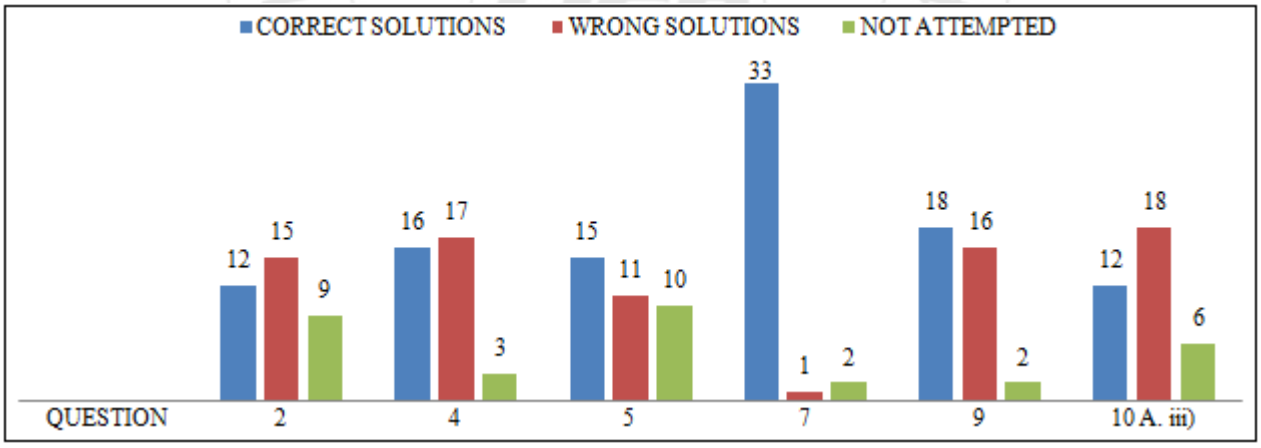

Figure 2: Graphical presentation of control class performance in six questions

In this class, there were nearly equal numbers of students who got the questions correct and those who got them wrong. Question seven was well answered because it has a number of ways in which they could answer it, that is, by elimination, substitution or graphically.

Cleary, the questions were well done by the experimental class because they underwent pair or group interactions. Cooperative small group learning is a highly structured educational model where each member is not only responsible for learning an individual concept, but also for educating other group members about it. It is based on the belief that all group members succeed or fail together. Each member is required to take ownership of an idea and gain an understanding of it. Then all other group members share their knowledge of other concepts to fellow group members. When each concept is understood and assembled, the group successfully grasps a new concept. Group members support each other and hold each other accountable for their contributions. However suffice to mention that question two (on simultaneous equations) was equally well done by the control group. This was probably because three different methods were given in class and the question did not demand for a specific method to be used.

Effectiveness of the CSGL on attitude

The sure ways for me to know that my students had favorably reacted to the CSGL strategy was through; classroom observations as they carried out tasks and as they taught their classes (others were photographed), one to one interviews (sometimes recorded) and the questionnaire.

Observations

From the classroom, students freely asked questions and wrong answers were always sources of discussion. A good example is the discussion of the wrong solution in 4.1.5, where students agreed on why the answer was wrong and how the two methods could not give different solutions. I saw a will to be successful in them as they simultaneously interacted, as they explained their own reasoning (right or wrong), as they defended their answers (write or wrong), as they depended on one another, as they took risks and above all, as the females participated. All the above situations saw improved attitude towards Mathematics and school, improved liking for fellow classmates, increased self-esteem and also improved in critical thinking

Factor Analysis

This study used principal component analysis to extract factors. It also used varimax rotations done after the initial extraction of factors which impose the restriction that the factors cannot be correlated. You also need to determine the number of factors that you want to extract. Included here is the scree plot and the plot of the rotated factors to explain the attitude of the participants towards the CSGL strategy.

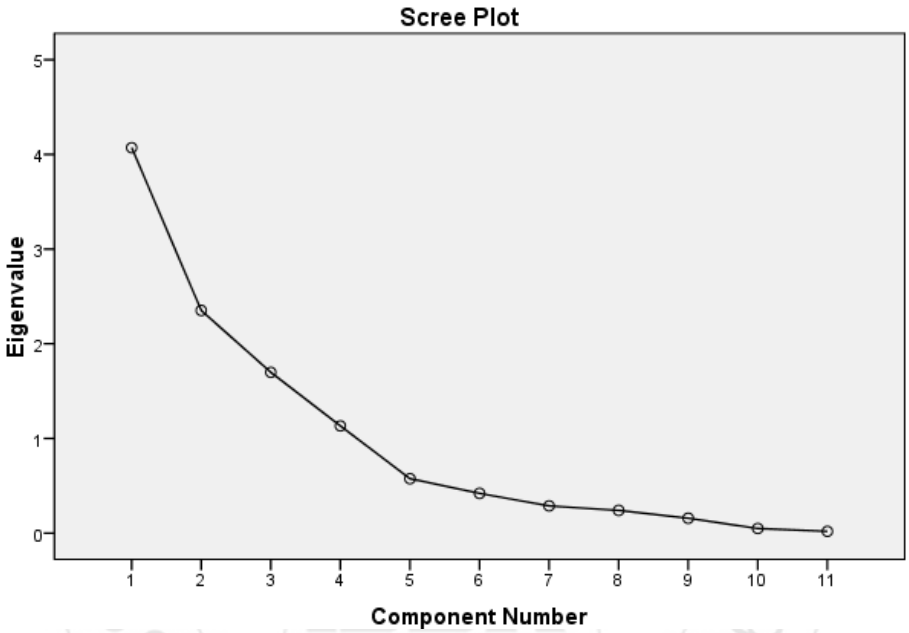

Figure 3: SPSS Scree Plot

The scree plot graphs the eigenvalue against the component (factor) number. You can see these values in the first two columns of the table immediately above. From the fourth factor onwards, you can see that the line is almost flat, meaning that each successive factor is accounting for smaller and smaller amounts of the total variance.

Table 5: SPSS rotated matrix

Items	Factor			
	1	2	3	4
Use of first names before a question is asked kept us attentive through out	0.949			
Students could defend their solutions	0.833		0.328	
Learners had more talk time than the lecturer	0.433	0.396		0.412
Results in Mathematics improved		0.806		
Classroom environment was inviting		0.774		
Active and interacted freely		0.695	0.662	
Developed a liking for Mathematics	0.377	0.49	0.475	0.304
Lecturer valued students thinking than correct answers	0.437		0.76	
Learning aids were appropriately used			0.651	0.398
Developed a liking for classmates				0.755
Each member of the group had a task and could report	0.437			0.643
Extraction Method: Principal Axis Factoring.				
Rotation Method: Varimax with Kaiser Normalization				

This table contains the rotated factor loadings (factor pattern matrix), which represent both how the variables are weighted for each factor but also the correlation between the variables and the factor. Because these are correlations, possible values range from -1 to +1.

Factor - The columns under this heading are the rotated factors that have been extracted. As you can see by the footnote provided by SPSS (a.), four factors were extracted. These are the factors that Iwas most interested in to try to name. In this case. Factor one was, 'students involvement" because variables like "was attentive', 'defended the answer' load highly on it. Factor two was 'environment improved results', factor three was 'classroom interactions' and the fourth factor was, 'good relationship.'

Oral communication

From the Oral communication and audio recordings, categories were done manually. Two categories were identified and are given below.

Table 6: Categories of themes identified

Positive Impact	*Negative Impact*
- Participation was good - Fosters attentiveness - Free to ask questions - There was democracy - It was liked - Allowed female participation - It was enjoyed - It improved performance - The strategy conforms to the curriculum	- It was time consuming with big classes - The bright children didn't want to share at the beginning - Big classes are an obstacle to the method - There is a lot to prepare as a teacher – activities, aids and tasks.

From the table it is clear that students appreciated the teaching of proportion and in equation using the CSGL. This was shown by comments like; it was liked, asked questions, participated and others which also applied to their learners in the teaching of other topics. (for those that used the strategy).

The Zambian curriculum and the CSGL

Fellow lecturers admitted that the curriculum has given lecturers an insight of using pair and group work in classrooms but usually thought that it was time consuming. Actually there is a column in the teacher education syllabus which reads, 'Pedagogy for school syllabus". Basically, our teacher education syllabus has been aligned with the primary school syllabus. It is hoped that this will promote the acquisition of knowledge and skills with greater emphasis on pedagogy, (MOE, 2012). Having observed CSGL lessons, an appreciation was shown and promised to do as the curriculum demands.

Although the MOE has not sent any single material to the college in line with the new syllabus, it was agreed that we can try to incorporate innovations that can help in the improvement of performance as well as attitude even without the new materials. In fact a comment was passed that there can never be good performance if the attitude is all negative about the subject, confirming that the two are inseparable.

This chapter has illustrated the activities that were undertaken in order to answer the three research questions. There is no doubt that the CSGL has proved that it can work in the mathematics classroom to enhance performance and attitude, especially that it is supported by the curriculum.

6. Conclusion

The work of Vygotsky has been underlining all my readings. Socio-cultural factors are essential in the development of the mind. The learner develops intellectually in terms of memory, attention, thinking, perception, and consciousness which evolve from the social (interpersonal) to the individual(intrapersonal). The primary development is the social with the individual dimension being secondary.

Cooperative Small Group Learning is the future direction mathematics instructors will need to incorporate in their classrooms to increase the level of success of all Zambian students. We need to move from traditionally being involved in pencil-and-paper based activities and independent situations to learning distributed among co-participants. Given the increase in use of technology, the challenges that are likely to be presented will involve rethinking our notions of what it means to do mathematics, what it means to be a learner of mathematics, and how we might begin to address issues of assessment when mathematics learning is distributed among the group.

This study projects highlights for improving mathematics teaching and learning using the CSGL strategy in teacher colleges. It worked in the teaching of two topics. The author calls for all teacher educators to continue attempts to effectively deliver mathematical concepts and change students' attitude by incorporating the CSGL strategy in different contexts. Education is a very powerful instrument for social change and transformation and innovative teaching practice is the only way to enhance the quality of our education. There are a number of traits required of the innovative lecturer which include humility, courage, impartiality, open-mindedness, empathy, enthusiasm, judgment and imagination (Hare, 1993). It is these lecturers who will infuse deeper learning in their students.

7. Future Scope

Suggestions for further study

Some of the suggested areas of further study include:

- Using the CSGL strategy to teach other topics in mathematics as well as using it to teach other subjects
- Which grades in primary school are most appropriate for the use of the CSGL strategy?
- Monitoring the implementation of the pedagogies stated in the Zambian curriculum in primary schools.

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