# ARE PRIMARY SCHOOL STUDENT TEACHERS MAJORING IN MATHEMATICS, BETTER PRIMARY SCHOOL MATHEMATICS TEACHERS?

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**Abstract:** *This study, sort to compare pedagogical skills of primary school student teachers studying mathematics as a major subject and those studying mathematics as an applied subject. This was an important source of feedback for primary school colleges' curriculum planners and primary school teacher educators. The study was guided by a quantitative research philosophy. The population of this study was composed of primary school student teachers studying mathematics as a major subject and those studying it as an applied subject. Data were collected by administering a mathematics test to determine student teachers' mathematics content levels. Lesson observations, interviews and teaching practice file content analysis were carried out to determine student teachers' pedagogical skills levels. Results for 27 paired samples of student teachers from three primary school teachers colleges were compared using descriptive statistics. Hypothesis t-tests and ANOVA confirmed that, students majoring in mathematics had more mathematics content. There was no significant difference in their pedagogical skills levels. The disparity in mathematics content levels was accounted for by the fact that, students majoring in mathematics passed it well at 'O–level, received more tuition in the subject and some were studying 'A' –level mathematics privately. An equal level of pedagogical skills was as a result of teaching methods being emphasized in every subject. The study concluded that, since there was no significant difference in pedagogical skills, between students studying mathematics as a major subject and those studying it as an applied subject, the time allocated for the major subjects can be reduced. Study requests colleges to balance emphasis on content and pedagogical skills by assisting mathematics majors to identify and carry out research in mathematics teaching during their curriculum depth study (C.D.S)*

***Key Words:*** *Mathematics teaching, student teachers, pedagogical skills*

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## INTRODUCTION

Efforts to contribute to the solution of pupils' poor performance in mathematics in Zimbabwe directed us to Nziramasanga's commission report (1999:324). The report suggests that, factors influencing the study of mathematics in Zimbabwe include: inappropriate syllabuses, teaching material, training of teachers, assessment procedures and the medium of instruction. The study noted that, all other factors were dependent on the teacher and the teacher training process. This perception focused this study's lenses on mathematics primary school student teachers' pedagogical skills.

A curriculum Development Unit (C.D.U) study by Maweni, Ndemera and Gudza (1993:17) traced the problem of pupils' poor performance in mathematics to the primary school. The report noted that, secondary school teachers blame primary school teachers for failing to develop a strong mathematics background. They allege that, primary school teachers teach pupils for a pass at grade 7 examinations without understanding. In addition, the report alleges that, primary school teachers will not have specialised in mathematics hence their interest and competency in mathematics leaves much to be desired.

Such a need for subject specialisation was explained by Mukorera (2001) who pointed out that, the primary teacher education curriculum is divided into four sections: Teaching practice, Theory of Education, the Main/ Academic subject and Professional Studies. The main/ academic subject has two major aims to:

1) provide each student the opportunity to study ONE of the Applied Education subjects to a greater depth than is possible in the syllabus.
2) produce primary school teachers who, in addition to being able to teach all subjects have greater expertise in one particular subject, which enables them to:
    a) be innovative in the teaching of that subject with confidence.
    b) contribute to the teaching of that subject in a significant way.
    c) identify and develop children's interest and potential talent in the subject
    d) act as the subject resource persons in their schools
    e) assist at in –service courses for the subject.

The need for specialist primary school teachers was emphasised by Ndawi and Masuku (2002) who reported that pupils' and parents' level of sophistication is now so high to demand a primary school teacher with a degree. They argued that, the degree is necessary if teachers are to be respected by these stakeholders as worth-while practitioners. Such considerations imply that, studying mathematics as the main subject may not be enough for a primary school teacher to earn stakeholders' respect. This rational for the main subject was missed by Kausiyo (1994:2) who says: 'As a primary school student teacher, I strongly feel that, the inclusion of the main subject contributes nothing other than adversely affects the production of a qualitative primary school teacher.' This student can be supported by Hewes (1979) who complained that, college curricula are monstrously overloaded, with academic content, some of which is of doubtful value to the teacher in his classroom. This perception is justified from the observation that, the purpose of a teacher's college is to develop student teachers' teaching (pedagogic) skills and not a total focus on students' content enrichment.

These sentiments argue for the existence of mathematics teaching specialisation at primary school level. The objectives of the main subject cited by Mukorera (2001) point (2) were regarded as critical discriminating indicators of a student teacher who studied mathematics as a major subject from one studying it as an applied subject.

The fact that, there are student teachers majoring in mathematics teaching at primary school level, contrary to the Ministry of Education and Culture's (1993:4) call for an integrated curriculum, provoked debate between researchers and colleagues lecturing in primary school colleges. The arguments were based on the understanding that, student teachers majoring in mathematics passed it well at 'O' level, showed interest in teaching the subject and received tuition in it should exhibit innovative pedagogical skills unless there are loopholes in the process. The debate culminated into the current study seeking the supremacy of student teachers majoring in mathematics over students studying mathematics as an applied subject. This is an important base for developing national confidence in the existence of mathematics specialists at primary school level. It provides feedback on primary school college curriculum planners and mathematics college educators.

## CONTEXTUAL ANALYSIS

In Zimbabwe primary school teachers' entry requirements are now (2015) passes in 'O' level subjects including Mathematics and English. All colleges have adopted the ZINTEC model of two terms in college, five terms in the field and the final two terms in college (2, 5, 2) models. This model is known for its strengths in reducing the effects of teacher shortage in schools (Chivore, (1990) and its emphasis on pedagogical skills development. These are critical variables when Zimbabwe is hard hit by mathematics teachers' brain-drain.

It is worth registering that, most of the primary school teacher trainers have secondary school qualifications and secondary school teaching experience with no or little experience in primary school teaching (Buchols, etal: 1997). Such an anomaly could justify Colderhead and Shorrocks(1997:40) observation that much of the content from college is, 'quite intellectual rather than practical.'

While a teacher's high level of content is cherished, there is need to take cognizance as Siyakwazi and Siyakwazi (1999:19) who warned that, 'Problems arise from the tendency of some teacher education programmes to emphasize subject matter in the major academic disciplines at the expense of teaching methodology.' After all, teaching is all about communicating academic information. The teacher's ability to assist others learn.

Peniek et al (1988: 17) sums up the desired balance between pedagogical and content knowledge when they said, 'While strong content preparation may be necessary, it is not sufficient for teaching. Teachers should have pedagogies which blend well with content on their main subjects'. One wonders whether primary school teachers majoring in mathematics have balanced content and pedagogical skills to render them specialists primary school mathematics resource teachers.

According to Mtetwa and Kwari (2008), the task of teachers colleges during pre-service teacher education is to adequately prepare students in both the subject content they will teach and the teaching methods they will employ in the field. Nziramasanga's commission report (1999; 330), point (3.9) stressed that, the mathematics teacher is viewed as someone well trained with a firm mathematics background and personal interest in the subject. It is not clear whether the firm background refers to content as well as pedagogic knowledge.

While Gatawa (1990) is calling for an integrated curriculum, primary school teachers asked for the introduction of specialist mathematics teachers at all levels or alternatively at grade 7 only (Nziramasanga' commission report, (1999). Ndarwi (2002) strongly supports the subject specialisation call at primary school level. His studies found specialisation at primary school promoting learning and achievement. One wonders whether the specialisation call is an acceptance of a lack of mathematics pedagogical expertise in primary school trained mathematics teachers.

This study accepts that, colleges aim to increase students' mathematics content knowledge (Grouws and Schultz, 1996) and pedagogical skills which results in teachers' changing their classroom practices in ways that result in increased student learning (Lampert,1990). The study is disturbed by (C.D.U. 1996) report which revealed that third year primary school teachers in Zimbabwe had extreme mathematics content deficiencies. The majority failed a test on time, percentages, decimals and fractions intended for grade 6 and 7 pupils.

## STATEMENT OF THE PROBLEM

There are conflicts in literature on the objectives of the major subject in primary school teacher training and research findings which suggest in-adequacy in mathematics pedagogical skills among Zimbabwe's primary school teachers. The unsynchronised scenario raised two pertinent research questions focused on student teachers' mathematics content and pedagogical knowledge variables:

1. Do primary school student teachers majoring in mathematics show better pedagogical skills than those studying mathematics as an applied subject?
2. What factors could account for the difference?
3. What implications do these findings have on the student teachers' curriculum?

The following pair of hypotheses was also raised concerning primary school student teachers.

**$H_0$**: there is no difference in pedagogical skills for student majoring in mathematics and those studying mathematics as an applied subject.

**$H_1$**: there is a difference in pedagogical skills for students majoring in mathematics and those studying it as an applied subject.

## RESEARCH METHODOLOGY

### Research Design

This study is guided by a combination of qualitative and quantitative research philosophy. Qualitative techniques enabled a holistic perception of the data to be gathered during teaching practice lesson observation. Quantitative approaches facilitated the analysis of quantitative variables such as students' performance in the test. The variables being compared are student teachers' mathematics content and pedagogic skills. Their indicators include their performance in the mathematics content test (quantitative) and teaching practice observation behaviours (qualitative). The study used a descriptive survey due to its ability to identify, quantify and describe mathematics student teachers' content and pedagogical knowledge levels. Since the study's purpose is to explore findings for policy influences, purposive samples were found appropriate. The design gathers information from student teacher samples using a variety of techniques in the participant's natural environment (Mayhut and Morehouse, 1994). This was important for researchers not to disturb learning processes and account for the influence of environmental factors on students' teaching strategies. (Verma and Mallick, 199:77). Use of different techniques facilitates data, source, method and sample triangulation to validate findings.

**Population and Sampling**

The population of this study was composed of primary school student teachers on their fifth term on teaching practice. A purposive sample of 54 student teachers (two pairs of 27 students each) from three primary school teachers' colleges in Zimbabwe participated in the study. These students were considered familiar classroom practitioners, whose pedagogical skills were almost equal to those of a qualified teacher, hence rich sources of the pedagogic variable. They had almost completed their training, hence were expected to have the content to enable them to teach any class in a primary school. Participants' selection was based on their availability, being rich sources of the variable and willingness to participate in the study. This selection criterion observes ethical issues of research involving adults. Their participation was by voluntary concern.

Samlping was carried out at two levels. First a census of those student teachers majoring in mathematics, then random selection of an equal number from the college pool of mathematics applied students. To select specific students, computer generated random numbers were matched to student' registration numbers. The process was repeated until 27 matched pairs were raised for quantitative comparison.

**Instruments**

We adopted the primary school colleges' teaching practice supervision form by adding the following aspects as hinted by Mukorera (2001).

1. Innovativeness as shown by use of
    - Student's own examples during the lesson
    - Individualised instruction
    - Games, discovery and project methods

- Own teaching aids, their concept illustrative, relevance and availability
- Shop corner and raising pupils' awareness of new currency: United States dollar, Rand, Pula and Pounds used in Zimbabwe.

2. Student's initiatives and contribution to developing other teachers in mathematics teaching as expected by Shumba (2001)
3. Choice of Curriculum Depth Study (C.D.S) topic and its relevance to mathematics teaching
4. Student's response to exceptional pupils during and after the lesson.
5. Structuring and use of marking scheme with method marks indicated as advised by Bourdillon (1983:49)

We ended up with a student teacher supervision grid which required researchers to rate 12 aspects of a student's competency as weak, satisfactory, good, very good and excellent. The grid was used for Teaching Practice (T.P.) file content, lesson and classroom observation analysis.

**Mathematics Content Test**

The second instrument was a mathematics content test, whose items were distributed as shown in the specification grid below:

**Table 1, test Specification Table**

| Level of Content | Source of Questions | Weight |
|---|---|---|
| Grade 7 | ZIMSEC, Nov 2005, paper 2<br>Questions: 1, 9, 10, 11 and 12 | 45% |
| 'O' level | ZIMSEC, Nov 2002, paper 2<br>Questions: 1a, 2a, 2c, 9a, and 10b | 40% |
| 'A' level | Cambridge, Nov 1998, paper 9200/4<br>Q1- Pure Mathematics and Q2-Statistics | 15% |

In structuring the test, researchers considered that grade7 is the basic content that C.D.U (1996) complained about. 'A' Level questions were intended to discriminate those students with more mathematics content from those without. All items required process skills and marks were awarded for question analysis, procedural knowledge, accurate calculations and correct answers as advised by Chinamasa (2008; 213). The test was chosen because it is a familiar instrument for measuring knowledge, saves administration time and facilitates assessment of student ability in mathematics content and process skills. Its' administration facilitated the collection of data from a large sample within a short time. Test scripts provided a record of each student's thought processes.

## DATA COLLECTION AND ANALYSIS

Researchers and one lecturer from each of the three primary teachers' colleges collected the data. Team members underwent orientation training to enable them to understand the instrument and promote uniformity in its application. Host college lecturers facilitated entry, permission granting and communication between researchers and participants. Pilot studies were done in one Primary School College.

Selected participants were informed of the study and requested to bring their T.P. files to college during their week-end school. Invitations to participate were sent to 45 pairs (15 from each college) but only 27 pairs from the three colleges managed to bring their T.P. files and volunteered to write the test under examination conditions. All students completed the test within 2 hours. The two researchers marked the scripts and revised the test with candidates for participants' benefits and improving scoring reliability. Marks were recorded and scripts returned to participants.

Results of the test were presented as grouped data using descriptive statistics as an ethical requirement. A student's t-test was applied to confirm the existence of a difference between performance of students majoring in mathematics and those studying it as applied subjects.

Marks from 25 pairs of lesson critics for students observed teaching mathematics were extracted from T.P. files. One of the pairs was from the group of students studying mathematics as a major subject and the other pair was from the group studying mathematics as an applied subject. These marks were compared and a t-test applied to establish pedagogical differences between the two groups. Mathematics lesson plans from T.P. files were analysed for students' innovativeness as shown by use of own examples, strategies and teaching aids. Lesson planning and individual evaluations were examined for topic breakdown, concept sequencing and follow up to individual pupils' needs. Structuring and use of marking schemes was established from weekly tests and their marking schemes in the student's T.P files. All these aspects were rated on the evaluation grip for each group.

Researchers managed to observe eleven pairs of mathematics lessons delivered in urban and peri-urban schools. This was an opportunity to assess classrooms' shop corner, response to economic climate by displaying posters of multi-currency. These were also rated on the evaluation grid and discussed as strengths and weaknesses to benefit participants. Discussions also observed ethics which require participants to benefit from the study.

Interviews were held with student teachers to establish the Curriculum Depth Study (C.D.S) or research project topic. Students were also asked to identify areas that required improvements in mathematics teaching and their initiatives for developing other primary school teachers' skills in mathematics.

Findings were rated on the evaluation grid coded and each group frequency totals were computed using Statistical Package for Social Sciences (SPSS) version 11.5. Data was presented as descriptive statistics and hypotheses tested using a One–way Analysis of Variance (ANOVA) at 5% level of significance.

## FINDINGS AND DISCUSSIONS

Participants were distributed by group and gender as shown in the table:

**Table 2: Participants' Distribution N = 54**

| Gender | Mathematics Major | Mathematics Applied | Total |
|---|---|---|---|
| Female | 7 | 3 | 10 (19%) |
| Male | 20 | 24 | 44 (81%) |
| Total | 27 | 27 | 54 (100%) |

The table shows that female participation in the teaching of mathematics is still low (19%). Interviewed students said acceptance to main subjects depended on one's 'O' level passes. Of the 27 participants majoring in mathematics 19 had A's and 8 had B grades. One female explained that female students are afraid of failing the main subject and repeating hence they found it prudent to go for subjects in which they had confidence. We noted that female participation in mathematics at college level is still low.

**Table 3 Mathematics Test Results N = 54**

| | Student's mark | | | | | | |
|---|---|---|---|---|---|---|---|
| Group | 40 -50 | 51 -60 | 61 -70 | 71 - 80 | 81 - 100 | Mean | Standard Deviation |
| Major | 0 | 5 | 7 | 8 | 7 | 72, 5 | 73, 5 |
| Applied | 4 | 7 | 11 | 4 | 1 | 62, 2 | 90, 0 |
| Total | 4 | 12 | 18 | 12 | 8 | | |

A comparison of the mean, reveals that the group majoring in mathematics did better than the group studying mathematics as an applied subject (62, 2 < 72, 5). The standard deviation for majors is less than that of applied group (73, 5 < 90, 0). This shows a smaller variation for the group majoring in mathematics. This variation can be accounted for by the extra tuition in mathematics content that the group received and discriminating 'A' level questions in the test. During interviews, 9 (33%) of those students majoring in mathematics pointed out that they were also reading 'A' level mathematics so that they can use the qualification as an entry requirements to degree programmes or enabling them to teach 'A' level classes. This finding supports the misconception that, the purpose of the major subject is to prepare students for further 'A' level and University work, (Kausiyo, 1994: 2). Colleges and their students have different philosophies for the main subject. Some applied mathematics students 13 (48%) did not attempt the 'A' level questions despite the fact that, the questions are based on the cosine rule and histogram, which are 'O' level concepts (syllabus 4008, 4028: Section 6.8.2 and 6.11.1) respectively.

We paired scores from the same college to equate the influence of unique college variables. For the 27 matched pair differences at 5% level, v = 26df, the two tailed critical value for t=2,056. The calculated t = 4,4 confirming a significant difference in content between mathematics majors and applied group at 5% level.

**Table 4 Pedagogical Rating Frequencies**

| | Ratings | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Weak** | **Satisfaction** | **Good** | **Very Good** | **Excellent** | **Totals** |
| Major | 212 | 321 | 199 | 120 | 16 | 868 |
| Applied | 239 | 316 | 189 | 87 | 17 | 848 |
| Totals | 451 | 637 | 388 | 207 | 33 | 1 716 |

The rating totals are peaked on 'satisfactory' this could be influenced by the ratter central tendency. Students were rated very good at routine aspects such as stating behavioural objectives, regular marking and evaluation. They were found wanting in the use of games, discovery and projects. Major weaknesses were on the use of own examples, and preparedness to staff –develop other teachers in mathematics.

During interviews, students pointed out that, their school mentors' abandoned them with classes which were too large for games or discovery methods to be used. Articles on the class shop corner had gathered layers of dust undisturbed. Student teachers were not using theshpo-corner in the teaching of numbers or money topic. They were also not responding to the economic environment in their teaching. Only 2 out of 22 classes observed (19%) had specimen bearer cheque posters, nothing on the US$, Rand, Pula, Pound or Kwacha.

Out of the 27 students majoring in mathematics, only 5 (18%) were working on research project topics related to mathematics teaching. During interviews, students explained that, they were not confined to their area of subject specialisation in their choice of research topic. Their research supervisors were not mathematics teachers. We felt that, if the objects of research projects (contributing to curriculum development) are to be realised, there is need to assist those students studying mathematics teaching and learning.

A comparative analysis of marks from mathematics lesson observations by college supervisors was done. For a two- tailed t-test at 5 % level, v =26 df. The critical value for t=2,056. For the mark differences, the calculated value for t=1.36. The Null hypothesis (Ho) was accepted and we concluded that, there was no significant difference in pedagogical skills for those students majoring in mathematics and those studying mathematics as an applied subject.

**Table 5 Pedagogical ratings: Descriptive Results**

| Group | Sum | N | Mean | Standard Deviation |
|---|---|---|---|---|
| Maths Major | 868 | 5 | 173,6 | 113,5 |
| Applied | 848 | 5 | 169,6 | 119,1 |

**Table 6; One –Way ANOVA table**

| Source of Variation | Df | Sum of Squares | Mean Squares | f-calculated | p- value |
|---|---|---|---|---|---|
| Between group | 1 | 40 | 40 | 0,003 | 5,32 |
| Within group | 8 | 108 292.4 | 13 536.55 | | |
| | 9 | 108 332.4 | | | |

To establish (by source and method triangulation) if there was a difference in pedagogical skills for the two groups, an ANOVA test at 5% level has critical value f=0,003. Null hypothesis (Ho) was accepted, confirming that there was no significant difference in the pedagogical skills of students majoring in mathematics and those studying it as an applied subject.

## CONCLUSSION

This study sort to establish the superiority of primary school student teachers majoring in mathematics over those students studying mathematics as an applied subject. Findings reveal that those students majoring in mathematics have more mathematics content. The difference was confirmed by a t-test in which $t_{crit}$=2,056< $t_{calc}$ =4,4 and rejecting of null hypothesis.

The pedagogical skills for those students majoring in mathematics are not significantly different from those skills for students studying mathematics as an applied subject. This was confirmed by the t-test and one-way ANOVA for a difference. According to Ndawi and Masuku (2002), the students were at stage 11, the formalism stage of Beeb's model.

Factors accounting for students majoring in mathematics, content superiority include the fact that: they had better 'O' level passes, received more tuition in mathematics and some were motivated enough to study for 'A' level mathematics examinations. Unfortunately students majoring in mathematics failed to achieve Mukorera's (2001) objective (b). They did not show evidence for:

i. Innovativeness, they taught mathematics as per text-book. Their research project topics were in other subject areas reflecting inability to identify research areas of interest in mathematics.
ii. Being keen to initiate and participate in mathematics staff-development activities.
iii. Using activities like games which develop pupil's interest in mathematics
iv. Responding to economic changes by displaying new currency, US$, Rand, Pound, and bearer cheque specimens to raise pupils' awareness.
v. Identifying and developing pupil's potential in mathematics as shown by lack of individual pupils' instruction.

The lack of pedagogical skills difference between students majoring in mathematics and those students studying it as an applied subject can be explained by the following observations: In primary schools, teaching methods are found in all subjects promoting integration. The phenomenon may encourage mathematics lecturers to concentrate on content at the expense of methodology during the time for main subjects. One can also argue that, primary school college lecturers are trained for secondary schools, they find their expert power in content rather than methodology, hence develop more content than pedagogies skills.

**The study recommends the following implications:**

1. More female students can be encouraged to study mathematics as a major subject at primary school college level. In fact, an affirmative action is being called for.
2. College lectures encourage and assist students majoring in mathematics to identify and carry out research in mathematics teaching and learning for their Curriculum

Development Studies or Research project. Students majoring in mathematics should be supervised by lecturers from the mathematics department.

3. Colleges recruit more lecturers from primary school teachers rather than secondary school teachers. This inclination brings in lectures with primary school classroom experiences rather than those with secondary school experiences.
4. College curriculum includes aspects to staff-development techniques to enable students to staff-develop other teachers in schools.
5. Equal emphasis to be placed on the development of content and pedagogical knowledge for main subject areas.
6. College curriculum designers can allocate more time to teaching methods rather than content, because the primary school child desires method rather than content.

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