**EXPLORING THE RELATIONSHIP BETWEEN TEACHER COMPETENCE AND STUDENT ACHIEVEMENT TO IMPROVE CLASSROOM INSTRUCTION**

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*ABSTRACT*

*Factors that affect student learning and achievement are numerous. One key factor that is believed to have an effect on student performance is the teacher’s competence in what he/she teaches. In order to establish this relationship, senior two (S 2) students and their teachers from 524 secondary schools sampled randomly from all the 112 districts of Uganda were tested. There were three tests: English Language, Mathematics and Biology, based on the national secondary school curriculum. Each student sat for all the three tests and each of the teachers sat for a test in the subject he/she teachers.*

*This paper presents the results of the performance of the students and teachers in Mathematics and how the two are related. The paper also highlights the implications of the results for the policies guiding teacher education and support services so as to improve teaching and learning in schools in the country.*

**1.0. INTRODUCTION**

There are two teaching qualifications recommended for one to teach in a secondary school in Uganda. After the Uganda Advanced Certificate of Education (UACE) course, one may take a three year course and obtain a Degree in Education (B Ed) (or B Sc and B A with Education). Students who fail to gain admission into the University may join a National Teachers’ College, study for two years and are awarded a Grade V Teaching Certificate (equivalent to a diploma), specializing in secondary education. However, there are also small proportions of secondary school teachers with Grade V (Primary) or Grade III teaching certificates, which qualifications are for primary school teachers plus holders of a degree or diploma in fields other than education, as well as holders of UACE. This category is referred to as ‘untrained’ teachers in this presentation.

This presentation reports a summary of the results of a study that was conducted to examine the achievement of Senior 2 (S 2)[[1]](#footnote-2) students and their teachers with different qualifications in Mathematics. It also explores the relationship between teacher achievement and student achievement in the various topics of Mathematics.

**2.0. PREVIOUS RESEACH**

**2.1 FACTORS WHICH AFFECT STUDENT ACHIEVEMENT**

Researches to determine the factors which affect student achievement have made varying revelations. Some studies, for instance Coleman et al (1966), have suggested that the main determinant of student achievement is the individual’s background and social context. Glass et al (1982), on the other hand, report class size as one of the key variables that influence the performance of students. The researches that investigated the association between teacher quality and student achievement, mainly consider teacher characteristics like gender and teaching experience.

**2.2 TEACHER LEVEL OF TRAINING AND STUDENT ACHIEVEMENT**

Uganda National Examinations Board (2011) in comparing the performance of students with that of teachers of different teaching qualifications, finds that students with teachers who possess the recommended teaching qualifications performed better than those whose teachers have other qualifications. Harris and Sass (2010) studied the effects of the types of teacher education and training on the productivity of teachers in promoting student achievement. The results of the study show that attainment of advanced degrees does not improve teacher productivity. Middle school math is the only subject/grade-level combination where obtaining an advanced degree is found to promote the ability of a teacher to boost student achievement. The study also reports that in-service professional development has little or no effect on the ability of teachers to improve student achievement, with the possible exception of middle school mathematics. The researchers also find no evidence showing that teachers’ pre-service (undergraduate) training or college entrance exam scores are related to productivity. However, the results of a study by Ferguson (1993) insinuate that teacher qualifications could affect what students learn. This research examines whether teacher licensure test scores and other teacher qualifications affect middle school student achievement and finds that licensure test scores in general aptitude, subject-matter knowledge, and reading pedagogy had no significant effects on student achievement. Teachers with elementary school credentials had slightly better success in the classroom than did teachers with secondary school credentials.

**2.3 TEACHER SUBJECT KNOWLEDGE AND STUDENT ACHIEVEMENT**

The few studies which investigated the influence of teacher subject knowledge and student achievement produced varying results. Begle (1972) in his study to investigate the relationship between algebraic understanding of teachers and student achievement in algebra in one academic year, found no significant correlations between teacher understanding of algebra and student achievement. On the contrary, Metzler and Woessmann (2010) drawing on data on math and reading achievement of 6th-grade students and their teachers in Peru, obtained a significant effect of teacher subject knowledge on student achievement, A one standard-deviation increase in teacher subject knowledge raises student achievement by about 10 percent of a standard deviation.

**3.0 THE STUDY**

**3.1 OBJECTIVES**

In the NAPE survey of 2011, teacher factors impacting on learners’ achievements are investigated. The findings show that the mean scores of the learners taught by University graduate and Grade V (diploma) teachers were lower than expected. In addition, learners have continued to perform well in some topical / skill areas and poorly in others. It was felt that this could be partly due to the level of competence of the teachers in the topical / skill area(s). This study, therefore, uses the data from the 2011 NAPE study determines the level of subject matter competence of secondary school teachers in Mathematics and examines the relationship between teacher competence and student achievement. The specific objectives of the study, among others are:

* Determine the level of subject matter competence of secondary school teachers in Mathematics.
* Examine the patterns of teacher and student performance in different topics of Mathematics.
* Examine the relationships between teacher subject matter competence and learner achievement.

**3.2 METHODOLOGY**

***3.2.1 Sample Selection***

The 524 secondary schools already selected to be assessed in the 2011 National Assessment of Progress in Education (NAPE) participated in the study. NAPE uses a two-stage stratified cluster sampling design. In the first stage, a random sample of schools, stratified by zone, is selected. The second stage involves selecting a random sample of 30 S 2 students from among those present in the school on the day of the assessment. In each school, the S 2 teacher of Mathematics was included in the sample. In all, there were 17,427 students and 458 teachers.

***3.2.2 Instruments***

There were two types of instruments: a Mathematics test and a questionnaire. Both students and teachers sat for the same Mathematics test, though the teachers’ test were printed on paper of a different colour and disguised as a questionnaire. The test was criterion-referenced and based on the Uganda National Secondary School Curriculum. It was developed by secondary school teachers and officers from the National Curriculum Development Centre, Kyambogo University and UNEB. The tests consisted of multiple choice, restricted and free response items each carrying 1 – 10 marks. Students and teachers responded to the items by writing their answers on the question paper itself. They were expected to show their working. The test contained 35 items and carried a total score of 100 marks. The time for the test was 2½ hours for students and 1¾ hours for teachers. In addition to the test, teachers filled in a questionnaire to indicate their gender and highest teaching qualification, among others.

***3.2.3 Data Analysis***

The student test scripts were scored by secondary school teachers who worked in teams of eight people and scored the scripts using the conveyer belt system. The team leaders from each group scored the teachers’ scripts and all the scoring was done in a central venue in Kampala. The test scores were captured using EpiDATA (version 3.02), and data analysis was done using the STATA (version 11.0) statistical package. Data analysis was done at two levels. The analysis involved determining the overall achievement level in Mathematics in terms of mean scores and the percentages of students and teachers reaching the defined levels of proficiency.

Students’ achievement in the test was described using one of three levels: ‘Advanced’, ‘Adequate’, and ‘Basic’. This criterion was set at the time of preparing the test. Detailed description of the categorization of the competencies, by performance levels is given in Appendix 1. A student is rated proficient if he/she has reached ‘Advanced’ or ‘Adequate’ level of proficiency. The teachers’ scores were categorized into two: ‘Proficient’ or ‘Not proficient’. A teacher is rated proficient, if he/she reached the ‘Advanced’ level as specified for the students.

**4.0 RESULTS**

**4.1 OVERALL ACHIEVEMENT OF TEACHERS AND STUDENTS IN MATHEMATICS**

This section describes the achievement of teachers and students in Mathematics in terms of the proportions of respondents rated proficient. Table 1 shows the percentage of teachers and students rated proficient in Mathematics.

**Table 1: Percentage of Teachers and Students Rated Proficient in Mathematics**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| GENDER | TEACHERS | | STUDENTS | |
| N | PERCENTAGE | N | PERCENTAGE |
| MALE | 418 | 71.5 | 9470 | 43.9 |
| FEMALE | 40 | 70.9 | 7957 | 32.2 |
| TOTAL | 458 | 70.3 | 17,427 | 38.2 |
| P value |  | .9599 |  | .0000\*\*\* |

Note: \*\*\* indicates significance at .001 level.

As many as 70.3% of the teachers were rated proficient in Mathematics, with nearly equal proportions of males and females: 71.5% and 70.9% respectively, reaching this level of excellence. However, the proportion of students who reached the defined competency level of 38.2%, was much lower. In addition, significantly more boys (43.9%) than girls (32.2%) were proficient. There was a weak correlation between the teachers’ and students’ achievement (r =0.1265; n=523; p = .0041\*\*\*). This means that there is a small significant effect of teacher subject knowledge on student achievement.

**4.2 ACHIEVEMENT OF TEACHERS AND STUDENTS BY TEACHER PROFESSIONAL QUALIFICATION**

The mean scores of the teachers and students in Mathematics by teacher qualification are shown in Table 2.

**Table 2: Mean Scores of Teachers and Students in Mathematics by Teacher Qualification**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| HIGHEST TEACHING QUALIFICATION | TEACHERS | | | STUDENTS | | |
|  | N | MEAN | S E | N | MEAN | S E |
| Degree in Education | 168 | 81.3 | 1.44 | 6,642 | 39.1 | 0.93 |
| Grade V | 215 | 82.4 | 1.10 | 8,431 | 34.6 | 0.72 |
| Untrained | 75 | 79.4 | 1.30 | 2,354 | 32.2 | 1.19 |
| Total | 458 |  |  | 17,427 |  |  |

The mean scores of the teachers of different qualifications were not significantly different, but the teachers who were untrained obtained the lowest mean score of 79.4%, compared to 81.3% and 82.4% for degree and Grade V holders respectively. However, the mean scores of the students were significantly lower than the teachers’, regardless of the teacher’s qualification. For instance, teachers with a Degree in Education obtained a mean score of 81.3% compared to the mean of 39.1% scored by their students.

Students taught by teachers with a Degree in Education had the highest mean score, followed by those whose teachers had Grade V and then those taught by untrained teachers. The difference in the mean score of students taught by teachers with Degree in Education and those taught by untrained teachers was significant.

**4.3 ACHIEVEMENT OF TEACHERS AND STUDENTS IN TOPICS OF MATHEMATICS**

The achievement of teachers and students in the key topics of Mathematics at S 2 level is examined in this section. The proportion of teachers and students who reached defined competency levels in various topics of Mathematics is given in Table 3.

**Table 3: Percentage of Teachers and Students Rated Proficient in Topics of Mathematics by Teacher’s Highest Qualification**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TOPIC | TEACHING QUALIFICATION | TEACHERS | SIG | STUDENTS | SIG. |
| Measures | B Ed | 88.3 (0.03) | .0129\* | 40.5 (0.02) | .0012\*\* |
| Grade V | 85.7 (0.04) | 31.5 (0.02) |
| Untrained | 84.7 (0.05) | 28.7 (0.03) |
| Numerical concepts | B Ed | 80.4 (0.04) | .0010\*\* | 74.3 (0.02) | .2405 |
| Grade V | 78.0 (0.04) | 71.6 (0.02) |
| Untrained | 74.8 (0.07) | 63.4 (0.03) |
| Geometry | B Ed | 27.0 (0.05) | .0270\* | 19.4 (0.02) | .0008\*\*\* |
| Grade V | 29.1 (0.04) | 12.7 (0.01) |
| Untrained | 18.6 (0.06) | 10.7 (0.01) |
| Graphs | B Ed | 66.4 (0.05) | .7254 | 13.4 (0.02) | .0003\*\*\* |
| Grade V | 61.2 (0.05) | 7.4 (0.01) |
| Untrained | 53.8 (0.08) | 5.9 (0.01) |

Note: \* indicates significance at .05 level; \*\* at .01 level and \*\*\* at .001 level.

The performance of both teachers and students varied across the topics of Mathematics, but generally followed a similar trend. Higher proportions of both the teachers and the students were rated proficient in ‘Measures’ and ‘Numerical Concepts’ than in ‘Graphs’ and ‘Geometry’. Teachers of all categories performed best in ‘Measures’ and worst in ‘Geometry’. For instance, 88.3% of the teachers with a Degree in Education were proficient in ‘Measures’, 80.4% in ‘Numerical Concepts’, 66.4% in ‘Graphs’ and only 27.0% in ‘Geometry’.

Students, regardless of the qualification of their teacher, performed best in ‘Numerical Concepts’, then ‘Measures’, ‘Geometry’ and ‘Graphs’, in that order. For example, the majority of students (74.3%) taught by degree holders were rated proficient in ‘Numerical Concepts’. This figure dropped to 40.5% in ‘Measures’ and further to only 19.4% and 13.4% for ‘Geometry’ and ‘Graphs’ respectively.

Significantly more teachers than students reached the defined proficiency level in all the topics, except ‘Numerical concepts’. Wider differences occurred in the performance in ‘Graphs’, and ‘Geometry’ than in the other two topics.

In each topic, teachers with a Degree in Education performed best (except for Geometry), followed by those with Grade V Teaching Certificate and then the untrained teachers. Similarly, the highest proportion of students rated proficient was of those whose teachers had a Degree in Education and the lowest was of students taught by untrained teachers. The differences in the proportions of students rated proficient by teacher qualification were statistically significant. The differences in the percentage of teachers and students rated proficient in topics is shown in Figure 1.



Students’ and teachers’ performance varied significantly in ‘Measures’ and ‘Graphs’, meaning the teachers obtained much higher scores than the students in these topics. In ‘Numerical concepts’, the difference in the performance of the two was not statistically significant. This was also the topic that registered best performance from the students and the second best from teachers. However, both teachers and students performed poorly in ‘Geometry’ leading to a small difference in their performance.

**5.0 CONCLUSION AND DISCUSSION**

The majority of secondary school teachers of Mathematics attained scores that reached the defined proficiency level, implying that the teachers possess the mathematical knowledge specified at secondary school. There was no significant difference in the performance of teachers in Mathematics by gender, but among the students, boys did significantly better than the girls. Maybe because secondary school teachers specialize in subject(s) of their choice and this is usually a subject they are gifted in and are interested in. For the students, there may be gender stereotyping, especially in the rural areas, whereby Mathematics and Science are considered to be subjects for the males. This belief in reinforced by the fact that the majority of the teachers of these subjects are men.

Performance of the teachers with different qualifications did not vary much, but the degree holders performed best, followed by the Grade V teachers and then those who are not qualified to teach in secondary schools. This result implies that secondary school teachers, irrespective of their qualifications, have mastery of the subject matter. It seems the teacher training programs adequately equip student teachers with the necessary subject contents. The untrained teachers could have gained their mathematical knowledge from the courses they had attended in secondary schools or tertiary institutions.

There was a variation in the level of competence in the different topics of Mathematics, with more teachers showing ability in ‘Measures’ and ‘Numerical Concepts’ than in ‘Graphs’ or ‘Geometry’. The teachers with a Degree in Education performed best while the untrained teachers performed worst in each of the topics, but the differences were not statistically significant. Perhaps the additional contents that the degree holders cover in the university give them advantage over the others.

Students performed at a low level, with just over a third reaching the defined proficiency level, irrespective of their teachers’ teaching qualification. However, the students taught by teachers with a Degree in Education performed significantly better than those whose teachers held other qualifications. Students’ performance in the various topics of Mathematics was generally similar to their teachers’, but poorer. The differences in the performance were greater in ‘Measures’ and ‘Graphs’, in comparison to ‘Geometry’ and ‘Numerical concepts’. Possibly teachers lack confidence to teach the topics they themselves are not well grounded in or they do not have the pedagogical skills required to teach certain topics.

There was a weak positive relationship between teachers’ and students’ scores. This implies that when a teacher is knowledgeable in a subject, there is a likelihood of the students performing better in the subject. Goe and Stickler. (2008) too, reported that teachers with stronger mathematics knowledge produced better student achievement in Mathematics, compared to the less knowledgeable teachers, particularly at secondary level. Supporting evidence is also provided by Clotfelter (2006a) who finds that teacher licensure test scores have a marginally positive relationship to middle school students’ Mathematics test scores. Rowan et al. (2005 ), as well, find that teachers’ mathematical knowledge is significantly related to student achievement gains in both first and third grades after controlling for key student- and teacher-level covariates. This result, just as that of the current study, is obtained via a measure focusing on the specialized mathematical knowledge and skills used in teaching mathematics.

The findings from this study, as well as from others, therefore, seem to indicate that there is a positive relationship between teacher subject matter competence and student achievement. However, the relationship appears not to be linear, it tapers off at some stage. It looks like there is a threshold beyond which formal training for teachers may not yield additional impact on student achievement. In addition, the subject matter in teacher training programs ought to be related to the school curriculum contents that the teacher will eventually use in teaching. This underscores the importance of designing teacher training programs such that there is harmony between the college subject matter and the school curriculum. Besides, there may be need to review the pedagogy component of the training courses with a view to strengthening it and making it more practical. The results in this study and those cited above further suggest that policies which encourage the investments in enhancing the quality of teachers may have a bearing on improvements in student performance. These findings also provide support for policy initiatives designed to improve students’ mathematics achievement by improving teachers’ mathematical knowledge. It must however, be noted that possessing subject competence per say, without having the necessary skills to impart similar knowledge to others or without an enabling environment may not make any impact.

**6.0 LIMITATION**

This study did not control for variations in student, teacher and school characteristics and this could have affected the results. As Glewwe and Kremer (2006) point out that, the existing evidence on the association between teacher knowledge and student achievement is still likely to suffer from bias due to unobserved student characteristics, omitted school and teacher variables, and non-random sorting and selection into classrooms and schools. They add that obvious examples where such bias would occur include incidents where better-motivated teachers stimulate more student learning but also accrue more subject knowledge; where parents with a high preference for educational achievement both choose schools or classrooms within schools with teachers of higher subject knowledge and also further their children’s learning in other ways; and where principals place students with higher learning gains into classrooms of teachers with higher knowledge.

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**APPENDIX 1 DESCRIPTION OF THE COMPETENCIES BY PROFICIENCY LEVELS**

*NOTE:*

A student at any proficiency level is assumed to have mastered all the competencies specified at his/her level plus the competencies below:

| **TOPIC** | **PROFICIENCY LEVEL** | **COMPETENCIES IN EACH PERFORMANCE LEVEL** |
| --- | --- | --- |
| NUMERICAL CONCEPTS (Including Number Patterns & sequences & Estimation) | BASIC | * Performs the four basic operations. |
|  | * Lists multiples and factors of numbers. |
|  | * Corrects a given number to a specified number of decimal places. |
| ADEQUATE | * Finds the LCM and HCF. |
|  | * Expresses percentage as a ratio or vice versa. |
|  | * Uses the concepts of fractions, decimals, percentages and ratios |
|  | * Completes a number sequence. |
|  | * Performs the four basic operations on decimals. |
| ADVANCED | * Uses the concept of LCM and HCF in daily life. |
| CARTESIAN COORDINATES AND GRAPHS | BASIC | * Plots points on a Cartesian plane. |
| ADEQUATE | * Finds the equation of a line for a given set of points. |
|  | * Draws a distance-time graph from a set of points. |
| ADVANCED | * Makes inequality statements using inequality symbols. |
|  | * Interprets simple distance-time or speed-time graphs. |
| MEASURES | BASIC | * Carries out currency conversions. |
|  | * Computes the circumference and area of a circle. |
| ADEQUATE | * Solves problems involving shopping. |
|  | * Computes the surface area of given shapes. |
| ADVANCED | * Computes principal, rate, time and simple interest. |
| GEOMETRY | BASIC | * Indicates compass bearings. * Measures angles and lengths accurately. |
|  | * Identifies the hypotenuse, opposite and adjacent sides of a right angled triangle in relation to a given angle. |
| ADEQUATE | * Finds the exterior or interior angle or the number of sides of a regular polygon. |
|  | * Draws circles and triangles. |
| ADVANCED | * Constructs a line parallel to another. * Constructs a triangle of given dimensions. |

1. Students in the second year of secondary education. [↑](#footnote-ref-2)