The teaching of basic mathematical concepts to pre-service teachers in universities: A case of mountains of the moon university, Uganda

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ABSTRACT

Mathematics is key during teaching and school management; the relevance of teaching basic mathematics to the pre-service teachers at universities was investigated. A random sample of 80 pre-service teachers was used and a quantitative experimental design was adopted. The results indicated that there was a significant difference at 0.05 level between the mathematical concepts that pre-service-teachers had at entry and at the end of the basic course in mathematics. There was no significant difference at 0.01 level between the pre-service teachers' scores in basic mathematics and their subjects of specialization at the start of the course but the difference was significant at 0.01 level at the end of the course. Also, there was a change in the pre-service teachers' mindset about the course over time during the teaching and learning process.

Key words: Pre-service teachers, basic mathematics and teaching.

INTRODUCTION

The role of Mathematics in the teaching and learning process does not need to be told to any individual or society. This explains why the subject is considered among the most important subjects in Ugandan education system. Mathematics has been regarded as the foundation of science and technology, (Odumosu et al., 2001). The process of teaching as well as school management requires some basic concepts of mathematics especially during planning, accountability, budget control, assessment and evaluation and management of change. There is hardly any area of science that does not make use of mathematical concepts to explain its own concepts, theories or models. Simeon and Francis (2012) discoursed that mathematics is the queen of science and technology and also a tool for scientific and technological development; similarly, Mathematics is regarded as the major tool available for formulating theories in the Science, Engineering, and Economics as well as in other fields such as Education. However, according to Opolot-Okurut (2005), majority of the students at all levels of education have a low attitude towards the subject.

Teachers are researchers in their own classrooms, they provide guidance to their learner and this comes after a simple investigation about the problem at hand. Teachers handle students' data such as examination scores and students' bio data; all these require proper presentation, analysis and relevant recommendations for new innovations in schools.

School managers such as directors of studies, deputy head teachers and head teachers do a lot of planning, budgeting, forecasts and projections that require the knowledge of mathematics. As an attempt to close this gap, students enrolling for teaching courses at universities are introduced to basic Mathematics that is aimed at instilling in them the relevant mathematical concepts such as data handling, numerical concepts, matrices, equations and relationships, these concepts according to Kurniz (2008) requires a gradual process.

Owing to the role and application of mathematics according, all pre-service teachers in universities are
introduced to basic mathematical concepts that are sought to help them during the teaching and learning process. The question in this study is whether students who enroll for teaching related programs at universities do not have these concepts. The purpose of this study was to establish the difference between what the mathematical concepts Pre-service teachers have at entry and what they have at the end of the basic mathematics course in order to establish the relevance of teaching the course unit.

**Main objective**

To establish the relevance of teaching basic mathematics to the pre-service teachers in Universities.

**Hypotheses**

1. Ho: There is no difference between pre-service teachers' Mathematical knowledge at entry and at the end of the basic mathematics course.
2. Ho: There is no difference between pre-service teachers' scores in the basic mathematics course and their subjects of specialization at the start of the course.
3. Ho: There is no difference between the pre-service teachers' state of mind about the basic mathematics course at the start and at end of the course.

**MATERIALS AND METHODS**

Pre-service teachers who registered for Bachelor of Arts with Education and Bachelor of Science with Education in first year of 2018/2019 at Mountains of the Moon University constituted the sampling frame. The total number of registered pre-service teachers was 185 form which a sample of 80 respondents was randomly selected. An experimental design was adopted according to some researchers (Bandura, 1977; Best and Kahn, 1999; Brewer, 2005). Two data sets were collected at the start and at the end of the course. The first data set consisted of a test that was aimed at finding out the level of mathematical knowledge of the pre-service teachers and the questionnaire that captured the mindset of the pre-service teachers at the start of the course. The second data set had similar tools with an aim to measure the change in the mathematical knowledge and mindset of the pre-service teachers. The data were analyzed using the statistical package for social scientists (SPSS) and the summary is presented hereafter.

**RESULTS**

**Level of pre-service teachers' mathematical knowledge**

The pre-service teachers' level of mathematical knowledge, such as ability to solve equations, data handling, dealing with numbers, graphs and logical thinking, was measured at 2 levels. The 1st measurement test was at the start of the semester before the basic course in mathematics was taught, while the 2nd measurement test was at the end of the semester after the basic course was fully taught to the pre-service teachers. The results are discussed here under.

The 1st test was administered to eighty randomly selected pre-service teachers, it measured the concepts that covered the basic mathematics such as data handling, equations, graphs, numerical concepts and matrices. The results of the test were compared between 2 major characteristics of the pre-service teachers; the gender and the subject of specialization. The subject of specialization was conceptualized in 2 categories: pre-service teachers specializing in mathematics and those not specializing in other subjects not mathematics. The results of these characteristics are discussed in this study.

**Distribution of students' scores in tests 1 and 2 by gender**

The tests were administered to eighty (80) pre-service teachers under the same conditions, one at the start of the semester and the other at the end of the semester. The distribution of the pre-service teachers' scores is shown in Table 1.

According to Table 1, the mean of the pre-service teachers' scores in Test 1 was 22 and 25 for female and male teachers, respectively. This indicates that there was a difference between the scores obtained by female and male teachers in Test 1 with male pre-service teachers performing better than female. In the study by Ajai and Imoko (2015), such difference was registered but was found not to be significant. The median score in Test 1 was 20 and 25 for female and male teachers respectively, while the most common score was 25 for both female and male teachers. The inclusive (overall) mean is to right of the mode of Test 1, so the distribution of the scores was positively skewed with Pearson coefficient of skewness as 0.7 and 1.0 for female and male, respectively. The kurtosis was 1.1 which is positive, indicating that the shape of the distribution was not flat and the median was 25 indicating that 50% of the pre-service teachers had scores of 25 and below. The inclusive standard deviation was 7.4, this indicates that teachers' scores slightly deviated from the men score.

Similarly, the mean of the students' scores in Test 2 were 62 and 66 for female and male teachers, respectively, while for inclusive men was 64.5. Similar to Test 1, the means of Test 2 indicate a knowledge difference across gender. The kurtosis for Test 2 was -0.1, indicating that the distribution
of Test 2 is flat. The inclusive median was 65 and the mode was 65, this indicates that 50% of the students had scores of 65 and above. Also, it was observed that the inclusive mean, mode and median of Test 2 were almost the same, indicating that the distribution is almost normal. The inclusive standard deviation of Test 2 was 16.3, this suggests that 68% of the students had mean scores of between 48.2 and 80.8.

The results in Table 1 further showed that there is a difference between the teachers’ scores in Test 1 and Test 2. It was observed that the mean difference across gender between Test 1 and Test 2 was found to be almost the same. This indicated consistency in knowledge difference between female and male teachers, which is in line the finding of Ajai and Imoko (2015). The results also showed an increase in the mean scores for both female and male teachers, this is probably attributed to the knowledge the pre-service teachers obtained from the basic mathematics course, an indication that the course results into additional knowledge and as such, it is relevant to the pre-service teachers. The distribution of the scores shifted from being positively skewed in Test 1 to almost normally distributed in Test 2. The range of the scores in Test 1 was 35 when compared with 75 in Test 2, this indicates that the rate of knowledge achievement of pre-service teachers with high scores in Test 1 was high as compared with their counterparts with lower scores in Test 1. This therefore, suggests that the background knowledge of the students has a significant effect on the subsequent knowledge achievements. This is indicated by Pearson correlation coefficient \( r = 0.4869 \) which is however a week relationship between the two levels of knowledge.

**Comparison between pre-service teachers’ scores in test 1 and test**

The main question addressed in this subsection is whether there is a mathematics knowledge difference before and after the teaching of the basic mathematics course to the pre-service teachers at universities. The mathematics knowledge level was measured in terms awareness and application of mathematical concepts that the basic mathematics course aims at. The distribution of the relationship between the two test scores is shown in Table 2.

Table 2 shows results of the hypothesis test for the difference between the 2 means from the 2 tests. The null hypothesis being tested is \( H_0: \) There is no difference between the pre-service teachers’ mathematical knowledge at entry and at the end of the basic mathematics course, that is, there is no difference between the pre-service teachers’ mean scores in the two tests. The results showed that the test statistics (20.2) was numerically greater than the critical value (1.96). In this case, the null hypothesis is rejected implying that there is a significant difference between the pre-service teachers’ mathematical knowledge at entry and at the end of the basic mathematics course at 0.05 level.

**Relationship between pre-service teachers’ scores and their subjects of specialization**

The students’ scores in the second set of measurement were analyzed against their subjects of specialization. The subjects considered were History, Geography, Mathematics, Physics, Agriculture, Economics, entrepreneurship, Religious Studies, and Fine Art. These subjects were subdivided into 2 groups: Mathematical subjects (Mathematics, Economics, and physics) and Non-mathematical (History, Entrepreneurship, Geography, Religious Studies, Agriculture and Fine Art). The analysis was done within groups and across groups with the aim of comparing students’ scores across subjects and across groups. The results of the analysis are illustrated hereafter.

**Students’ gender and pre-service teachers’ of specialization**

The distribution of the participants comprised 39% female and 61% male. 26% were specializing in Mathematics of which 19% were female and 81% were male and 74% were specializing in other subjects such as History, Geography, Economics, Fine Art and Religious studies of which 46% were female and 54% were male. These results showed more male participated in the study than the female teachers. Similarly, teachers specializing in mathematics were less as compared with those specializing in other subjects. The number of female teachers specializing in mathematics was much less than the male teachers specializing in the subject with a percentage range of 62% which was much bigger than the percentage range of 8% between the female and male teachers specializing in other subjects.

**Pre-service teachers’ scores in test 1 and test 2 by subject of specialization**

The main question discoursed here is whether the students’ test scores in basic mathematics differ by their subjects of specialization or not. The summary of the related results is shown in Tables 3 and 4. Table 3 shows that there was a difference between the mean score of mathematics teachers and non-mathematics teachers in Test 1; however, this difference was not significant at 0.01 levels as shown in Table 4. Similarly,
there was a difference between the mean scores of the teachers in Test 2 and this difference was significant at 0.01 level as shown in Table 4. These results showed that all the teachers had almost the same knowledge level at the start of the semester; however, there was a significant difference at the end of the basic course between teachers who were specializing in mathematics and those specializing in other subjects other than mathematics. This also indicated that the content of the course unit is required by all the teachers irrespective of their subjects of specialization, but teachers not specializing in mathematics should be given a high level of attention as their rate of internalizing mathematics concepts was low as compared with their counterparts.

Pre-service teachers’ mindset about the basic mathematics course

The variation in pre-service teachers’ mindset about the basic mathematics course offered at the university was
Table 4: Test for the difference between the mean scores of Test 1 and Test 2 for the Mathematics teachers and Non-mathematics teachers.

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Test 1</th>
<th>Test 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean score for Mathematic students</td>
<td>28.3</td>
<td>79.0</td>
</tr>
<tr>
<td>Mean score for Non-Mathematics teachers</td>
<td>24.4</td>
<td>59.0</td>
</tr>
<tr>
<td>Standard deviation for Mathematics teachers</td>
<td>6.3</td>
<td>14.4</td>
</tr>
<tr>
<td>Standard deviation for Non-Mathematics teachers</td>
<td>7.2</td>
<td>13.7</td>
</tr>
<tr>
<td>Sign. $\alpha$ (2 tailed)</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Critical value $\frac{Z}{\sqrt{2}}$</td>
<td>2.57</td>
<td>2.57</td>
</tr>
<tr>
<td>Test statistic $z$</td>
<td>2.2</td>
<td>5.6</td>
</tr>
</tbody>
</table>

![Figure 1: Distribution of pre-service teachers' mindset about the basic mathematics course.](image)

Figure 1: Distribution of pre-service teachers’ mindset about the basic mathematics course.

measured using a 5 Likert scale questionnaire. The questionnaire covered the teachers’ interest in the course, ability to make a study plan, awareness of the applicability of the course, having a hope of passing the course, willingness to study the course continuously, ability to patiently solve related problems and students’ confidence level. The results obtained are shown in Figure 1.

Figure 1 shows the teachers' mindset about the basic
mathematics course. The teachers who showed a high level of interest in the basic mathematics course at the start of the course were 65%. This increased to 69% at the end of the teaching. Teachers were also asked whether the course unit is their favorite or not; at the start of the course very few (30%) indicated that the course was their favorite, while 70% ranked the course among the desired course units. The results at the end of the course indicated a slight increase in the number of teachers who felt the course unit was their favorite, however, proportion was still low. This is attributed to the low attitude of learners towards mathematics in general.

At the beginning, most teachers indicated that they had no study plans for the course, only 45% reported the use of discussion groups, self-reading and use of e-learning resources as their study plans. At the end of the course, 65% of the teachers developed a relevant study plan. These were stirred by the class exercises and tests. This indicates that the learners had no study plan at the beginning of any particular teaching but developed the plan during the teaching process. Teachers and other instructor need to ensure that learners are engaged in numerous activities to ensure that they develop a study plan for success.

The application of basic mathematics course in teaching and learning were not recognized by the pre-service teachers at the start of the course, only 21% of the teachers indicated that the course is relevant and has application in the teaching and learning process. However, after the teaching, the proportion of the teachers with a positive mindset about the applicability of the course in teaching was 95%. This change in mindset was reported to be as a result of the number of practical exercises the students could have engaged in during the lessons; one of the student narrated that:

"This course is reality in schools, I can now make a teaching timetable of a school wawoowo....".

Figure 1 also shows that the students had little or no hope of passing the course unit at the beginning, only 35% reported that they are hopeful about passing the course unit. This was also reflected by level of teachers’ confidence in mathematics. The number of teachers who reported as having hope for passing was almost equal in proportional as those who showed a high level of confidence. The proportion of the teachers who had patience and love to continue studying the course also increased from 35 and 15% to 67 and 51%, respectively. In general, there was a difference between the pre-service teachers’ mindset at the start of the course and at the end of the course, these results are in line with the findings of Akin and Izzet (2011) and Tam (2017) who obtained about variation in students’ mathematics mindset.

Conclusion

The teaching of the basic mathematics course is relevant to all students enrolling for teaching related courses as pre-service teachers at universities. The study yielded two important results: (1) Students enrolling at university in the teaching courses have a knowledge gap on mathematical concepts that are frequently used during the teaching and learning process and this gap does not depend on their subjects of specialization. However, the pre-service teachers who are specializing in mathematics have a high level of knowledge grasping and application than those specializing in other subjects such as History, Geography, Economics and Agriculture. (2) Pre-service teachers and other learners have a negative mindset about courses at the start of the teaching but develop a positive mindset as the teaching go on and after interacting with the content and practical examples of the course.

RECOMMENDATIONS

The basic mathematics course should be emphasized in all teacher training institutions to close the existing knowledge gap on mathematical concepts relevant to the teaching process. The teaching of this course should highly engage teachers who are not specializing in mathematics as their teaching subject in order to progress at the same rate as those whose subject of specialization is mathematics. Care should be taken as learners (pre-service teachers’) mindset is always negative as far as mathematics is concerned but they have an ability to change as they interact with the content of the course. Such courses should only emphasize application of content rather than just knowledge. Further research may be conducted to ascertain the performance gap in schools that may exist between teachers who were introduced to basic mathematics course and those who were not introduced to the course during their training time.

REFERENCES


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