Prospective Mathematics Teachers' Knowledge of Fractions

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Abstract:- **The main purpose of this study was to assess Nigerian prospective mathematics teachers' knowledge of fractions. This study adopted descriptive research design using ex-post facto type. The study population comprised of all 300L prospective mathematics teachers in F.C.T College of Education, Zuba Abuja. The study used Fraction Knowledge Test (FKT) and a self-administered questionnaire to collect data from 68 prospective mathematics teachers who were selected by the use of simple random sampling. Data were analyzed using descriptive statistics and multiple regressions at 0.05 level of significance. Result of the findings revealed that prospective teachers displayed better fraction knowledge on procedure than on conception; they had difficulty in division of fractions because of their inadequate knowledge in multiplicative thinking and their fraction procedural knowledge moderately correlated with their problem solving. Based on the findings, it was recommended that universities and colleges of education in Nigeria should, as a matter of urgency, help prospective teachers to develop deep understanding of mathematics (especially fraction concept) that they need for their future teaching and proper monitoring of teaching activities in both primary and secondary schools school be intensified.**

Keywords: **Prospective mathematics teachers, knowledge and fraction**

I. INTRODUCTION

There is no way we talk of fraction as a concept in mathematics without mentioning mathematics itself. Mathematics can be described as the study of quantity, structure, shape and change. It developed, through the use of abstraction and logical reasoning from counting, calculation measurement, and the study of shapes and motions of physical objects. It also explained further that it is the study of patterns of structure, change and space; more informally, one might say it is the study of "figure and numbers." Mathematics is also used as an instrument for validation in the developmental affairs such as social, technological etc, through the manipulation of data for example, our opinion rely on statistical data, our health is controlled by indices of our body chemistry. We are socially classified according to our income and daily life is paced by schedules, dates and time, it is reasonable to conclude that mathematics- a celebrated key to achievement, man's supreme intellectual achievement and most original creation of the human spirit. To achieve some of these tremendous roles mathematics play, the teachers of the subject cannot be over-looked. A teacher or schoolteacher is a person who provides education for pupils (children) and students (adults). The role of teacher is often formal and ongoing, carried out at a school or other place of formal education. In many countries, a person who wishes to become a teacher must first obtain specified professional qualifications or credentials from a university or college. These professional qualifications may include the study of pedagogy, the science of teaching. Teachers, like other professionals, may have to continue their education after they qualify, a process known as continuing professional development. Teachers may use a lesson plan to facilitate student learning, providing a course of study which is called the curriculum.

O'kwu (2013) opined that mathematics is one of the core subjects in primary and secondary levels of education in Nigeria and is used to determine those qualified or not to enter the tertiary level of education. Despite this, students tend to perform poorly in mathematical concepts especially fractional aspects. WAEC (2002) and (2008) for example, consistently observe that among all the topics in secondary school mathematics, the one towards which students have shown negative attitude is fractional concept that involve simplification. Broby and Adetula (2000) in their general consensus opined that the amount of mathematics learning that takes place in a classroom situation depends greatly on the influence of teachers or rather what the teachers do. Mathematics teachers, in this respect, are considered as the determinants of quality of mathematics education and teacher of mathematics as the source of effective learning of mathematics. It is an indisputable fact that an adequate supply of competent mathematics teacher is an essential ingredient for good mathematics teaching. This is so because mathematics is regarded as the key to all human endeavour, in the sense that any step taken by human being in life, in one way or the other, involve mathematics. For example, consider a person (likely an illiterate) who is ready to prepare breakfast, measures 3 cups out of 10 cups of rice in the kitchen has employed *fraction concept* in mathematics that is, 3 out of 10 cups (it can be written in fraction as $\frac{3}{10}$).

On the other side, failure to master simple fractions tasks can have serious consequences, for example: A newly graduated registered nurse who administered one-half grain of morphine when, in fact, one-eighth grain was ordered, reasoning that since 4 plus 4 equals 8, 1/4 plus 1/4 equals 1/8 (instead of 1/2). Although the patient survived, the dose was enough to depress her respiration to a life threatening level. With these examples, teaching of mathematics, especially *fraction concepts,* needs a sound and competent teacher that can

handle the subject effectively. The nature of mathematics is such that prospective teacher needs to be properly trained both in the subject matter and the methodology of the subject.

Statement of the Problem

It has been observed that as important as fraction is, mathematics teachers find it difficult to teach the concept with different learning styles and they are unable to connect the concept of fractions with other concepts like ratio, rate etc. The quality of any educational system lies on the effectiveness of the teachers. This study is therefore, tends to assess the knowledge by which the prospective mathematics teachers posses.

Research Questions

The following research questions were generated and answered in this study.

1. How do prospective teachers perform in fractional mathematical knowledge and problem solving?
2. Do the prospective teachers perform equally in fractional procedural and conceptual knowledge?
3. How do prospective teachers perform in six components (equivalence, addition, subtraction, multiplication, division, and transfer) of fractions in procedural and conceptual knowledge, respectively?

Research Hypotheses

The following research hypotheses have been generated for the study:

1. There is no significant difference between the prospective teachers' performance in fractional mathematical knowledge and problem solving.
2. There is no significant relationship between the prospective teachers performance in fractional procedural and conceptual knowledge.
3. There is no significant relationship between the performance of prospective teachers in six components of fraction in procedural and conceptual knowledge.
4. There is no significant difference between the attitude of prospective teachers and effective teaching of fraction.

Significance of the Study

The study would enhance teachers' knowledge in mathematics and also enhance education performance in the Nigerian education sector. The study would also expose prospective mathematics teachers to build more confidence in themselves when teaching mathematics. The study would also help lecturers in colleges of education and universities in Nigeria to expose prospective teachers more on different learning styles that will be of help to them when they were found on field as in-service teachers. The study would also help prospective mathematics teachers to have in-depth understanding of fraction especially, in the areas of procedural and conceptual knowledge.

II. METHODOLOGY

Research design adopted in this study is descriptive survey design using ex-post facto type. It was chosen because the researcher does not have control of the independent variables, their manifestation have already occurred or because it involves empirical research in the data required for the study without actually manipulating the sample to test the research question already. Population of the study comprised of all 300L prospective mathematics teachers out which sixty-eight (68) respondents were randomly selected for this study.

Data were collected from respondents through questionnaires and Fraction Knowledge Test (FKT) given to them for administration. And this was made possible with the help of head of department of mathematics. The researcher employed descriptive statistics and multiple regressions for the analysis of data.

III. FINDINGS

Demographic analysis of Respondents

The following presents the Bio data characteristics of respondents in terms of sex and age

Table 4.1.1: Frequency Distribution of Respondents by Sex

Sex	Frequency	Percentage (%)
Male	40	58.8
Female	28	41.2
Total	68	100.0

Table 4.1.1 above shows that 40(58.8%) of the respondents were males, while 28(41.2%) of them were their female counterparts.

Table 4.1.2: Frequency Distribution of Respondents by Age

Age	Frequency	Percentage (%)
Less than 20 years	9	13.2
20 years and above	59	86.8
Total	68	100.0

Table 4.1.2 shows that 9(13.2%) of the respondents were less than 20 years, while 59(86.8%) of them aged 20 years and above.

Research Hypothesis 1

HO_1: There is no significant difference between the Prospective Teachers' Performance in Fractional Mathematical Knowledge and Problem Solving.

Table 4.2.1:

Variable	N	Mean	Std. Dev.	Crit-t	Cal-t.	DF	P
Teachers' Performance in Fractional Mathematical Knowledge	68	22.616	3.0470	1.96	23.382	67	.000
Problem Solving	68	16.075	2.9540				

The table 4.2.1 above showed that there was a significant difference between the Prospective Teachers' Performance in Fractional Mathematical Knowledge and Problem Solving (Crit-t = 1.96, Cal.t = 23.382, df = 67, P < .05 level of significance). Since t-calculated (23.382) is greater than t-critical (1.96) at 0.05 level of significance, the null hypothesis is therefore rejected. This implies that there was a significant difference between the Prospective Teachers' Performance in Fractional Mathematics Knowledge and Problem Solving.

Research Hypothesis 2

HO_2: There is no significant relationship between the Prospective Teachers' Performance in Fractional Procedural and Conceptual Knowledge.

Table 4.3.1:

Variable	Mean	Std. Dev	N	R	P	Remark
Prospective Teachers' Performance in Fractional Procedural knowledge	22.6176	3.0470	68	.596**	.000	Sig.
Conceptual Knowledge	2.5735	0.7394				

** 0.01 Level of Sig.

It is shown in the table 4.3.1 that there was a significant relationship between the Prospective Teachers' Performance in Fractional Procedural and Conceptual Knowledge (r = .596**, N=68, P < .01). The Null hypothesis is therefore rejected.

Research Hypothesis 3

HO_3a: There is no joint effect of independent variables (Equivalent, Transfer, Multiplication, Addition, Subtraction and Division) on Conceptual Knowledge.

Table 4.4.1:

Model	Sum of Squares	DF	Mean Square	F	Sig.
Regression	16.949	6	2.825	8.754	.000
Residual	19.684	61	.323		
Total	36.633	67			

R = .680; R^2 = .463; Adj R^2 = .410

It was shown in the table 4.4.1 above that the joint effect of independent variables (Equivalent, Transfer, Multiplication, Addition, Subtraction and Division) on Conceptual Knowledge (F(6,61) = 8.754; R = .463, R^2 = .463, Adj. R^2 = .410; P < .05). About 46% of the variation in Conceptual Knowledge was accounted for by the independent variables.

HO_3b: There is no relative effect of independent variables (Equivalent, Transfer, Multiplication, Addition, Subtraction and Division) on Conceptual Knowledge.

Table 4.4.2:

Model	Unstandardized Coefficient		Standardized Coefficient	T	Sig.
	B	Std. Error	B		
(Constant)	-.663	.572		-1.159	.251
Equivalent	4.979E-02	.049	.107	1.009	.317
Transfer	.106	.055	.288	1.935	.058
Multiplication	.118	.058	.272	2.046	.045
Addition	.160	.121	.184	1.326	.190
Subtraction	-.104	.126	-.095	-.820	.415
Division	.104	.153	.070	.680	.499

The result of table 4.4.2 above shows the relative contribution of each of the independent variables on the dependent: Equivalent (β = .107, P >.05); Transfer (β = .288, P >.05); Multiplication (β = .272, P <.05); Addition (β = .184, P >.05); Subtraction (β = -.095, P >.05); and Division (β = .070, P >.05) on Conceptual Knowledge.

Hence, while Multiplication was significant, Equivalent, Transfer, Addition, Subtraction and Division were not.

Research Hypothesis 4

HO_4a: There is no joint effect of independent variables (Equivalent, Transfer, Multiplication, Addition, Subtraction and Division) on Attitude.

Table 4.5.1:

Model	Sum of Squares	DF	Mean Square	F	Sig.
Regression	4339.789	6	723.298	32.769	.000
Residual	1346.446	61	22.073		
Total	5686.235	67			

R = .874; R^2 = .763; Adj R^2 = .740

It was shown in the table 4.5.1 above that the joint effect of independent variables (Equivalent, Transfer, Multiplication, Addition, Subtraction and Division) on Attitude (F(6,61) = 32.769; R = .874, R^2 = .740, Adj. R^2 = .740; P < .05). About 76% of the variation in Attitude was accounted for by the independent variables. Furthermore, it was shown that there is a positive joint effect of independent variables and prospective teachers' attitude to teaching of fractions (R=.874). This implies that six components (equivalent, transfer, addition, subtraction, multiplication and division) of fractions are relevant and could influence prospective teachers' knowledge on fractions. Also, 76.3% of total variance of prospective teachers' knowledge on fractions is due to the six components of fractions (Adjusted R^2=.740). This means that the remaining 23.7% is due to other factors and residuals. Also, the R value of .874 obtained tested significant (F(6,61)=32.769; P<.05). This shows that the R value is not due to chance.

HO_4b: There is no relative effect of independent variables (Equivalent, Transfer, Multiplication, Addition, Subtraction and Division) on Attitude.

Table 4.5.2:

Model	Unstandardized Coefficient		Standardized Coefficient	T	Sig.
	B	Std. Error	B		
(Constant)	19.453	4.730		4.113	.000
Equivalent	-.153	.408	-.026	-.372	.711
Transfer	2.254	.454	.491	4.970	.000
Multiplication	1.971	.478	.365	4.127	.000
Addition	.167	.997	.015	.167	.868
Subtraction	1.743	1.046	.128	1.667	.101
Division	1.293	1.263	.070	1.024	.310

Table 4.5.2 above shows the relative contribution of each of the independent variables on the dependent: Equivalent (β = -.026, P >.05); Transfer (β = .491, P <.05); Multiplication (β = .365, P <.05); Addition (β = .015, P >.05); Subtraction (β = .128, P >.05); and Division (β = .070, P >.05) on Conceptual Knowledge.

Hence, while Transfer and Multiplication were significant, Equivalent, Addition, Subtraction and Division were not.

IV. DISCUSSION OF FINDINGS

After examining the participants' overall performance, the researcher found that prospective teachers needed to develop a better understanding of division of fractions. Their existing knowledge related to the topic was not adequate to allow them to either work on division problems for themselves, or to assist students to understand and solve such problems. The main reason for this low level of performance was reliance on the fair sharing. Nevertheless, prospective teachers demonstrated greater procedural than conceptual thinking. This might be due to their early education and training. This also reinforces the lack of conceptual knowledge in fractions for these prospective teachers. Prospective teachers possessed high quality of Fractional Procedural Knowledge (FPK) (61 out of 68). But this superiority was based on their computation skills, not based on their understandings on underlying structural relationships of mathematics. This indicates that prospective teachers in Nigeria know how to compute with fractions but did not understand the rationale behind fractional computation. Prospective teachers performed differently in the six components of fraction knowledge (Equivalent, Transfer, Multiplication, Addition, Subtraction and Division). Prospective teachers performed better in multiplication, addition, subtraction fractions than in equivalent, transfer, and division fraction procedural knowledge. This implicated that prospective teachers were more familiar with conventional computation skills than with informal operation skills in fractional procedural knowledge.

On the other hand, the prospective teachers also performed differently in the components of conceptual fraction knowledge. In the analysis, the prospective teachers

performed better in multiplication and transfer than other components (equivalent, addition, subtraction, and division). This was in line with Ball (2005), who indicated that division of fractions were the most difficult understandings for prospective teachers. Also, if teachers have limited understanding of multiplicative thinking, the risk will remain that the teachers or their students might use the rate or ratio model inappropriately.

V. RECOMMENDATIONS

Based on the result obtained, the researcher recommends the following:

I. Prospective teachers need more stimuli to construct their conceptual knowledge, especially when they will be teaching mathematics in elementary schools in two or three years later after the completion of their education program.

II. From the findings, it implicated a necessity for enriching prospective teachers' fraction knowledge in Nigeria, especially their fraction conceptual knowledge.

III. Prospective teachers need mathematical knowledge and skills beyond basic competency with the topics they intend to teach. They need, for example, to be able to give or evaluate mathematical explanations, and to connect representations to underlying mathematical ideas and other representations.

IV. Universities and Colleges of education in Nigeria should help prospective teachers develop deep understanding of mathematics (especially fraction concepts) that they need for their future teaching.

V. There is need to put more effort in teaching methodology in our universities and colleges of education in Nigeria right from inception to graduation.

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