ASSESSING SENIOR SECONDARY STUDENTS' KNOWLEDGE OF BASIC MATHEMATICAL SKILLS AND ALGEBRA

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Abstract:

This study assessed the extent of the senior secondary students' knowledge of basic mathematical skills and algebrainObio/Akpor Local Government Area (LGA) of Rivers State, Nigeria. Four research questions and four hypotheses guided the study. A minimum sample of 400 students obtained from a population of 18,087 using Taro Yamane formula was selected by simple random sampling. Basic Mathematical Skills Test (BMST) and Algebra Performance Test (APT) were used for data collection. The instruments were validated by experts in Mathematics Education while their reliabilities were established using test-retest method. The reliability coefficients of 0.74 and 0.78 were obtained for BMST and APT respectively by correlating the test and re-test scores of BMST and APT using the Pearson product moment correlation. Mean and standard deviation were used to answer the research questions while sample t-test and analysis of variance (ANOVA) were used to test the hypotheses at 0.05 significant level. Major result of the study showed that students' knowledge of basic mathematical skills and algebra is significantly high. The result also revealed that the differences in the male and the female students' knowledge of basic mathematical skills and algebra were not significant respectively. It was recommended among others that the current instructional process and practice in Mathematics at the basic and senior secondary education levels should be sustained and instead improved upon by the Mathematics teachers.

Keywords: assessing, senior secondary students, knowledge, basic mathematical skills, algebra

1. Introduction

Mathematics is an indispensible subject of study. It plays an essential role in forming the basis of all other sciences which deal with the material substance of space and time. The ability of a nation to develop in scientific and technological advancement is directly proportional to its fitness in the area of Mathematics. This is true because Mathematics is the bedrock of Science and technological development or advancement. Harvey (2008), views Science as the body of knowledge about the universe. He also posited that Mathematics turns out to provide a useful tool for expressing scientific concepts. This means that the basic comprehension of the nature of Mathematics is essential for scientific literacy. Hence, it is important that for a student to perform well in Science, they need to appreciate the usefulness and the beauty of Mathematics. Many reports have explained why Mathematics matters and why it is important that we produce young people who are good at Mathematics and why it has become increasingly urgent that we address the problems with Mathematics education (ACME, 2011). One of the problems in Mathematics education could be the students' poor knowledge of basic mathematical skills which are pre-requisite knowledge for Mathematics learning.

Mathematical skills are abilities, knowledge, and competencies acquired through Mathematics instruction which are vital for higher level Mathematics learning and real life problem solving. Examples of mathematical skills are process, problem solving, computational, translational, manipulative, accuracy, drawing, thinking, creative and transferable skills. The mathematical skills required to learn a more advanced Mathematics are regarded as basic mathematical skills. In other words, basic mathematical skills are foundational prerequisite skills for Mathematics teaching and learning. Hayes (2005), posited that basic mathematical skills consists of analyzing, problem solving with addition, subtraction, multiplication, division, fractions and decimals process skills. Hayes added that basic mathematical skills have to also do with computational skill (ability to carry out arithmetic accurately) and ability to think logically and carry out other mathematical operations confidently.Basic mathematical skills are skills of factorizing, processing, adding, subtracting, multiplying, dividing, observation, classification, quantification, measurement, inferring, communication, formulating hypothesis, experimenting, making operational definition, presenting data, interpreting data, predicting and controlling variables. In simple terms, basic mathematical skills are the basic operations of addition, subtraction, multiplication and division of numbers (whole, fraction and decimal) and algebra. Basic mathematical skills are the fundamental and inevitable concept of Mathematics prior to Mathematics and Science achievement. This reflects the fact that basic mathematics skills are essential.

The basic mathematical skills students learn from basic education are the fundamental skills upon which all higher level Mathematics courses build. It is highly beneficial that students master previous mathematical concepts, application, and skills prior to learning algebra and other higher level Mathematics themes. Conversely, it is noted that the student who is deficient in the fundamental and conceptual understanding

of basic mathematical skills such as basic operations of addition, subtraction, multiplication and division of whole numbers, fractions etc, commonly exhibit error pattern when learning algebra, hence, attributed to deficiency in basic mathematical skills (Brown & Quinn, 2007). Therefore, the study seeks to assess the senior secondary students' knowledge of basic mathematical skills and algebra for possible deficiency.

2. Statement of the Problem

One of the major goals of Science, Technical and Vocational education in Nigeria is to produce Scientist for national development and provide trained manpower in the applied sciences, technology and business (FRN, 2014). The Technology, Engineering and Mathematics (STEM) education program is one of the relentless efforts of the Nigerian Government to promote STEM education and consequently produce the needed manpower for the scientific and technological advancement of the country. Unfortunately, the quality of Science students produced by the senior secondary schools seems to be diminishing. This diminishing effect in the Sciences could be attributed to the abysmal performance of students in Mathematics.

Mathematics is of central importance to modern society because of its roles in the development of Science, Technology and Engineering. Mathematics education is the intersection subject of the study fields of Science, Technology, and Engineering. Mathematics is therefore central in the STEM education, which implies that the knowledge of Mathematics is the key to learning Science, Technology and Engineering. But there is evidence of poor performance of students in Mathematics in senior secondary certificate examinations (Zalmon & Wonu, 2017). This abysmal performance of students in senior secondary Mathematics which consequently affects their performance in the Sciences may be due to their deficiency in basic mathematical skills. Hence, the study is an assessment of the senior secondary students' knowledge of basic mathematical skills. Their knowledge of algebra in the senior secondary Mathematics curriculum shall also be ascertained.

3. Aim and Objectives of the Study

Assessing senior secondary students' knowledge of basic mathematical skills and algebra is the aim of the study. In specific terms, the study:
1) Determined the extent of senior secondary students' knowledge of basic mathematical skills.
2) Assessed the extent of students' knowledge of algebra in the senior secondary Mathematics curriculum.
3) Ascertained the extent of the male and the female senior secondary students' knowledge of basic mathematical skills.
4) Investigated the extent of the male and the female students' knowledge of algebra in the senior secondary Mathematics curriculum.

3.1 Questions

The following research questions guided the study:

1) What is the extent of senior secondary students' knowledge of basic mathematical skills?
2) What is the extent of students' knowledge of algebra in the senior secondary Mathematics curriculum?
3) What is the extent of students' knowledge of basic mathematical skills on the basis of gender?
4) What is the extent of students' knowledge of algebra in the senior secondary Mathematics curriculum based on gender?

3.2 Hypotheses

Four hypotheses guided the study:

H_{01}: The extent of senior secondary students' knowledge of basic mathematical skills is not significant.

H_{02}: The extent of students' knowledge of algebra in the senior secondary Mathematics curriculum is not significant.

H_{03}: There is no significant difference between the male and the female students' knowledge of basic mathematical skills.

H_{04}: There is no significant difference between the male and the female students' knowledge of algebra in the senior secondary Mathematics curriculum.

4. Methodology

The study adopted a survey research design. The population consists of 18,087 senior secondary school students which comprises of 7,668 males and 10,419 females in Obio/Akpor Local Government Area of Rivers State (RSSSSB, 2018).A sample of 400 students obtained from the population using Taro Yamane Formula was used for the study. Purposive sampling technique was employed to select ten public co-educational senior secondary schools in the area. The Basic Mathematical Skill Test (BMST) and the Algebra Performance Test (APT) were the instruments used for data collection. The BMST and APT comprised of twenty-five multiple-choice questions each. BMST was used to collect data to measure student's knowledge of Basic Mathematical Skills (BMS) while APT was used to collect data to ascertain student's knowledge of algebra theme of the senior secondary Mathematics curriculum.Four experts in Mathematics Education validated the instruments while the reliabilities of BMST and APT were established by test-retest method. After correlating the test and re-test scores for each instrument using the Pearson product moment correlation, 0.74 and 0.78 correlation coefficients were obtained for BMST and APT respectively. The correlation coefficients of 0.74 and 0.78 showed that the instruments were reliable. The instruments were administered by the researchers to the respondents in the respective schools. The data collected were analysed using mean, standard deviation, sample t-test and Analysis of Variance (ANOVA).

4.1 Results

Research question one: What is the extent of students' knowledge of basic mathematical skills?

Table 1: Sample mean and standard deviation on the extent of
the senior secondary students' Knowledge of Basic Mathematical Skills (KBMS)

	N	Mean	Std. Deviation	Std. Error Mean
KBMS	400	68.00	14.37	.72

The table above showed the sample mean and standard deviation on the extent of students' knowledge of basic mathematical skills. The result indicated that senior secondary students have high knowledge of basic mathematical skills (M= 68.00, SD= 14.37).

Research question two: What is the extent of students' knowledge of algebra in the senior secondary Mathematics curriculum?

Table 2: Sample mean and standard deviation on the extent of students'
Knowledge of Algebra (KOA) in the senior secondary Mathematics curriculum

	N	Mean	Std. Deviation	Std. Error Mean
KOA	400	65.50	13.86	.69

The table above showed the sample mean and standard deviation of the extent of students' knowledge in algebra. The result from the table revealed that the students' knowledge of algebra in the senior secondary Mathematics curriculum was high (M= 65.50, SD= 13.86).

Research question three: What is the extent of students' knowledge of basic mathematical skills on the basis of gender?

Table 3: Mean and standard deviation on the extent of the male and
the female senior secondary students' knowledge of basic mathematical skills

Gender	N	Mean	SD	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Male	200	69.64	14.28	1.01	67.65	71.63
KBMS Female	200	66.36	14.30	1.01	64.37	68.35
Total	400	68.00	14.37	.72	66.59	69.41

The table above showed the extent of the male and the female senior secondary students' knowledge of basic mathematical skills. From the table, the male students have higher knowledge of basic mathematical skills (M= 69.64, SD= 14.28) than their female counterparts (M= 66.36, SD= 14.29).

Research question four: What is the extent of students' knowledge of algebra in the senior secondary Mathematics curriculum based on gender?

Table 4: Mean and standard deviation on the extent of the male and the female students' Knowledge of Algebra (KOA) in the senior secondary mathematics curriculum

Gender	N	Mean	SD
Male	200	66.31	13.61
KOA Female	200	64.68	14.09
Total	400	65.50	13.86

The table above showed the extent of the male and the female students' knowledge of algebra in the senior secondary Mathematics curriculum. The male students have higher knowledge of algebra (M= 66.31, SD= 13.61) when compared with their female counterparts (M= 64.68, SD= 14.09).

H_{01}: The extent of senior secondary students' knowledge of basic mathematical skills is not significant.

Table 5: Summary of sample t-test statistics on the extent of senior secondary students' knowledge of basic mathematical skills

	t	df	Sig. (2-tailed)	Mean	95% Confidence Interval	
					Lower	Upper
KBMS	94.67	399	.00	68.00	66.59	69.41

The table above showed the extent of senior secondary students' knowledge of basic mathematical skills. From the table, $t_{cal.}$ =94.67 is greater than the $t_{crit.}$= 1.96, $p<0.05$ at 0.05 level of significance. Hence, the null hypothesis is rejected. Therefore, the extent of senior secondary students' knowledge of basic mathematical skills is significant. That is, the senior secondary students' knowledge of basic mathematical skills is significantly high.

H_{02}: The extent of students' knowledge of algebra in the senior secondary Mathematics curriculum is not significant.

Table 6: Summary of sample t-test statistics on the extent of students' knowledge of algebra in the senior secondary Mathematics curriculum

	t	df	Sig. (2-tailed)	Mean	95% Confidence Interval	
					Lower	Upper
KOA	94.53	399	.00	65.50	64.13	66.86

The table above showed the extent of students' knowledge of algebra in the senior secondary Mathematics curriculum. From the table, $t_{cal.}$ =94.53 is greater than the $t_{crit.}$= 1.96, $p<0.05$ at 0.05 level of significance. Hence, the null hypothesis is rejected. Therefore, the extent of students' knowledge of algebra in the senior secondary Mathematics

curriculum is significant. It means that, the students' knowledge of algebra in the senior secondary Mathematics curriculum is significantly high.

H03: There is no significant difference between the male and the female students' knowledge of basic mathematical skills.

Table 7: Summary of analysis of variance on the male and the female
students' knowledge of basic mathematical skills

	Sum of Squares	df	Mean Square	F	Sig.
Gender	265.69	1	265.69	1.39	.240
Error	76348.30	398	191.83		
Total	76613.99	399			

The table above showed the analysis of variance on the male and the female students' knowledge of basic mathematical skills. The null hypothesis was retained since $F_{1,398}= 1.39$, $p>0.05$. Hence, there is no significant difference between the male and the female students' knowledge of basic mathematical skills.

H04: There is no significant difference between the male and the female students' knowledge of algebra in the senior secondary Mathematics curriculum.

Table 8: Summary of analysis of variance on the male and the female
students' knowledge of algebra in the senior secondary Mathematics curriculum

	Sum of Squares	df	Mean Square	F	Sig.
Gender	84.87	1	84.87	.64	.42
Error	52208.89	398	131.84		
Total	76613.99	399			

The table above showed the analysis of variance on the male and the female students' knowledge of algebra in the senior secondary Mathematics curriculum. The null hypothesis was retained since $F_{1,398}= 0.64$, $p>0.05$. Hence, there is no significant difference between the male and the female students' knowledge of algebra in the senior secondary Mathematics curriculum.

5. Discussion

5.1 Students' knowledge of basic mathematical skills
Findings from this study revealed that students' knowledge of basic mathematical skills is significantly high (Mean = 68.00, SD = 14.37; $t_{cal.}$ =94.67 >$t_{crit.}$= 1.96, $p<0.05$). This finding is in agreement with Faridah (2004), who posited that students with high level of willingness towards problem solving have high level of mathematical skills.

5.2 Students' knowledge of algebra in the senior secondary Mathematics curriculum

The result of the study showed that students' knowledge of algebra in the senior secondary Mathematics curriculum is significantly high (M= 65.50, SD= 13.86; $t_{cal.}$ =94.53 >$t_{crit.}$= 1.96, p<0.05). This finding corroborated with earlier result by Zalmon and George (2018), who found out that 76% of the students perceived the algebra content of the senior secondary Mathematics curriculum easy to learn. It means that 76% of the students surveyed had high knowledge of algebra as this theme of Mathematics poses little or no challenge to them. Also, Nduka and Zalmon (2017) reported that algebraic processes as a theme of the senior secondary Mathematics was not commonly difficult with students.

5.3 Gender and students' knowledge of basic mathematical skills

The study found out that the male students have higher knowledge of basic mathematical skills (M= 69.64, SD= 14.28) than their female counterparts (M= 66.36, SD= 14.29). However, this difference between the male and the female students' knowledge of basic mathematical skills is not statistically significant ($F_{1,398}$= 1.39, p>0.05). This result conformed to that of Wonu and Zalmon (2018) who discovered that gender difference in Mathematics performance is not significant.

5.4 Gender and students' knowledge of algebra in the senior secondary Mathematics curriculum

From the study, the male students have higher knowledge of algebra (M= 66.31, SD= 13.61) when compared with their female counterparts (M= 64.68, SD= 14.09). But this difference in the male and the female students' knowledge of algebra in the senior secondary Mathematics curriculum is not significant ($F_{1,398}$= 0.64, p>0.05). Similar results were obtained by Wonu and Harrison (2018), who discovered that gender difference in Mathematics performance is not significant.

6. Conclusion

This study established that the senior secondary students have high knowledge of basic mathematical skills and algebra. Gender differences in the students' knowledge of basic mathematical skills and algebra are not significant.

6.1 Recommendations

The study recommend as follows:

1) The instructional process and practice in Mathematics at the basic and senior secondary education levels should be sustained and instead improved upon by the Mathematics teachers.
2) Since gender factor makes no difference in students' knowledge ofmathematical skills and algebra, we recommend therefore that, both the male and the female students be encouraged to study Mathematics and courses in the mathematical

Sciences to enable the country train the needed manpower to drive technological advancement.

3) The few students with low knowledge of mathematical skills and algebra can be encouraged to improve through cooperative learning strategy, peer learning, differentiated learning and diagnostic and remedial instructional strategies.

4) The female students should have confidence in themselves while learning Mathematics. They should believe that they can compete favourably with their male counterparts in learning Mathematics. Parents, guidance and teachers should have confidence in their female wards in studying Mathematics and Mathematics related courses at the tertiary institutions as much as they have in their male wards.

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