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Comparative Analyses of Gender, School Location, School Type and Students' Age in Mathematics Basic Skills Scale for Sustainable Development

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Abstract

Basic skills in Mathematics should be measured using a psychometrically validated scale for continual achievement. Mathematics Basic Skills Scale is a sub-scale with eight items that reflects certain mathematical abilities and was applied to 1,984 senior secondary school 1 students in Nigeria through a study that adopted a comparative research type alongside a correlational research design. An independent sample t-test in SPSS showed that there was no significant difference (sig. < .05, 0.015) in the proficiency of male and female learners in Mathematics basic skills (MBS). Then, $H_0$1 was not retained. $H_{02}$was retained because the 2-tailed test result showed no significant difference (sig. > .05, 0.184) between the rate of MBS among students in public and private schools. The test's results for the equality of the variance by Levene and the 2-tailed test revealed that the rate of MBS development among learners in rural and urban areas does not significantly differ. So, H_{03} was retained. $H_{04}$was not retained because the 2-tailed test showed that the Mathematics basic skills (MBS) of the learners differ within the age groups (H_{04}= sig < .05, .036, and .004).

Key Words: Mathematics Basic Skills, Comparative Analyses, Sustainable Development.
Word Counts: 187.

Introduction

Sustainable development is a framework for tackling global issues like poverty, inequality, environmental degradation, climate change, peace, and justice. It aims to strike a balance between social inclusion, economic progress, and preservation so that the demands of the current generation are satisfied without endangering the capacity of future generations to satisfy their own needs. Economic, environmental, and social sustainability are a few of the essential elements of sustainable development. Inclusiveness and fair growth, development, and sustainability emphasise ethical consumption, environmentally friendly economic practices, and the growth of "green economies," which lessen their negative effects on the environment, while promoting innovation and job creation. The three main goals of environmental sustainability are pollution reduction, climate change mitigation, and natural resource conservation. Among its objectives are those to save habitats and lower carbon.

However, the social sustainability of community development, social equality, and human rights should be considered. It ensures that marginalised people are included in decision-making processes and advances access to healthcare, education, and other important services (United Nations, 2023; Intergovernmental Panel on Climate Change, 2023; World Bank, 2023). The 17 Sustainable Development Goals (SDGs) of the United Nations were adopted in 2015 and offer a worldwide road map for attaining a better and more sustainable future by 2030. They address many different topics, such as ending poverty, promoting gender equality, using sustainable energy, and encouraging ethical production and consumption (United Nations Framework Convention on Climate Change, 2023). Nigeria confronts many issues, such as population growth, economic inequality, environmental deterioration, and social inequality, making sustainable development an important subject. The issue of the growth of the economy and reduction of poverty is due to its heavy reliance on oil, Nigeria's economy presents obstacles to sustainable development. The government has implemented economic diversification plans, emphasising manufacturing, technology, and

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agriculture. Nonetheless, a significant portion of the population—roughly 40%—lives in poverty, and poverty rates are still high.

Nigeria must use a multifaceted strategy to handle the problems of government, the economy, society, and the environment to meet its sustainable development goals. Even though there are many obstacles, there is a route forward- thanks to continuous efforts and worldwide support. It is crucial to maintain dedication to reforming and implementing policies. Furthermore, investments in youth empowerment, infrastructure, adaptation to climate change, maintaining good governance, and bolstering anti-corruption measures are critical for sustainable development. Education is a key factor in the fulfillment of sustainable development goals. In such vein, Mathematics is one of the major subjects for such accomplishments through good and sustainable performance of learners.

Close observation of the performances of students revealed that there was a varying and unsustainable improvement. For instance, a total of candidates numbering 1,287,920 or 79.81 percent—of the candidates who took the exam received credits and above in at least five disciplines, including Mathematics. In comparison to the results of the same exam in 2022 (76.36%), the performance was better. But, in 2021, (81.7%), the performance was lower (Kanabe, 2022 & Anichukwueze, 2023). From this angle, Mathematics is a field that has to be taken seriously because it contains a variety of values. Its numerous instructional qualities demonstrate the subject's growing significance in social and academic contexts. Mathematics lectures teach values in a simplified rather than explicit way when comparing oneself to others (Dede, 2006). Different skills, useful knowledge, thinking, reasoning ability, mental discipline, patience, hard work, logical thinking, cultural advancement, intellectual growth, character building, social relationships, and global understanding are all developed through Mathematics.

The purpose of the skills is to enable learners to solve challenges. Think Teach Academy (2023) claims that, secondary school Mathematics is more than merely skills-based, in contrast to primary school Mathematics, where students need to use mental shortcuts for solving problems. Students still have to tackle challenges when they go to secondary school. Accurate measurements are possible in the affective domain. Affective learning should not be disregarded because one of its goals is to assess subjects like Mathematics that are challenging for children to understand. Research on the effective field of Mathematics instruction has generally considered the aspects of motivation, attitude, and belief, but has mostly disregarded the values teaching dimension (Seah and Bishop, 2000).

Values are the most important factor in enhancing Mathematics instruction and learning (Seah, 2002). Sadly, values, despite being one of the most stable affective domains, seem to receive the least attention. This is because even though Mathematics has many values associated with it, the majority of respondents saw it as being value-free (Nik Azis and Tapsir, 2013). Nonetheless, efforts must be made to raise values in light of these ideals. It is necessary to make the values persistent and to effectively achieve their goals. This made it necessary to create tools for gauging the impact of Mathematics value orientation on students' accomplishments and the degree to which these values needed to be improved. So, the Mathematics Basic Skills Scale (MBS) was developed.

Statement of Problem

As a vital component of many spheres of life and a useful tool for day-to-day work in different human undertakings, Mathematics is a foundation for growth, development, and advancement. This study, the comparative analyses of gender, school location, school type, and student's age in Mathematics basic skills scale for sustainable development, is crucial and proves that no nation can advance beyond its grasp of Mathematics. In the meantime, given the results of the recently revealed 2023 examination, candidates for the WAEC examinations have shown varying performances over the last three years.

The unsustainable success could have been caused by the candidates' lack of understanding of the principles of Mathematics education, as well as their inadequate or non-existent

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orientation to these principles. Basic math abilities are some of the aspects of math values that students should be keeping an eye on to improve and maintain their math performance. Hence, this study was done on the Mathematics basic skills scale's comparative analyses of school location, gender, school type, and student's age.

Hypotheses

The four null hypotheses tested in this study are:

$H_{01:}$ The rate of proficiency in Mathematics basic skills (MBS) among learners who identify as male and female does not differ significantly.

$H_{02:}$ The degree of Mathematics basic skills (MBS) among students in public and private schools does not significantly differ from one another.

$H_{03:}$ The level of Mathematics basic skills (MBS) development among learners in rural and urban areas does not significantly differ from one another.

$H_{04:}$ The Mathematics basic skills (MBS) of the learners of different age groups do not significantly differ from one another.

Objectives of the study

1. To discover if there is a difference or not between the Mathematics basic skills acquired by male and female learners.
2. To discover if there is a difference or not between the Mathematics basic skills acquired by public school and private school learners.
3. To discover if there is a difference or not between the Mathematics basic skills acquired by the learners in rural and urban schools.
4. To discover if there is a difference or not between the Mathematics basic skills acquired by learners of different age groups.

Methodology

The study is a comparative research type and it adopted a correlational research design. The population of the study comprised all the co-educational (Public, Private, Rural, and Urban) secondary schools in Nigeria.

A multi-stage sampling technique was adopted for the selection of subjects for this study: using the pre-existing grouping of Nigeria into six geopolitical zones, a simple random sampling technique was used to pick three geopolitical zones (North Central, South West, and South-South). Then, a systematic sampling technique was employed for the selection of six schools - three from rural and urban areas, one each from public and private - which were chosen at random within each state. Then, with an average of thirty pupils in each of the chosen schools. Two thousand (2,000) students were chosen from among all the schools, from which 1,984 were selected for the scale development.

According to Deziel (2018), with a 3% margin of error, a 95% confidence interval of 1.96 z-score, the sample size = $p(1-p)/(e/z)^2$, where e = 0.03, p = 0.5. Therefore, as the total population of Senior Secondary 1 Mathematics students in Nigeria (N) = 1,583,933 (NBS, 2019), the true sample size is one thousand and sixty-seven students (1,067). It means that, according to Matt (2014), the true sample size is equal to sample size x population divided by the sample size plus population minus one, which is equal to 1,066 (Matt, 2014). When the number of examinees increases, the standard error of measurement decreases and the amount of information increases (DeMars, 2010). Then, 1,984 was chosen as the sample size for the study.

An 8-item Mathematics basic skills (MBS) scale was used to gather data for the study. The scale was developed from a component derived through the exploration of contents for the construction of this study. The component is called Mathematics basic skills (MBS). MBS comprised four Mathematics skills. The four basic skills are addition, subtraction, multiplication, and division. These are the basic skills every child acquires at the early stages of learning Mathematics and then develops for better performance. The development of the comprehensively validated instrument with proven psychometric qualities was prompted by the need for both educational and economic progress.

To establish the instrument's validity, fourteen items were constructed from the related mathematical components, through trial-testing processes, expert reviews, pilot-testing, exploratory data analysis, and exploratory factor

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analysis (EFA). The result of pilot-testing revealed Kaiser-Meyer-Olkin Measure (KMO) = 0.976 (> 0.6) and Bartlett's test of sphericity (37268.82) established sample adequacy for the goodness of fit. EFA and CFA further established the validity of the scale, because the results showed goodness of fit index (GFI) = 0.91, adjusted goodness of fit index (AGFI) = 0.89, normed fit index (NFI) = 0.92 and comparative fit index (CFI) = 0.95, root mean square error of approximation (RMSEA) = 0.05, square root mean of the residual (SRME) = 0.04 and Tucker-Lewis index (TLI) = 0.94. After all the tests that the fourteen items were subjected to, only eight of the items survived.

So, the Mathematics Basic Skills (MBS) scale contained eight items. All the items satisfied the benchmark (cutoff = 0.3). The items stated the nature of the values (basic skills) in Mathematics that learners can acquire for problem-solving thus: Item 1 = 'Knowing the workings behind the answer to a mathematics problem'; Item 2 = 'Counting accurately'; Item 3: 'Having ideas of shape and size'; Item 4: 'Having ideas of directions and movements'; Item 5: Understanding things like numbers and images that repeat logically'; Item 6: Adding things together with '+'sign'; Item 7: 'Thinking and finding solutions to world's problems using new ways that are different from other students' ways'; and Item 8: 'Expressing solutions to problems clearly and consistently'. This instrument was intended to serve as an efficient means of assessing the relevant values in learners.

Variables of the study

The Variables of the study comprised one endogenous variable (Mathematics Basic Skills) and four exogenous variables (School Type, School Location, Gender, and Students' Age). Gender, School location, and School type were directly two groups. But, Students' age were at three levels, but, collapsed into two groups: level 1 = 10-12years, level 2 = 13years and level 3: above 13years to 21years. Group 1 (10-12 and 13years), Group 2 (13years and above 13-21years).

Data Analysis

Version 27 of the Statistical Analysis Package for Social Science (SPSS), for analysis, was used to score and compute the data collected. An Independent sample t-test in comparing means of the SPSS was used for the analyses. The results are presented in Table 1 below.

Table 1:Results and Interpretation of the Analyses

Results of Analyses from SPSS Independent Sample t-test

Mathematics Basic Skills (MBS)	Gender	School Type	School Location	Age	
				1st Group	2nd Group
F (Levene's test for equality of variance)	.171	7.384	.248	.226	.056
Sig. (The equality of the variance test by Levene)	.679	.007	.618	.635	.813
t_{cal}	-2.424	1.329	1.637	-2.113	2.917
Df	1982	1982	1982	178	1934
Sig (2-tailed)	.015	.184	.102	.036	.004
Mean Difference (t-test for mean equality)	-.915	.502	.628	-2.941	2.212
Standard Error Difference (t-test for mean equality)	.378	.378	.384	1.392	.758
Lower limit	-1.656	-.239	-.124	-5.689	.725
Upper limit	-.75	1.23	1.380	-.194	3.699
Cohen's d	-.109	.060	.075	-.356	.263

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$H_{01:}$ The rate of or proficiency in Mathematics basic skills (MBS) amongst learners who identify as male and female does not differ significantly.

The results of H_{01} demonstrated that the equal variances (For the equality of variances test for Levene) assumed sig >.05; that is, t_{cal} = -2.424, df = 1982, F =.171, mean diff. = -.915, standard error diff. =.378, lower = -1.656, upper = -.75; that is, sig =.679 equal variances assumed. Meanwhile, the 2-tailed hypothesis test findings revealed sig <.05, or sig =.015. This implies that there was a significant difference between the male and female learners' Mathematics basic skills (MBS), the null hypothesis was rejected. The null hypothesis one (H_{01}) was rejected since the lower and higher bounds (lower = -1.656, upper = -.75) are below zero. The effect size of the independent sample Cohen's d is -.109. This indicates that the difference's effect magnitude was negligible or very low.

$H_{02:}$ The rate or degree of Mathematics basic skills (MBS) among students in public and private schools does not significantly differ.

The analysis presents the results of H_{02} as revealed by the 2-tailed hypothesis test sig >.05, or sig =.184. Considering the 2-tailed hypothesis test results, it was given that there was no substantial difference between students' arithmetic basic skills (MBS) in public and private schools. Even, the difference's impact size was negligible or very small, as indicated by Cohen's d independent sample effect size of .060. So, the null hypothesis was retained.

$H_{03:}$ The rate or level of Mathematics basic skills (MBS) development among learners in rural and urban areas does not significantly differ.

The study of H_{03}'s results revealed that the equal variances (for equality of variances using Levene's test) assumed sig >.05; that is, t_{cal} = 1.637, df = 1982, F =.284, Mean diff. =.628, Std error diff. =.384, lower = -.124, upper = 1.380, with sig = 0.618 equal variances assumed. Additionally, the 2-tailed hypothesis test findings indicated sig >.05, or sig =.102. Since there was no discernible difference between the Mathematics basic skills (MBS) of the rural and urban learners, the null hypothesis was not rejected. The impact size of the difference was either extremely small or negligible, according to Cohen's d independent sample effect size of.075.

$H_{04:}$ The Mathematics basic skills (MBS) of the learners of different age groups do not significantly differ from one another.

According to the findings of the H_{04} analyses, the equal variances (for Levene's test, which is a measure for equality of variances) assumed sig >.05 for the first two age groups (10–12 years with 13 years), meaning that t_{cal} = -2.113, df = 178, F =.226 mean diff. = -2.941, standard error diff. = 1.392, lower = -5.689, upper = -.194. However, the 2-tailed hypothesis test findings similarly revealed sig <.05, or sig =.036. Consequently, the null hypothesis H_{04} was not maintained as the 2-tailed was significant and both the lower and upper bounds are smaller than zero. This suggests that learners of different age groups have significantly different mathematical basic skills (MBS). However, the independent sample Cohen's d effect size of -.356 indicates that the difference's effect size was negligible or extremely small.

Similarly, the H_{04} analysis results for the final two age groups (13 years and above) indicated that the equal variances (for an equal number of variances, using Levene's test) assumed sig >.05, that is, t_{cal} = 2.917, df = 1934, F =.056, mean diff. = 2.212, standard error diff. =.758, lower =.725, upper = 3.699, with sig = 0.813 equal variances assumed. However, the 2-tailed hypothesis test findings likewise revealed sig <.05, or sig =.004. Consequently, the null hypothesis H_{04} was not maintained because the 2-tailed was significant and both the lower and upper bounds are above zero. The effect size of the independent sample's Cohen's d is .263. It demonstrates that the difference's magnitude was negligible or very modest. These findings provide additional evidence of the notable variations in learners' math basic skills (MBS) across age groups.

Discussion

The four Mathematics basic skills (MBS) are addition, subtraction, multiplication, and

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division. These mathematical abilities are expected of everyone, especially those beginning their education. It shows the reason for the scope of the study spread to every region in Nigeria, putting all the co-educational secondary school students into consideration. The comparison study was carried out in order to confirm the significance of the fundamental abilities and the differences in them between learners.

There was a significant difference in the Mathematics basic skills (MBS) of the male and female learners. However, the difference's impact was negligible as the findings of Ganley & Lubienski (2016) confirm few gender disparities in arithmetic performance to support this. However, when the assessment is less relevant to the material taught in school, gender inequalities on Mathematics examinations tend to be more prominent (for example, on the SAT-Math as opposed to the Mathematics test in school). In addition, the independent sample Cohen's d effect size was small and negative, which corroborates the assertion made by Breda, Jouini, and Napp, 2023, that there is a negative global gender gap in Mathematics performance. This gap is about 40% larger among students who want to pursue Mathematics than the general population.

Through the second null hypothesis, there was no significant difference between the public school, and the private school learners in the rate of MBS acquired. The necessity for all students in all public and private schools to have basic Mathematics skills has been feasible. The teachers in the public schools may have found this to be a challenge, which would have forced them to figure out how to successfully give their students the foundational knowledge in Mathematics that can help them succeed. This is in contrast to public choice theory, Crane's (2010) research suggests that public schools' bureaucratic rules on teacher preparation, curriculum, and instruction may improve student performance rather than worsen it.

The third null hypothesis was accepted because there was no discernible difference between the MBS of the rural and urban learners, the null hypothesis was maintained, which shows that, wherever the location of the learner, once such learner is really taught the rudiments of basics in the learning of mathematics and be properly engaged by the teachers, such learner will surely develop or acquire the Mathematics basic skills. Furthermore, according to Graham & Provost (2012), many rural schools have special characteristics, that have been linked to mathematical achievement, such as smaller class sizes and a sense of community, despite the difficulties faced by rural learners. However, this was against Young's 2006 finding that pupils in rural schools do not perform as well as those in urban schools. It is feasible for students in rural locations to achieve just as well as those in urban settings.

Meanwhile, the null hypothesis H_{04} findings provided additional evidence of the notable variations in learners' Mathematics basic skills (MBS) across age groups. That is, the development rate of MBS in learners in different age groups is different. The study by Zubkovic, Pahljina-Reinic & Kolic-Vehovec (2021) reveals that older students valued Mathematics less than younger students, who had less positive Mathematics self-concept and lower Mathematics.

Conclusion

Generally, Mathematics basic skills (MBS) are important for every learner at any school, at whatever location, and within the school age ranges/groups to acquire. But, the rate at which such learners acquire the skills is different. This study was able to discover that:

1. there was a difference between the rate or level of Mathematics basic skills acquired by the male and female learners;
2. there was no significant difference between the rate or level of Mathematics basic skills acquired by the public school and private school learners;
3. there was no difference between the rate or level of Mathematics basic skills acquired by the learners in the rural and urban schools; and
4. there were differences between the rate or level of Mathematics basic skills acquired by the learners of different age groups.

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Recommendations

The following recommendations were made:

1. The diagnostic tool the Mathematics basic skills (MBS) subscale, must be regularly used to measure and discover the learners' Mathematics value and orientation towards Mathematics.
2. Necessary corrections must be made by the teachers or instructors as needful after MBS has been used to diagnose any problem pertaining to the learners' Mathematics basic skills development.
3. Counsellors must regularly use the MBS to measure and discover the necessity for them to counsel the learners on Mathematics value or Mathematics basic skills' development and give them the appropriate orientation towards Mathematics for their better performance in the subject.
4. Parents must be introduced to the usefulness of MBS and intimately be informed on how important the usage of the scale is for the progress of their wards in Mathematics basic skills development.

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