



## Assessing post-graduate Students' Ability to Match Levels of Measurement with the Appropriate Measures of Central Tendency

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### ABSTRACT

*This study aimed to address the issue of students' incorrect use of measures of central tendency in relation to the measurement scale involved. The participants in the study were ninety-seven post-graduate students (both doctoral and masters) from the Faculty of Education at Delta State University, Abraka, Nigeria. Among the participants, there were seventy-three students, with 31 doctoral students and 42 masters students included in the sample. The research adopted a descriptive survey design and was guided by three research questions and three hypotheses. Data collection was conducted using a 9-item questionnaire, and the hypotheses were tested using the independent samples t-test. The mean was utilized to address the research questions. To evaluate the performance of each research participant on each measurement scale, a benchmark of 6 points (out of 12 points) was established. The findings indicated that both groups of students scored below the benchmark of six points on each measurement scale, indicating a lack of ability to properly match scales of measurement with the appropriate measure of central tendency. However, doctoral students' demonstrated slightly better performance compared to their masters counterparts. Among the three null hypotheses tested, only hypothesis two, which focused on the ability of students to match the ordinal scale of measurement with the appropriate measure of central tendency, yielded significant results in favor of the doctoral students. Overall, the study concluded that there is an inadequate understanding among students regarding the application of the mean, median, and mode in accordance with the required level of measurement. Therefore, it is crucial to place greater emphasis on strengthening the fundamentals in this area of study.*

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### INTRODUCTION

In many Nigerians' general belief, the more educated you are, the more likely you are to use sophisticated language when speaking English. This belief suggests that one's social standing is diminished if they fail to employ idioms, figures of speech, theatrical or flowery expressions. Interestingly, this sentiment seems to extend to the realm of statistical analysis in research. Some perceive statistics such as pie charts, bar charts, histograms, percentages, measures of central tendency, and measures of

variability as too simplistic or basic for research purposes. Instead, they opt for more complex statistical techniques like multiple regression, factor analysis, path analysis, t-tests, chi-square tests, and non-parametric tests such as the median test, Mann-Whitney U-test, Kruskal-Wallis, among others. It is important to clarify that the point being made here is not that these statistical tools should be disregarded. Rather, they should be used appropriately. The so-called "simple statistics" are also valuable research tools that should not be overlooked.

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This tendency to downplay the use of measures of central tendency has resulted in limited understanding of their applicability. Wikipedia (2019) asserts that it is quite common for individuals to misuse averages. Similarly, Oaikhenan and Udegbunan (2004) report that using the mean for discrete data leads to unrealistic results. To correctly apply any statistical technique, one must have knowledge about the variables involved, whether they are discrete, continuous, or bimodal (Gardenier, 2001). The present researcher has observed cases where undergraduate and some post-graduate students at the Faculty of Education, Delta State University, Abraka, Nigeria, indiscriminately use averages.

This practice may stem from a lack of understanding regarding the uses and characteristics of measures of central tendency, which is the primary focus of this study. The mean, as noted by the National Teachers' Institute, NTI (2000), is a unique measure that incorporates all scores in a distribution during computation (Gravetter & Wallnau, 2004). However, it is susceptible to the influence of extreme values (Ukwuije & Orluwene, 2012; Mann, 2010). Conversely, the median represents the point that bisects a distribution (Anastasi & Urbina, 2007) and is less affected by extreme scores or observations, making it suitable for skewed distributions (Best & Kahn, 2007). The mode, unlike the mean, is not affected by extreme values (Ukwuije & Orluwene, 2012).

Outliers, or extreme values, are scores that deviate significantly from the rest of the sample due to their extreme nature (Best & Kahn, 2007). In a normal distribution, there is typically at most one outlier (Brase & Brase, 2009). According to the authors, outliers are either greater than the upper quartile by an amount greater than one and a half times the interquartile range or less than the lower quartile by an amount greater than one and a half times the interquartile range.

Understanding the applicable measurement scales for the averages under consideration in this study is also important. Just as the mean can be used for data measured on interval and ratio scales, the median can also be employed for ratio and interval scales, as well as ordinal scales

(Gravetter & Wallnau, 2004). Consequently, the median is not applicable to nominal scale data. Similarly, the mean should not be used when data are measured on nominal or ordinal scales. The mode is the only measure of central tendency that can be used across all measurement scales, including nominal scale (Gravetter & Wallnau, 2004; Brase & Brase, 2009). Statisticians in education and psychology select the four levels of measurement based on assumptions and interpretations they make regarding these measurements (p. 16).

### Relationship between Average and Skewness

In a symmetrical distribution, the mean, median, and mode coincide, typically resulting in a single mode (Ukwuije & Orluwene, 2012). Skewness, on the other hand, measures the extent of distributional asymmetry (Hippel, 2010). The shape of a distribution is influenced by its tails and peakedness (Agarwal, 2015). A distribution with a longer tail on the right-hand side is positively skewed, as described by Gravetter and Wallnau, cited by Ossai (2016). In a classroom setting, positive skewness (or right skewness) can be observed when difficult test questions cause a higher concentration of lower scores (Joe, 2000; Gravetter & Wallnau, 2004; Ossai, 2016). Examples of distributions exhibiting positive skewness include chi-square, exponential, gamma distributions, and the income distribution of workers in Nigeria, where the majority of workers have modest incomes (Hippel, 2010; Joe, p. 13).

According to NTI (2000), a distribution is negatively skewed when it has a longer tail on the left-hand side. In such cases, there is a peak at the lower end of the scale, and the floor of the distribution is high (Anastasi & Urbina, 2007). Ossai (2016) pointed out that easy test questions, where many students achieve high scores, can lead to a negatively skewed distribution. Negative skewness poses challenges in capturing individual differences due to the lack of a test ceiling (Anastasi & Urbina, 2007).

Ukwuije and Orluwene (2012) summarized positive and negative skewness, stating that in left skewness, the mean < median < mode, while in right skewness, the mean > median

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> mode (p. 32). Therefore, knowing the measures of central tendency makes it easier to determine the shape of a distribution. Agarwal (2015) observed that the difference between the mean and the mode is three times the difference between the mean and the median. Additionally, the mode equals three times the median minus twice the mean. Consequently, the modal score in a distribution can be deduced once the mean and median are known.

### **Statement of the Problem**

High-sounding statistical tools are often preferred by many undergraduate and post-graduate students. The result is that simple statistical tools are ignored even when they are appropriate. More worrisome is the fact that some students seem to be confused with matching averages with the appropriate measurement scale. This is apparently common among many under-graduate and some post-graduate students of Delta State University. This appears not surprising since some students fail to understand that a set of numbers should be arranged in order of size before obtaining the median (Ossai, 2014). Thus, this investigation was aimed at finding out the extent of students' ability to match levels of measurement with the appropriate measure of central tendency.

### **Research Questions**

The study provided answers to the following research questions:

1. What is the mean ability of students in matching the nominal scale with the appropriate measure of central tendency?
2. What is the mean ability of students in matching the ordinal scale with the appropriate measure of central tendency?
3. What is the mean ability of students in matching the interval/ratio scale with the appropriate measure of central tendency?

### **Hypotheses**

Three null hypotheses directed the study:

1. Students' ability to match the nominal scale with the appropriate measure of central tendency does not differ significantly among masters and doctoral post-graduate students of Delta State University, Abraka.
2. Students' ability to match the ordinal scale with the appropriate measure of central tendency does not differ significantly among masters and doctoral post-graduate students of Delta State University, Abraka.
3. Students' ability to match the interval/ratio scale with the appropriate measure of central tendency does differ significantly among masters and doctoral post-graduate students of Delta State University, Abraka.

### **METHODOLOGY**

A descriptive survey design was employed in the study. The population of the study was made up of ninety-seven post-graduate students domiciled in the faculty of Education, Delta State University, Abraka, Nigeria. Through simple random sampling technique, a sample size of seventy-three (73) students was drawn from the population. This was made up of forty-two (42) masters degree students and thirty-one (31) doctoral students. The two categories of students have taken basic courses in statistics and research. A 9-item questionnaire was the instrument used for data collection. Research subjects were required to match levels of measurement (nominal, ordinal and interval/ratio) with the appropriate measures of central tendency. The ability to perform this task by the two categories of respondents was analysed using independent samples t-test. The items under each of the levels of measurement attracted a maximum score of 12 points. The interval scale and ratio scale were grouped together. A score of 6 points was taken as the benchmark of the performance of a research participant in each of the categories. Hypotheses test was conducted at an alpha level of .05 significance.

### **DATA ANALYSIS AND RESULTS**

Answers to research questions were provided as follows:

**RQ1:** What is the mean ability of students in matching the nominal scale with the appropriate measure of central tendency?

**Table 1:** Mean ability in matching the nominal scale and measures of central tendency

Variable	N	Mean	SD	MD
Master	42	4.76	1.3	0.34
Doctorate	31	5.10	1.4	

Table 1 indicated that masters and doctoral students obtained mean scores of 4.76 and 5.10 respectively. This gives a mean difference of 0.34 points in favour of the doctoral students.

**RQ2:** What is the mean ability of students in matching the ordinal scale with the appropriate measure of central tendency?

**Table 1:** Mean ability in matching the ordinal scale and measures of central tendency

Variable	N	Mean	SD	MD
Master	42	4.52	1.56	1.45
Doctorate	31	5.97	1.89	

Table 2 shows that masters and doctoral students obtained mean scores of 4.52 and 5.97 respectively. A mean difference of 1.45 points (in favour of doctoral students) separates the two categories of research participants.

**RQ3:** What is the mean ability of students in matching the interval/ratio scale with the appropriate measure of central tendency?

**Table 1:** Mean ability in matching the interval/ration scale and measures of central tendency.

Variable	N	Mean	SD	MD
Master	42	5.0	1.79	0.8
Doctorate	31	5.8	1.97	

From table 3, mean scores of 5.0 and 5.8 were respectively obtained by masters and doctoral students. It also shows a mean difference of 0.8 to the advantage of the doctoral students.

**Hypothesis one:** Students' ability to match the nominal scale of measurement with the appropriate measure of central tendency does not differ significantly among masters and doctoral post-graduate students.

**Table 4:** Independent samples t-test of students' ability to match the nominal scale with the appropriate measure of central tendency.

Variable	N	Mean	SD	df	t	sig.
Masters	42	4.76	1.3	71	-1.021	.311
Result						

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Doctoral	31	5.10	1.4
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Table 4 shows a t-value of  $-1.021$  and a p-value of  $.311$ ; since this exceeds alpha level of  $.05$  level of significance, the null hypothesis was accepted. This implies that students' ability to match the nominal scale of measurement with the appropriate measure of central tendency does not differ significantly

among masters and doctoral post-graduate students.

**Hypothesis two:** Students' ability to match the ordinal scale of measurement with the appropriate measure of central tendency does not differ significantly among masters and doctoral post-graduate students.

**Table 5:** Independent samples t-test of students' ability to match the ordinal scale with the appropriate measure of central tendency.

Variable	N	Mean	SD	df	t	sig.	Result
Masters	42	4.52	1.56				
Doctoral	31	5.97	1.89				
				71		$-3.337 .001$	sig.

Table 5 shows a t-value of  $-3.337$  as well as a p-value of  $.001$ ; given that the p-value is lower than the alpha value of  $.05$  level of significance the stated null hypothesis was rejected. This implies that students' ability to match the ordinal scale measurement with the appropriate measure of central tendency differs

significantly among masters and doctoral post-graduate students.

**Hypothesis three:** Students' ability to match the interval/ratio scale of measurement with the appropriate measure of central tendency does not differ significantly among masters and doctoral post-graduate students.

**Table 6:** Independent samples t-test of students' ability to match the interval/ratio scale with the appropriate measure of central tendency.

Variable	N	Mean	SD	df	t	sig.	Result
Masters	42	5.0	1.79				
Doctoral	31	5.8	1.97				
				71		$-1.819 .073$	Not sig.

Table 6 shows a t-value of  $-1.819$  and a p-value of  $.073$ ; since the alpha level of  $.05$  is less than the p-value of  $.073$ , the stated null hypothesis was upheld. This means that students' ability to match the interval/ratio scale of measurement with the appropriate measure of central tendency does not differ significantly among masters and doctoral post-graduate students.

central tendency. Two categories of students (masters and doctoral) were involved. A subject from each of the groups needed to have scored at least 6 points out of a maximum score of 12 points in each of the levels of measurement. Research question one showed that mean scores of 4.76 points and 5.10 points were respectively obtained by the masters and doctoral students. Although there was a mean difference of 0.34 points in favour of the doctoral students, no group got up to an average score of 6 points. This indicates that both categories of students could not match the nominal scale of measurement with the

**DISCUSSION OF FINDINGS**

The primary aim of this study was to find out post-graduate students' ability to match levels of measurement with the appropriate measures of

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appropriate measure of central tendency (the mode).

This trend repeated itself in research question two where the mean scores were respectively 4.52 and 5.97 for the masters and doctoral students. The mean difference in favour of the latter group improved; still the group scored below the average point. Although 0.8 points (to the advantage of the doctoral subjects) separated the two groups, none had up to the average point of six. Therefore, responses to research questions two and three showed that the two categories students could not correctly relate the ordinal, interval and ratio scales of measurement with the appropriate measure of central tendency. Majority of the students associated the nominal scale with the mean and median. They failed to understand that it is the mode that is more appropriate in the nominal scale of measurement as posited by Brase and Brase (2009) as well as Gravetter and Wallnau (2004) and Manikandan (2011). Mean cannot be used for nominal or nonnominal ordinal data. Just as majority of students from both categories were confused with the application of the nominal scale, many students from the two groups did not know that the median is applicable to all levels of measurement, except the nominal scale.

Of the three hypotheses tested in the study, only the one concerning students' ability to match ordinal scale with the appropriate measure of central tendency was significant. The doctoral students did better than their master's counterparts, although both categories fell below the average score. This significant result and the non-significant result are misapplications of statistics. It is statistical fallacy that damages the quest for knowledge (Wikipedia, 2019). This corroborates the view of Gardenier and Resnik (2001) that carelessness or deception in the use of statistics results in harms and costs to society; they also opined that "poor statistics in science leads to poor science" p. 258.

In the education industry, the consequences of applying wrong statistics (in particular, wrong average) in analyzing the performance of testees may be devastating. Same applies to carelessness or negligence in the use of statistical tools. A wrong computation of Grade

Point Average (GPA) or Cumulative Grade Point Average (CGPA), for instance, can lead to students being wrongly placed in classes of degrees that they do not merit. Similarly, a teacher who uses the median in handling a distribution of scores that is skewed may also be causing harm to the testees. In particular, evaluation of learning outcome such as this will not reflect the true abilities of learners. Rather, it will jeopardize the future of learners (Ossai, 2021). The below-average performance of the two categories of students can be attributed to their attitude towards statistics. Ossai (2014) reported in a study involving undergraduate students of Delta State University, Abraka that non-science students had a negative attitude towards educational statistics.

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