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META-ANALYSIS OF INFLUENCE OF GENDER ON STUDENTS' ACADEMIC ACHIEVEMENT IN CHEMISTRY IN NIGERIA

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Abstract:
Evident reports on the inconsistencies of the findings of the studies on the influence of gender on student's academic achievement in chemistry in Nigeria necessitated this study. The study is aimed at integrating the results of previous empirical studies on the influence of gender on students' academic achievement in chemistry in order to come up with a conclusive idea. Two research questions and one hypothesis guided the study in which meta-analytic research design was used. The population of the study consists of all previous research reports on gender and achievement in chemistry. Sixty-two studies produced in Nigeria between 1990 – 2017 drawn using purposive sampling technique was used for the study. Percentages and statistical transformations were used to analyze the data for the result while the Winer combined test was used in testing the hypothesis. From the data analysis, it was found that gender generally has small effect on the students' achievement in chemistry. It was also found that the percentage variance in the students' academic achievement attributed to gender is 3.8% which is also small. Based on these findings some recommendations were made.

Introduction

Chemistry education constitutes a crucial factor in the improvement of the life of individuals and the attainment of sustainable economic growth. Chemistry has continued to play important roles in the lives of mankind as it has helped to produce many of the technologies which many people now enjoy ranging from the life saving pharmaceuticals to computers and other information technologies.

Considering the relevance of chemistry, it is expected that the achievement of students in public examinations would be on the increase. Contrary to this, indices from research reports and from examinations such as those organized by the West African Examination Council (WAEC) showed students' poor achievement in chemistry[1]. Poor achievement in sciences in general and chemistry in particular have been a matter of great concern to parents, educationists and the nation at large. The WAEC chief examiners report on chemistry practical in 2014 and 2015 stated thatthe raw mean score was 25.00 and standard deviation of 9.06 for 2014 and 27.00 and standard deviation of 8.83 for 2015. These result indicate a poor performance by the students in practical chemistry which is a vital area in chemistry

Recent research reports have been targeted at finding out what exactly is responsible for the evident high failure rate in chemistry. Most of the researchers [2, 3,4,5] point to gender as the major cause of the poor achievement of students in the subject.

Conflicting reports exist with regards to gender and students' academic achievement in chemistry. The result of some studies carried out revealed a significant gender difference with males achieving higher than girls in chemistry achievement test [3, 6]. On the contrary, the results of some other studies found a significant difference in students' academic achievement in chemistry in favour of females[4,7]. From the literature also, there are studies that found no significant difference in academic achievement in chemistry due to gender[8].

These trends of inconclusiveness in the studies provided a gap which this study wants to fill. To reconcile these discordant notes on the result of gender on achievement in chemistry, integration of the results becomes necessary so that a composite figure is produced. Glass [9] proposed a meta-analytic approach as a

method for combining the result of a series of studies in the same area. Meta- analysis is a statistical technique for amalgamating, summarizing and reviewing previous quantitative research [10]. The objective of a meta-analytic study is to obtain the overall or mean effect size of the studies integrated. This study therefore is to find out the generalized pattern of relationship between gender and students' achievement in chemistry in Nigeria using meta-analytic procedure.

The basic idea here is to express the actual magnitude of group difference from different studies on a common scale so that findings from studies employing different measures and different methods can be meaningfully compared. Effect size indicator is used to establish a correlation between the independent variable and the individual scores on the dependent variable. Effect size is a standardized measure of treatment effect that may be applied to a single study or average across several studies of similar type to provide a composite figure [11]. Effect size indicators such as the Pearson product moment correlation "r" Glass delta (Δ), Cohen's d and hedges "g" all have one thing in common and that is that they can be expressed in terms of a test of significance(X^2 ,t, z and F) and size of the study.

From the background information so far, it is seen that the objective of this study therefore is to find out the generalized pattern of relationship between gender and students' academic achievement in chemistry in Nigeria through meta- analytic approach.The study aims at investigating some available research findings on the influence of gender on student's achievement in chemistry so as to provide a composite figure in Nigeria using meta- analytic procedures.

Research Questions

The following research questions guided the study

(1)What is the magnitude of the effect size of each of the studies examined on the influence of gender on the academic achievement of students in chemistry?

(2)What is the mean effect size for all the studies examined on the influence of gender on the academic achievement of students in chemistry?

Research Hypothesis

The overall influence of gender on students' academic achievement in chemistry is not statistically significant

Methodology

The research design for the study is a meta-analytic research design. The area of study is Nigeria. The study examined reports of research works on the influence of gender on students' academic achievement in chemistry carried out in Nigeria. The population consists of all previous research reports on the influence of gender on students' academic achievement in Nigeria between 1990 and 2017. These will include studies from Journals, Conferences proceedings, theses and dissertations covering the period from the year 1990 to 2017. The sample consists of 62 published journal articles and unpublished Ph.D and masters research reports on the influence of gender on students' achievement in chemistry. The studies that constitute the sample include every study that:

(1) Was conducted on Nigerian respondents only to avoid environmental factors that may be interfering with the findings
(2) Appeared in literature between 1990 and 2017
(3) Reported gender as a factor that influencesstudents' achievement in chemistry. The purposive sampling technique was adopted in selecting the studies that constituted the sample

The researcher with the help of two assistants traveled throughout the six geopolitical zones of Nigeria to identify and collect relevant research studies on the topic. The researcher and the research assistants visited the libraries of universities and research institutes spread across Nigeria to retrieve data from project reports, dissertations, journal articles and other research documents. A coding system was used to ensure that all the information required from the various studies were recorded and examined in a consistent way.

Statistical transformations, effect size and combined test approaches were used to analyze the data collected. The effect sizes calculated were interpreted based on Cohen's [12] guidelines on interpretation of effect size to find which is large, medium or small. According to Cohen, effect size r <0.2 represent small effect; 0.2 < or≤ 0.5 represent medium effect while 0.5 < or ≤ 0.8 represent large effect.

In order to test the null hypothesis used in this study at 0.05 level of significance, the Winner combined test method was used.

Results

The data are presented in tables according to the guiding research questions and hypothesis.

Research Question 1

What is the magnitude of the effect size of each of the studies examined on the influence of gender on the academic achievement of students in chemistry?

Table 1: Effect sizes Associated with the individual studies Examined on Gender and Academic Achievement in Chemistry.

Statistical Method used	Total No of cases	Quality of effect size Effect size	No of studies	Percentage
t-test	24	.Large	6	9.68
One-way ANOVA	2	Medium	8	12.90
ANCOVA	31			
Chi-square X^2	1	Small	48	77.41
Mean and standard Deviation	4			
Total	**62**		**62**	**100**

Table 1 shows the distribution of studies examined on gender based on quality of effect size. Table 1 shows that out of the 62 effect sizes,6 (9.68%) were large effect sizes, 8 (12.90%) were medium effect sizes while 48(77.42%) represents small effect sizes. In order words, out of the 62 studies examined, the results of only 6 indicate a high degree of effect. The result of 48 studies indicate small degree of effect of gender on students achievement in chemistry.

(1) Research Question 2

What is the mean effect size for all the studies examined on the influence of gender on the academic achievement of students in chemistry?

Table 2: Mean Effect size Associated with all the studies on the influence of gender on Students' Achievement in Chemistry.

N	$\sum(n-3)\sum Weighted\ Z$	$\sum \frac{weightedZ}{\sum(N-3)}$	Average Z average z	Variance	r value of (mean effect size)	%
62	10092	2006.609	0.1988	0.195	3.802	

Table 2 shows that the reported value of the mean effect size of all the 62 studies integrated is0.195 = 0.2. From Cohen'sinterpretation of effect sizes < 0.2 represent small effect while effect size 0.2, d ≤ 0.49 represent medium effect. Based on this interpretation of effect

sizes, it means that the mean effect size of 0.195 of this study represents a small effect size. The table also shows that the percentage variance in students' academic achievement in chemistry attributable to gender is 3.80%

Research Hypothesis The overall influence of gender on students' academic achievement in chemistry is not statistically significant

Table 3: Winner Combined Test for Studies on Gender and Students' Achievement in Chemistry

$\sum t$	$\sum(df/df-2)$	z-calculated	z-critical
188.3669	63.4528	23.65	1.96

From Table 3 the calculated z –value is 23.65 and the critical value is 1.96 at 0.05 level of significance. This indicated that the calculated value is greater than the critical value and the null hypothesis is therefore rejected. This means that the overall effect of gender on students' academic achievement in chemistry is significant.

Discussions

The findings of this study indicate that the magnitude of the influence of gender on students academic achievement in chemistry varies among the studies integrated. The finding so far indicate that gender generally has effect on achievement in chemistry. This finding agrees with the views of other researchers who also found that gender is a significant factor in student's achievement in chemistry [13, 14, 15]. The difference may be due to the result of the education research and practice which reflected a belief that education-related gender differences are genetic in origin. The general assumption is that males and females have different intellectual capabilities so that males are genetically pre-disposed to succeed more than females.

The result of this study further indicated that though there is a significant gender difference in academic achievement in chemistry, the percentage variance in the students' academic achievement in chemistry attributable to gender is shown to be small (3.8%). This implies that the magnitude in students' achievement that can be attributed to gender is only 3.8% which is low. . This means that the age long disparity in science between male and female students can be laid to rest with the use of appropriate teaching strategies.

Conclusion

From the data presentation and analysis so far, it could be noted that the accumulated results of primary studies show that majority of the findings in the primary studies indicate that gender has no significant influence on achievement in chemistry. Though the mean effect size is moderate, the magnitude of the mean effect size is however small.

Recommendations.

Based on the result of the findings of this study, the researcher recommends that since academic competency and better performance in chemistry does not highly depend on gender, both male and female students studying chemistry should be equally encouraged in their studies for full participation in development and utilization of their potentials. Moreover, parents and guardians should be encouraged to give equal educational access to both males and females since both have equal potentials of excelling in

sciences especially chemistry if given equal opportunity.

Finally more research works should be tailored towards finding other factor that affect students' academic achievement in chemistry, having found that gender has little or no influence on students' academic achievement in chemistry.

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