

Meta-Analysis of Research Findings on Influence of Gender on Students' Achievement in Mathematics

Alphonsus O. Ovute

Department of Science Education, Michael Okpara University of Agriculture,
Umudike, Umuahia, Abia State, Nigeria

Abstract: In literature, many study findings exist that determined the influence of gender on students' achievement in mathematics. This study integrated the collective research findings of previous studies on the influence of gender students' achievement in mathematics at senior secondary school level. The study covered all published and unpublished research findings on the influence of gender on students' achievements in mathematics and was limited to studies conducted between 1992-2012. Two research questions one hypothesis guided the study. The design of the study was a meta-analysis survey design. Purposive sampling technique was used in collecting relevant studies. The data collection instrument was adapted from instrument developed by Ovute (2012) and modified to suit the present study. The inter-rater reliability of the instrument was 0.81 frequencies, percentages, mean scores and standard deviation were used in answering the research questions while t-test, effect size Winer combined test were used in testing the null hypothesis at 0.05 level of significance. Some of the findings included; at $p < 0.05$, there was no significant difference between the mean achievement scores of male and female students in mathematics. Based on these findings, it was recommended that meta-analysis research should be conducted in other areas of science and mathematics education to accumulate research findings on such areas in order to come up with unified data or information that will help to guide future research.

Key words: Meta-Analysis • Influence of gender • Mathematics • Students' achievement

INTRODUCTION

In Nigeria, mathematics is taught as a core subject at the primary and secondary school levels. It is also a subject required at credit level pass for admission into various courses in various tertiary institutions in Nigeria. These help to add credence to the claim that mathematics as a subject is highly needed in Nigeria for technological development. The importance of mathematics notwithstanding, there is variations gender as well as school locations with regard to achievement of students in mathematics at secondary school level. The issue of gender disparity of gender gap in mathematics achievement at all levels of education in Nigeria and beyond have been reported in literature. Also, the cases of disparity in achievement on mathematics achievement across urban and rural schools locations have been

documented in literature. These research reports on the influence of both gender and school location on students' achievement in mathematics are very necessary to guide mathematics instructions [1-3].

Although many studies have been conducted toward finding the influence of gender on students' achievement in mathematics such as Ellis and Williams (2008) [3]; Bahana (2008) [1]; among others, there is no evidence that results of such research have been utilized or allowed to make any significant impact on mathematics teaching and learning. One major problem that might be responsible for this was the divergent or dissimilar conclusions of the many studies in the area that addressed common research questions and/or hypotheses. In order words, the findings of may studies on the influence of gender on students achievement in mathematics at the secondary school level as reported in literature have shown

inconsistencies or disagreement among the many studies done. For instance, whereas Ali, Adeniyi, Olarinonye, as mean achievement of males and females in mathematics at secondary level, while study result of Eze (1997) [4], showed a significant difference between the achievement of males and females in mathematics tests respectively.

In literature, such inconsistencies and disagreement were as many as there are researchers addressing the common research questions and/or hypotheses on the relative influence of gender in mathematics achievement. If the findings in the area of the influence of gender on mathematics achievement at secondary schools are to make significant impact on mathematics teaching and learning and to education in general, there is the need to find appropriate method of examining the results of previous studies that have been conducted with regards to the influence of gender on students' achievement. This calls for a synthesis and aggregation of such inconsistencies and diverse research results in order to examine the pattern and therefore build up an accumulated knowledge on the issue of gender and mathematics achievement.

Meta-analysis of a research according to Glass in Ovute (1999) [5] is the technique of combining result of independent studies for the purpose of integrating the findings. Meta-analysis is usually conducted on a group of studies that are related through sharing a common hypotheses or operational definitions of independent or dependent features. The procedure of Meta-analysis has been used in aggregating the results of many previous studies in common areas. For instance Ovute (1999) [5] employed the meta-analysis procedure in combining the results of forty eight (48) previous studies on the effects of discovery learning on students' achievement in science. Also, Ukwungwu (2001) [6] utilized the technique of meta-analysis to aggregates the results of many research studies on the effect of gender on students' interest and achievement at secondary school level science subjects. So, far, many Meta-analysis studies have been done toward integrating the results of previous independent studies that have addressed common research questions and/or hypotheses.

Purpose of the Study: The general purpose of the study is to integrate the collective research findings of previous studies on the influence of gender on students achievement in Mathematics at the secondary school level. Specifically the study intends to:

- Calculate the effect size for each of the previous study analyzed on the influence of gender on students' Mathematics achievement.
- Locate the results of previous studies on the influence of gender on students' achievement in Mathematics.

Research Questions: The following research questions guided the study.

- What the results of previous studies on the influence are of gender on students' achievement in mathematic as shown by the means scores?
- What are the magnitudes of effect size associated with results of previous studies?

MATERIALS AND METHODS

Design of the Study: The study adopted a meta-analysis survey design in collecting the results of previous primary studies reported with respect to influence of gender on students' achievement in mathematics. The ancestry approach of information retrieval whereby citations were tracked from one study to another using bibliographic/references was adopted in locating the studies included in the present analysis. The design is appropriate because it ensured that many related studies were located. Also, it ensured that studies results reported at different levels are not repeated during the process of analysis.

Analysis of Study: The area of study is Nigeria. Nigeria is a country consisting of thirty-six states (36) and a capital city (Abuja). In each of the 36 states and Abuja, there are many institutions of learning and research. Many studies have been conducted in various areas including the location on students' achievement in mathematics. The scores of research in this area have varying and conflicting findings which need to be identified and analyzed to come up with a single result, hence the meta-analysis used in the present day.

Population of the Study: The population of this study consisted of all previous empirical research findings on the effect of gender on the achievement of students in mathematics in secondary school. The previous studies included in this analysis should address the common research question(s) and/or hypotheses with reference to

the effect of gender on students' achievement in mathematics in Nigeria schools. The result of literature search provided the number of studies used for the study.

Sampling and Sampling Technique: Studies included in this present meta-analysis, should have these features (characteristics);

- It should involve students' Achievement in mathematics
- The study was conducted in Nigeria. Since a common examination syllabus is used in all primary and secondary schools within Nigeria, it is considered useful to restrict the sampling of studies to schools within Nigeria. The result to be generated will be generalizable to student's achievement in mathematics in Nigeria schools for the fact that the same mathematics contents are taught to the students.
- The study reported the relative effects of gender on students' achievement in mathematics. In other words, only studies that determined the effect of gender on students' mean achievement in mathematics will be included in the present study.
- The study or abstract of the study or data on the study was available to the researcher. This enabled the coding of the study features (characteristics) that were required for the meta-analysis.

Validation of Instrument: In developing the instrument due attention was given to guidelines provided by meta-analysis like Cohen and Glass in Ovute (1999) [5]. A pilot instrument was developed and given to two experts in measurement and evaluation and one in mathematics education, the experts were requested to scrutinize the study coding sheet and of previous findings. Following the corrections, the coding sheet was modified and used for collecting information from studies identified for the meta-analysis.

Reliability of the Instrument: Rater reliability was carried out using four (4) selected article. Two experts in measurement and evaluation were given the four articles (studies) to read independently. The experts made the number of ratings from each of the study. Based on their ratings, an inter-rater agreement α was calculate using the formula provided by Countler, Thompson White and Morgan in Ovute (1999) [5].

$$R = \left[\frac{\alpha_{AB+} O_A + O_B}{\alpha_{AB} d_{AB}} \right]$$

Where

- AB is agreement between rater A and B
- AB is disagreement between rater A and B
- A is omission by rater A
- B is omission by rater B

The value (R) calculated represented the index of reliability of the instrument used for data collection. The rater reliability of the instrument was calculated as 0.81.

Method of Data Collection: All previous primary studies that dealt with influence of gender on students' achievement in mathematics were collected using ancestral tracking system, where references are used in locating or identifying the primary studies. The coding sheet was used in coding the features of each work located.

Method of Data Analysis: The data to be collected was analyzed using frequencies, percentages, mean scores and standard deviation to answer the research questions. The frequencies and percentages showed numerical term the results of studies that were analyzed. The mean and standard deviations were also be used to determine the effect size. Effect size estimate was calculated for each study using the formula:

$$\text{Effect size} = \frac{X_1 - X_2}{Sd_2} \text{ (Ovute, 1999) [5]}$$

Where

- X_1 = Mean of male students/or students in rural school
- X_2 = Mean of female students/or student in urban school
- Sd_2 = Standard deviation score of either group.

The above formula was used when the study reported the means and standard deviation of male and female students score in mathematics.

- $d < 0.2$ means small effect
- $0.2 < d < 0.49$ means medium effect
- $0.5 < d > 0.8$ means large effect

RESULTS

The data were presented according to the research questions that guided the study.

Research Question One: What have been the results of the previous studies on the effect of gender on the achievement of students in mathematics?

The result of Table 1 shows that in most of the studies conducted, the male students produced higher mean score than the female students. Examples of such studies included items 1, 2, 3, 4, 5, 7, 8, 9, 10, 11 and 13. There was however some cases where the results of the studies showed that the female mean scores were higher than the male mean scores. Examples of such cases where female mean scores were higher than those of the male means scores included items 6 and 12. The control group standard deviations varied from 1.08 to 21.42. In other

words, some studies recorded wide range of disparity in the scores while others recorded low (homogenous) scores. Also the t-calculated values for the various studies ranged between -7.72 to 12.05.

Research Question Two: What has been the magnitude of effect size associated with the results of previous studies on the effect of gender on students' achievement in mathematics?

The Table 2 showed the magnitude of effect size associated with the results of previous studies on the effect of gender on students' achievement in mathematics. The calculated effect size ranged from -0.53 to 2.25. The highest effect size was recorded by study item 2 (2.25) while the lowest effect size was recorded by study item 12 (-0.53). The total calculated mean effect size for the thirteen studies that were analyzed was 0.82.

Table 1: Presents the results of previous studies on the effect of gender (male/female) on students' academic achievement in mathematics.

S/N	Study author and year	Male		Female		Control group S.D	t- calculated
		N	\bar{x}	N	\bar{x}		
1	Hyde (1990)	70	13.70	70	11.27	3.04	4.86
2	Fennema (1990)	120	9.97	120	3.82	2.73	12.05
3	Larmon (1990)	40	18.17	40	10.81	5.41	6.31
4	Else-Quest (2010)	120	32.34	120	24.72	8.20	7.24
5	Hyded (2010)	80	24.20	80	22.13	3.62	3.28
6	Linn (2010)	104	9.00	98	12.00	7.00	-2.03
7	Ali (2006)	50	10.23	50	7.11	2.30	6.78
8	Malore (1993)	150	23.41	120	19.28	21.42	1.67
9	Allport (1993)	40	8.18	40	7.84	1.08	1.42
10	Ovute (1999)	60	12.46	60	12.34	4.63	0.14
11	Rosential (1995)	24	60.35	23	57.80	12.40	4.06
12	Harris (1995)	54	21.71	54	23.33	3.10	-7.72
13	Darson (1996)	80	19.14	80	14.25	2.83	10.87
Total		$\Sigma df = 1921$					$\Sigma t = 68.13$
		$\Sigma df - 2 = 1895$					

Table 2: Effect Size Associated with results of previous studies on effect of Gender on academic achievement.

S/N	Male		Female		SD	Effect size $\frac{X_1 - X_2}{SD}$
	N	\bar{x}	N	\bar{x}		
1	70	13.70	70	11.27	3.04	0.80
2	120	9.97	120	3.82	2.73	2.26
3	40	18.17	40	10.81	5.41	1.36
4	120	32.34	120	24.72	8.20	0.93
5	80	24.20	80	22.13	3.62	0.57
6	104	9.00	98	12.00	7.00	-0.43
7	50	10.23	50	7.11	2.30	1.36
8	150	23.41	120	19.28	21.42	0.19
9	40	8.18	40	7.84	1.08	0.31
10	60	12.46	60	12.34	4.63	0.03
11	24	60.35	23	57.80	12.40	0.20
12	54	21.71	54	23.33	3.10	0.53
13	80	19.14	80	14.25	2.83	1.72
Total (grand mean)						0.82

DISCUSSION

The discussion of the findings was done according to the major findings of the study as follows:

First, the study found that previous studies that were reported on the effect of gender on students' achievement in mathematics showed that males produced higher mean achievement score than the females. Out of the 13 cases located by this study on the effect of gender on students' mean achievement in mathematics the calculated mean score indicated that male students achieved higher than the female students in 11 cases out of 13 cases. This accumulated result supports the earlier reports of Fleming and Motone (1983) which indicated that males' mean achievement in mathematics was higher than those of the females. However, contrary to the present finding Hyde, fennema and Larmon (1990) found that female students outperformed male students in mathematics. The present finding which indicated that males achieved higher mean score than females is considered meaningful because many independent studies (13 cases) were examined, out of which males' outperformed females' in 11 cases, representing 84.61% of the total study population.

Another finding of the study was that previous studies on the effect of gender on students' achievement in mathematics was that the calculated effect size varied from -0.53 to 2.26, in favour of the male students. This indicates that in the overall, male students had higher performance. This finding agree with the result of Else-Wuest, Hyded & Linn (2010) which reported that there were only small gender differences between male and female achievement in mathematics in favour of male students. The authors also found that the size of the gender differences varied from one nation to another [7]. In the present study, the size of the gender difference in mathematics achievement varied from -0.53 to 2.66, the small size of variation in mean achievement may be due to the fact that both male and female students were taught by the same category of teachers, using the same curricula and under the present information technology age.

CONCLUSIONS

From the results presented and discussed, it was shown that the accumulated results of the independent studies analyzed indicated that gender has no significant influence on the achievement of students in mathematics. This implies that the average students taught mathematics obtained equal score, the gender notwithstanding.

REFERENCES

1. Bahana, S.R., 2008. *Cochrane Handbook for Systematic Review of Interventions*, Chishester: Willey.
2. Hyde, J., R. Fennema and K. Larwan, 1990. How Large are Cognitive Gender Differences? *Annual Reviews of Psychology*, 35: 156-163.
3. Ellis, S. and O. William, 2008. *Applied Meta-analysis: Applied Meta-analysis for Social Science Research*. NewYork: Gilford Publications.
4. Eze, A.E., 1997. *Special Methods of Teaching Physics*. An Unpublished Manuscript. Federal College of Education, Eha-Amufu.
5. Ovute, A.O., 1999. *Meta-analysis of Research Findings on Effects of Discovery Learning on Students' Achievement in Science*. An Unpublished Ph.D Thesis, University of Nigeria, Nsukka.
6. Ukwugwu, J.O., 2001. *Meta-analysis of Gender Differences in Science Achievement*. Ph.D Thesis, U.N.N.
7. Ovute, A.O., 2012. *Analysis of Design Issues in Postgraduate Research in Nigerian Universities*. *International Journal of Science, Technology & Mathematics Education*, 1(1): 25-30.