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A Review of Science and Mathematics Education Research on Gender: A Nigerian Perspective

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Abstract
This study was aimed at exploring the research conducted in Nigeria in science and mathematics education which mainly concern on gender. We choose eight years published articles from 2008 to 2015. The areas of emphases were on pinpointing five science and mathematics education: chronological distributed; areas of research; type of participant; research design; method of data collection and finally the sources of data for the reviewed articles. We choose different journals articles published on the website based on the discussion of the original authors in science and mathematics education. The findings sum up the essential logical coherence of science and mathematics education literature in the three areas of science, mathematics and science and mathematics education disciplines for the whole years. Finally, the findings and recommendations were discussed.

***Keywords*:** *Science Education, Mathematics Education, Science and Mathematics, Gender, Nigeria*

Introduction

Science is the systematic reflection of natural consequences and conditions in order to learn facts about them and to formulate laws and principles grounded on these facts, or the organized body of knowledge that is gained from such observations and that can be verified or proven by further investigation Morris.[1] According to Harel[2] "Mathematics is defined as the union of two sets: the set of WoU, which consist of all the institutionalised ways of understanding in mathematics throughout history, and the set of WoT, which consist of all the ways of thinking that characterised the mental acts whose products comprise the first set." P.286. On the other hand, science education is defined as the means of sharing the process and content of science with persons who are not regarded traditionally to be a member of the scientific community; the persons may perhaps be

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students, farmers, market women or else the entire community.[3] When the two disciplines (science and mathematics) contents are connected, they are referring to science and mathematics, science and mathematics integration in the teaching and learning is the mixing the two fields which is critical to motivate and involve students in meaningful learning.[4-5]

The goal of integrating science and mathematics is to make teaching and to learn more meaningful in such a way that it will increase the students' interest and reduce their fair in learning science and mathematics. Moreover, they can apply it to solve their personal and societal problems all these depend on the quality of teaching and learning received by the students. In this regards, math and science have long been considered to be inextricably linked disciplines.[6] They are symbiotic to each other because if science can supply students with concrete examples of abstract mathematical ideas, on the other hand, mathematics can enable pupils to reach a more in-depth understanding of science concepts.[7] Moreover, delivering means to quantify and explain science relationships. The integration of science and mathematics together is considered more important than teaching the individual subject in isolation, as Koirala & Bowman [8] and Frykholm & Glasson[9] established that integrating curriculum of different fields can deliver students with more reliable and significant learning experiences, rather than split concepts presented in single subject curricula.

In the 21st century where the global economy is fast growing in science technology and innovation, Nigeria as a developing nation needs a strong workforce of innovators, problem solvers inventors in the field of science and technology which can have diversified knowledge and skills to innovate and compete in the global marketplace as other countries. Despite the global decline in the interest of students to take up science mathematics and technology.[10] The importance of science and mathematics to the nation's growth and development can never be overemphasised, however, the integration of these subjects at senior secondary school level in Nigeria has been not be giving much consideration, despite all its importance, whereas developed countries such as US, UK. Moreover, Australia the issues of integrating science and mathematics has become history for long. Instead, they are at the stage of integrating four disciplines of science technology engineering and mathematics.

Despite the significance of science and mathematics toward the nation, yet, public presentation of secondary school students in Nigeria was not encouraging, particularly the female students. As confirmed by Eguridu [11] that, more than 70% of candidates that took for 2014 November/December West African Senior Secondary School Certificate Examination (WASSCE) unsuccessful to get five credits in Mathematics and English including science subjects. This could be due to the inadequacy in term of how teachers viewed the nature and curriculum of scientific discipline and Mathematics Education. Which leads to a degree of contention in the Philosophical urgency in many modern-day Curriculum.[12] Also, Abur *et al*. [13] point out that, the technological backwardness of Nigeria seems to stay as one of the most reliable indications of the shortcomings of the nation's educational system since the Nigerian government is experiencing many challenges in succeeding the goal of strengthening science and technology. This could be a reason why Aremu [14] call for the Nigerian government without delay declare a state of emergency in the education sector at all levels.

Gender is an essential factor in Nigerian secondary school education.[15] However, the disparity has been established at almost all levels of education among male and female students, in this regards

Gusau *et al*.[16] point out that the particular portion of male and female students especially in science and mathematics at higher educational institution, compared to the southern region, statistically northern parts were very low. Especially female, that there is the need to find out for the gender in balance.

Thus. The call was made by Odunaike *et al.* [17] that, Nigeria is in need of additional females' scientists and technologists in making a decision. Because it would empower them to regulate the means of technological investigation and encourage policies which can favour female species since the gender disparity for female once in respect to the opportunity to education particularly at secondary school level is established.[18] To this regard, UNESCO [19]revealed that Education for All Goal 5 (Five) calls for Eliminating gender disparities in both elementary plus secondary education by the year 2005. Moreover, attaining gender equality in education by 2015, using guaranteeing girls' full and equal access to and accomplishment in basic education of noble calibre, and in Nigeria, policies and laws have been ordained to support women's education.[20] Evidence indicated a gender disparity in science and maths in Nigeria, for instance, Ameh [21] revealed a decline of performance for male and female students in science and maths from 2011 to 2014 as 38.93%; 45.52%; 36.57% and 31.28 %. Respectively, Again, Ezenwa, [22] revealed that the students' performance in Nigeria as regards to science and mathematics subjects is less than forty (40%) per cent of the students passed West Africa Examination Council Examination at the credit level. [23]

In its effort to quit the gender disparity and the challenges in science and technology, the Federal Government of Nigeria has initiated policies ordained to support women's education [20], one of these policies is the Nigerian National Policy on Science, Technology and Innovation ST&I (2012). Which has a specific target as "empowering women in the utilization of ST&I for economic development (p32)? Likewise, in 2004 the federal ministry of science and technology revealed that, there has been attention on the focal point in Nigeria on the problem dwelling enrolment, interest and achievement in science, mathematics and technology, among which are vision statement of this policy that stated "by 2020 that Nigeria will have a large, strong, diversified, sustainable and competitive economy that can effectively harness the talents and energies of its people and responsibly, exploits its natural talents to guarantee a high measure of living and quality of life for its citizens" (p, 27). Besides, since the year 2005, Nigeria became more aware and began to address the rising concern about having a vanguard of investigation in science and technology.[24]

In connection with the above, this paper, therefore, emphasizes the research fields of science, mathematics and science mathematics education on gender disparity which was carried out by researchers for eight years in Nigeria. The purpose of this paper is to provide a general summary of science and mathematics education on gender which has been conducted in Nigeria and to evaluate and deliberate the situation and find the potentials for future development. Besides, the paper targets to explore the type of participant; research design; method of data collection and finally the summary of significant findings for the reviewed articles in the area of science and mathematics concerning gender disparity. However, it is apparent that some restrictions were found which could give other researchers opportunities to carry out research that will focus on male or female students in the area of science and mathematics education. This paper engaged in a meta-analysis which is considered more appropriate than a traditional narrative review. Meta-analysis provides authentic reliable and open means to embraces existing results, even though,

meta-analysis is suitable in reviewing, evaluating as well as synthesising the actual realistic outcomes of the study.[25-26]

Methodology

This study traced research conducted on gender difference in science and mathematics education using ProQuest as the primary scanning bibliographic database. The reason for choosing researches conducted on gender-wise is there are issues on gender disparity in Nigeria which need to be equipped. The chance to make use of ProQuest has been signed at ease with the appearance of web-based providers which includes: Science Direct; Web of Science; Emerald; Google Scholar; Scopus [TM]; Springer; Education Resources Information Centre (ERIC), Tylor and Francis. All the databases were scanned to retrieve the published articles in science, mathematics and science education regarding gender disparity in Nigeria. The key search terms used in screening the articles are a Gender difference in science and mathematics education. Gender difference in science education. Gender difference in mathematics education, male and female performance in science and mathematics education, comparison of male and female academics achievement in science and mathematics education. Challenges of male and female students in science and mathematics as well as challenges of male and female students in science and mathematics in Nigeria. However, the articles were examined and analysed according to the division of science such as chemistry, physics and biology, while in the field of mathematics it has been categorised into statistics and mathematics, and gender, divided into male and female and gender, all this was done to avoid bias when searching, screening or analysing the articles. These key terms are regarded as presentative of the search conducted in the databases concerning the objectives and definition of science and mathematics education.

The search was limited to a total of 50 published articles from 2008 to 2015 in Nigeria on science and mathematics education. Even though, Nigeria is far behind in publishing the articles in the higher-impact factor journals, however, we tried to retrieved articles from recognised journals such as Asian Journal of Education and e-Learning, Multicultural Education & Technology Journal, Procedia Social and Behavioural Sciences, Educational Research and Review, International Journal of Mathematical Education in Science and Technology and European Scientific Journal. What was analysed from the articles are the titles, field of research, abstracts, samples, data and data collection, research design and participants and findings conducted at different levels of education, therefore this paper offers the empirical results involving the temporal distribution of gender difference in science and mathematics in Nigeria. The research findings were interpreted using the narrative review in support of an empirical statistic. Humphery [27], stated that, the abundant of qualitative review papers are great because they do not just review the literature, but they also organize it, they frame it, besides they deliver a way forward for the future, and the findings of meta-analysis should be positioned in the research context, and interpret findings in a meaningful approach. It was not only aimed at given the overall success of individuals concerning Nigerian research. However, but this narrative review will also be used as a means for providing broad future research and development of Nigerian science and mathematics education in term of gender.

Results

The findings supply a descriptive analysis of the science and mathematics education gender wise research field; it indicated that there is a research base for the gender difference in science and mathematics education in Nigeria. Corresponding to this, these findings sum-up the scope of research being conducted in the area by scholars in the field of gender difference in science and mathematics education and where the research is being published. The findings are systematised into six parts:

i) Chronological distribution
ii) Research areas
iii) Type of participant
iv) Research design
v) Method of data collection
vi) Sources of data collection

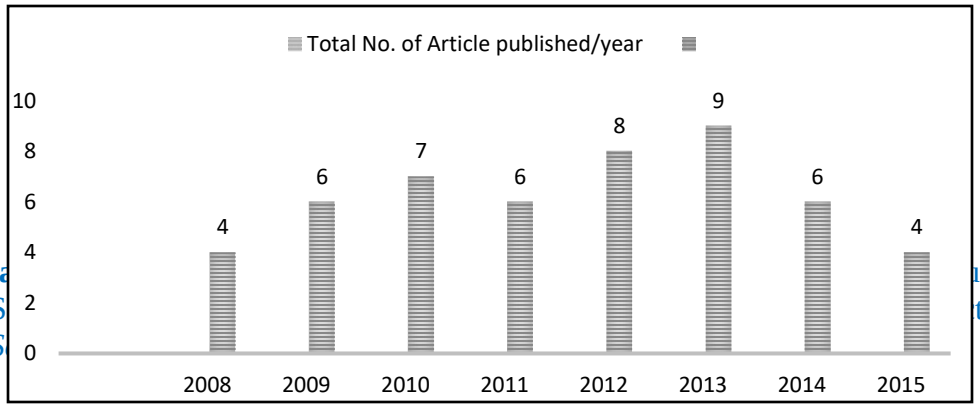
Figure 1. Distribution of reviewed articles from 2008 t0 2015

Chronological Distribution of Research Studies in Gender Difference in Science and Mathematics Education

The above figure (figure 1) shows the distribution of the examined articles published. A total number of articles analysed is 51 for eight years. The results indicated that the diffusion of science and mathematics (S&M) education articles published varied from 2008 to 2010, since, as at 2008 a total number of 4 articles were reviewed, while, in 2009 increased to 6 and fluctuated to 7 articles in 20010. There was an increase in the trend of articles from 2011 to 2013, ranges from 80% to 90% increase. Also, the reviewed articles were decreased to 60% in the following year, and drop down again to 60% in 2015. It has also examined that, the highest number of articles reviewed was in 2013 with 10% as a total increase. Even though 2013 has the highest published articles since 2008, only four articles were retrieved in 2008 and 2015 about the gender difference in science and mathematics.

The total number of research areas involved was 14 which were sum-up from the 51 articles reviewed. Some articles possess more than one area whiles others do not have anyone. The total number of articles analysed throughout were 63, however, in the field of science and mathematics (S&M) education, mathematics education has the highest number of articles published with a total of 65 issues, this is followed by science education with a total of 26 issues and lastly, science and mathematics education with only 3 issues. The description of the frequency of these research areas in the field of science and mathematics education can be seen in Table 1 below:

Table 1: Research Areas in Science and Mathematics Education in Nigeria



No.	Field of Research	Sci.	Maths	Sci. & Maths	Total
1	Teaching and learning	6	3	0	9
2	Curriculum	0	0	0	0
3	Instruction (Inst.)	1	2	0	3
4	Culture	0	0	0	0
5	Male Female	1	0	0	1
6	Assessment	2	2	0	4
7	Perception	1	1	1	3
8	Motivation &Attitude	3	5	0	8
9	Problem solving	1	0	0	1
10	Interest	1	1	0	2
11	Anxiety	0	0	0	0
12	Challenges	1	0	0	1
13	Achievement/performance	9	19	2	30
14	Others	1	2	0	3
	Total	**27**	**35**	**3**	**65**

For eight years, achievement and performance research area have the highest number used in all the fields with 19%, followed by teaching and learning with 6%. Also, the three areas emerged with the same percentages in all the fields; the areas are instruction, assessment and other research areas with 2%. The trend of the male and female students in teaching and learning in Nigerian schools indicated how much importance was given in the achievement of students in the fields of science and mathematics about gender difference. Though, integration of the science and mathematics was not given priority, as shown only two issues out of 30 in the achievement and or performance, despite the importance of integrating this two (science and mathematics) fields together. Another area of priority given in Nigeria in the fields of science and mathematics on gender difference is Motivation and attitude. Particularly in the field of mathematics, however, mathematics education has the highest number of issues reviewed for eight years with a total of 34 areas of research, followed by mathematics education, while, only three areas of research were found in the field of science and mathematics education. Also, the result from the table below shows that there is a gender difference in term of research in the fields of science and mathematics education, and the area of anxiety has not been given much attention as zero was found in all the fields. However, interest was slightly considered in science and mathematics education fields but, not in the integration of science and mathematics education. On the other hand, the perception and assessment too were considered necessary in the published articles in the field of science and mathematics.

The type of participant considered in the analysis of the published articles from 2008-2015 are eight participants in all the fields of science and mathematics education, the description of the participants and the samples used are shown in table 2. Out of the total number of participant articles that used both male and female students have the highest percentage with 45 articles. Out of which mathematics education has 23%, followed by science education, however, experts Which include primary and secondary teachers, lecturers as well as experts in the fields of science and

education has the second order in the number of participants from the articles reviewed. From all the 51 articles reviewed and analysed the participants, which were not involved in the research are: administrators; parents and male students as well as adults. Besides, the trend indicates that female students and using documents in the study in the fields of science and mathematics education were not given priority. Since is only 1% of the articles were found to consider these participants, Amazingly, most of the researchers prepared for us only students, instead of considering the importance of involving parents and administrators as participants in the study, very few involved experts and female students in their research.

Table 2: Type of Participant in Science and Mathematics Education in Nigeria

No.	Research Area	Sci.	Maths	Sci. & Math	Total
1.	Qualitative research	0	0	0	0
2.	Parent	0	0	0	0
3.	Male Student	0	0	0	0
4.	Female Students	1	0	0	1
5.	Male & Female Students	20	24	1	45
6	Expert Primary teachers; Lecturer	0	0	0	0
7	Adults	0	0	0	0
	Total	**1**	**0**	**0**	**1**

The trend of the methodological approaches used in Nigeria in the fields of science e and mathematics education from 2008 to 2015 indicates that there are three research design used, which includes qualitative, quantitative and mixed methods. However, developmental research was not used as a type of research methodology in all the fields, and only one mixed method type of research was employed for eight years. The table below indicates the total number research method design used by local research in Nigeria on the area of science and mathematics education. Throughout publication from 2008 to 2015, a total of 48 research design were used by the local researchers.

Table 3: Research Design in Nigerian Science and Mathematics Education

No.	Research Design	Sci.	Maths	Sci. & Math	Total
1.	Qualitative research	2	1	0	3
2.	Quantitative research	19	22	3	44
3.	Mixed method	1	0	0	1
4.	Developmental Research	0	0	0	0
5.	Others	0	0	0	0

Total number of Research	**22**	**23**	**3**	**48**

As can be seen from the above table (Table 3) Majority of the researchers in Nigeria employed Quantitative research design with 92% in all the fields. Despite the abundance of the population of people in Nigeria the local research in the field of science and mathematics prepared to be employed Quantitative method design instead of using qualitative methods and developmental method to triangulate their findings. Mathematics education on has the highest number of the quantitative research design followed by science education, but, out of the 92% quantitative research design employed throughout the period of publication, only 7% quantitative research design was used in the fields of science and mathematics but has not being used in the integrated science and mathematics fields. We also examined that, mixed method research design has not been given attention in almost all the fields since only science education articles were found to use only one mixed method design though out despite the importance of mixing two methods (qualitative and quantitative) in the field of social science research. Finally, none of the fields was found to employ developmental research method, although developmental research is the best type of research to be used when designing to evaluate educational programs.

The trend of research design of Nigerian science and mathematics education conducted on gender from 2008 to 2015 has been analysed and can be seen in Figure 2. Distribution which was based on the years of publication of the articles in the fields of science and mathematics education. This trend shows that local Nigerian researchers are good enough for employing statistical analysis and there has been a shift in the quantitative research design method from 2008 to 2013 but declined by 2014.

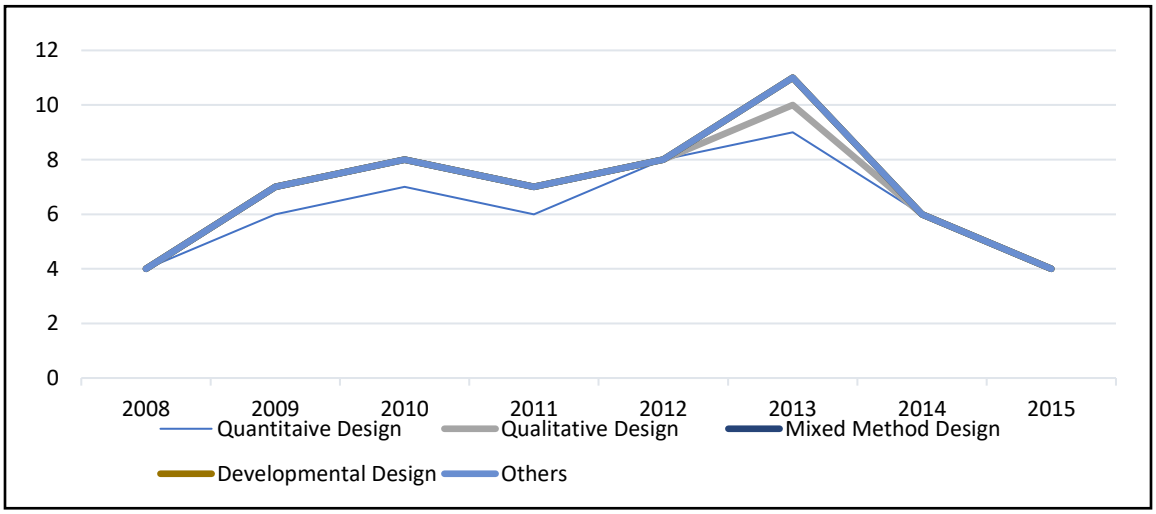


Figure 2. Distribution of Research Design from 2008 to 2015

Another critical area we analysed in this study is different sources of data employed by the researchers in the fields of science and mathematics education in Nigeria. It is clear from the Table 4 and Figure 4 that, the majority of the local researchers in Nigeria used primary data as their sources of information in their findings, 92% of the data sources from 2008 to 2015, was primary data, while, only 8% of the published articles were found to used secondary data as their source. No, an article was found to employ secondary data source in the field of integrated science and mathematics.

Table 4: Type of Data Sources in Science and Mathematics Education in Nigeria

S/N	Research Are	Sci.	Maths	Sci. & Maths	Total
1	Primary Data	22	22	3	48
2	Secondary Data	2	2	0	4
3	Primary and Secondary Data	1	0	0	1
Total		**25**	**24**	**3**	**52**

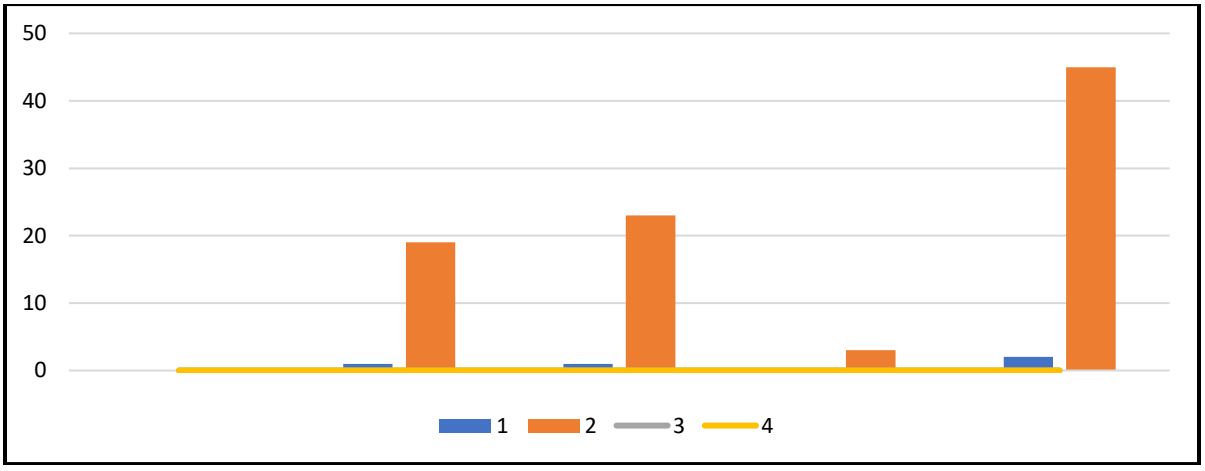


Figure 4: Type of Data Sources in Science and Mathematics Education in Nigeria

Despite the importance of using both primary and secondary sources of data in the fields of science and mathematics education, the local Nigerian researchers in the fields of science and mathematics were found to neglect and not consider the use of primary and secondary data souse in their research. Also, only 1 article in the field of science education that used both primary and secondary data as its source. This study did not limit its findings only on research areas, type of participants, research design and sources of data, but also considered the method of data collection paramount in the fields of science and mathematics education. Table 5 and Figure 5 therefore, demonstrates the methods used in data collection from the reviewed articles from 2008 to 2015. A total of 4 methods of data collection were used in all the fields.

Table 5: Methods of Sources of Data Collection in Science and Mathematics Education in Nigeria

No,	Method	Sci.	Maths	Sci. & Maths	Total
1	Conducting Interview	1	1	0	2
2	Conducting Interview and using document	19	23	3	45
3	Administration of Questionnaire	0	0	0	0
4	4Conducting Interview & Administration of Questionnaire	0	0	0	0
5	Using Delphi technique	0	0	0	0
6	Using Documents	2	0	0	2
7	Observation	0	0	0	0
	Total	**23**	**24**	**3**	**50**

Table 5 above and Figure 5 below indicated that the administration of the questionnaire was the most prominent method of data collection used for the whole fields because 90% of the articles published used this method of data collection, mathematics education researchers used the questionnaire more than science education, because. While mathematics education local researchers in Nigeria used 51% of the questionnaire as a method of collecting data, science education employed 42 % whereas science and mathematics education employed only 7% as their method of data collection. However, only 2% of the published articles found to use the interview as their source of data collection in the field of science education and mathematics education. Moreover, another 2% of the researchers employed documents as their sources of data collection whereas, only one published article used interview and documents in the field of science education.

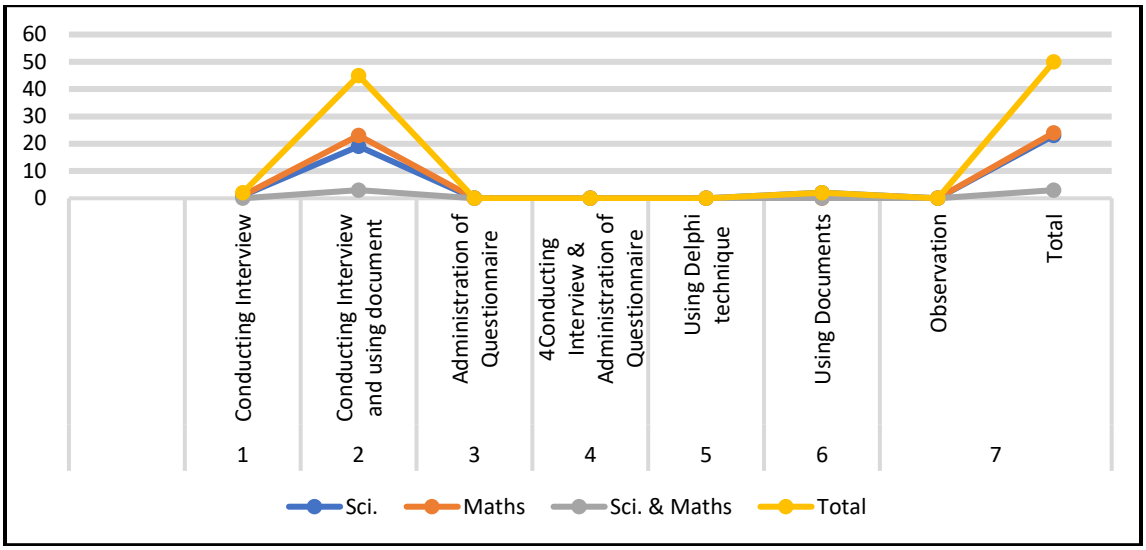


Figure 5: Methods of Sources of Data Collection in Science and Mathematics Education in Nigeria

Furthermore, Delphi technique as a means of gathering data from a different expert, found to be more reliable in as a source of data collection was not used in all the fields. Instead, they gave more priority to the questionnaire, which mostly administered to the group of students. Consequently, conducting an interview, using questionnaire and observation are essential elements of data collection in the field of social science research, particularly if the researcher wants to explore his study make life as well as in-depth investigation. However, the Nigerian local research in the fields of science education and mathematics education based on the articles retrieved and reviewed from 2008 t02015 did not use these two essential instruments as their sources of data collection.

Discussion

It has been established that science and mathematics are also considered as the life for technological advancement Ekon *et al*. [28], it is, therefore, apparent that without proper foundation in secondary school science and mathematics no nation can achieve its scientific and technological advancement in this area.[29] Incorporating technology and engineering in this fields could indicate the role played by science education in the technological advancement of the 21st century in the global perspectives, as indicated by Jayarajah *et al*.[30] That, STEM education means only science and mathematics, even though the products of technology and engineering have so greatly influenced everyday life Jayarajah *et al*. [30], this will make students be problem solvers, creatives and be able to make innovations.

About research areas in Nigeria science and mathematics education, convincing evidence indicated that there is the apparent dominance of studies on mathematics education to other disciplines of science education and science and mathematics education in the Nigerian context. The significance of researching the field of mathematics education on gender-wise is unavoidable. Still, the main

focus of the reviewed research was on the male and female student's achievements and their performances in the teaching and learning concerning science and mathematics education. Though, the achievement and performance of student's attention were not given to curriculum and instruction and assessment. There is the need for science and mathematics teachers to use effective strategies in their instruction to foster students' interest in science and mathematics particularly in female students as well as infuse in them a sense of efficiency about the perception of their science and mathematics abilities.[31] Therefore, more research on curriculum that will integrate both science and mathematics in the area of female students interest and anxiety is required, because the areas were not thoroughly researched in Nigeria.

On the other hand, this study found that most of the researchers in Nigeria gave more priority to students, instead of considering the importance of incorporating the experts, and parents in their study, since Lack of parental reinforcement and expectation discourages girls' interest in science and maths.[32] Moreover, the use of documents can also stimulate the effectiveness of the designing programs that could increase students interest in learning science and mathematics education, but these elements were not given much emphasis. However, despite the importance of gender equity, which was given more priority, studies should have been conducted to the individual sex either male or female, particularly female students because Girls, in particular, have continued to experience low levels of confidence and this does not appear to have improved over the last 20 years.[33] However, from the findings of the published articles analysed, it has been established that gender difference exists in relation to students' achievement, also most of the researchers show that female students perform low compared to their male counterparts, very few found no significant difference between male and female students achievement on science and mathematics education. Therefore, there is the need for more research in Nigeria that will motive and arose the student's interest to perform excellently mainly female in the fields of science and mathematics.

It is essential to use a quantitative approach as a design in the field of science and mathematics education, most of the researches conducted in Nigeria used Quantitative research as their research design, through a qualitative approach and mixed methods provides full and authentic and in-depth information to the researchers. Since, mixed methods research is a methodology toward inquiry concerning gathering together qualitative and quantitative data, interpreting the two forms of information, and using divergent designs that may perhaps comprise philosophical assumptions and theoretical framework.[34] Additionally, in the field of educational research, developmental research refers to the taxonomic study of designing, developing and evaluating instructional programs[35], developmental research method was not given attention regarding the designing a teaching and learning environment that could enhance students' interest. Particularly female in learning science and mathematics using developmental research method, it is, therefore, significant to carry out research using developmental research as a design approach.

The results of this review indicate that in all the fields of science and mathematics education primary data was the frequent data used in the studies carried out in Nigeria. The primary data is considered the most reliable data to be used in getting authentic information on the participants of the study as stated by Privitera [36] that, the source of an idea or research is called primary source. However, very few researchers employed secondary data in the fields of science and mathematics education, while, only in the field of science education researchers make use of both primary and secondary data despite the importance of using this two types of data more than a single one. In

term of the sources of data collection in Nigeria, the majority of the researchers in the fields of science and mathematics education administered Questionnaire in collecting their data. Despite the facts that, questionnaire provides adequate information of the respondents, interview too can provide life and explore the real and authentic information on the respondents, but very few use conduct interview and using documents in their data collection. Delphi techniques is another means of getting information from different individuals who are professionals in the fields. As stated by Abdalrob and Daniel [37] that, Delphi technique as a combination of processes used to survey and gather the experts' opinions on a specific subject. This technique was not used as a means of sourcing the data. It is, therefore, essential to carry new research in Nigeria in the fields of science and mathematics education that will use both primary and secondary data as well as conducting an interview, observation and use Delphi techniques, which were neglected by the local Nigerian researchers in the fields of science and mathematics education.

Conclusion

The research areas in science and mathematics education on gender difference in Nigeria has been researched, yet, little research has been carried out to determine the effects of exciting science and mathematics education approach on students' interest anxiety, and their perception on this field. Another area of importance is involving parents in researching the field of science education and mathematics education. Quantitative research design method using questionnaires as a source of primary data were widely used by the local Nigerian researchers in the fields of science and mathematics education. However, there is a dire need for more research by Nigerian researchers in the fields of science and mathematics education, since technology and engineering depend on the knowledge of science and mathematics education. This can produce innovators; critical thinkers graduate mainly female in the STEM fields for the economic and technological growth of Nigeria and world at large. It is also vital that, science education literature and practices do not overwhelm the influence of mathematics education investigators and experts.

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