# Impact of Concept Mapping on Academic Performance of Males and Females among Secondary School Physics Students in Katsina State, Nigeria

**BY**

**MUHAMMAD Jamila Ruma**

**AND**

**SA'ID Jamilu Abdurrahman**
**Department of Science Education,**
**Faculty of Education,**
**Ahmadu Bello University, Zaria**

## ABSTRACT

*The study investigates the Impact of Concept Mapping on Academic Performance of males and females among Secondary School Physics Students in katsina State, Nigeria. A total of 91 students from a public secondary school in Katsina education zone was purposively selected from a population of 3,968 science students, using simple random sampling technique. This study adopted pre-test and post-test quasi- experimental research designs. Two groups were formed: The Males and Females group. The two group students were taught Motion concept using Concept Mapping strategy. The instrument used for data collection was Motion Concept Performance Test (MCPT). The instrument was validated by both Physics teachers and lecturers in science education department. The reliability coefficient of MCPT was 0.79. Pearson Product Moment Correlation coefficient statistics was used to determine the reliability coefficient of MCPT, Based on the objective, this study was guided by a research question and answered using descriptive statistics. The null hypothesis stated was tested at 0.05 level of significance using statistical tool t-test statistics. The results obtained from data analysis show that there is no significance difference in the academic performance of male and female students exposed to concept mapping teaching strategy in motion concepts. Based on the findings of the study, it is recommended among others that Concept Mapping Strategy was found to be gender friendly since both gender showed improving Academic Performance as a result Teachers should be encouraged to use Concept Mapping instructional strategy in teaching Physics through adequate and frequent supervision as well as reward by the ministry of education.*

**KEYWORDS: Concept Mapping, Academic Performance, Gender, Secondary School, Physics Students, Katsina State, Nigeria**

## Introduction

Physics is one of the science subjects taught at senior secondary and tertiary levels of education in Nigeria. It is a branch of science which concerns itself with fundamental ideas about nature and attempts to establish relationships between different quantities as precise as possible. In view of the foregoing, Josiah (2012), as a physical science, Physics is a subject that is

concerned mainly with matter as it relates to energy and deals with the study of laws that determine the structure of the universe with reference to matter and energy in the universe. The Federal Repubic of Nigeria (FRN, 2013) places the subject as a core subject that each science student must be exposed to at Senior Secondary School level.

Reports by Chief Examiners of the Examination bodies in Nigeria like the West African Examination Council (WAEC, 2016) and National Examination Council (NECO, 2016) indicated that students' Academic Performance in Physics is not encouraging over the years (See Table 1.1). Uzoka (2012) reported that the Academic Performance of students in WAEC and NECO has not been impressive in recent times. Many reasons account for students poor Academic Performance in science and technology areas as reported by researchers. Atadoga & Lakpini (2013) for example found that the persistent low Academic Performance in science education is attributed to teacher instructional strategies, among others. Josiah (2012) stated that there are many reasons for the students' poor academic performance in Physics such as large population of students, method of instruction used in teaching Physics and gender difference. Studies like Atovigba, Owu and Ijeneli (2012) and Hassan (2010) stated that male and female students perform significantly different in physics

Concept Mapping according to Kinchin (2005), is a strategy that help students organise their cognitive frameworks into more powerful integrated patterns. Concept Mapping is used to deliver instruction for brain strumming, note-taking, memory retention, and summary, new knowledge creation and to increase meaningful learning (Brown in Imoko, 2005). According to Cakir (2008), Concept Mapping is a schematic representation of ideas or concepts, showing their relationship in form of flow chart. It is a visual representation which allows the development of a holistic understanding that words alone cannot convey (Plotnick in Imoko & Agwagah, 2006). According to Canas and Novak (IHMC, 2008), Concept Mappings are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type and relationships between concepts are indicated by a connecting line linking two concepts. Concept Mapping is a visual organizer that helps students represent a topic or concept by showing its relationships (Novak, 2008). If Physics is too difficult to the students and the teachers' instructional method can go a long way to improve the Academic Performance of both male and female students.

Academic Performance according to Ogundukun, and Adeyemo, (2010) is seen as the exhibition of knowledge attains or skills developed by students in a subject designed by test scores assigned by teachers. Atadoga, and Lakpini, (2013), Obeka (2014) and Bello (2015) observed that students' Academic Performance in sciences in Nigeria is not encouraging and is attributed to teacher instructional strategies, among others. Thus, instructional strategies used by teachers in teaching-learning process have significant negative influence on students' Academic Performance (Atadoga, & Lakpini, 2013). Some methods of teaching have been discovered to improve teaching-learning. The desire to improve the academic performance of both male and female students in science through more effective instructional strategies has led to selecting other teaching method (Concept Mapping) which if proper teaching strategies are used it will have positive effect on both gender.

Gender is another variable in this study. Gender is adopted in this study because, it is stated in the National Policy on Education that every individual have access to education both males and females. It is the state of being male or female with reference to social or cultural differences (Shafiq, 2013). The role of gender in Academic Performance has led a lot of researchers to carry out studies on it. Examples are kyei, Apam and Nokoe, (2011) and shafiq (2013). According to Ativigba, Okwu and Ijenkeli (2012), gender difference in science can be attributed to the fact that, from birth, a girl child is exposed to avoid science. The societal set up does not give her the opportunity to experience the environment which is the pre-requisite to learning of science; rather, she is kept in doors to do the house work. Several Studies such as Ajai, Imoko and O'kwu (2013) and Nwezi (2010) had shown that one of the variables affecting learning in general and Science in particular is gender. According to Kyei, Apam and Nokoe (2011), females are not only under-represented in science but their levels of academic performance in Science and Technology is low compared to their male counterparts. Against this background, the study attempts to use the impact of Concept Mapping Strategy to investigate if it have any gender difference.

## Theoretical Framework

The study is based on a Constructivist theories of learning which has its root in cognitive psychology. Constructivism stems from the work done by several theories including information processing theory, David Ausubels Theory, Brunnier learning theory. Concept Mapping is rooted in Ausubel`s Assimilation Theory (Ausubel, Novak & Hanessian, 1978). Concept mapping is a meta-cognitive learning strategy based on the Ausubel assimilation theory (Ausubel 1978). It has its origin in a research done at Cornell University with a view to studying changes in students understanding of science concepts over a 12-year span of schooling (Novak, 1990). The research group led by Novak worked with the idea that new Concept meanings were acquired through assimilation into existing concept/proposition frameworks. Assimilation theory posits that new knowledge can be learned most effectively by relating it to previously existing knowledge. Concepts Mapping may be viewed as a methodological tool of assimilation theory that displays fundamental elements of the theory such as subsumption, integrative reconciliation and progressive differentiation. Concepts Mapping allow for the representation of non-hierarchical relationships or cross-links, as well as other types of non-hierarchical arrangements. Ausubel (1968) proposed how meaningful verbal learning and retention can be facilitated through the use of extrinsic organizing devices that modify the students' cognitive structure. Ausubel (1968) stressed that if existing cognitive structure is clear, stable and suitably organized, it facilitates the learning, interest and retention of new subject matter.

## Statement of the Problem

The persistent poor performance of students in SSCE Physics for quite some times now has become a major concern to Science Educators, Parents and other stake holders in Science Education. The West African Examination Council (WAEC, 2017) has reported that there is increasing mass failure in Physics WAEC over the years. A eight years (2010-2017) analysis of students' Academic Performance in Physics is revealed in Table 1.

**Table 1: Performance of Students in Physics at SSCE Level (WACE) in Katsina State, from 2010-2017**

| Year | No. of students in attendance | No. of students that passed at credit level | No. of Students that Failed | % Passed | % Failed |
|---|---|---|---|---|---|
| 2010 | 21,606 | 2,427 | 19,179 | 11.24 | 88.76 |
| 2011 | 30,707 | 699 | 30,008 | 2.28 | 97.72 |
| 2012 | 38,602 | 4,146 | 34,456 | 10.74 | 89.26 |
| 2013 | 33,720 | 7,954 | 25,766 | 23.58 | 76.42 |
| 2014 | 37.223 | 11,337 | 25,766 | 30.46 | 69.54 |
| 2015 | 39,577 | 8,578 | 30,999 | 21.67 | 78.33 |
| 2016 | 14,513 | 8,272 | 6,241 | 56.99 | 46.01 |
| 2017 | 25,737 | 2,411 | 23,326 | 9.37 | 90.63 |

**Source: Katsina State Ministry of Education (2018)**

From the data, it reveals that Physics students have difficulties in the learning of Physics which has resulted in poor academic performance at Senior Secondary School level (WAEC) in all the years except for the year 2016 where the percentage pass is 56.99 and the percentage failed is 46.01. Several Studies such as Ajai, Imoko and O'kwu (2013) and Nwezi (2010) had shown that one of the variables affecting learning in general and Science (Physics) in particular is gender. According to Kyei, Apam and Nokoe (2011), females are not only under-represented in science but their levels of academic performance in Science and Technology is low compared to their male counterparts. According to Ativigba, Okwu and Ijenkeli (2012), gender difference in science can be attributed to the fact that, from birth, a girl child is exposed to avoid science. This situation calls for improvement in the method teaching of science (physics) such that both male and female students can perform better. Therefore, the study specifically focused on determining the Impact of Concept Mapping on Academic Performance of male and female students.

### Objective of the Study

The objective of the study is to examine the impact of Concept Mapping on Academic Performance of male and female Physics students at secondary schools Katsina state.

### Research Question

What is the difference in mean Academic Performance between male and female students taught Physics using Concept Mapping?

### Null Hypothesis

The following null hypothesis was constructed and tested at $P \leq 0.05$ level of significance:

**HO:** There is no significant difference in the mean Academic Performance of male and female Students taught Physics using Concept Mapping.

## METHODOLOGY

### Research Design

Quasi Experimental research design of pretest, posttest was employed for this study. Intact class (non-randomized group) was used for the study. In this study, two groups were used which are the Males and Females group. Both students were taught using Concept Mapping strategy. A concept of Motion was used in teaching the students. The duration of the experiment was six weeks. After treatment, performance test was administered to both Male and Female Groups.

MA $\longrightarrow O_1 \longrightarrow X_1 \longrightarrow O_2$

FE $\longrightarrow O_1 \longrightarrow X_0 \longrightarrow O_2$

**Fig. 1: Research Design Illustration**

### Population of the Study

The population for this study covers all public senior secondary schools Physics students in Katsina education zone. There are twenty (20) public senior secondary schools offering Physics as one of the science subjects with population of 3,968 out of which 17 are co-educational and 3 are single sex in Katsina education zone (2 boys only and 1 girl only). From this figure, 2,812 are males while 1,156 are females. Detail of the population of this study is presented in Table 2.

**Table 2: Population of the Study**

| SN | School | Male | Female | Total |
|---|---|---|---|---|
| 1. | Government Girls College (Senior) Katsina | - | 305 | 305 |
| 2. | Government Senior Secondary School KofarYandaka | 467 | 269 | 736 |
| 3. | Government College (Day Wing) Katsina | 289 | 118 | 407 |
| 4. | Government College Pilot Katsina | 183 | - | 183 |

| | | | | |
|---|---|---|---|---|
| 5. | Government Pilot Secondary School KofarSauri | 75 | 23 | 98 |
| 6. | Government Senior Secondary School Kambarawa | 185 | 65 | 250 |
| 7. | Government Senior Secondary School KofarKaura | 248 | 107 | 355 |
| 8. | Government School for Blind Katsina | 14 | 5 | 20 |
| 9. | Government Senior Secondary School Dutsen Safe | 89 | 21 | 110 |
| 10. | Katsina College Katsina (Senior) | 568 | 169 | 737 |
| 11. | Sir Usman Nagogo College of Arabic & Islamic Studies | 56 | 33 | 89 |
| 12. | Family Support Senior Secondary School, Katsina | 54 | 21 | 75 |
| 13. | Government Senior Secondary School Natsinta | 65 | 23 | 88 |
| 14. | Government Senior Secondary School Jibia | 187 | 40 | 227 |
| 15. | Government Senior Secondary School Daddara | 26 | 9 | 35 |
| 16. | Government Senior Secondary School MagamaJibia | 59 | 39 | 58 |
| 17. | Government Senior Secondary School Dankama | 36 | 20 | 56 |
| 18. | Government Senior Secondary School Yandaki | 87 | 24 | 111 |
| 19. | Government Secondary School Girka | 18 | 10 | 28 |
| 20. | Government girls senior secondary school jibia | - | 58 | 58 |
| | **TOTAL** | **2,812** | **1,156** | **3,968** |

**Source: (Katsina State Ministry of Education, 2018)**

**Sample and Sampling Technique**

In this study, a total number of 91 students from a Senior Secondary School was selected. To select the sample of students, purposive sampling technique was used, in this study, three arms of science student (SS II A, B and C) were identified in the school. From which intact class of SS IIA for male and female students offering Physics were selected for use in the study. The school was sampled using simple random sampling technique. To select the sample school, the names of the seventeen co-educational public senior secondary schools were written on pieces of paper, squeezed and put in a container and one piece of paper was picked at a time by the researcher.

**Table 3: Sample of the Study.**

| SN | GROUPS | STATUS | NO |
|---|---|---|---|
| **1** | **A** | Male | 39 |
| **2** | **B** | Female | 52 |
| **TOTAL** | | | 91 |

**Instrumentation**

**Motion Concept Performance Test (MCPT)**

The instrument was developed from the past WAEC, NECO and JAMB questions by the researcher to assess the Academic Performance and Retention of students in Motion concepts. WAEC, NECO and JAMB past questions were adopted; reason being the most standardize questions that undergo rigorous checking. The Performance test was based on the objectives of the topics selected as stated in the Senior Secondary school Physics syllabus. The test items were made up of forty-five (45) multiple choice test items each with four alternatives (A-D). The questions cover all three levels of Bloom (1956) taxonomy. Namely: Cognitive; Knowledge, Comprehension, Application. Detail distribution of the items is presented in Table 3.3.

**Table 4: Item Specification for MCPT Based on Bloom Taxonomy of Cognitive Domain**

| SN | Content | Kn | Cn | A | Total |
|---|---|---|---|---|---|
| 1 | Description of motion | 4 | 3 | 0 | 7 |
| 2 | Speed, Velocity and Acceleration | 3 | 3 | 3 | 9 |
| 3 | Equations of motion | 2 | 2 | 6 | 10 |
| 4 | Projectile motion | 3 | 3 | 1 | 7 |
| 5 | Simple Harmonic motion | 3 | 1 | 2 | 6 |
| 6 | Newton law of motion | 2 | 2 | 2 | 6 |
| **Total** | | **17** | **14** | **14** | **45** |

**Key: Kn (knowledge); Co (comprehension); Ap (application).**

**Data Analysis Procedure**

The research question was answered using data collected and analysed using descriptive statistics in form of mean and standard deviation, while the null hypothesis was tested using t-test statistic using data of Posttest performance score of students in Male and Female groups.

**Result and Discussion**

**Research Question:** What is the difference mean Academic Performance between male and female students taught Physics using Concept Mapping? Here, mean and standard deviation of post-test academic performance of male and female students were compared. The detail of the result is presented in the table below

**Table 5: Mean and Standard deviation of Academic Performance Scores of Male and Female Students**

| Variable | N | Mean | Standard Deviation | Mean difference |
|---|---|---|---|---|
| Male | 39 | 31.79 | 7.51 | -0.06 |
| Female | 52 | 31.85 | 7.11 | |

The Table 5 revealed that the mean academic performance score of male students is 31.79, and standard deviation of 7.51 is observed. Female students in the same group have a mean score of 31.85 with standard deviation of 7.11. This shows that both male and females students taught motion concepts using concept mapping Strategy have almost similar mean academic score in their posttest.

**HO:** There is no significant difference in the mean Academic Performance of male and female Students taught Physics using Concept Mapping.

**Table 6: Summary of t-test Analysis of Academic Performance Scores of the Male and Female Students**

| Variable | N | Mean | S.D | Df | t-value | p. | Decision |
|---|---|---|---|---|---|---|---|
| Male | 39 | 31.79 | 7.51 | | | | |
| | | | | 89 | 0.033 | 0.974 | Not Significant |
| Female | 52 | 31.85 | 7.11 | | | | |

***Not Significant as p > 0.05 level of significance**

From the results in the Table 6, it is observed that the t-value of 0.033 is obtained and the p-value observed is 0.974 at the degree of freedom of 89. The critical p-value of 0.974 is greater than the alpha value of 0.05. This shows that there is no significant difference. A no significant difference implies retaining of null hypothesis and rejecting alternate hypothesis. The null hypothesis that states that there is no significant difference in the academic performance of male and female students exposed to concept mapping strategy in motion concepts is retained.

## Discussion

From the result in Table 5 and 6 revealed that there is no significance difference in the academic performance of male and female students exposed to concept mapping strategy in motion concept. This is attributed to the fact that during instruction using concept mapping, both male and female students were very active in discovering concepts on motion and associating these concepts with others. By showing relationship between the concepts. In this process students in their heterogeneous groups are able to utilize their critical thinking and communication skills which leads to a better retention of the learnt concept. This finding is in harmony with those of authorities such as Karakuyu (2010), Aina (2013), Bello (2015), Ajai and Imoko (2015) and Danjuma (2016) who in their separate studies in various discipline found that the application of instruction treatment on a mixed gender school population improves the academic performance of students irrespective of gender. The finding of Karakuyu (2010) revealed that there is no significance difference in the performance of gender in Biology due to exposure to concept mapping strategy. Similarly, Bello (2015), further supports the assertion in his study on impact of computer-assisted instruction and Enriched lecture method on interest and performance in physics which shows that male and female students exposed to computer-assisted instruction and Enriched lecture method have no gender difference. In addition, Ajai and Imoko (2015) opines that problem-based learning method enhances academic performance of students in spite of their gender.

## Conclusion

Based on the findings from this study, it is concluded that Students taught Motion concept using Concept Mapping strategy performed better in spite of their gender.

## Recommendations

Concept Mapping Strategy was found to be gender friendly since both gender showed improving Academic Performance as a result Teachers should be encouraged to use Concept Mapping

instructional strategy in teaching Physics through adequate and frequent supervision as well as reward by the ministry of education.

## REFERENCES

Atadoga, M.M & Lakpini, M.A (2013) A Comparison of Numeracy Achievement of Primary School Pupils Taught using Whole Class and Varied Classroom Organization Instructions. *Proceedings of Multicultural African Conference, Held at Faculty of Education, Ahmadu Bello University, Zaria.*

Ajai, J. T. Imoko, B.I. and O'kwu, E.I. (2013) Comparison of the Learning Effectiveness of Problem-Based Learning (PBL) and Conventional Method of Teaching Algebra. *Journal of Education and practice*, 1(4), 234-243.

Ausubel, D.P., Novak, J.D., & Henesain, H. (1978) *Educational Psychology: A Cognitive. View* (2nd Ed.). NewYork, NY: Holt, Rinehart and Winston.

Ausubel, D.P. (1978) *Educational Psychology: A Cognitive View* (2nd Ed.). New York, NY: Holt, Rinehart and Winston.

Ausubel, D.P. (1968) *Education Psychology. A Cognitive View*. New York. Holt, Rinehart and Winston Inc.

Atovigba, M. V., Vershima, M. A., O'Kwu, E. I., & Ijenel, E. (2012) Gender Trends in Nigeria Secondary School Students' Performance in Algebra. *Research Journal of Mathematics and Statistics,* 4(2), 42-44

Aina, J. K. (2013) Gender Analysis of Students Academic Performance in Physics Practical in Colleges of Education, Nigeria. *Advance in Arts, Social Science and Education Research,* 3(5), 447-452

Ajai, J. T. & Imoko, B. I. (2015) Gender difference in Mathematics Achievement and Retention Score: A Case of Problem-based Learning Method. *International Journal of Research in Education and Science (IJRES),* 1(1), 45-50

Bello, M. (2015). *Impact of Computer-Aided Instruction and Enriched Lecture Method on Interest and Academic Performance in Physics among Secondary School Students, Zaria Nigeria*.Unpublished M.Ed. theses, Department of Science Education, Faculty of Education, Ahmadu Bello University, Zaria-Nigeria.

Cakir, M. (2008) *Constructivist approach to learning in science and their implication for science pedagogy*: A literature review. Retrieved from: http://www.ijese.com/IJESE_v3n4_ Cakir. Pdf

Canas, A. J., & Novak, J. D. (2008) *The theory underlying concept maps and how to construct and use them.* Technical report IHMC Cmap tools 2006-01 Rev 01-2008 Institute of Human and Machine Cognition, Florida.

Danjuma, A.B., (2016) *The Perception of Physics Teachers and Students on Physics Education for Economic Empowerment and Development in Niger State*. Paper Presented at School of Science, Niger State College of Education.

Federal Republic of Nigeria (2013) *National Policy on Education Revised*, Abuja: Federal Ministry of Education.

Imoko, I.B. (2005) *Effect of concept mapping on students' achievement and interest in trigonometry*. Unpublished Ph.D thesis, University of Nigeria, Nsukka.

Imoko, I.B. & Agwagah, U.N.C. (2006) Improving students' interest in Mathematics through the concept mapping technique: A focus on gender. *Journal of Research in Curriculum and Teaching 2(1), 120-127*

Josiah M.M. (2012) School Location versus Academic Achievement in Physics: Does Computer-Assisted Instruction (CAI) Has Any Effect? *Journal of Educational and Social Research, 2(8), 12-18.*

Kinchin, I. M. (2005) Writing to be Published or Writing to be Read. *Journal of Natural History* 39, 3229-3233

Kyei, I., Apam, B.K. & Nokoe, K. S. (2011) Some gender differences in performance in senior high mathematics examinations in mixed high schools. *American journal of Social and Management Science* 12(3), 2156-2160.

Katsina State Ministry of Education. (2018) Annual Bulletin Published by the Ministry.

Karakuyu, Y. (2010) Effect of Concept Mapping on Attitude and Achievement in a Physics Course. *International journal of the Physical Sciences* 5(6), 724-737.

Nwezi, U, M. (2010) *It's all in the Brain of Gender and Achievement in Science and Technology Education*. 51st Inaugural Lecture of the University of Nigeria, Nsukka.

Novak, J. D. (1990) Concept Mapping: A useful tool for Science Education. *Journal of Research in Science Teaching,* 58(7)

Novak, J.D. (2008) *Concept Maps*: What the heck is this? Retrieved from: https://www.msu.edu/-luckie/ctools/

National Examination Council (2016). *Regulations and Syllabuses for Senior Secondary Certificate Examination (SSCE) for Candidates in Nigeria*. Minna.

Ogundokun M.O & Adeyemo D.A. (2010) Emotional Intelligence and Academic Achievement: The Moderating Influence of Age, Intrinsic and Extrinsic Motivation. *The African symposium,* 10(2), 127-141.

Obeka, S.S (2014) *Repositioning Education Through Innovative Teaching on Academic Performance in Practical Geography at Senior Secondary School Examination in North Central Nigeria.* Faculty of Education Conference Proceeding.

Shafiq, H. (2013) *Effects of Gender on Algebra, Geometry, and Trigonometry Performance in Public New York State High School in Grades 9-12*. Doctoral dissertation, Columbia University.

The West African Examination Council (2016) *Regulation and Syllabuses for West Africa Senior School Certificate Examination (WASSCE)* Abuja. Federal Government press.

Uzoka, F. A. (2012) *Challenges and prospects in nursery school education and early childhood education in Nigerian education for teacher production*. Unpublished paper, Federal College of Education (T), Asaba-Delta state.