GENDER PERFORMANCE AND ATTITUDE TO CONCEPT-MAPPING AMONG SENIOR SECONDARY SCHOOL BIOLOGY STUDENTS IN ZARIA, NIGERIA

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Abstract
Gender Performance and Attitude to Concept-mapping among Senior Secondary School Biology Students in Zaria, Nigeria was investigated in this study. Quasi-experimental design without control group was adopted. A sample of 162 students in intact classes from three co-educational schools were randomly drawn from the population of 5956 students. Sample comprised 80 males and 82 females. Circulatory system was taught for a period of six weeks. The three experimental groups were taught using Concept Identifying, Proposition Identifying and Student Generated Concept-mapping strategies respectively. The two instruments used for data collection were fill-in-the-map Concept-mapping Tests and a questionnaire titled Attitude of Students towards Concept-mapping Strategies (ASCSQ). Instruments were accordingly validated by experts. ASCSQ had reliability coefficient of 0.70 while Inter-Rater Reliability (IRR) for scoring the Concept Identifying, Proposition Identifying and Student Generated Concept-mapping Tests were 0.80, 0.60 and 0.80 respectively. Two research questions were answered using means and standard deviations while two null hypotheses were tested at P≤0.05 with Analysis of Variance and Kruskal Wallis using SPSS version 22. Result revealed that gender has no significant impact on Biology students' understanding of the three Concept-mapping Strategies (P =0.346>0.05). Also, P = 0.087 > 0.05 indicate a no significant difference in the attitude of Biology students towards Concept-mapping strategies. Based on these findings, it was recommended among others that fill-in-the-maps made from expert/teacher concept-maps should be adopted by Biology teachers in assessing students' knowledge in concept-mapping.

Keywords: Concept-mapping Strategies, Gender Performance, Attitude, Assessment tool, Secondary School, Biology Students

Introduction
Gender is the division of people into two categories: male and female. Through interaction with caretakers, socialization in childhood, peer pressure in adolescence, gendered work and family roles, women and men are socially constructed to be different in behaviour, attitudes and emotions (Gbadamosi, 2013). The sources of gender differences in educational outcomes have been a subject of considerable study and debate. One particularly contentious issue involves the possible role played by biological differences between males and females. The issue of gender differences is paramount to educational researchers nowadays. There have been divergent views and reports as to the comparative ability of male and female in human endeavours especially in education. In educational circles there exists a widespread assumption that the transmission of knowledge is by and large free of gender bias and that in coeducational institutions of learning, girls and boys receive equal educational opportunities (Faulkner, 2012). However, review of other relevant work shows gender disparity in science particularly in sub-Saharan Africa (Sinnes, 2004; Benjamin, 2015).

Sinnes (2004) in an extensive work on gender equity in science education identified potential explanations to gender inequity in sub-Saharan Africa. These factors include biological differences between boys and girls, poverty, socio-cultural expectations, differential self confidence in science, attitudes and interest, identity formation and gender insensitive science education. Other research findings have also alluded to these factors (Bryan & Varat, 2008; AAAS, 2014; Benjamin, 2015). In other words, gender intervenes in the normal relationship between competence in a subject matter, on one hand, and one's self-confidence in one's ability to master the subject on the other (Cislak, Formanowicz & Saguy, 2018). Boys are given the chance of playing a more active part in the learning process than girls, but it is now starting to dawn on educators that girls' abilities and potentials are not being fully developed and that more particularly those skills needed for a functioning work force in Science, Mathematics and Technology were being neglected (AAUW-Report, 2016; UNESCO, 2017).

Novak (2013) defined Concept Mapping as a graphical representation of the hierarchical relationship among concepts and propositions. He further described the various characteristics of a concept map to include the nodes (which takes the shape of a circle, square or rectangle) representing concepts. He defined a concept as a perceived regularity (or pattern) in events or objects, or records of events or objects designated by a label. When the nodes are joined together with appropriate one-way, two-way, or non-directional links or lines accompanied with linking words that explain the relationships among the nodes. Propositions consist of two or more concepts connected using linking words to form a meaningful statement (Canas & Novak, 2012). Finally, an important feature of a Concept map is its hierarchical structure. The hierarchical structure of a concept map places the most general, highly inclusive concepts at the top with the more specific, less generalized concepts arranged appropriately in a lower position. Concept-mapping strategies are not limited to Teacher Generated or Student Generated. Additionally, there are different variations which include expert generated, fill-in-the-map and cooperative concept-mapping strategies (Wang & Dwyer, 2006). Novak (2011) reported that Expert Generated maps are more accurate representations of the nature and organization of information than Teacher/Student Generated maps and it reduces the possibility that students may process information in a random or haphazard way. The expert map is used as a scaffold that helps learners to attain higher levels of performance. Fill-in-the-map is a strategy that combines scaffolding instruction with the principles of completion strategy proposed by Van-Merrienboer (1990) in concept-mapping. Provision of partial solutions of tasks is the rationale behind this strategy. Studies (Wang & Dwyer, 2006; Soleimani & Nabizadeh, 2012; Anohina-Naumeca, 2014; Nuru, 2018) have found out that scaffolding instruction combined with completion strategy enhances students learning ability and the degree of transfer of knowledge. The fill-in-the-maps used for learning and assessment in this study: Student Generated Mapping Strategy (SGMS), Concept Identifying Mapping Strategy (CIMS) & Proposition Identifying Mapping Strategy (PIMS) were designed and used based on the combination of Scaffolding instruction and Completion strategy.

Attitude can be defined as feelings, beliefs and values held about the enterprise of school science and the impact of science on society (Hacieminoglu, 2016). Research on attitude has gained a lot of attention in the realm of science education especially from the perspective of teaching and learning. While students negative attitudes towards science are related to traditional and didactic teaching method, their positive feelings are associated with constructivist science classrooms. Classroom environment, use of variety of innovative teaching and learning techniques which are student centered have been reported to have enhanced

students attitude positively (Akcay, Yager, Iskander & Turgut, 2010). Several studies (Osborne, Simon & Collins, 2003; Anwar & Bhutta, 2014; Hacieminoglu, 2016; Tyler & Osborne, 2017) also indicate that the influence of classroom environment and teaching pedagogies are significant determinants of attitude of students toward science. This research also intends to determine the attitude of students towards the three concept-mapping strategies used for instruction. The current study will provide teachers with empirical evidence to draw conclusions concerning the effectiveness of concept-mapping as an assessment tool in secondary school biology and also for determining gender disparity and attitude of students towards concept-mapping use in Nigeria.

Statement of the Problem

Studies have shown that gender intervenes in the normal relationship between competence in a subject matter and self-confidence in one's ability to master the subject. This highlights the need to determine if gender differences will occur in the performance of boys and girls and their abilities to construct concept maps as they study together with the three concept-mapping strategies. Although there are various scoring methods available for researchers to utilize (Novak & Gowin, 1984; Lomask, Baron, Greig & Harrison, 1992; Koul, Clariana & Salehi, 2005; Kinchin, 2006, among others), many of the concept-mapping studies do not involve the evaluation of concept maps. Most often, the concept maps are used as a learning strategy and the final assessment of student achievement is a criterion-referenced post-test. This does not reflect the true picture of students performance in the actual concept-mapping activity. There is the need therefore to determine students rubric performance. Literatures indicate vast number of studies on the effectiveness of concept-mapping in Nigeria (Alebiosu & Micheal, 2011; Ojebiyi & Salako, 2013; Arokoyu & Obunwo, 2014; Sakiyo & Waziri, 2015; Onuoha, Ejimonye, Eneogu & Ugwuanyi, 2016), but there have been little or no specific studies on the use of concept-mapping strategies to determine gender performance and attitude of secondary school biology students. Further research into this area is justified.

Research Questions

The following research questions were formulated to guide the conduct of the study:

(i) What is the difference between the mean rubric scores of male students and that of their female counterparts in understanding the three Concept-mapping strategies among Senior Secondary School Biology students in Zaria Education Zone?

(ii) Is there any difference in the attitude of students taught Biology using Concept-Identifying, Proposition-Identifying and Student-Generated Concept-mapping strategies in Zaria Education Zone?

Null Hypotheses

The following null hypotheses were postulated to guide this study at $P \leq 0.05$:

HO_1: There is no significant difference in the mean rubric scores of male students and that of their female counterparts in understanding the three Concept-mapping strategies among Senior Secondary School Biology Students in Zaria Education Zone.

HO_2: There is no significant difference in the attitude of students taught Biology using Concept-Identifying, Proposition-Identifying and Student-Generated Concept-mapping Strategies.

Methodology

The design for this study was quasi-experimental study. The population of the study involved all SS II Biology students from twenty-seven public senior secondary schools in Zaria Education Zone (5956) with average age range of 17 years as at 2016. From the twenty-seven senior secondary schools in the population, nine co-educational schools were selected by balloting and pretested using Concept-mapping Tests. The results of the pretest were subjected to one-way ANOVA, then Scheffe's test. From the result, five schools did not differ in their mean scores. From the five schools, three schools were randomly selected by balloting. The sample size of 162 SS II Biology students drawn from an intact class each in the three co-educational schools comprised 80 males and 82 females. Four Science Education experts from Ahmadu Bello University, Zaria validated the two instruments used for this study: Concept-mapping Tests (adapted from Dosanjh, 2011) and a questionnaire titled Attitude of Students towards Concept-mapping Strategies Questionnaire (ASCSQ) adapted from Mutodi and Chigonga (2016). A pilot study was done to determine the inter-rater reliability of scoring the concept-maps and reliability of ASCSQ. The researcher and one of the experienced Secondary School Biology teachers, from one of the sampled schools scored six concept maps together (two of each type) to calibrate the scoring. All maps created by the subjects were evaluated using a scoring instrument created by Lomask, Baron, Greig and Harrison (1992). Subsequently, each scorer individually scored five of the same Concept Identifying, Proposition Identifying and Student Generated concept maps. Cohen's Kappa was used to calculate Inter-Rater Reliability (IRR) to be 0.80 for Concept-Identifying, 0.60 for Proposition-Identifying and 0.80 for Student-Generated maps. Split-half method was used for reliability of ASCSQ. Spearman rank correlation was used to determine the coefficient value of 0.70 which made the instrument reliable for data collection in this study.

All participants in the three experimental groups of students in intact classes made up of 51 for SGMG, 50 for CIMG and 61 for PIMG received one week (one-hour, twenty minutes each day) of their respective Student-Generated, Concept-Identifying or Proposition-Identifying concept-mapping training by the researcher. The training includes an introduction to concept-mapping, guided practice, independent practice and feedback on the concept maps. Treatment was done by teaching circulatory system topic by the researcher and students constructed their respective concept maps for six weeks in all sampled schools. Concept maps were scored and feedback was given to students at the end of every lesson. Data was collected by administering the fill-in-map circulatory system Concept-mapping Tests for CIMG and PIMG while students in SGMG constructed their maps at the end of the study. The ASCSQ was also administered. Frequency, simple percentages, means, standard deviation, ANOVA and Kruskall Wallis were used to test the null hypotheses at $P \leq 0.05$ using SPSS version 20.

Results

Research Question One: What is the difference between the rubric scores of male students and that of their female counterparts in understanding the three Concept-mapping strategies among Senior Secondary School Biology students in Zaria Education Zone?

To answer this research question, the rubric scores of students exposed to SGMS, CIMS and PIMS were sorted out according to gender and subjected to descriptive statistics. Means and SD were computed and presented in Table 1.

Table 1: Means and SD of rubric scores of male and female students taught Biology with SGMS, CIMS and PIMS

	Male		Female		
EGs	**Mean**	**S. D**	**Mean**	**S. D**	**MD**
SGMG	2.52	0.67	3.18	0.84	0.66
CIMG	3.54	0.86	3.23	0.69	0.31
PIMG	2.41	0.55	2.95	0.49	0.54

Results presented in Table 1 indicate that male students in the Student Generated Mapping Group (SGMG) had mean rubric scores of 2.52±0.67 while that of the female students was 3.18±0.84, for students in Concept Identifying Mapping Group (CIMG) the mean rubric scores are 3.54±0.86 and 3.23±0.69 while in Proposition Identifying Mapping Group (PIMG) the mean rubric scores are 2.41±0.55 and 2.95±0.49 for males and females respectively. The scores showed that both male and female students in CIMG group had the highest mean rubric scores. The significance of the observed variability was tested in the related hypothesis.

Null Hypothesis One

There is no significant difference in the mean rubric scores of male students and that of their female counterparts in understanding the three Concept-mapping strategies among Senior Secondary School Biology Students in Zaria Education Zone.

To test this hypothesis, the mean rubric scores of males and females in the three concept-mapping strategies were subjected to ANOVA. A summary of the result is presented in Table 2.

Table 2: Summary of analysis of variance on mean rubric scores of male and female students taught Biology with SGMS, CIMS and PIMS

Source	**Sum of Squares**	**df**	**Mean Square**	**F**	**p-value**	**Remark**
Concept-mapping Strategies (EG)	12.41	2	6.21	12.59	.000	S
Gender	.059	1	.059	.12	.729	NS
EG * Gender	1.05	2	.527	1.07	.346	NS
Error	76.94	156	.493			
Corrected Total	90.72	161				

*Significant at P≤ 0.05 level

From the observed F-values of 0.12 and 1.07 obtained at 1, 2 and degree of freedom 156 in the test, the variability between the means could be considered not to be statistically significant. The observed probability level of significance for gender (0.729) and the interaction between concept-mapping strategies and gender (0.346) was not significant at 0.05 level of significance. By these observations, the null hypothesis one was therefore retained.

Research Question Two: Is there any difference in the attitude of students taught Biology using Concept-Identifying, Proposition-Identifying and Student-Generated Concept-mapping strategies in Zaria Education Zone?

To answer this research question, data from ASCSQ of students exposed to SGMS, CIMS and PIMS were subjected to descriptive statistics. Means ranks were computed and presented in Table 3.

Table 3: Summary of mean ranks of attitude of senior secondary students taught Biology with SGMS, CIMS and PIMS

Variable	N	Mean Rank
SGMG	51	64.4
CIMG	50	65.5
PIMG	61	62.1

Table 3 presents the summary of mean ranks of attitude of biology students towards the concept-mapping strategies. Students taught with SGMS had a mean rank of 64.4, CIMS had a mean rank of 65.5 while PIMS had a mean rank of 62.1. This indicate a positive attitude of all sampled students towards concept-mapping strategy. Significance of the difference in mean ranks was further tested with Kruskall Wallis.

Null Hypothesis Two

HO_2: There is no significant difference in the attitude of students taught Biology using Concept-Identifying, Proposition-Identifying and Student-Generated Concept-mapping Strategies.

To test this hypothesis, the mean ranks of attitude of students taught Biology with the three concept-mapping strategies were subjected to Kruskall Wallis statistics. A summary of the result is presented in Table 4.

Table 4: Summary of Kruskall Wallis (H-Test) analysis of Biology students attitude towards SGMS, CIMS and PIMS

Source	N	Mean Rank	Chi-Square	df	Sig.	Remark
SGMG	51	62.4				
CIMG	50	65.5	5.99	2	0.087	NS
PIMG	61	60.1				

NS: Not Significant at P > 0.05 level

Results in Table 4 shows that at 0.05 level of significance, the P value obtained (P = 0.087 > 0.05) was greater. By these observations, the null hypothesis two was therefore retained. This indicate that the positive attitude exhibited by learners is not significantly different across the three concept-mapping strategies.

Discussion

Significant difference in the mean rubric scores obtained by male and female students taught using the three concept-mapping strategies was tested in null hypothesis one. The result of the ANOVA procedure used in the test revealed that the male and female students did not differ significantly in their rubric scores. The null hypothesis that there is no significant difference in the mean rubric scores of male students and that of their female counterparts in understanding the three Concept-mapping strategies among Senior Secondary School Biology students in Zaria

Education Zone was therefore retained. This result revealed that gender may not play a significant role on the level of understanding of the three concept-mapping strategies (P =0.346>0.05). The male and female students did not differ significantly in their ability to construct concept maps in Biology. This finding is similar to Onuoha *et al.,* (2016) who investigated the effect of concept-mapping instructional strategy on students' achievement and interest in Economics in Secondary Schools in Enugu Education Zone, Nigeria. Their findings revealed no gender effect, even though the experiment was on academic performance rather than rubric scores. Result is also similar to Sakiyo and Waziri (2015) who carried out a study to investigate the use of concept-mapping teaching method on secondary school Biology students' academic achievement in Adamawa state. one-way Analysis of Covariance (ANCOVA) revealed that there was no significant difference in the performance between male and female students in the experimental group using pre and post-tests. This study is in contrast with Chawla & Singh (2015) who noted that girls have been found to be more concerned than boys about their academic achievement in concept-mapping and participate more in professional growth activities.

In test of hypothesis two of this study, the difference in mean ranks of biology students taught with SGMS, CIMS and PIMS were tested with Kruskall Wallis at $P \leq 0.05$ level. The value $P = 0.087 > 0.05$ indicate a no significant difference in the attitude of biology students towards concept-mapping strategies. The null hypothesis that there is no significant difference in the attitude of students taught Biology using Concept-Identifying, Proposition-Identifying and Student-Generated Concept-mapping Strategies in Zaria Education Zone was therefore retained. Result obtained is similar to Alebiosu and Michael (2011). Their study on the effectiveness of using concept maps in improving the attitude of Senior Secondary students to Physics in Ibadan, Nigeria involved a pretest-posttest, control group quasi-experimental design. Findings showed that concept-mapping method had significant main effect on students' attitude ($F (2, 90) = 30.251$, $P < 0.05$) implying that using concept maps was more effective in improving students' attitude towards physics. Studies of Akcay *et al.,* (2010), Anwar & Bhutta (2014) & Hacieminoglu (2016) have also alluded to the fact that innovative teaching strategies enhances students attitude positively.

Conclusion

This study revealed that gender has no significant impact on biology students' understanding of the three Concept-mapping Strategies (such as Concept-Identifying, Proposition-Identifying and Student-Generated) at the Senior Secondary school level. Besides the traditional assessment strategies such as multiple choice tests, it was also established that Fill-in-the-Map Concept-mapping Tests may be a unique additional measure of students' performance when teaching with concept-mapping strategy. Analyzing concept maps for accuracy can provide teachers with more complete information regarding students' knowledge. More so, most of the sampled students used in this study agreed that fill-in-the-map concept-mapping tests can be used as assessment tools for learning.

Recommendations

The following recommendations were made:

(i) Fill-in-the-maps made from expert/teacher concept-maps should be adopted by biology teachers in assessing students' knowledge in concept-mapping. The expert map serve as a scaffold that helps learners to attain higher levels of performance.

(ii) Biology teachers should adopt Concept-mapping strategy since it facilitates the integration of concrete concepts into an abstract framework thereby benefitting both male and female students.
(iii) Biology teachers should also adopt Concept-mapping strategy since it enhances biology students attitude positively.

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