INDIVIDUALIZED CONCEPT MAPPING INSTRUCTIONAL STRATEGY AND ACHIEVEMENT OF SECONDARY STUDENTS IN PERCEIVED DIFFICULT BIOLOGY CONCEPTS

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Abstract
This study investigated the effect of Individualized Concept- Mapping Instructional Strategy (ICMIS) on the Achievement of Senior Secondary Two (SS2) Students in Perceived Difficult Biology Concepts. The aim of the study was to identify the biology concepts students perceived as difficult and to determine the effects of ICMIS on the mean achievement scores of students in the perceived difficult biology concepts. The study was guided by three research questions and three hypotheses. The study adopted a non-randomized Pretest- Posttest Quasi-experimental design. The sample was 179 SS2 biology students selected from two schools from the nine education zones in Taraba State using a multi-stage sampling technique. Intact classes were assigned to the experimental and control groups. Data was generated using Perceived Difficult Biology Concepts Inventory (PDBCI) with a Cronbach's Alpha coefficient of 0.76 and Biology Achievement Test (BAT) with KR_{20} of 0.87. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 alpha level of significance. The findings revealed that students exposed to ICMIS attained significantly higher mean achievement scores in BAT than those exposed to Conventional Teaching Strategy (F=10.08, p=0.01). In addition, male and female students taught using ICMIS did not differ significantly in achievement (F=0.39, p=0.53). There was also no significant interaction between strategies and gender (F=0.02; p=89). Based on these findings, the study recommended among others that biology teachers should use ICMIS to teach students perceived difficult biology concepts.

Keywords: Individualised concept mapping, achievement in Biology, difficult concepts, gender, Interaction effect

Introduction

The quality and quantity of science education received by secondary school students are geared toward developing future scientists, technologists, engineers, and related professionals. It thus appears that for a nation to develop in science and technology, the teaching and learning of biology needs to be improved (Umar, 2011). However, this seems not to be the case in Nigeria as several research works had recorded rather low students' achievement in biology and other science subjects (Achor & Agbidye, 2014; Pektas, 2014; Samba & Eriba, 2012; & David, 2018).

Ahmed and Abimbola (2011) lament that the achievement of students in biology for more than twenty-five years has been persistently poor in public examinations such as the West African Examinations Council (WAEC) and National Examination Council (NECO). Ahmed (2008) fears that the low achievement of students in science subjects at secondary school level poses danger as it could lead to Nigeria not having enough science and technology-related disciplines teachers in the long run.

Adegun and Adegun (2013) attributed students' poor achievements in sciences to poor teaching methods which fail to inspire students' learning. The authors add that the lack of understanding of science concepts results in students finding such concepts difficult to learn. Such difficult concepts are capable of causing students' poor achievement in examinations.

Many researchers agree that there is a demand for a shift in the rethinking of curriculum content and ways in which students are taught (Adeyemi, 2008; Kolawole, 2007; Johnson & Johnson, 2006;Okeke, 2007). It can be deduced from the authors' submissions that the uninspiring teaching strategies adopted by science teachers have led to under-achievement of students in science subjects, including biology. These studies show that teachers shy away from activity-oriented teaching methods and rely heavily on methods that are easy but most inadequate and inappropriate for teaching many science concepts at secondary school level. Kolawole (2007) argues that while the conventional traditional methods may be adequate for the teaching of humanities, it is quite inappropriate for the teaching of science and calls for a shift to methods that will enable the learners develop and acquire skills essential for scientific and technological development. This, Kolawole suggests, is likely to improve the students' understanding of science concepts which could lead to improving their achievements in external examinations. This new trend which is child-centered has led to the development of various instructional strategies, amongst which are; discovery learning, hands- on, minds- on, inquiry, cooperative or collaborative learning and concept mapping, amongst others.

Concept maps are graphical or pictorial arrangements that deal with a specific subject matter. They are useful tools in representing the structure of knowledge in a form that is psychologically compatible with the way in which human beings construct meaning. Novak and Gowin (2008) demonstrated that, the label for most concepts is a single word, although sometimes symbols such as + or % are used. The core element of a concept mapping is a proposition, which consists of two or more concepts connected by a labeled link. A Concept map is, as also viewed by Soika, Reiska, and Mikser (2012), a collection of propositions which is constructed in a certain way; it expresses graphically structured meaningful relationships which exist between different concepts.

The instructional procedure of Concept mapping can be done individually which is Individualized Concept mapping Instructional Strategy (ICMIS), or collaboratively, being Collaborative concept mapping Instructional Strategy (CCMIS). An individual concept map (ICM) is a visual representation of a student's knowledge structure on a particular concept as constructed by himself. In addition, ICM brings in light the individual differences in learning as different people usually generate different concept maps even on the same subject area (Broggy, 2009). Each individual concept map is therefore unique due to each person's own experience. Since the use of concept maps involves strategies like symbolizing, cataloguing, structuring and visualizing, they can assist individual learners construct their own conceptual structures of any scientific phenomena, including perceived difficult concepts. A number of research projects have been conducted on individualized concept mapping; (Ausubel 1962; Novak, 2008; Kinchin, 2014)among others. More specifically, the literature does not fully address the influence of individualized concept mapping on students' achievement in difficult biology concepts. The researcher faced with the speculative knowledge of the alluring potential of individualized concept mapping instructional strategy and noting the paucity of empirical research using the individualized concept mapping instructional strategy in the study area (Taraba State), decided to undertake this study on the relative effect of Individualized Concept Mapping Instructional Strategy on the Achievement of Senior Secondary 2 Students in Perceived Difficult Biology Concepts.

Perceived Difficult biology concepts are those concepts in biology which the students are not finding easy to learn. Study reports indicate that students generally experience difficulties in sciences including biology which most students consider simple because of its low mathematical content (Adeyemi, 2005; Umar, 2011; WAEC, 2011). Certain scientific concepts have been tagged 'difficult concepts' simply because either the teachers find them difficult to teach or the learners find them difficult to learn. This implies that the students lack the framework to deepen their understanding of these concepts. It is an observed fact that some concepts in biology curricula are very difficult for students to comprehend. Some of the concepts include homeostasis, genetics, evolution, nervous co-

ordination, ecology, cellular respiration, photosynthesis among others (Okebukola, 2005; Taylor, 2006; Samba & Eriba, 2012).

The focus of the current study therefore was to determine, through the views of the students in a pre-survey inventory, the biology concepts that both male and female secondary school students have the most difficulties learning and understanding, and the strategies or methods that can make biology learning more effective.

It appears that influence of gender and students' perception of difficult concepts in biology is still controversial and inconclusive. This controversy further underscores the need for this study, to find out the effect of individualized concept mapping instructional strategy on the achievement of male and female senior secondary school students in difficult biology concepts.

Statement of the Problem

Various methods and strategies like discovery, questioning, field trips, lecture, discussion, cooperative learning, concept mapping and problem solving have been used in teaching biology yet, poor achievement seems to persist among secondary school students in the certificate examinations throughout the country. This has denied many Nigerian students the opportunity of getting admitted into institutions of higher learning. There are therefore complaints from parents, teachers, curriculum planners and other stake-holders in the educational industry about the deteriorating achievements of students in both internal and external examinations in Nigeria.

Certain perceived difficult biology concepts identified by students in a pre-survey of this study have also been identified by other researchers as contributing to students' poor achievements in biology. Although educators have advocated the use of some of the innovative strategies in teaching difficult biology concepts, there is dearth of research based information on the use of individualized concept mapping strategy to mediate students' perceived difficult concepts in biology. The problem of this study put in question form then is: What is the effect of individualized concept mapping instructional strategy on the achievement of Secondary School two (SS2) students in perceived difficult biology concepts?

Research Questions

The following research questions were raised and answered in the study:

(i) What would be the difference in the mean achievement scores of students taught the same perceived difficult biology concepts using Individualized Concept Mapping Instructional Strategy (ICMIS) and Conventional Teaching Strategy (CTS)?

(ii) What is the difference in the mean achievement scores of male and female students taught perceived difficult biology concepts using Individualized Concept Mapping Instructional Strategy?

(iii) What would be the interaction effect of gender and strategies on the mean achievement scores of students taught the same perceived difficult biology concepts?

Hypotheses

The following null hypotheses (Ho) were formulated and tested at 0. 05 level of significance:

$Ho_{i;}$ There is no significant difference in the mean achievement scores of students exposed to perceived difficult biology concepts using Individualized Concept Mapping Instructional Strategy and Conventional Teaching Strategy.

$Ho_{ii;}$ There is no significant difference in the mean achievement scores of male and female students taught perceived difficult biology concepts using Individualized Concept Mapping Instructional Strategy and Conventional Teaching Strategy.

$Ho_{iii;}$ There is no significant interaction effect of strategies of instruction and gender on the mean achievement scores of students in perceived difficult biology concepts.

Methodology

The quasi-experimental design was used for this study. Specifically, a non-equivalent, non-randomized, control group, involving a pretest- posttest was applied in this study. Quasi-experimental design was considered ideal for this study because participants were already constituted into intact classes hence it was not ethical to randomly select them individually for experimental purposes. Besides, school administrators normally do not allow breaking of classes for random assignment of learners into groups for experimental purposes. An important component of the quasi-experimental study is the use of pre-testing or the analysis of prior achievement to establish group equivalence (Wachanga, Githae & Keraro, 2015). It was not feasible to randomly compose and group students, or to disrupt classes already in existence as the experiment lasted for ten weeks.

Population and Sample

The population of this study was all the 17,761 SS2 biology students in the nine Education Zones of Taraba State. Available data from the Taraba State Teaching Service Board Jalingo (2016/2017) showed that there were 222 secondary schools in the nine education zones of the state that offered biology with a population of 17,761 SS2 biology students.

The sample for the study comprised 179 SS2 biology students in the two schools selected from the nine education zones of Taraba State (Post Primary Schools Management Board (PPSMB) Jalingo (2016/2017) using multi-stage sampling technique. This sample was based on nine intact classes, comprising one class from each of the nine selected schools. At the first stage, purposive sampling technique was used to isolate all the co-education schools offering biology as a subject and with at least one experienced biology teaching staff and a functional biology laboratory. In the second stage, two schools were selected from each zone, using simple random sampling technique of hat and draw, giving a total of eighteen schools from the nine educational zones. Thirdly, the selected schools were respectively randomly assigned to groups, which were one experimental and the other control through hat and draw method. In the fourth stage, simple random sampling technique was used to select one intact SS2 class each from the experimental group, and another class from the control group of the selected schools. The total number of 179 students in the two classes constituted the sample for the study.

The criteria for selecting the schools were based on the following guidelines:
The school must be; (i) a public school;(ii) a coeducational school (with boys and girls);(iii) have at least three periods of biology per week, including a double period; (iv) have presented students for Senior Secondary School Certificate Examination(SSCE) for at least five years; (v) have qualified teachers with at least a B.Sc education degree in biology, with at least 5 – 6 years teaching experience and (vi) have a functional biology laboratory.

Instrumentation

One instrument and a set of lesson plans (intervening instruments), that is, Biology Achievement Test (BAT), were used for data collection. BAT was adapted from West African Examinations Council (WAEC) past examination question papers of within 1988 and 2015. The Biology Achievement Test items were based on West African Examinations Council (WAEC), which are standardized, since the target of the study is to improve the students' achievement at this level. The test consisted of 40 structured multiple choice questions drawn from the concepts of tissue respiration and ecology, which were perceived and identified by students in a pre-survey study to be difficult.

A Perceived Difficult Biology Concept Inventory (PDBCI) pre -survey instrument was designed to get students' feelings concerning the teaching of perceived difficult concepts in biology to SS2 students.The PDBCI was a 31 item inventory (1 per concept) for the 4-Likert scale type of options provided: Very Difficult (VD = 4), Difficult (D = 3), Slightly Difficult (SD= 2) and Not Difficult (ND =1). Thus a mid-value of 2.50 ([4+3+2+1]/4 = 2.50) was considered as difficult whereas below 2.50 was not difficult. Out of the 31 concepts, 9 ecology and tissue respiration concepts were scored above 2.5 and were identified by the SS2 biology students under the reliability testing as difficult.The test items were selected by the researcher based on the senior secondary school biology syllabus.

Validation of Instruments

BAT and the lesson plans used by the researcher in the study were standardized tests. However, since standardized tests do have environmental, regional and sociological sensitivity they were also subjected to a panel of two science education experts in Benue State University, and another biology expert in Taraba State University to determine the face, construct and content validity based on the sub-concepts. They agreed that the test items were quite satisfactory and reflected the comprehensive coverage and structure of the concepts from which they were selected.

Initially 50 items were selected by the researcher. The first four items were rejected by one of the experts, who pointed out that they did not reflect difficult ecology concepts as required. The affected items were replaced with more appropriate options. After validation and psychometric analysis, 40 items survived the scrutiny. A table of specification using Bloom's taxonomy of learning objectives was applied for the 40 achievement test items.

Reliability

A pilot study was carried out to test the reliability of the research instruments and the feasibility of the research design. The pilot school (Government Day Secondary School Ardo-Kola) selected was not among the schools in which the research was carried out. Four research assistants (biology teachers) who participated in the pilot study were trained for one week. The meaning of concept maps, the strategy of "concept mapping", how it should be taught and applied were explained. The details of how and when the instruments were to be administered were also explained to them. In doing this, the researcher encountered some difficulties with the research assistants. They found it difficult to combine this assignment with their regular teaching schedules. However, they spent extra time to overcome this problem.

Kuder (KR_{20}) Richard was used for the Biology Achievement Test (BAT). The reliability coefficient (r) for the achievement test items was 0.87. The instrument was therefore considered reliable for this study, and to have good internal consistency, because according to Pallant (2010), one of the main issues in measuring a scale is the scale's internal consistency reliability, which according to the author, is a measure of how well the items on a test measure the same construct or idea. Pallant affirmed that the alpha coefficients (r) of a scale from 0. 7 upwards is reliable.

Method of Data Collection

During the first week before the commencement of the experiment, the BAT was administered on the sample of 179 in the experimental and control groups for the study as pretest. The main objective of administering the pretest was to ascertain the academic equivalence of the students in the perceived difficult biology concepts before the commencement of the experiment. The tenth week was used for the post-test for all the two groups. The treatment took place once a week in one double period each of 80 minutes. The treatment lasted for a period of ten weeks.

Two groups were used for the study, namely:
Group A: Individualized concept mapping instructional strategy experimental group
Group B: Control group.

Group A was engaged in concept mapping individually. Students were to draw concept maps of the perceived difficult biology concepts following the steps outlined by Samba (2012) adapting from White and Gunstone (2006), for effective construction of concept maps, but on individual bases as presented in the lesson plans.

The control group (B) was taught the same perceived difficult biology concepts as in groups A but were not given any of the treatments. In other words, the control group was not exposed to the ICMIS treatment. The normal conventional teaching strategy of "chalk and talk" was used by their regular class teachers for the lessons in the control group.

Method of Data Analysis
Mean scores and standard deviation were used to answer the research questions, while analysis of co-variance (ANCOVA) was used for testing the hypotheses at 0.05 alpha level of significance, with the pre-test scores as covariates. ANCOVA was used because it removes the initial differences among groups so that the groups could be considered equivalent since intact classes were used (Ali, 2006).

Results
Data analysis and interpretation were done by research question, and corresponding hypothesis.

Research Question 1
What would be the difference in the mean achievement scores of students taught the same perceived difficult biology concepts using Individualized Concept Mapping Instructional Strategy (ICMIS) and Conventional Teaching Strategy (CTS)?

Table 1: Mean Achievement Scores and Standard Deviations of Students in the ICMIS and CTS Groups

Group	N	Pre BAT Scores		Post BAT Scores		Mean Gain
		$\bar{x}$	δ	$\bar{x}$	Δ	
ICMIS	88	11.73	4.12	23.28	8.48	11.55
CTS	91	11.89	5.42	19.77	6.05	07.88
Mean Difference		0.16		3.51		03.67

Table 1 presents the mean achievement scores and standard deviations of students in ICMIS and CTS groups. The table reveals that, at pre BAT, the difference in the mean achievement scores of students in the ICMIS and CTS groups was 0.16 while at post BAT, the difference was shown as 3.51. The mean gain by the ICMIS group was 11.55 while that of the CTS group was 7.88. The difference in the mean gains of the two groups was 3.67, in favor of the ICMIS(experimental group).

Hypothesis 1
There is no significant difference in the mean achievement scores of students taught the same perceived difficult biology concepts using Individualized Concept Mapping Instructional Strategy (ICMIS) and Conventional Teaching Strategy (CTS).

Table 2: Summary of One-Way ANCOVA Report Comparing the Effect of ICMIS and CTS On Students' Achievement in Perceived Difficult Biology Concepts

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	553.19	2	276.59	5.09	0.01	0.06
Intercept	9519.46	1	9519.46	175.45	0.00	0.56
preBAT	0.49	1	0.49	0.01	0.92	0.00
Group	547.15	1	547.15	10.08	0.01	0.06
Error	9549.56	176	54.26			
Total	92824.00	179				
Corrected Total	10102.75	178				

Table 2 presents summary of one-way ANCOVA comparing the effect of ICMIS and CTS on students' achievement in perceived difficult biology concepts. The table shows that $F(1,176) = 10.08$, $p < 0.05$ for the ICMIS and CTM group. With this result, the test statistic was considered to be significant since $p = 0.01 < 0.05$. The null hypothesis which states that there is no significant difference between the mean achievement scores of students taught the same perceived difficult biology concepts using ICMIS and CTS was rejected. The effect size was shown as 0.06 which indicates that students from ICMIS group had an average mean achievement score of 6.00 more than those in CTS.

Research Question 2

What is the difference in the mean achievement scores of male and female students taught the same perceived difficult biology concepts using Individualized Concept Mapping Instructional Strategy (ICMIS)?

Table 3: Mean Achievement Scores and Standard Deviations of Male and Female Students in the ICMIS Group

Gender	N	Pre BAT Scores		Post BAT Scores		Mean Gain
		$\bar{x}$	δ	$\bar{x}$	δ	
Male Students	44	12.55	4.43	22.70	8.38	10.15
Female Students	44	12.00	4.39	23.86	8.63	11.86
Mean Difference		00.55		01.16		-01.71

Table 3 presents the mean achievement scores and standard deviations of male and female students in the ICMIS group. The table shows the difference in the mean achievement scores of male and female students at pre BAT as 0.55. The difference at post BAT is shown as 01.16. The mean gain by the male students is 10.15 while that of the female students is 11.86. The difference in the mean gain of male and female students is 01.71. The results reveal that the female students gained more, and performed slightly better in the post-BAT test than the male students when exposed to the ICMIS.

Hypothesis 2

There is no significant difference in the mean achievement scores of male and female students taught the same perceived difficult biology concepts using Individualized Concept mapping Instructional Strategy (ICMIS).

Table 4: Summary of One-Way ANCOVA Report Comparing the Effect of ICMIS on Male and Female Students' Achievement in Perceived Difficult Biology Concepts

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	31.56	2	15.78	0.22	0.81	0.005
Intercept	5554.90	1	5554.90	75.88	0.00	0.472
PreBAT	2.00	1	2.00	0.03	0.87	0.000
Gender	28.49	1	28.49	0.39	0.53	0.005
Error	6222.34	85	73.20			
Total	53963.00	88				
Corrected Total	6253.89	87				

Table 4 presents summary of one-way ANCOVA report comparing the effect of ICMIS on male and female students' achievement in perceived difficult biology concepts. The table shows that F(1,85) = 0.39 and p = 0.53 for gender. The test statistic was considered not to be significant since p = 0.53 > 0.05. With this result, the null hypothesis which states that there is no significant difference in the mean achievement scores of male and female students taught the same perceived difficult biology concepts using ICMIS was not rejected. The effect size was shown as 0.005 which indicates that the difference in mean achievement scores between gender was 0.5. This is indicative that male and female students equally benefited from ICMIS.

Research Question 3

What would be the interaction effect of gender and strategies on the mean achievement scores of students taught the same difficult biology concepts?

Hypothesis 4

There is no significant interaction effect of strategies of instruction and gender on the mean achievement scores of students in perceived difficult biology concepts.

Table 5:One-Way ANCOVA Report on the Interactive Effect of Gender and Strategies on Students' Achievement in Perceived Difficult Biology Concepts.

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	667.59	4	166.90	3.01	0.02
Intercept	14700.79	1	14700.79	264.74	0.00
PreBAT	39.38	1	39.38	0.71	0.40
Group	575.99	1	575.99	10.37	0.01
Gender	40.89	1	40.89	0.74	0.39
group * gender	1.10	1	1.10	0.02	0.89
Error	9995.46	180	55.53		
Total	127642.00	185			
Corrected Total	10663.06	184			

Table 5 presents one-way ANCOVA report on the interactive effect of gender and strategy on the mean achievement scores of students in perceived difficult biology concepts. The table shows that (1,184) = 0.02, p = 0.89 for interaction. Since p = 0.89 > 0.05, the interaction effect was considered not to be significant. The null hypothesis which states that there is no significant interaction effect of strategies of instruction and gender on the mean achievement scores of students in perceived difficult biology concepts was not rejected.

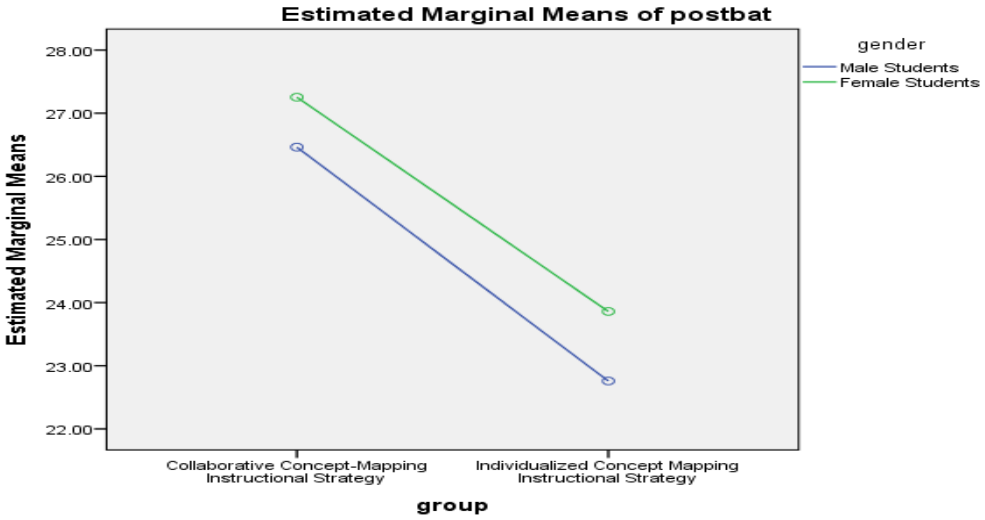

Fig 1: Interaction of Gender and Strategies on the Mean Achievement Scores of Students in Perceived Difficult Biology Concepts

Figure 1 presents a graph of the interaction effect of gender and strategies on the mean achievement scores of students in BAT. The graph lines for gender did not intercept which suggests that there was no interactive effect of gender and strategies on students' achievement in BAT.

Discussion of Findings

Results from the study indicate that students taught perceived difficult biology concepts using ICMIS attained significantly higher mean achievement scores in biology than those who were exposed to conventional teaching strategies. This finding did not come as a surprise as ICMIS is capable of stimulating critical thinking which may have brought out more ideas which went a long way to upgrade individual conceptual framework. This finding is in agreement with Comek, Akinoglu, Elmac, and Gundogdu (2016) in the study on effect of individualized concept mapping on students' academic achievement and attitude in science education that there was a statistically significant difference between the experimental and control group for academic achievement. The finding also agrees with Nwawuba's (2016) finding that there was significant difference in the achievement mean scores of students in biology when taught using individualized concept mapping and conventional method in favour of individualized concept mapping strategy.

Similarly, the finding is in consonance with Sakiyo and Waziri's (2015) finding that individualized concept mapping strategy enhanced students' academic achievement in biology when the researchers investigated the effect of individualized concept mapping teaching method on secondary school students' academic achievement in biology. Other studies that reported the superiority of individualised concept mapping strategy over conventional and traditional methods in biology generally include Ajaja (2013), Olugbemiro, Alaiyemola, and Okebukola (2010).

On the contrary, the study by Mojirola, Omole, Yusuf, and Guga(2016) showed that the use of experiments in teaching significantly improved the performance of students in biology more than the use of concept mapping and lecture method. The use of concept mapping though it enhanced performance of students was not significantly better than the lecture method. The use of experiments made for better retention levels than the use of concept mapping and lecture method. The present study however went further to fill in a gap and empirically revealed that the students exposed to individualized concept mapping instructional strategy specifically achieved higher post BAT scores on perceived difficult biology concepts**.**

Possible cause for the positive impact of ICMIS on students' comprehension of the perceived difficult biology concepts in this study is that applying ICMIS may have coached learners to have an organized and well-structured information of the perceived difficult concepts. ICMIS may have enabled the individuals in this study to activate and energize their prior biology knowledge and to attempt connections between their prior knowledge and the new information they received that eventually improved their bulk of knowledge as successful learners. ICMIS may have also served as an instructional tool to promote individuals' conceptual understanding and allowed the learners to analyze structures, group ideas into categories, and get the main ideas in order to understand the perceived difficult concepts easily, as has been asserted by (Novark & Gowin, 1984).

Results from this study indicate that both male and female students performed well when exposed to the ICMIS in learning the perceived difficult biology concepts irrespective of their gender. The findings of this study are in agreement with the submission of Sakiyo and Waziri (2015) and Githae, Keraro and Wachanga (2015) who separately reported that there was no significant difference between male and female students exposed to individualized concept mapping and that there was no statistically significant gender difference in achievement of secondary school students in biology when exposed to collaborative concept mapping instructional strategy. The finding is also in consonance with Ajaja's (2013) report that male and female students' achievement did not significantly differ in ICMIS. In line with this finding, it is expedient that both male and female students at the secondary school level should be exposed to ICMIS in teaching especially the perceived difficult biology concepts.

It is revealed that there was no significant interaction effect of strategy and gender on students' achievement in perceived difficult biology concepts. This finding is in agreement with Adeyemi and Cishe's (2016) finding that there was no significant interaction between strategy (CCMIS & ICMIS) and gender. The finding is also in consonance with Comek, Akinoglu, Elmac, and Gundogdu's (2016) submission that there was no significant interaction between gender and method when the researchers investigated the effect of individualized concept mapping on students' academic achievement and attitude in science education. The finding is also in conformity with Ogonnaya, Okechukwu, Abonyi, and Ugama's (2016) finding that there was no significant interaction effect between gender and teaching methods on students' achievement in Basic Science, and Ajaja (2013) who reported that there was no significant interaction effect between sex and method of instruction on achievements.

On the contrary, Kolawale's (2007) findings revealed that boys performed significantly better than girls in ICMIS on achievements in mathematics. The finding of the current study which showed no significant difference in male and female achievement may be due to the fact that both boys and girls were interested in the strategies. The conclusion of the finding of this study is that both male and female students at the secondary school level did not show differences in achievement in the perceived difficult biology concepts when exposed to ICMIS.

Conclusion

The findings of this study led to the conclusion that Individualized Concept Mapping Instructional Strategy (ICMIS) significantly improved the academic achievement of students in perceived difficult biology concepts. It is also shown from the results of the study that male and female students' achievement when exposed to ICMIS did not significantly differ. This means that the strategy would be successful in teaching perceived difficult biology concepts to SS 2 students.

Recommendations

Based on the findings of the study, the following recommendations are made:

(i) Biology teachers should use individualized concept mapping instructional strategy to teach perceived difficult biology concepts at the senior secondary school level because it has been found to be effective in teaching these aspects of the subject.

(ii) Teacher' training institutions like Colleges of Education and Universities should develop a curriculum for training professional teachers in the art of individualized concept mapping so that they can learn to use the interactive strategies to teach perceived difficult biology concepts.

(iii) Seminars, workshops and symposia should be organized by Biology Teachers' Association of Nigeria (BTAN), the Taraba State Chapter of Science Teachers Association of Nigeria (STAN), the Taraba State Ministry of Education and the Taraba State Post Primary Schools Management Board (PPSMB) to enlighten biology teachers on the effectiveness of ICMIS in teaching perceived difficult biology concepts.

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