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Effects Of Conceptual Change Texts And Concept Mapping In Remediating Students' Attitude Towards Chemistry In Delta State

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Abstract: *The study looked at the effects of conceptual change texts (CCT) and concept mapping (CM) in remediating students' attitudes toward chemistry in Delta State. This study was guided by two research questions and three hypotheses. The study used quasi-experimental factorial designs with 3x2 pre-test and post-test control groups. 18,879 chemistry students from 473 public secondary schools in Delta State made up the study's population. The sample of the study consisted of 328 SSII chemistry students from six public co-educational high schools intact courses. Using a straightforward random sample procedure, the six intact classes were chosen. The instrument utilized for data collection was the Chemistry Attitude Scale (CAS), which was validated by three experts and has a reliability coefficient of 0.89. Means, standard deviations, and ANCOVA were used to analyze the data. The findings revealed that: there was a significant difference in the mean attitude scores among students taught chemistry using CCT, CM, and lecture method (LM), favoring CCT followed by CM and LM; and there was no significant effect of the interaction of teaching methods (CCT, CM and LM) and sex on students' attitude toward chemistry. The study concluded that CCT and CM are useful instructional methodologies for improving students' attitude towards chemistry. It was advised that secondary school chemistry teachers use CCT and CM when teaching chemistry.*

Keywords: Conceptual change texts, concept mapping, attitude

Introduction

In the Nigerian educational curriculum, chemistry is a science subject studied at both secondary and tertiary education levels. Students are first introduced to chemistry at the senior secondary school level. Studying the characteristics, composition, reactions and uses of matter is the domain of chemistry. It is expected that the knowledge of chemistry will advance the students' understanding of the composition, properties, changes and uses of matter that form the environment around us. Chemistry is of great relevance to national development. Jimoh (2007) stated that chemistry is crucial to the growth of any country, but particularly so in Nigeria, where the petroleum and petrochemical sectors provide the bulk of the country's wealth. The pursuit of global sustainable economic growth is centered on chemistry. It has a significant impact on a number of industries, including food (fertilizers and pesticides), clothes (textile fibers), housing (cement, concrete, steel, bricks), medicine (drugs), transportation (fuel, alloy materials), and a variety of other products including cosmetics, paint, and soap. Additionally, there are several opportunities in chemistry in the medical field, food processing, extractive industries, petroleum and petrochemical sectors, among other fields.

Given the significance of chemistry, it was made a compulsory subject for science students at the secondary school level to facilitate its study and related discipline at higher level of education. Despite chemistry's significance, senior secondary students have had trouble studying it as seen by their dismal results on external exams (West African Examinations Council, WAEC, 2017-2021). The major students' weakness identified by the WAEC Chief examiner's report was that students lack basic understanding of simple chemistry concepts. This may be attributed to students' attitude towards chemistry and the conventional lecture method (LM) mostly used by chemistry teachers.

LM is the widely used method of teaching in secondary schools in Nigeria. Through continual practice of facts and drills, this approach encourages students to master course material (Anyafulude, 2014). The approach makes sure that the course outline is finished on time, but it also pushes students to memorize and regurgitate knowledge from learning experiences rather than absorbing and assimilating it (Ajaja, 2013). In addition, LM of teaching does not recognize students' alternative conceptions during instruction. LM does not take into cognizance the fact that students construct ideas about natural phenomena (chemistry concepts) before formal instructions in the classroom. These alternative conceptions are rooted deeply in students memory, if not determined and remedied may lead to students' development of negative attitude towards chemistry. Therefore, there is need to try alternative teaching method such as conceptual change texts (CCT) and concept mapping (CM) that is believed to facilitate positive conceptual and attitudinal change.

According to Cayci (2018), CCT is a method of instruction that includes justifications, case studies, examples, visuals like pictures and/or images, and scientific justifications for why significant misunderstandings exist.

CCT identifies students' misconceptions, clarifies why they are incorrect, and demonstrates why they are incorrect with specific instances. According to Ozkan and Selcuk (2013), CCT always starts with a question to cause the student's perspective to be false. The most common misconceptions about that subject are then presented, along with arguments to convince students they are false. Here, the goal is to give students the opportunity to query the ideas and recognize the limitations of their preconceived knowledge. When students are able to do this, they are given fresh information and examples that will help them replace their erroneous concepts with the right ones. According to several research (Cayci, 2018; Ozkan & Selcuk, 2013), CCT is one of the best conceptual transformation methodologies for removing false beliefs and building scientific concepts in a meaningful, long-lasting, and useful way. On the basis of the literature at the researcher's disposal, it is yet to be determined how effective CCT and CM are at encouraging secondary school students' in Delta State to have a positive attitude toward chemistry. To ascertain if CCT is more efficient than CM in assisting students' development of a good attitude toward chemistry in Delta State secondary schools is one of the justifications for this study.

CM is a graphic depiction of the relationships between concepts using connecting terms in a hierarchical way. CM is one of the most commonly used techniques in teaching concepts and identifying and eliminating the misconceptions in the field of education (Wang, Wu, Kirschner & Spector, 2018). CM is endorsed by Ausubel (1963) meaningful learning theory. According to meaningful learning theory, learners must integrate new concepts with reference to past knowledge by linking them into a systematic structure in order to learn meaningfully. CM is an important tool to help recognise students' biases (misconceptions) as well as understand conceptual change and restructure the attitude of students. The goal of CM is to visualize connections and relationships among a hierarchy of notions, ranging from the extremely concrete to the abstract (Ajaja, 2013). The author also highlighted that since its debut, CM has developed into a very valuable tool for teaching and learning, aiding in the understanding of ideas by illustrating links with other ideas. Studies have shown that CM enhances students' academic achievement as well as positive attitudinal change (Ajaja, 2013; Bii, 2019)

The definition of attitude is the propensity to react favourably or unfavourably to a particular object (Oskamp & Schultz, 2005). The way one feels about learning chemistry reflects their interests in the subject. When students have a favourable attitude toward a subject, it will enhance their motivation to learn the course and reverse is the case when students' attitude is negative. The teaching method adopted by teachers' can make or mar students' development of positive attitude towards chemistry. Although, empirical studies have shown that CCT and CM aid students development of positive attitude, but the superiority of one over the other in enhancing students' attitude towards chemistry in Delta State is yet to be determined. This necessitated this study.

Statement of Problem

A review of WAEC Chief Examiner's reports from 2017-2021 have shown that students' performance in chemistry has remained poor. The worst overall performance ever, was noted in 2018 according to WAEC Chief Examiner's Reports. According to the WAEC Chief Examiner's assessment, the main reason why pupils performed poorly on the chemistry portion of the 2018 West African Senior Secondary Certificate Examination (WASSCE) was that they lacked conceptual comprehension of fundamental chemical principles. It is thought that one reason for the poor performance in chemistry is the fact that students may habour negative attitude towards chemistry. Students' negative attitude towards chemistry may be attributed to the LM often adopted by chemistry teachers. This is because LM promotes memorisation and regurgitation of learnt concept as a result of students' passive involvement during instruction and does not take into cognizance students' alternative conceptions. For meaningful learning to take place, there is the need for students' development of positive attitude towards chemistry. Students' attitudes toward chemistry may be made or broken by the teacher's choice of teaching strategy. According to the researcher, different teaching strategies may have different impact on students' attitudes toward chemistry. The problem which this study sought to solve is: will CCT and CM enhance students' development of positive attitude towards chemistry than LM?

Purpose of the Study

The study concentrated on how CCT and CM changed students' attitude towards chemistry. The study's specific objectives were to ascertain the following:

1. the difference in mean attitude scores among students taught chemistry using CCT, CM, and LM;
2. the difference in mean attitude scores between male and female students taught chemistry using CCT and CM;
3. the interaction between teaching methods and sex on students' attitude toward chemistry.

Research Questions

1. How do students taught chemistry using CCT, CM, and LM differ in terms of their mean attitude scores?
2. How do male and female students who were taught chemistry with CCT and CM differ from one another in terms of their mean attitude scores?

Hypotheses

1. Students who learned chemistry utilizing CCT, CM and LM showed no significant differences in their mean attitude scores.
2. The mean attitude scores between male and female students who were taught chemistry with CCT and CM did not differ significantly.

3. Students' attitude towards chemistry is not significantly impacted by the interaction of teaching methods and sex.

Methodology

A 3x2 pre-test, post-test, control group quasi-experimental factorial design was used in this investigation. Three instructional groups (CCT, CM & LM groups) and two sex levels (male & female) made up the design. The independent variable is instructional methods at 3 levels (CCT, CM & LM), the moderator variable is sex and the dependent variable is attitude. The choice of quasi-experimental design is predicated on the non-randomization of subjects. To avoid interfering with classroom activity, entire classes were used in this investigation. The design for this study is depicted in Table 1.

Table 1: Design of the Study

Group	Pre-test	Treatment	Post-test
CCT (Exp. grp 1)	O_1	X_{CCT}	O_2
CM (Exp. grp 2)	O_3	X_{CM}	O_4
LM (Ctrl grp)	O_5	X_{LEC}	O_6

Where, O_1, O_3 and O_5 = Pre-test of CCT, CM and LM; O_2, O_3 and O_5 = Post-test of CCT, CM and LM; X_{CCT}, X_{CM} and X_{LEC} = Treatment with the use of CCT, CM and LM.

The population for the study consisted of 18,879 chemistry students in secondary schools in Delta State. Three hundred and twenty eight (328) SSII chemistry students from six (6) public co-educational secondary schools in Delta State made up the study's sample size. Simple random sampling technique was used to choose these schools. Data were collected with 20 items Chemistry Attitude Scale (CAS). The reliability of the Chemistry Attitude Scale (CAS) was established using Cronbach Alpha. This is because it is most suitable for establishing the reliability coefficient of likert scale items. In this method, CAS was administered to 25 SSII chemistry students in a Grammar School in Ethiope East Local Government Area, who are outside the sample area for this study. The response of the students were scored and subjected to Cronbach Alpha analysis using SPSS. On analysis, a reliability coefficient of 0.89 was obtained.

Assigning students to the CCT group, CM group (the experimental group), and LM group (the control group) and educating the teachers who would be working with the experimental group were the first steps in the treatment. Both the experimental and control groups underwent pre-testing with CAS to ascertain their comparability before the start of therapy. Students in the experimental group received treatment using CCT and CM, whereas those in the control group received treatment with LM. Students in the experimental and control groups had CAS post-testing following item re-shuffling at the conclusion of the six-week treatment period. Students in the experimental and control groups' pre- and post-test results were compiled and analyzed.

Results

✓ How do students taught chemistry using CCT, CM, and LM differ in terms of their mean attitude scores?

Table 2: Mean ($\bar{x}$) and Standard Deviation (SD) of Pre-test and Posttest Attitude Scores of Students Taught Chemistry with CCT, CM and LM

Group	N	Pre-test		Posttest		Mean Gain
		Mean ($\bar{x}$)	SD	Mean ($\bar{x}$)	SD	
CCT	108	24.26	8.95	62.64	5.44	38.38
CM	92	23.49	5.61	60.38	9.08	36.89
LM	128	22.90	7.19	57.97	8.91	35.07

Table 2 shows a gain of 38.38, 36.89 and 35.07 for students in CCT, CM and LM groups respectively. Students that were taught chemistry with CCT, CM and LM had different mean attitude scores, as evidenced by the variation in the mean gain. The corresponding hypothesis was tested to ascertain if the difference was significant.

✓ Students who learned chemistry utilizing CCT, CM and LM showed no significant differences in their mean attitude scores.

Table 3: Summary of ANCOVA Comparison of Posttest Mean Attitude Scores of Students Taught Chemistry with CCT, CM and LM

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1358.484[a]	3	452.828	7.097	.000
Intercept	101861.631	1	101861.631	1596.474	.000
Pretest	75.936	1	75.936	1.190	.276
Methods	1227.353	2	613.676	9.618	.000
Error	20672.540	324	63.804		
Total	1210042.000	328			
Corrected Total	22031.024	327			

Students who were taught chemistry using CCT, CM, and LM had significantly different mean (x) attitude scores, ($F(2,324) = 9.618$, $P(0.000)<0.05$), as shown in table 3. The null hypothesis is thus disproved. The students who were taught chemistry using CCT, CM and LM showed a significantly different mean attitude score. Scheffe's post-hoc test was used to determine the direction of the difference, as indicated in table 4.

Table 4: Summary of Scheffe's Post-hoc Test Comparison of Conceptual Change Texts, Concept Maps and Lecture Methods on Attitude

(I) Teaching methods	(J) Teaching methods	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
CCT	CM	2.258	1.134	.139	-.53	5.05
	LM	4.670*	1.044	.000	2.10	7.24
CM	CCT	-2.258	1.134	.139	-5.05	.53
	LM	2.412	1.092	.049	-.27	5.10
LM	CCT	-4.670*	1.044	.000	-7.24	-2.10
	CM	-2.412	1.092	.049	-5.10	.27

Table 4 shows that CCT and CM are more successful than LM at improving students' attitudes toward chemistry.

- ✓ How do male and female students who were taught chemistry with CCT and CM differ from one another in terms of their mean attitude scores?

Table 5: Mean ($\bar{x}$) and Standard Deviation (SD) of Attitude Scores of Male and Female Students Taught Chemistry with CCT and LM

Methods	Sex	N	Posttest		Mean Difference
			Mean ($\bar{x}$)	SD	
CCT	Male	74	62.30	5.63	1.08
	Female	34	63.38	5.01	
CM	Male	57	59.93	9.24	1.18
	Female	35	61.11	8.90	

According to table 5, there is an average attitude score difference of 1.08 between male and female students taught chemistry with CCT, favouring female students, and an average attitude score difference of 1.18 between male and female students taught chemistry with CM, favuoring female students. As reported in table 6, the corresponding hypothesis was tested to see if these differences were significant.

- ✓ The mean attitude scores between male and female students who were taught chemistry with CCT and CM did not differ significantly.

Table 6: Independent Samples t-test Comparison of Posttest Attitude Scores of Male and Female Students Taught Chemistry with CCT and CM

Methods	Sex	N	$\bar{x}$	SD	df	t-cal.	Sig. (2-tailed)
CCT	M	74	62.30	5.63	106	0.963	0.338
	F	34	63.38	5.01			
CM	Male	57	59.93	9.24	90	0.605	0.547
	Female	35	61.11	8.90			

P > 0.05

Male and female students who were taught chemistry through CCT did not differ significantly in their mean attitude scores, according to table 6 (t = 0.963, P(0.338) > 0.05). Further evidence is provided in table 6, which demonstrates that there is no statistically significant difference between the mean attitude scores of male and female students who were taught chemistry using CM (t = 0.605, P(0.547) > 0.05). As a result, the null hypothesis is not disproved.

- ✓ Students' attitude towards chemistry is not significantly impacted by the interaction of teaching methods and sex.

Table 7: Summary of ANCOVA on Effect of Interaction of Teaching Methods and Sex on Students' Attitude

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2319.803[a]	6	386.634	6.296	.000
Intercept	101685.635	1	101685.635	1655.965	.000
Pretest	44.673	1	44.673	.728	.394
Methods	1386.836	2	693.418	11.292	.000
Sex	82.718	1	82.718	1.347	.247
Methods * Sex	772.569	2	386.284	2.291	.062
Error	19711.221	321	61.406		
Total	1210042.000	328			
Corrected Total	22031.024	327			

F(2, 321) = 2.291, P(0.062) > 0.05 in table 7 shows no significant effect of teaching methods and sex on students' attitudes toward chemistry. Consequently, the null hypothesis is not disproved. As a result, there is no discernible impact of the interplay between sex and teaching strategies on students' attitudes toward chemistry..

Discussion of Findings

The study found that students who learned chemistry via CCT, CM, and LM had significantly different mean attitude scores. According to the Scheffe's post-hoc test, CCT significantly outperformed CM in terms of the mean attitude scores of students who were taught chemistry. The more practical character of CCT may also account for the students' better attitude scores when taught chemistry using CCT as opposed to CM. In CCT classroom, meaningful explanation, demonstrations coupled with practical experiments were carried out in the course of teaching in order to identify and remedy students' misconception. This singular act to a great extent made the lesson very real thereby reducing students' abstraction in chemistry. However, in CM classroom, only meaningful explanation and demonstration were carried out. Therefore, the practical nature of CCT reduced students'

abstraction in chemistry concepts more than the use of CM. This may have accounted for the higher attitude scores of students taught chemistry using CCT over their counterparts taught with CM.

According to Scheffe's post hoc text, CCT and CM are more successful than LM at improving students' attitudes about chemistry. The possible explanation for this observation may be predicated on the fact that CCT and CM arouse, stimulate and sustain students' interest in chemistry since the students are practically active during the teaching and learning process. This could be the reason why students who learned chemistry using CCT and CM had better attitude scores than those who learned the subject using LM, who were more passive during the teaching and learning process. This result is consistent with that of Kaya and Geban (2011), who found that there was a substantial mean difference between the posttest scores of students who learned chemistry using CCT and those who learned it using traditionally structured training, favouring those who learned it using CCT. This study supports that of Otor and Achor (2013), who discovered that students who were taught chemistry using CM scored much higher on attitude ratings than those who were taught using traditional LM.

A non-significant difference in the mean attitude scores between male and female students who were taught chemistry utilizing CCT and CM was also indicated by the study's findings. This suggests that in terms of students' attitudes about chemistry, CCT and CM did not make a distinction between genders. This may be explained by the fact that CCT and CM both pique and maintain the interest of both male and female students during training. This result is consistent with that of Gokulu and Geban (2014), who found no evidence of a gender gap in students' views toward chemistry as a subject of study or their grasp of the concepts of atom, molecule, ion, and matter. This result is consistent with that of Abdulkarim and Raburu (2013), who reported that there was no discernible difference due to gender or the interplay between gender and instructional approaches.

Finally, the study found that the interplay between teaching strategies and sex had no discernible impact on students' attitudes toward chemistry. This suggests that, in terms of students' attitudes about chemistry, CCT and CM are not sex related. This result is in line with that of Abdulkarim and Raburu (2013), who discovered no appreciable interactions between teaching strategy and gender in respect to students' attitudes about physics.

Conclusion

The study's findings led to the conclusion that CCT and CM encourages students to learn. Their positive disposition to learn leads to more positive attitude towards chemistry. CCT is comparably more effective in helping students, irrespective of sex, to develop a more favourable attitude towards chemistry than CM.

Recommendation

The researcher recommended the following:

1. The adoption of CCT and CM by chemistry teachers in teaching chemistry concepts at the secondary school level.
2. Chemistry teachers should strive to pay keen attention to students' misconceptions during chemistry instruction to facilitate students' comprehension of chemistry concept concepts and positive attitudinal.

Contribution to Knowledge

1. The study established that CCT is a more effective approach than CM in boosting students' attitude towards chemistry.
2. The study established that CCT and CM did not differentiate between sexes with reference to students' attitude towards chemistry.

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