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Application of SPACE Model Cognitive Behavioural Therapy in Improvement of Students` Achievement in Chemistry in Secondary Schools in Obio-Akpor Local Government Area of Rivers State

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ABSTRACT

This study investigated the SPACE model of Cognitive Behavioural Therapy in the improvement of students` achievement in chemistry. The study was guided by three research questions and three hypotheses. A quasi-experimental research design of pretest posttest non-equivalent control group design was used in the study. The area of the study was Obio Akpor Local Government Area of Rivers state. All the senior secondary school chemistry students in the area formed the population out of which 94 students were selected from two intact classes in two schools using purposive sampling technique. The study used a Chemistry Achievement Test as instrument for data collection. The instrument was validated by three experts. The reliability of the instrument was determined using Kudder-Richardson (KR-20) formula which produced an internal consistency index of 0.84. Mean and standard deviation were used to answer the research questions while ANCOVA was used to test the hypotheses at 0.05 level of significance. The findings revealed that SPACE model of Cognitive Behavioural Therapy is highly potent in improving students` achievement in chemistry. The study also found that male students` achieved significantly higher in chemistry than the female students. More so, the results showed that the interaction effect of instructional strategy and gender is significant. Thus, it was recommended among others that the SPACE model of Cognitive Behavioural Therapy should be adopted by teachers in the teaching of chemistry.

Keywords: Chemistry, SPACE Model, Cognition Behavioural Therapy, Achievement

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INTRODUCTION

The contribution of Chemistry to human and societal evolution is highly indispensable. Chemistry which focuses on the composition and properties of matter has brought about great milestones and breakthroughs in the world of science and technology. This contribution is consequently seen in other areas of human endeavours such as in the advancement of economy, criminal justice, production of improved and quality agricultural products and other basic needs of mankind such as chemicals for killing insects and pests, preservatives, cleaning detergents and soaps, among others (Giginna & Nweze, 2014). These benefits above are indications of the relevance of chemistry towards the advancement and sustainability of mankind. Thus, efforts are required to be intensified by teachers, students and all those who are concerned to ensure that the knowledge of chemistry is properly acquired and applied so as to foster scientific and constructive mindsets as well as the right attitude toward science and technology. The

extent to which these mindsets and attitudes to science are developed by learners can easily be ascertained through students` academic achievement.

In essence, academic achievement of students is like a mirror that reflects the degree and effectiveness of instructional processes within the class. As Ocheni (2021) defines, it is the measure of academic success or otherwise of a learner. Hence, with academic achievement, the degree to which students understands and apply the knowledge and principles of science, especially chemistry can be determined. Basically, a sound academic achievement reflects students' progress in chemistry, whereas, when the achievement is poor, it could translate to poor skills or inadequacies in chemistry. This means that it is expected of students to ensure that their academic achievement in chemistry is satisfying. Disappointingly, the reality is in contrast to these expectations. In essence, studies show that students` achievement in chemistry especially at the secondary school level is very poor. Hassan et al (2015) reported consistent failure among students in chemistry. The study of Ayodele (2018) reveals continuous decline in students` achievement in chemistry. This report further aligns with the findings of Shadreck and Enunuwe (2018) that secondary school students achieve poorly in chemistry. These information above reflect the poor state of students` achievement in Chemistry at the secondary school level. To top it all, the West African Examination Council (WAEC) Chief Examiner in the annual reports of the examination board shows the poor statistics of students` achievement in the subject from 2007 to 2018. According to the statistics 46.16%,44.47%, 44.49%, 50.70%, 49.54%, 43.13%, 72.34%, 62.49%, 60.60%,57.74%, 62.68% and 61.95% of students had credit pass in chemistry for the years 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018 accordingly. These statistics shows that even though there appears to be slight improvement at some point, the achievement of students in chemistry is still unsatisfactory as the percentages shows an inconsistent pattern.

The implication of the foregoing could mean that such benefits of chemistry as advancement in science and technology, national development and societal sustainability may not be attainable easily. Therefore, it becomes necessary to investigate factors which could be leading to students` poor achievement in chemistry. Some of these factors according to researchers include but not limited to lack of teachers` proficiency in chemistry, poor instructional procedures, inadequate qualified teachers, poor laboratory facilities, among others (Hassan et al, 2015). Even though these factors have been identified, studies have shown that the prominent and most responsible factor leading to students` underachievement in chemistry is poor instructional procedures or methods adopted in Nigerian secondary schools (Bamidele & Oloyede, 2013). According to the authors, the conventional method which is often used by teachers and which is synonymous to talk and chalk method has not been very effective. In view of this, researchers have employed several instructional strategies such as lecture method, demonstration method (Cheruiyot, 2020), cooperative learning (Geleta, 2015), and so on. Yet, students` achievement in chemistry at the secondary school level is still unsatisfactory. Perhaps, it is expedient to consider innovative teaching strategies that is all encompassing and as well give learners the ability to control and manage their

cognition and emotions as well as other related academic stressors while learning. One of such instructional approach is the Social context, Physiological, Action, Cognition and Emotion (SPACE) model of Cognitive Behavioural Therapy (CBT).

The SPACE model of CBT which is often taken to be an acronym of social context, physiology, action, cognitions and emotion was designed by Edgerton and Palmer (2002). This was basically developed for the management of psychological traits such as anxiety, stress and emotional disorders, etc. However, it has found extension into the classroom for the improvement of students` academic performance. As Edgerton and Palmer (2005) noted, the SPACE model is used for assessment and intervention of students` learning and management of psychological related variables. This model according to the author focuses on five stages; situation or social context (peoples` belief regarding social roles), physiology (breathing, tension, anxiety etc.), action (what is being done and not done), cognition (thoughts, memories, values, worth etc.) and emotions (feelings, affections, mood etc.) Basically, this model could expose students to learn how their thoughts, emotions, and physical responses are interrelated. Thus, this could help students develop a mastery of their learning which could consequently improve their academics. The SPACE model of cognitive behavioural therapy helps an individual by separating the different components of cognitive, behavioural and emotional reactions which are related to their situations such as learning (Palmer & Szymanska, 2014). Cavalho, Gasper de Matos and Anjos (2018) also noted that the SPACE model enables trainees such as students to easily solve-problems in their learning and manage their stress.

This implies that the SPACE model of cognitive behavioural therapy as an instructional approach could be potent in improving students` academic achievement in chemistry. This is obtainable because, as Edgerton and Palmer (2005) noted, with the SPACE model, students` cognition can build up and sustain emotional reactions, thereby creating continual reciprocal relationship between emotions and cognitions. This could consequently facilitate students` learning and improvement in achievement since a positive state of mind can be instrumental to healthy learning. Thus, students` achievement in chemistry could be improved if the SPACE model of cognitive behaviorual therapy is properly applied. Sinclair (2016) reported that the cognitive behaviour therapy is highly effective in the improvement of students` academic competence. Zyromski and Joseph (2009) equally found that using cognitive behaioural approaches improves students` achievement. These findings are similar to the study of William and Palmer (2009), and Ogba et al (2020) who respectively reported on the effectiveness of the SPACE model of cognitive behaviorual therapy. It is important however to acknowledge that despite the proven effectiveness and efficacy of the SPACE model of cognitive behavioural therapy in the improvement of students` achievement, it is yet to gain the attention of researchers in Nigeria, especially in the teaching of chemistry. It is therefore paramount for this present study to apply the SPACE model of cognitive behavioural therapy in the improvement of students` achievement in chemistry. Nevertheless, a factor which must be taken into consideration when emphasizing

students` achievement is their gender since it could influence their learning of chemistry and subsequently, achievement.

Gender is concerned with a social construct which demonstrate which role, behavioural or attributes that are for either males or females (Newman, 2021). It is an essential aspect in the spheres of teaching and learning. As such it is capable of influencing peoples` action and reactions within the society (Canadian Institute of Health Research, 2021). In essence, students` gender could influence students` achievement in chemistry. Aniodoh and Egbo (2013) revealed a significant influence of gender on students` achievement in chemistry in favour of female students. However, Udousoro (2011), Godpower-Echie and Ihenko (2017), Ajayi and Ogbeba (2017) all found that gender does not have any significant influence on students` achievement in chemistry. Ajayi and Ogbeba (2017) also found no significant interaction effect of instructional strategy and gender on students` achievement in chemistry. These results are a reflection of inconsistencies in findings of scholars. This kind of division among researchers is inappropriate. Hence, further investigation is required to address this disparity. Therefore, the present study will consider the influence of gender on students` achievement in chemistry when taught using the SPACE model of cognitive behavioural therapy.

In accordance with the foregoing, it has been found that students` achievement in chemistry is poor. Efforts by scholars to improve students` achievement in chemistry using various instructional approaches have proven to be ineffective. Researchers are also in disagreement on the influence of gender on their achievement in chemistry. Perhaps, it expedient to at this point consider the use of SPACE model of cognitive behavioural therapy in order to improve students` achievement in chemistry while also considering the influence of gender in Obio Akpor LGA of Rivers State, Nigeria.

Purpose of the Study

The purpose of this study is to examine the effect of application of the SPACE model of Cognitive Behavioural Therapy to improve students` achievement in chemistry in secondary schools in Obio-Akpor Local Government Area of Rivers State. Specifically, the study will determine:

1. The mean achievement scores of students taught chemistry using the SPACE model of Cognitive Behavioural Therapy and those taught using conventional method.
2. The influence of gender on the mean achievement of students taught chemistry using the SPACE model of Cognitive Behavioural Therapy
3. The interaction effect of instructional strategies and gender on students` academic achievement in chemistry.

Research Questions

1. What are mean achievement scores of students taught chemistry using the SPACE model of Cognitive Behavioural Therapy and those taught using the conventional method?
2. What is the influence of gender on the mean achievement of students taught chemistry using the SPACE model of Cognitive Behavioural Therapy?

3. What is the interaction effect of instructional strategies and gender on students` academic achievement in chemistry?

Hypotheses

1. There is no significant difference in the mean achievement scores of students taught chemistry using the SPACE model of cognitive behavioural therapy and those taught using the conventional method.
2. There is no significant difference in the mean achievement scores of male and female students taught chemistry using the SPACE model of Cognitive Behavioural Therapy.
3. There is no significant interaction effect of instructional strategies and gender on students` academic achievement in chemistry.

METHODOLOGY

This study adopted a quasi-experimental research design of the pre-test post-test non-equivalent control group design. This design allows for two or more independent variables in a study using different group of participants and it equally permit various comparisons such as main effect and interaction effect (Field, 2017). The researcher manipulated two independent variables of the study. The independent or treatment variables are the SPACE model and conventional method while gender is the moderating variable and achievement in chemistry is the dependent variable.

The participants of this study comprised 94 (49 males and 45 females) chemistry students selected using purposive sampling technique from two (2) intact classes in two public secondary schools in Obio Akpor local government area of Rivers State. One school was randomly assigned to the treatment group while the other school the control group. Purposive sampling was used to ensure that only mixed schools where chemistry is taught are selected for the study because of the gender variable. The choice of two schools was to enable the research monitor and easily control for extraneous variables such as group diffusion that may arise. The study used intact classes in which all the students were actively engaged.

The study made use of one instrument titled; Chemistry Achievement Test (CAT). The instrument comprised 20 multiple-choice test items with four options of A, B, C, and D. The validation of the instrument was done by three experts; One in Measurement and Evaluation, and two in Chemistry unit. The experts examined the relevance, clarity, appropriateness and adequacy of the items. The content validity of the instrument was established using table of specification in line with the modified Bloom`s taxonomy of education measure. The internal consistency reliability of the instrument was determined using Kudder-Richardson-20 (KR-20) formula. This yielded an index of 0.84. The choice of KR-20 is because the instrument is dichotomously scored (i.e., correct/incorrect responses).

The treatment lasted for four weeks. Students in treatment and control groups were taught by their class teacher. The research trained the teachers of both groups on how to guide the students` learning using the SPACE model and conventional method. Before the treatment proper, the students were first administered the CAT as pretest to

measure their baseline knowledge. Students` responses on the test were scored and recorded. The experiment was carried out using the regular school time-table and the lesson periods. The lesson lasted for 40 minutes each. At the end of the treatment, the CAT was reshuffled and administered to both groups as post test to measure the achievement of students in chemistry. This administration of the test was done on the same day for both groups, after which the tests were marked using the marking guide and students` scores were recorded. The scores from pre-test and post-test were thus compared so as to measure the effect of the treatments.

The experimental group received instructions on chemistry through the SPACE model. The subject exposed to the SPACE model were coached on how to regard their social context or situation based on social roles, this was followed by physiology on how to manage their breathing, tension and anxiety, after which they learn what is to be done and the ones not to be done. Subjects then learn values, improve memories and thoughts and finally, emotions allow them to exhibit control over their feelings, affections and mood, thus, resulting in mastery over learning. Emphasis was laid on keeping to the lesson periods and at the end of the lesson, assignments and exercises followed. In the same way, the control group was exposed to the conventional method. The instruction was presented by the teacher. At the end of the instruction, assignments and exercises were given to the students.

RESULTS

Research Question 1

What are mean achievement scores of students taught chemistry using the SPACE model of Cognitive Behavioural Therapy and those taught using the conventional method?

Table 1

Pretest and Posttest of the Mean Achievement Scores of Students in Chemistry

Strategies	Pre-Test			Post-Test		
	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean Gain
SPACE Model	47	7.70	2.11	17.17	1.72	9.47
Conventional Method	47	8.70	2.17	14.83	1.82	6.13

Table 1 shows the pretest and posttest mean scores of senior secondary school students exposed to SPACE model of cognitive behavioural therapy and those taught chemistry using the conventional method. The result shows that the mean achievement scores of students in chemistry taught using SPACE model is (n=47, $\bar{X}$= 7.70, SD= 2.11) for pretest and (n=47, $\bar{X}$= 17.17, SD= 1.72) for posttest with a mean gain of 9.47 while the students exposed to the conventional method had a mean achievement score of (n=47, $\bar{X}$= 8.70, SD= 2.17) for pretest and a posttest score of (n=47, $\bar{X}$= 14.83, SD= 1.82) and with a mean gain of 6.13. This result is an indication that the SPACE model of cognitive behavioural therapy is more potent in improving students` achievement score in chemistry more than the conventional method.

Research Question 2

What is the influence of gender on the mean achievement of students taught chemistry using the SPACE model of Cognitive Behavioural Therapy?

Table 2

Pretest and Posttest of the Mean Achievement Scores Based on Gender of Students taught chemistry using the SPACE model of Cognitive Behavioural Therapy

Gender	Pre-Test			Post-Test		
	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean Gain
Male	49	8.20	2.12	16.73	2.25	8.53
Female	45	8.20	2.27	15.20	1.65	7.00

Table 2 reveals the mean achievement scores of male and female students in chemistry. From the result, the mean pretest of the male students in chemistry is (n=49, $\bar{X}$= 8.20, SD= 2.17) while their protest is (n=49, $\bar{X}$= 16.73, SD= 2.25) and the mean difference is 8.53. On the other hand, the female students had a pretest mean achievement score of (n=45, $\bar{X}$= 8.20, SD= 2.27) and a posttest mean achievement score of (n=45, $\bar{X}$= 15.20, SD= 1.65) with a mean difference of 7.00. This result is an indication that the mean achievement score of male students exposed to the instructional strategies in chemistry is higher than that of the female students.

Research Question 3

What is the interaction effect of instructional strategies and gender on students` academic achievement in chemistry?

Table 3

Pretest and Posttest of the Interaction Effect of Instructional Strategy and Gender on Students` Achievement in Chemistry

Strategies	Gender	Pre-Test			Post-Test		
		N	$\bar{X}$	SD	$\bar{X}$	SD	Mean Gain
SPACE Model	Male	30	7.83	2.12	17.97	1.56	10.14
	Female	17	7.47	2.12	15.76	0.90	8.29
Conventional Method	Male	19	8.79	2.04	14.79	1.75	6.00
	Female	28	8.64	2.28	14.83	1.90	6.19

Table 3 shows the data on the interaction effect of instructional strategies (SPACE model and conventional method) and gender (male and female) on students` academic achievement in chemistry. From the result, the male students taught chemistry using SPACE model had a pretest mean score of (n=30, $\bar{X}$= 7.83, SD= 2.12) for pretest and (n=30, $\bar{X}$= 17.97, SD= 1.56) with a mean gain of 10.14 while the female students exposed to the same strategy had a mean achievement score of (n=17, $\bar{X}$= 7.47, SD= 2.12) for pretest and (n=30, $\bar{X}$= 15.76, SD= 0.90) for posttest with a mean difference of 8.29. The result shows that the mean achievement score of male students under the SPACE model is higher when compared to their female counterparts. More so, the Table shows that the male students exposed to the conventional method had a pretest mean score of (n=19, $\bar{X}$= 8.79, SD= 2.04) and a posttest mean score of (n=30, $\bar{X}$= 14.79, SD= 1.75) with a mean

gain of 6.00 while the female students under the conventional method had a mean pretest score of (n=28, $\bar{X}$= 8.64, SD= 2.28) and a posttest mean score of (n=28, $\bar{X}$= 14.83, SD= 1.90) and a mean difference of 6.19. This result indicates that the mean achievement of female students under the conventional method is higher than that of the female students. The result generally showed that the male and female students exposed to the SPACE model achieved higher than the male and female students exposed to the conventional method respectively.

Hypothesis 1

There is no significant difference in the mean achievement scores of students taught chemistry using the SPACE model of Cognitive Behavioural Therapy and those taught using the Conventional Method.

Table 4

ANCOVA Result of the Significant Effect of Teaching Strategies on Students` Achievement in Chemistry

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	219.036[a]	4	54.759	24.495	.000	.524
Intercept	1045.037	1	1045.037	467.463	.000	.840
Pretest	37.648	1	37.648	16.841	.000	.159
Strategy	116.607	1	116.607	52.160	.000	.370
Gender	21.676	1	21.676	9.696	.002	.098
Strategy * Gender	26.914	1	26.914	12.039	.001	.119
Error	198.964	89	2.236			
Total	24482.000	94				
Corrected Total	418.000	93				

a. R Squared = .524 (Adjusted R Squared = .503)

Table 4 shows the ANCOVA result of the significant effect of teaching strategies on students` achievement in chemistry. From the result, the F-ratio of 52.160 obtained with a probability value of 0.000 which is less than the a-prior value of 0.05 set as level of significance for decision making. Thus, the null hypothesis is rejected. Inference drawn is that, there is a significant difference in the mean achievement scores of students taught chemistry using the SPACE model of Cognitive Behavioural Therapy and those taught using the conventional method. Furthermore, the result shows that an effect size of (η^2_p = 0.370) which represent 37% of the variance increase in students` achievement in chemistry was due to the treatment effect.

Hypothesis 2

There is no significant difference in the mean achievement scores of male and female students taught chemistry using the SPACE model of Cognitive Behavioural Therapy.

Analysis of results in Table 4 on the significant difference between male and female students in chemistry with respect to their achievement test shows that the $F(1,89)= 9.696$, $p<0.05$ was obtained. This result shows that the p-value of 0.002 obtained is less than 0.05 level of significance, hence, the null hypothesis was rejected. Conclusion

drawn based on this result is that, there is a significant difference in the mean achievement scores of male and female students in chemistry. Table 2 further showed a partial eta square of (η^2_p = 0.098), indicating that 9.8% of the increase in students` achievement score in chemistry was due to the influence of gender.

Hypothesis 3

There is no significant interaction effect of instructional strategies and gender on students` academic achievement in chemistry

The result in Table 4 on the significant of the interaction effect of instructional strategies and gender on students` achievement in chemistry shows that the F-ratio (1, 89) =12.039, $p<0.05$ was obtained. The p-value of 0.001 obtained is less than 0.05 level of significance set for decision making, thus, the null hypothesis is rejected. Inference drawn is that there is a significant interaction effect of instructional strategies and gender on students` academic achievement in chemistry. The result further showed an effect size of ($\eta^2_p$ = 0.119) which means that 11.9% variance of the increase in students` achievement in chemistry is due to the interaction effect of instructional strategies and gender.

DISCUSSION OF FINDINGS

The result of this study revealed that the SPACE model of cognitive behavioural therapy improved students` achievement in Chemistry more than the conventional method. Further analysis showed that the SPACE model is significantly more potent in improving students` achievement when compared to the conventional method. This result could have been like this because, the SPACE mode provides students with the opportunity to understand and manage their cognitions and emotions, thereby, leading to improvement in their learning and consequently, their achievement. This could have contributed to the improvement in students` achievement in chemistry. This result supports the findings of Sinclair (2016), Williams and Palmer (2009) and Ogba et al (2020) who respectively reported on the effectiveness of the SPACE model. The agreements among these reports are indications of the effectiveness of the SPACE model in enhancing students` achievement.

The findings of this study further revealed that male students had a higher mean gain in chemistry compared to the female students. This was revealed by the ANOVA result which showed that the male students` significantly achieved higher in chemistry than their female counterparts. This means that, the utilization of the instructional strategies favoured the male students more than the female students. This result is plausible because, males generally tend to embrace science related subjects such as chemistry more than the females, this interest and preference of male students for science subject could have influenced their achievement in chemistry over the female students. This result is strengthened by the result of Aniodoh and Egbo (2013) that gender determines students` achievement. On the other hand, Udousoro (2011, Godpower-Echie and Ihenko (2017), and Ajayi and Ogbeba (2017) respectively reported that no significant difference exists between male and female students in terms of their achievement in chemistry. This disparity in findings may be based on the location of the study and the type of instructional strategies adopted.

Furthermore, the result of this study showed that there is an interaction effect of instructional strategies and gender on students` achievement in chemistry. The inferential test conducted using ANCOVA indicated that the interaction effect of instructional strategy and gender is significant. This is evidenced in the interaction graph in Fig 1 where the interaction lines crossed. This means that instructional strategies combined with gender to influence students` achievement in chemistry. This result however disagrees with the report of Ajayi and Ogbeba (2017) that the there is no significant interaction effect of instructional strategies and gender on students` achievement. These differences may be due to the subject area and the kind of instructional approaches adopted.

CONCLUSION

In line with the results of this study, it is concluded that the SPACE model of cognitive behavioural therapy is significantly potent in improving students` achievement in chemistry. More so, the study concludes that male students significantly achieve higher in chemistry than the female students. Finally, the study concludes that instructional strategies and gender have a significant interaction effect.

RECOMMENDATIONS

Based on the result of this study, the following recommendations were highlighted.

1. Chemistry teachers should ensure that the SPACE model of cognitive behavioural therapy is adopted in teaching students. This will help in improving their achievement in chemistry.
2. The Ministry of Education and concerned authorities should ensure that such innovative instructional strategies as the SPACE model be integrated into the national curriculum of chemistry.
3. Teachers should be exposed through trainings and workshops as well as conferences and seminars on how to properly adopt the SPACE model in teaching students` chemistry
4. Teachers should make sure that during instructional delivery, efforts should be made to ensure that the instructional processes are not gender bias, this could bridge the gap between the achievement of male and female students in chemistry.

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