Volume: 1, Issue: 1
Page: 14-26
YEAR: 2021

EURO GLOBAL CONTEMPORARY STUDIES JOURNAL (EGCSJ.COM)

Effects of Interactive-Engagement and Analogy-Enhanced Strategies On Students' Anxiety in Chemistry in Ekiti State Secondary Schools

AUTHOR(S): Amos Olusola OGUNJOBI (Ph.D.),

AND

Folasade Busayo OJOBOLA (Ph.D.)

Abstract

The study determined the effects of interactive-engagement and analogy-enhanced instructional strategies on students' anxiety in Chemistry in Ekiti State secondary schools. The research design used was quasi-experimental design that employed pre-test, post-test and control group design. The sample for the study consisted of all the 198 SSSII students offering Chemistry in intact classes of the six secondary schools selected for the study. The selection was done through multistage sampling procedure. Chemistry Students' Anxiety Rating Scale (CSARS) was used for data collection while three Instructional Guides for Teachers using the Instructional Strategies (IGT) were used. The validity of the instrument was ascertained using face and content validity procedures. A field testing was carried out on the instrument using test re-test method to determine the reliability of the instrument and it yielded coefficient of 0.83. The experimental procedure for this study was in three stages, the pre-treatment stage (one week), the treatment stage (six weeks) and the post-treatment stage (one week). Descriptive statistics such as frequency counts, percentages, mean, standard deviation and bar-charts were used to answer the research question raised. Inferential statistics such as Analysis of Variance (ANOVA) and Analysis of Co-variance (ANCOVA) (using pre-test scores of covariates) were used to test the hypotheses generated at 0.05 level of significance. The findings of the result revealed that there was significant difference in the anxiety of students exposed to

E.G.C.S.J
Accepted 5 April 2021
Published 15 April 2021
DOI: 10.5281/zenodo.5035476

Published By

interactive-engagement, analogy-enhanced and the conventional strategies in Chemistry while the anxiety of students exposed to Interactive-Engagement, Analogy-Enhanced and conventional strategies of teaching do not differ by gender and school location. It was recommended among others that there is need for inclusion of interactive-engagement and analogy-enhanced instructional strategies in the secondary school curriculum as alternative teaching strategies that would reduce the anxiety of Chemistry students.

Keywords: Interactive-Engagement, Analogy-Enhanced, Anxiety, Chemistry,

ABOUT AUTHOR

Author(s):

Amos Olusola OGUNJOBI (Ph.D.)
Science Education Department
Federal University Oye-Ekiti, Ekiti State, Nigeria
olusola.ogunjobi@fuoye.edu.ng

And

Folasade Busayo OJOBOLA (Ph.D.)
Science Education Department
Federal University Oye-Ekiti, Ekiti State, Nigeria
folasade.ojobola@fuoye.edu.ng

Introduction

Science education occupies a revered position in the contemporary world education practice. Chemistry in particular is central to many of the scientific fields of human endeavours; therefore, its teaching should be given serious attention. Moreover, the Federal Republic of Nigeria (FRN, 2013) in her National Policy on Education (NPE) stipulated that Chemistry is one of the three core science subjects in the secondary school curriculum, and a minimum of credit pass in it is required for admission into tertiary institutions for most science courses.

The significance of Chemistry is further elucidated in the 2017/2018 edition of the Unified Tertiary Matriculation Examination brochure, where it is stipulated that a minimum of credit pass in Chemistry is required for candidates seeking admission into science-related courses like: medical and health sciences, engineering, pharmaceuticals, agriculture, among others. Unfortunately, the number of candidates attaining minimum credit pass in Chemistry has been on the decline over the years.

Anxiety in Chemistry is a result of fear nurtured by students that perceived Chemistry as a very difficult subject. Science as a subject consists of complex rules and principles. Without a firm comprehension of these means, it will be a burden for the students to understand scientific facts and information (Palmer, 2012). It has been observed that most students fear Chemistry, hence they see Chemistry as vague, which may be a product of the abstract nature of Chemistry and the approach (instructional strategy) being used by most of the Chemistry teachers (Cheung, 2009). When students develop this negative attitude, learning Chemistry becomes tedious and this leads to chemistry anxiety (chemophobia) (Genden, 2011).

Chemistry anxiety can also be attributed to students' concept about the challenging nature of Chemistry, inclusion of multitude of facts, and its perceived abstract nature. Students' anxiety for chemistry learning leads to loss of interest in the science. Chemistry anxiety affects students' performance. It has been observed that so many students fear chemistry, and such fear is characterized by frustrations among the students towards the subjects (Jegede, 2007). Causes of Chemistry anxiety are many and include; past bad experiences in science class, lack of role models, gender, and racial stereotyping. Though some degree of anxiety may be helpful in the learning process, a high level of anxiety impedes optimum performance in science learning (Udo, Ramsey & Mallow, 2004). Genden (2011) have examined Chemistry anxiety under three dimensions: learning Chemistry anxiety, Chemistry evaluation anxiety and handling chemical anxiety. Studies generally indicated that students, whether male or female, urban or rural based show great anxiety towards the learning of Chemistry (Jegede, 2007).

The importance of science particularly Chemistry, in the technological development of a nation cannot be over-emphasised. However, we cannot lose sight of the fact that in any teaching-learning situation; the instructional strategy used in dissemination of information to the students is very important. The problem of the study arose from the academic performance of students in Chemistry which has been observed to be on the downside over the years. Many reasons such as poor learning environment, inadequate laboratory facilities, lack of good textbooks, inadequate library facilities, ineffective and unqualified teachers, teaching strategies employed in disseminating instructions to the students, among others, have been adduced in literature for this poor performance of students. The mostly used instructional strategy is the teacher-centred strategy which cannot sustain the interest of the

learners throughout the period of instruction and seems to have greatly affected the anxiety of the students.

However, it appears as if much emphasis has not been placed on some of the new student- centred instructional strategies such as interactive-engagement and analogy-enhanced instructional strategies. Ezrailson, et al (2006) posited that, a model of interactive-engagement instructional strategy involves a pre-class assignment on the concept to be taught, which is a paradigm shift from post class assignment usually given as homework. This instructional strategy also incorporates concept testing and an instant student-response-system (which in this study will be flash card response system). Interactive engagement is a form of instruction which incorporates concept testing, class-wide discussion and instant student-response-system, which has been established to improve learning in secondary school classes (Meltzer & Manniwan, 2007). The concept questions are given by the teachers to stimulate minds-on-activities that would engage the students in class-wide discussions.

An analogy is a way of stating a comparative relationship between two sets of terms related to each other in the same way that another two terms are related to each other. For example, the governor is the elected head of a state in the same way that the chairman is the elected head of a local government. This comparison can be represented in this analogue: governor to state; chairman to local government. Studying and creating analogues help students develop comprehension of vocabulary and concepts as they improve their reasoning ability and their critical thinking skills.

The purpose of the study was to investigate the effects of interactive-engagement and analogy-enhanced instructional strategies on students' anxiety in Chemistry in Ekiti State secondary schools. The study specifically examined:

1. secondary school students' anxiety in Chemistry before and after treatment;
2. the difference in the anxiety of students exposed to interactive-engagement, analogy-enhanced and the conventional instructional strategies in chemistry;
3. the difference in the anxiety of male and female students exposed to interactive-engagement, analogy-enhanced and the conventional strategies in chemistry; and
4. the difference in the anxiety of rural and urban students exposed to interactive-engagement, analogy-enhanced and the conventional strategies in chemistry.

Research Question

This research question was raised for the study:

1. What is the secondary school students' anxiety in Chemistry before and after treatment?

Research Hypotheses

These hypotheses were postulated to guide the study and were tested at 0.05 level of significance:

- There is no significant difference in the anxiety of students exposed to interactive-engagement, analogy-enhanced and the conventional instructional strategies in chemistry.
- There is no significant difference in the anxiety of male and female students exposed to interactive-engagement, analogy-enhanced and the conventional strategies in chemistry.
- There is no significant difference in the anxiety of rural and urban students exposed to interactive-engagement, analogy-enhanced and the conventional strategies in chemistry.

Methodology

The research design that was used in this study is quasi-experimental design that employed pre-test, post-test and control group design. This design was employed to determine the effect of instructional strategy at three levels (interactive-engagement instructional strategy, analogy-enhanced and the conventional instructional strategies) being crossed with the location at two levels (urban and rural) and gender at two levels (female and male). The targeted population of this study consisted of all the 5,046 senior secondary school (SSS) II students offering Chemistry in all public senior secondary schools in Ekiti State. The sample for the study consisted of all the 198 SSSII students offering Chemistry in intact classes of the six secondary schools selected for the study. The selection was done through multistage sampling procedure.

Chemistry Students' Anxiety Rating Scale (CSARS) was used for data collection while three Instructional Guides for Teachers using the Instructional Strategies (IGT) were used. They were Instructional Guides for Teachers using Interactive–Engagement Instructional Strategy (IGTIEIS); Instructional Guide for Teachers using Analogy-Enhanced Instructional Strategy (IGTAEIS); and Instructional Guide for Teachers using Conventional Instructional Strategy (IGTCIS).

Chemistry Students' Anxiety Rating Scale (CSARS) was adapted from the Mass-Anxiety Scale (MAS) by Woldemmanuel et al., (2013). The items on the Mass-Anxiety Scale were reframed to suit the present study, some item were also replaced with new items that are germane to anxiety in Chemistry. It was designed to get information about student's anxiety level that relates to success in chemistry. It comprises two sections; A and B. Section A dealt with the demographic information on gender and location. Section B consisted of a Likert type scale with 20 items that the students responded to by ticking the option most agreeable to them, ranging from Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD).

The validity of the instrument designed for the study i.e. Chemistry Students' Anxiety Rating Scale (CSARS) was ascertained using face and content validity procedures by professionals in Psychology and Tests, Measurement and Evaluation. A field testing was carried out on the instrument which involved thirty (30) senior secondary II chemistry students randomly selected from the regular students being taught by their teachers through the conventional mode of instruction. The reliability of the instrument was established using test re-test method. The scores obtained for each of the instrument were subjected to Pearson Product Moment Correlation formula to obtain the reliability coefficients of 0.83 which was believed to be high enough for a research of this nature.

The experimental procedure for this study was in three stages, the pre-treatment stage (one week), the treatment stage (six weeks) and the post-treatment stage (one week). Eight weeks altogether were used for the whole study. The data obtained were analyzed using descriptive and inferential statistics. Descriptive statistics such as frequency counts, percentages, mean, standard deviation and bar-charts were used to answer the research question raised. Inferential statistics such as Analysis of Variance (ANOVA) and Analysis of Co-variance (ANCOVA) (using pre-test scores of covariates) were used to test the hypotheses generated at 0.05 level of significance.

Results

Research Question 1: What is secondary school students' anxiety in Chemistry before and after treatment?

In order to answer the question, mean scores relating to secondary school students' anxiety in Chemistry before and after treatment were computed and compared. The result is presented in Table 1

Table 1: Secondary School Students' Anxiety in Chemistry Before and After Treatment.

Group	***N***	***Pretest***		***Posttest***		***Mean Difference***	***% Mean Difference***	***Ranking***
		Mean	***SD***	***Mean***	***SD***			
Interactive Engagement	62	70.84	6.38	39.94	8.08	-30.90	-77.40	1st
Analogy-Enhanced	72	70.90	30.94	47.92	3.61	-22.98	-48.00	2nd
Conventional	64	69.11	6.20	66.38	6.24	-2.73	-4.11	3rd
Total	198	70.30	6.30	50.98	12.72	-19.32	-37.90	

Table 1 reveals that students in the Interactive-Engagement group had a mean score of 70.84 on anxiety in Chemistry while those in the Analogy-Enhanced and conventional groups were 70.90 and 69.11 respectively before treatment. After the treatment, students exposed to Interactive Engagement had the least mean score of 39.94 on anxiety in Chemistry, closely followed by those taught using Analogy-Enhanced (mean=47.92) while students exposed to conventional method had the highest mean score of 66.38. This implies that secondary school students' anxiety in Chemistry before treatment was generally high but reduced on exposure to treatment. The secondary school students' anxiety in Chemistry before and after treatment is further depicted in Figure i.

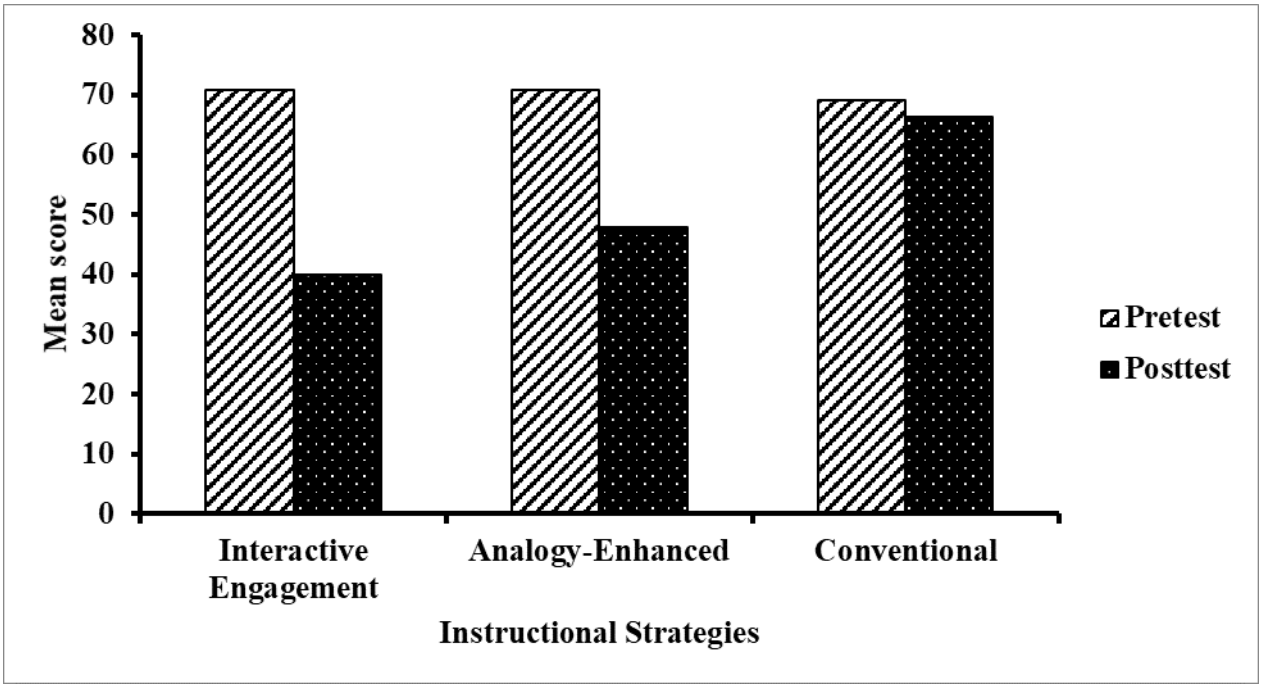

Figure i: Bar Chart Showing Secondary Schools Students' Anxiety in Chemistry Before and After Treatment.

Hypotheses Testing

Hypothesis 1: There is no significant difference in the anxiety of students using interactive-engagement, analogy-enhanced and the conventional instructional strategy in Chemistry.

Mean scores of students' anxiety towards Chemistry before and after treatment were computed and subsequently compared for statistical significance using Analysis of Covariance (ANCOVA) at 0.05 level of significance. The result is presented in table 2.

Table 2: ANCOVA of Students' Anxiety in Chemistry by Treatment

Source	SS	df	MS	F	P
Corrected Model	25107.855	3	8369.285	240.003	.000
Covariate(Pretest)	590.275	1	590.275	16.927	.000
Group	25089.949	2	12544.975	359.747	.000
Error	6765.099	194	34.872		
Total	546565.000	198			
Corrected Total	31872.955	197			

p<0.05

The result in Table 2 reveals that there is significant difference in the anxiety of students exposed to Chemistry using interactive- engagement, analogy-enhanced and the conventional instructional strategy in Chemistry at 0.05 level of significance ($F_{2,194}$ = 359.747;

p< 0.05). The null hypothesis is rejected. Multiple Classification Analysis (MCA) was used to determine the effectiveness of treatment (Instructional strategy) at enhancing students' anxiety in Chemistry. The result is presented in Table 3.

Table 3: Multiple Classification Analysis (MCA) of students' anxiety in Chemistry by treatment

Grand mean= 50.98					
Variable + Category	**N**	**Unadjusted Devn'**	**Eta²**	**Adjusted For Independent + Covariate**	**Beta**
Interactive-Engagement	62	-11.04	.79	-11.07	.02
Analogy-Enhanced	72	-3.06		-2.91	
Conventional	64	15.48		15.46	
Multiple R				0.024	
Multiple R^2				0.001	

Table 3 shows that students exposed to Interactive-Engagement strategy had the least adjusted mean score of 39.91(50.98+(-11.07) on anxiety in Chemistry, closely followed by those taught with Analogy-Enhanced instructional strategy with an adjusted mean score of 48.07 (50.98+(-2.91) while students in the conventional group had the highest adjusted mean score of 66.44 (50.98+15.46). This implies that Interactive-Engagement and Analogy-Enhanced constitute effective instructional strategies for reducing students' anxiety in Chemistry. The treatment accounted for about 79% (Eta^2=0.79) of the observed variance in students' anxiety in Chemistry. However, about 21% of the observed variance in the students' anxiety is not accounted for during treatment, because they are believed to be on the other hidden variables not checked in this study. Hence, there is need for post-hoc test analysis. Here, Scheffe post–hoc test was carried out.

In order to locate the sources of pairwise significant difference among the groups, Scheffe post-hoc test was carried out. The result is presented in Table 4.

Table 4: Scheffe post-hoc analysis of students' anxiety in Chemistry by treatment

Group	**1**	**2**	**3**	**N**	**Mean**
Interactive Engagement **(1)**		*	*	62	47.92
Analogy- Enhanced **(2)**			*	72	39.94
Conventional Method **(3)**				64	66.38

p<0.05 * denotes pair of group significance

Table 4 reveals that there is significant difference between the anxiety of students exposed to interactive Engagement and Analogy-Enhanced instructional strategy at 0.05 level of significance. Similarly, the mean difference between the anxiety of students in Interactive Engagement and control, Analogy-Enhanced and control groups is statistically significant at 0.05 level in each case.

Hypothesis 2: There is no significant difference in the anxiety of male and female students exposed to interactive-engagement, analogy-enhanced strategies and the conventional method in Chemistry

In testing the hypothesis, anxiety mean scores of male and female students in Chemistry in interactive-engagement, analogy-enhanced and conventional strategies were computed and subsequently compared for statistical significance using Analysis of Covariance (ANCOVA) at 0.05 level of significance. The result is presented in Table 5.

Table 5: 2 x 3 ANCOVA Summary of Students' Anxiety in Chemistry by Gender and Treatment

Source	SS	Df	MS	F	P
Corrected Model	25308.345	6	4218.058	122.726	.000
Covariate(Pretest)	637.176	1	637.176	18.539	.000
Sex	64.055	1	64.055	1.864	.174
Group	22659.387	2	11329.694	329.642	.000
Sex * Group	141.932	2	70.966	2.065	.130
Error	6564.609	191	34.370		
Total	546565.000	198			
Corrected Total	31872.955	197			

p>0.05 * denotes interactive effects of sex on the group

Table 5 shows that there is no significant difference in the anxiety of male and female students exposed to interactive-engagement, analogy-enhanced strategies and the conventional method in Chemistry at 0.05 level of significance ($F_{2, 191}$= 2.065; p>0.05). The null hypothesis is not rejected. Similarly, the main effect of sex ($F_{1, 191}$= 1.864, p>0.05) on students' anxiety in Chemistry is not significant at 0.05 level. However, treatment had significant effect on students' anxiety in Chemistry ($F_{2, 191}$= 329.642, p<0.05). `

Hypothesis 3: There is no significant difference in anxiety of rural and urban students exposed to interactive–engagement, analogy-enhanced strategies and the conventional strategy in Chemistry.

The mean scores of Chemistry students exposed to interactive-engagement, analogy-enhanced strategies and the conventional strategy in the Chemistry Students' Anxiety Rating Scale were computed and subsequently compared for statistical significance using Analysis of Covariance (ANCOVA) at 0.05 level of significance. The result is presented in Table 6.

Table 6: ANCOVA Showing Students' Anxiety in School Location by Treatment

Source	SS	Df	MS	F	p
Corrected Model	25161.459	6	4193.577	119.343	.000
Covariate(Pretest)	584.133	1	584.133	16.624	.000
Location	42.904	1	42.904	1.221	.271
Group	14516.503	2	7258.252	206.560	.000
Location * Group	6.104	2	3.052	.087	.917
Error	6711.495	191	35.139		
Total	546565.000	198			
Corrected Total	31872.955	197			

p>0.05 * denotes interactive effects of location on the group

Table 6 reveals that there is no significant difference in the mean scores of rural and urban students exposed to interactive-engagement, analogy-enhanced strategies and the conventional method in the Chemistry Students' Anxiety Rating Scale at 0.05 level of significance. The null hypothesis is not rejected. Similarly, the main effect of school location on students' anxiety in Chemistry is not significant at 0.05 level ($F_{2,191}$= 1.221; p>0.05). In contrast, the effect of treatment on students' anxiety in Chemistry is statistically significant at 0.05 level ($F_{2,191}$= 206.560; p<0.05)

Discussion

The study revealed that the students' anxiety in chemistry before treatment in secondary school was very high which later reduced after treatment, this may be probably be due to the fear being nursed by students in handling chemical and laboratory wares and the general belief that Chemistry is abstract in nature. This finding supports the assertion of Jegede (2007) that students' anxiety towards the learning of Chemistry and Chemistry laboratory activities make them loose interest, which might be due to past experiences in science classes, lack of role model, exposures to science anxious teachers, among others.

The study showed that there was significant difference in the anxiety of students using interactive- engagement, analogy enhanced and the conventional instructional strategies respectively. This is in concordance with the opinion of Akiri and Ugborugbo (2008) that anxiety has been linked to startle responses in infants, intrapsychic conflict, and separation of children from parents, classical and operate conditioning, derive level, emotional responsiveness, brain damage, interpersonal disapproval, self-creative freedom, failure of personal expectancies, self-preoccupation and excessive arousal. The finding also supports that of Jegede (2007) who submitted that students' anxiety toward the learning of Chemistry and Chemistry laboratory activities make them loose interest in that area.

This finding is also in concordance with the submission of Cheung, (2015) who observed that most students fear Chemistry, hence see it as vague. This may be a product of the abstract nature of Chemistry and the approach (instructional strategy) being used by

most Chemistry teachers. According to them, this can make the students perceive the subject as tedious and consequently become "chemophobic".

The study also showed that there was no significant difference between the anxiety of male and female students exposed to the two strategies and the conventional strategy in Chemistry. This is in contrast to the submission of Woldeamanuel et al, (2013) who opined that female student showed more fear or anxiety towards the learning of Chemistry than their male counterparts. This finding also further contradicted the finding of Jegede (2007), which was aimed at finding out students' anxiety towards the learning of chemistry, that female students have higher level of anxiety towards the study of chemistry than their male counterparts.

Further finding of this study is that there was no significant difference between the anxiety of rural and urban students exposed to the two strategies and the conventional strategy in Chemistry. From the findings of this study, it could be accentuated that location has no effect on the anxiety of the students. The finding of this study further corroborated the findings of Jegede (2007) that anxiety in Chemistry might be due to past bad experiences, lack of role models and racial stereotyping. He also went further to explain that students whether male or female and urban or rural-based shows great anxiety towards the learning of chemistry.

Conclusion

The study concludes that Interactive-Engagement and Analogy-Enhanced strategies reduced the anxiety of the students consequently leading to a better academic performance in Chemistry. The anxiety of students exposed to Interactive-Engagement, Analogy-Enhanced and conventional strategies of teaching do not differ by gender and school location.

Recommendations

Based on the findings of this study, it was recommended that:

i. There is need for inclusion of interactive-engagement and analogy-enhanced instructional strategies in the secondary school curriculum as alternative teaching strategies that would reduce the anxiety of Chemistry students.
ii. Since the anxiety of students in Chemistry are not gender-biased, interactive-engagement and analogy-enhanced instructional strategies should be enshrined as veritable tools for reducing students' anxiety, irrespective of gender.

References

Akiri, A. A. & Ugborugbo, N. M. (2008). An Examination of Gender Influence on Teachers Productivity in Secondary Schools. *J. Soc. Science,* 17(3), 185 – 191.

Cheung, D. (2009). Students' attitudes toward chemistry lessons: The interaction effect between grade level and gender. *Research in Science Education,* 39, 75–91.

Ezrailson, C., Kamon, L., Loving, C. & McIntyre, P. M. (2006). Teaching through Interactive Engagement. *School Science and Mathematics,* 106(7), 278.

Genden, J. (2011). What Are the Different levels of Anxiety?. Retireve March 8 2021. From http://www.livestrong.com/article/97139-differnt-levels-anxiety/

Jegede, S. A. (2007). Students' anxiety towards the learning of chemistry in some Nigerian secondary schools. *Educational Research and Review,* 2(7), 193–197.

Meltzer, D. E. & Manivann, K. (2007). Transforming the Lecture Hall Environment: The Full Interactive Physics Lecture. *American Journal of Physics,* 70(6), 639 – 654

Palmer, H. (2012). Science Anxiety and Self-Esteem: Performance in Science and Technology. Unpublished Ph.D thesis. West Visayas State University. Lapaz, Iloilo City.

Udo, M. K., Ramsey, G. P. & Mallow, J. V. (2004). Science anxiety and gender in students taking general education science courses. *Journal of Science Education and Technology,* 13(4), 435–446.

Woldeamanuel, M. M. (2013). Student's Anxiety towards the Learning of Chemistry in Some Ethiopian Universities. AJCE,

Cite this article:

Author(s), Amos Olusola OGUNJOBI (Ph.D.), Folasade Busayo OJOBOLA (Ph.D.), (2021). "Effects of Interactive-Engagement and Analogy-Enhanced Strategies On Students' Anxiety in Chemistry in Ekiti State Secondary Schools". **Name of the Journal:** International Journal of Academic Research in Business, Arts and Science, (EGCSJ.COM), P, 14- 26. **DOI**: http://doi.org/10.5281/zenodo.5035476 , Issue: 1, Vol.: 1, Article: 2, Month: April, Year: 2021. Retrieved from https://www.ijarbas.com/all-issues/

Published by

AND

ThoughtWares Consulting & Multi Services International (TWCMSI)