

Effect of Differentiated Instruction on Interest of Students in Organic Chemistry in Benue State, Nigeria

Akpoghol Timothy Vershima^{1*}, Jackson Ochigbudu Ode² and Janet Ngunan Adzape³

¹Department of Chemistry, Benue State University, Makurdi, Nigeria.

²Department of Science and Mathematics Education, Benue State University, Makurdi, Nigeria.

³Department of Chemistry Education, Joseph Sarwuan Tarka, University, Makurdi, Nigeria.

*E-mail: timversh@gmail.com

Abstract. The study investigated the effect of differentiated instruction on interest of students in organic chemistry in Makurdi, Nigeria. Non-randomized, non-equivalent quasi-experiment design was used for the study. Two research questions and two hypotheses guided this study. The population of the study was 14,360 senior secondary II students in Benue State Zone A Senatorial District for the 2023/2024 academic session comprising 7,232 male and 7,128 female students. Multi-stage sampling technique was employed to select a sample of 220 SS II students. Six intact classes constituted the sample. The instrument –Organic Chemistry Interest Scale (OCIS) was developed and validated by the researchers. The instrument was trial tested on 30 students and it yielded reliability coefficient of 0.92 through Cronbach alpha. Data were collected and analysed using mean and standard deviation to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The findings revealed a statistically significant difference between the mean interest ratings of students taught using differentiated instruction and traditional conventional strategy ($F = 584.310$, $P = 0.000 < \alpha = 0.05$). The findings also revealed that there is no significant difference between the mean interest rating of male and female students taught using differentiated instruction ($F = 0.583$, $P = 0.447 > 0.05$). Based on the findings of this study, it was recommended among others that teachers should adopt differentiated instruction in teaching organic Chemistry in senior secondary school as it has potential of improving students' interest in organic Chemistry and bridging gender gap in students' interest particularly in organic Chemistry.

Key words: Differentiated instruction, Organic Chemistry, Interest and Gender.

Introduction

Science education encompasses the teaching of science concepts, methods of teaching and addressing misconceptions held by learners regarding science concepts. Effective science teaching and learning is essential to equip citizens with scientific literacy necessary to function in the ever changing world. It is the key to the development of nations in different spheres such agriculture, medicine, engineering, Information and Communication Technology (ICT), housing among others [1]. At secondary school level, Chemistry is one of core science subjects offered by students. It is significant to man's successful living. It is a cardinal science subject required for further learning of a number of science related professional courses such as Medicine, Agriculture, Industrial chemistry, Botany, Pharmacy among others. Organic component of Chemistry plays a vital role in society and human lives particularly with respect to pharmaceutical drugs production, production of agrochemicals such as pesticides, herbicides and fertilizers, food additives, polymer synthesis including biofuels and solar cells as sources of energy [2].

Despite the significance of Chemistry to national development, students' interest in the subject has been low. Abdul [3] notes that there is generally low interest in Chemistry and science related disciplines at all levels of education in Nigeria. The analysis of Chemistry results of May/June (WAEC) senior secondary school certificate examinations in Nigeria, from 2015-2024 reveals low students' interest in Chemistry particularly the organic component as their results have been persistently poor due to lack of interest. Students' persistent failure and loss of interest in Chemistry have been linked to perceived difficulties in organic Chemistry by students and poor teaching method by Chemistry teachers [2]. This is supported by [4], who states that poor teaching methods employed by Chemistry teachers contributed to poor interest of students irrespective of gender in Chemistry. Furthermore, Ahmad [5] linked gender differences in academic performance and interest in Chemistry to the kind of defective chalk and talk teaching method adopted by Chemistry teachers that do not cater for individual differences among learners.

The use of teaching strategies that do not take into consideration the differences in terms of learning styles, needs and abilities of individual learners could be responsible as well for students' low interest in Organic Chemistry. Differentiated instruction is an instructional strategy that help students with diverse needs and learning to master challenging academic content [6]. It is therefore, a teaching approach that caters for varied learners. Thus, it is an approach to teaching that aims at meeting students' differences in the classroom. It requires the teacher planning and executing instruction based on students' different learning abilities as well as learning styles and adopting varied teaching

strategies in order to create the best learning experience possible for all categories of learners. According to Chen and Chen [7], differentiated learning is a pedagogical approach that provide teachers with a starting point for meeting students' diverse learning needs to engender inclusivity in learning. When the content delivered does not suit the learners' learning competencies and peculiarities, it could result to frustration and withdrawal of interest from learning tasks.

The concept of interest in relation to classroom teaching and learning has become the concern of educators and psychologists for years. In this study, interest is operationally defined as students' affective state of being engaged in mathematics learning whereby students enjoy the learning process. Interest is the feeling of attention and curiosity students develop for the teaching and learning of organic chemistry. As widely believed, interest has a vital role in mathematics learning [8-9]. Generally, students fear and dislike concepts because they see it as abstract [10]. This has resulted in their lack of interest, displaying negative attitude towards it, retaining concepts poorly taught and leading to persistent poor male and female students' performance in Chemistry.

Another variable that could influence students' interest in Chemistry is gender and it is an important variable in the school system. Gender refers to the condition of being male or female. It is analytic concept that describes sociological roles, cultural responsibilities and expectations of men and women in a given society or cultural setting. Eze [11] explained that gender described the personality traits, attitudes, behaviour, values, relative, power, influence, roles and expectation that society ascribes to the two sexes on differential basis. Therefore, gender is a psychological term and a cultural construct developed by society to differentiate between the roles, behaviour, mental and emotional attributes of males and females [12]. Ezeudu and Obi [13] state that teachers encourage gender stereotype by giving different treatment to males and females in class. Teachers go further to give different career guidance to males and females. However, it is expected that learning experiences offered to students in schools should not discriminate against males and females. There is need to see both male and female students given equal access to education especially in Chemistry.

Several studies have been conducted in literature on the effect of differentiated instruction on students' learning outcomes in different subject. For instance, Vanklaveren, Vonk, and Cornelisz [14] and Abbey [15] have reveals that differentiated learning has greater impact on students' learning outcome. Also, Deunk et al. [16] found that differentiated instruction has some potential for improving students' outcome when implemented in the classroom. However, evidence for the benefits of differentiated instruction on students' interest in organic chemistry is scarce in the study area. To this end, this study investigated the effects of differentiated strategy on senior secondary school students' interest in organic chemistry.

Research Questions

The study provided answers to the following questions.

1. What is the mean difference between the interest ratings of students taught organic chemistry using differentiated instruction and those taught using the conventional chalk and talk strategy?
2. What is the mean difference between the interest ratings of male and female students taught organic chemistry using differentiated instruction?

Hypotheses

These hypotheses were formulated and tested at 0.05 level of significance

1. There is no significant mean difference between the interest ratings of students taught organic chemistry using differentiated instruction and those taught using the conventional chalk and talk strategy.
2. There is no significant mean difference between the interest ratings of male and female students taught organic chemistry using differentiated instruction.

Research Method

This study adopted the quasi-experimental design of non-equivalent pre-test and post-test type. The design was used because the study involved experimental and control groups and the use of intact classes. The population of the study was 14,360 senior secondary II students from co-educational secondary schools in Benue State Zone A Senatorial District for the 2023/2024 academic session. The population according to Benue State Ministry of Education, Makurdi in 2024, was made up of 7,232 male and 7,128 female students. The sample of this study was 220 SS II students spread across six intact classes. The researchers adopted multi-stage sampling procedure. The sample of 220 students consisted of 115 students in the differentiated instruction group and 105 students in the conventional group. Out of 115 students in differentiated instruction group, 51 were males while 64 were females. One instrument –Organic Chemistry Interest Scale (OCIS) developed by the researcher was used for data collection.

The OCIS was a Likert type scale was designed by the researcher to obtain students' interest about organic chemistry. The twenty items of the OCIS comprised ten 10 positive items and ten 10 negative items. The OCIS was expected to elicit responses based on the feelings of the students on assignment points of 4, 3, 2 and 1 on four-categories: strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) for positive items and in reverse order for negative items. The instrument was

subjected to three experts' judgment to ascertain their face validity. Two of these experts were from Chemistry Education Unit, Department of Science and Mathematics Education in Benue State University, Makurdi and the other one was from Measurement and Evaluation unit in the same Benue State University, Makurdi. Their observations and suggestions were used to improve the quality of items in the instrument. The instrument was trial tested on 30 students of one of the co-educational secondary schools in the study area. The school was not among the schools that were selected for the study. The reliability coefficient of OCIS was calculated using Cronbach alpha and it yielded reliability coefficients of 0.92. This reliability coefficient is enough to guarantee the use of the instrument for data collection in the study. This is supported by Metha and Makhosi [17] who posits that an instrument with a reliability coefficient of 0.55-0.99 is sufficiently reliable for research purpose.

There were a total of six teachers from the six schools under study as research assistants. The researcher organized a five- day uniform training programme for all the Research Assistants in various groups. Three of these teachers were for the experimental group and the other three for the control group. These six teachers were trained by the researcher on how to go about the study. Before the treatment, the OCIS was administered to the experimental and control groups as pre-test. Two days were used for pre-testing of students in the experimental group and in the control group. The treatment lasted for four (4) weeks and it commenced in week one. During the period, students in the experimental group were exposed to differentiated instructional strategy and those in the control group were exposed to conventional strategy by trained Chemistry teachers from the sampled schools. Two lessons were taught every week. The contents that were taught were alkanes, alkenes and alkynes.

The schools for experimental groups were far from those of the control groups to avoid students and class interaction. After the completion of the lessons, post-OCIS was administered to the two groups to measure students' interest in organic chemistry. The data obtained was subjected to analysis according to the research questions and hypotheses. Research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The advantage of using ANCOVA lies in its ability to take care of any existing initial differences of the sampled students.

Results and Discussion

Research Question 1. What is the mean difference between the interest ratings of students taught organic chemistry using differentiated instruction and those taught using the conventional chalk and talk strategy?

Table 1. Mean Interest Rating and Standard Deviation Students in Organic Chemistry when taught using Differentiated Instruction and Conventional Chalk and Talk Strategy.

Groups	No of Students	Pre-Interest		Post-Interest		Mean Gains
		$\bar{X}$	δ	$\bar{X}$	δ	
Differentiated Instruction	115	1.39	0.49	2.75	0.46	1.36
Conventional strategy	105	1.41	0.49	1.23	0.44	-0.18
Mean difference		-0.02		1.52		1.54

Table 1 shows that the mean interest rating of students taught organic chemistry using differentiated instruction was 1.39 with the standard deviation of 0.49 and those taught using conventional strategy had 1.41 with the standard deviation of 0.49 at the pre-interest level. After the intervention programme, students taught using differentiated instruction obtained mean interest rating of 2.75 and the standard deviation of 0.46 while those exposed to conventional strategy obtained mean score of 1.23 with the standard deviation of 0.44. The difference in the mean gain between differentiated instruction and conventional strategy was 1.54 in favour of differentiated instruction.

Research Question 2. What is the mean difference between the interest ratings of male and female students taught organic chemistry using differentiated instruction?

Table 2. Mean and Standard Deviation of Interest Rating of Male and Female Students Taught Organic Chemistry using Differentiated Instruction.

Groups	No of Students	Pre-Interest		Post-Interest		Mean Gain
		$\bar{X}$	δ	$\bar{X}$	δ	
Male	51	1.39	0.49	2.75	0.42	1.36
Female	64	1.39	0.49	2.72	0.49	1.33
Mean difference		0.00		0.06		0.03

In Table 2 the mean interest rating of male and female students in organic chemistry were 1.39 and 1.39 respectively at the pre-test stage. After the intervention the mean interest rating in organic chemistry of male and female students were 2.75 and 2.72 with the standard deviation of 0.42 and 0.49 respectively. The difference in the mean gain between male and female students' interest ratings was 0.03 in favour of male students.

Hypothesis 1. There is no significant mean difference between the interest ratings of students taught organic chemistry using differentiated instruction and those taught using the conventional chalk and talk strategy.

Table 3. Result of ANCOVA of Students Interest Rating in Organic Chemistry when Taught using Differentiated Instruction and Conventional Chalk and Talk Strategy.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig	Remark
Corrected Model	127.058 ^a	4	31.764	155.82	0.000	S
Intercept	84.867	1	84.867	416.313	0.000	S
Preinterest	0.225	1	0.225	1.106	0.294	NS
Group	119.114	1	119.114	584.310	0.000	S
Sex	0.109	1	0.109	532	0.466	NS
Group*Sex	0.020	1	0.020	0.097	0.756	NS
Error	43.829	215	0.204			
Total	1071.000	220				
Corrected Total	170.886	219				

S = significant at $p < 0.05$ and NS = Not significant at $p > 0.05$

Table 3 shows that $F(1, 215) = 584.310$ and $p = 0.000 < \alpha = 0.05$, which is the result of ANCOVA in interest rating of students in organic chemistry using differentiated instruction and conventional strategy. The result reveals that there is significant difference in students' interest rating in organic chemistry of those taught using differentiated instruction and conventional strategy. The null hypothesis was therefore rejected, indicating that there was significant difference in mean interest rating of students taught with differentiated instruction and conventional strategy. The difference was in favour of differentiated instruction.

Hypothesis 2. There is no significant mean difference between the interest ratings of male and female students taught organic chemistry using differentiated instruction.

Table 4. Result of ANCOVA of Interest Rating of Male and Female Students when Taught Organic Chemistry using Differentiated Instruction.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	0.323 ^a	2	0.161	0.774	0.464	.014
Intercept	87.180	1	87.180	417.909	0.000	.789

Pretest	0.201	1	0.201	0.962	0.329	.009
Gender	0.110	1	0.122	0.583	0.447	.005
Error	23.364	110	0.209			
Total	892.000	115				
Corrected Total	23.687	114				

a. R Square = .014 (Adjusted R Square = -.004)

Table 4 reveals that $F(1, 110) = 0.583$ and $p = 0.447 > \alpha = 0.05$. Since p is greater than 0.05, the null hypothesis is not rejected. This implied that there was no significant difference in the mean interest rating of male and female students who were taught organic chemistry using differentiated instruction. The partial Eta squared of 0.005 was obtained meaning that only 0.5% of mean interest rating for gender could be accounted for by gender.

Discussion of Findings

The study examined differentiated teaching strategy and its effects on students' interest in organic chemistry. Findings of this study revealed that there is significant difference between the mean interest ratings of students taught organic chemistry using differentiated instruction and conventional chalk and talk teaching strategy. This implies that differentiated instruction enhanced students' interest in organic chemistry compared to conventional chalk and talk strategy. This finding is similar to that of several studies [14-16] whose results revealed that differentiated learning has greater impact on students learning outcome. Furthermore, the result of the study supported the findings of Kado et al. [6] whose result revealed a significant difference in favour of the experimental group taught using differentiated instructional strategy over the control group taught conventionally. The agreement of the findings could be attributed to the fact that differentiated instruction involves the use of varied materials and approaches that take individual differences among learners.

The findings of the study also revealed no significant difference in the interest of male and female students when taught organic chemistry concepts using differentiated instruction. This finding is consistent with the finding of Njagi [18] and Kado et al. [6] who found differentiated instruction to be gender friendly. The implication of the findings is that differentiate instruction is an effective instructional and when effectively used, chemistry teachers can improve the interest of students in chemistry. The fact that both male and female chemistry students demonstrated parity in interest in organic chemistry, it means that differentiated instruction can be used in a mixed class comprising males and female students to engender students' interest in organic chemistry.

Conclusion

Based on the findings of this study, the researcher concludes that differentiate instruction when enhances students' interest in organic chemistry and it is gender friendly. It is therefore recommended that:

1. Chemistry teachers should adopt the approach as it will enable them cater for the individual difference of students in the chemistry classroom.
2. Chemistry teachers and should embrace differentiated instruction while teaching organic chemistry to bridge gender differentials in students' interest in chemistry.
3. Pre-service Chemistry teachers should be trained on how to effectively use differentiated instruction in teaching organic chemistry after graduation to engender students' interest in the subject.

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