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Improving Interest and Performance in Organic Chemistry Pedagogy by Incooperating Animations

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Abstract Chemistry curricula incorporate many abstract concepts that are important but difficult for students to understand. Educational researchers have recently begun to concentrate on the development of a wide variety of visualization tools and novel pedagogies to aid students in science learning at all levels. This study used the Roger Frost organic animation package to ascertain the impact of interactive computer visualization (ICV) in the teaching of organic chemistry at the Nigeria Certificate in Education and Degree levels. It adopted a quasi-experimental research design and used Structured Personal Data Questionnaire (SPDQ) and Semester Result (SR) for data collection. A mobile virtual classroom was created and used throughout the study. The students identified mechanism of reactions, cycloaddition reactions, synthesis of proteins and certain aspects of IUPAC nomenclature as challenging areas in their study of organic chemistry. After the three months teaching period using the organic simulation program, results from evaluating the students showed that interest and confidence in the selection and answering of questions from topics taught using ICV improved, the mean performances of the students almost doubled when ICV was introduced in the teaching program, a mean value of 48.20 out of 60 was obtained which indicated that the animated teaching was effective to a high extent and a general enhancement of the interest of students in the study of organic chemistry. The researchers therefore recommended that teaching of organic chemistry should be enriched with relevant illustrations, organic chemistry text books should be sold with CDs having computer simulations of organic reaction mechanisms for better appreciation. Virtual chemistry room for computer assisted instructions should be included in the design of chemistry laboratory to enhance instructional delivery using the 21st century pedagogy. Computational chemistry should be included in the university chemistry curriculum. Also basic computer knowledge by academic staff should be emphasized to enable them cope with the proposed digitalization of the course.

Keywords: *organic chemistry, simulation, animation, ICV*

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1. Introduction

Chemistry is one of the important branches of science and occupies a central position in preparing students who wish to pursue career in medicine, industrial chemistry, food science, engineering and other applied/related disciplines. Chemistry curricula commonly have many abstract concepts that cannot be easily understood if these underpinning concepts are not sufficiently grasped by the student [1,2]. The abstract nature of chemistry concepts along with other learning difficulties means that chemistry classes require a high-level skill for proper application [3]. One of the essential characteristics of chemistry is the constant interplay between the macroscopic and microscopic levels of thought, and it is this aspect of chemistry learning that presents a significant challenge to novices [4]. The abstract concepts of chemistry require thinking on several levels and organic chemistry is no exception to this.

Organic chemistry is a component of the first year General Chemistry curriculum in the undergraduate program of most African universities. Beginners in the learning of Organic chemistry usually have confusion and difficulty because there are no problem-solving algorithms, it requires three-dimensional thinking and has an extensive new vocabulary. One of the major difficulties for students in organic chemistry is the understanding of the three-dimensional nature of molecules which they have great difficulty converting between the two dimensional drawings used in text books and on classroom boards to represent molecules and their three-dimensional structures. Without this understanding, to survive the course, students have to memorize a large vocabulary of molecules and rules to pretend they understand the three-dimensional structures. The difficulty encountered by undergraduate students in understanding the course prevents many of them from continuing with this career path.

Educational researchers have recently begun to concentrate on the development of a wide variety of visualization tools and novel pedagogies to aid students in science learning at all levels. These tools describe a spectrum of learning environments that support many different types of visualization from concretizing abstract concepts to understanding spatial relationships. Tools are now available that allow students to visualize experimental data sets, simulate experiments, or construct models of imperceptible entities. Visualization is any technique for creating images, diagrams, or animations to communicate a message. Visualization which involves visual imagery has been an effective way to communicate both abstract and concrete ideas since the dawn of man. Scientific visualization is the use of interactive, sensory representations, typically visual, of abstract data to reinforce cognition, hypothesis building, and reasoning.

At their core, each of these tools presents students and instructors with several unique opportunities for teaching and learning science that allow students to visualize complex relationships directly from computer-generated visualization tools to enrich traditional pedagogies [5,6,7]. Bennett [8] has suggested urgent changes in the roles of teachers, students and computers, so that students would interact collaboratively with teachers and technology. Technological tools that integrate multiple representations provide students with opportunities to visualize chemistry and promote conceptual understanding [9].

A cursory look at the performance of chemistry students in A.I.F.C.E in Organic chemistry III (CHEM 323 for degree program) and Natural Products and Amines (CHE 323 for NCE program) from 2010-2012 leaves a lot to be desired in the learning of this area of chemistry. Observation was made of a progressive increase in the percentage of students failing the courses by the years i.e 7 %, 55 % and 61 % for CHEM 323 and 40 %, 47 % and 52 % for CHE 323 in 2010, 2011 and 2012 respectively. A number of chemistry tutorial software and applications have been development but so far the researchers are yet to see anyone that have been incooperated in the teaching and learning of organic chemistry in Nigerian tertiary education institutions. The concern of the researchers in not allowing this trend to continue led to this study. This study adopted a new pedagogical approach in content delivery to ascertain the impact of using interactive computer visualization since it has been discovered that visualization tools aid students in the learning of science.

Specifically, the study focused on;

1. Comparing students' examination performances in the selected organic chemistry courses after a semester of exposure to the use of ICV with previous performances in the courses.
2. Determining the extent to which the use of ICV affected the interest of students in the study of organic chemistry.

2013/2014 third year degree and NCE students of the Department of Chemistry, Alvan Ikoku Federal College of Education, Owerri were used for the study. Two research questions were posed for this investigative study. They are;

1. Is there any significant difference between students' examination performances in the selected organic chemistry topics taught using ICV and their previous performance in the courses?
2. To what extent does ICV approach impact on the interest of the students in the study of organic chemistry?

2. Methodology

A quasi-experimental research design was adopted as already existing intact group were used. The population of this study comprised of the 2013/2014 third year degree students and final year NCE students of the Department of Chemistry in the School of Sciences AIFCE, Owerri. There were 56 Degree students and 76 NCE students giving a total population of 132 students and all were used for the study since it is a manageable size. This population was chosen because of the observed failure rate of students in the Organic chemistry courses (CHEM 323 and CHE 323) taken at these levels.

Structured Personal Data Questionnaire (SPDQ) and Semester Results (SR) were used to collect data for analysis.

A preliminary survey was carried out to determine the students' preferred interest in the different fields of chemistry and what influenced their preference. This study was done by randomly distributing structured questionnaire to the students in the classroom without prior information to them.

Mobile virtual classroom was set up using a laptop connected to a projector and screen. **Roger Frost Organic Chemistry Teaching Tools** purchased from Russet House Cambridge, UK was deployed for the study. Lesson plans for the two courses i.e CHE 323 and CHEM 323 were prepared from their course outlines as spelt out in the 2012 edition of the NCCE minimum standard and University of Nigeria Nsukka handbooks respectively. The content delivery was handled using two pedagogical techniques; ICV and conventional lecture method. The problematic areas of the courses were taught using ICV while the rest were taught by the conventional method. At the end of the second semester, test instrument which is the semester examination was administered to the students. Percentage and grand mean scores were used to answer the research questions. Independent t-test was also employed to determine the impact of ICV on the performance of students.

3. Results and Discussion

Result of the preliminary study revealed the following;

Table 1. Interest of students in specialized areas in chemistry

Areas of specialization	Students' preferred interest (%)
Physical Chemistry	13
Organic Chemistry	1
Inorganic Chemistry	21
Analytical Chemistry	60
Others	5

100 chemistry students were given the questionnaire while responded and expressed their preferred interest as shown above. Only 1 % of the respondents preferred organic chemistry. Responses gathered to determine the reasons for not choosing organic chemistry were are shown in Table 2.

Table 2. Students' reasons for not preferring a given area in chemistry

Proferred problems	Acceptance of reason (%)
Inability to picture what is taught	51
Unavailability of organic chemistry textbooks	3
Absenteeism from lectures	9
Poor communication ability of the lecturer	16
Total lack of interest in the subject	21

51 % of the respondents considered organic chemistry too abstract since they cannot paint a good picture of 3-dimentional objects and structures on a 2-dimentional teaching tool. This could have also made 16 % of them to consider their lecturers as unable to communicate the content of the course to them. A student who considers a course to have abstract concepts that the lecturers are unable to communicate will definitely lack interest in the said course. This finding agrees supports that better information retrieval occurs when people can attach verbal material to pictorial images and pictorial images to verbal labels, since the two systems are richly interconnected.

The results from the analyses of the data obtained from the post-test questionnaire prepared on a four point likert scale with accepted grand mean of 2.5 administered on sixty eight (68) NCE students and forty (40) degree students to determine the impact of use of ICV on their interest in study of organic chemistry gave Grand Means of 3.13 for NCE students and 3.38 for degree students. These values are clear pointers to the fact that ICV teaching demystifies and builds the students' interest in organic chemistry, makes them understand and retain what has been taught and improves their appreciation of the courses taught with these animations.

Table 3. Independent t-test result for the average performances of students in the ICV and Non-ICV teaching for NCE students

Variables	Number of Students	Mean Examination Performance for the Set	Standard Deviation	t	Degree of Freedom	Significance
ICV teaching	76	21.1184	15.0480	3.470	129	0.001
Non-ICV teaching	55	12.7818	11.2046			

Table 4. Independent t-test result for the average performances of students in the ICV and Non-ICV teaching for Degree students

Variables	Number of Students	Mean Examination Performance for the Set	Standard Deviation	t	Degree of Freedom	Significance
ICV teaching	56	34.7143	13.157	5.833	122	0.000
Non-ICV teaching	68	18.0441	17.738			

The results showed that the mean performances of the students almost doubled when ICV was introduced in the teaching program. This is an indication that the lectures were better understood when animations are used for teaching. In the degree class, the mean performance was approximately 35 out of the total score 70, which can be regarded as a good result. In the NCE class though the mean performance was 21 out of 60, it can still be regarded as a reasonable performance compared to the earlier 13 out of 60 that was achieved without teaching with animation. The results of the t-test obtained from the two results showed that there were very significant differences between the examination performances of the two classes of students when ICV is infused in the teaching of the selected topics in organic chemistry. The use of ICT in schools act as a catalyst in transforming the teaching and learning process as well as improve students' skills while causing behavioural changes.

4. Conclusion

With almost a hundred percent improvement in the students' performance in the final assessment relative to their previous performance, the use of ICV in the teaching of the selected areas in organic chemistry can be said to be very effective. The interest of the students in the study of organic chemistry was greatly improved using this teaching method. This improved interest was later translated into better performance in the courses as was observed in the final evaluation of the ICV program.

5. Recommendations

From the findings in this research, the following recommendations have been made in other to encourage students in the learning of organic chemistry:

1. Teaching of organic chemistry should not be too verbal but rather be enriched with simulations and computer aided visualizations.
2. Chemistry teachers, educational technologists and software developers should synergize their expertise and develop educational resources that will meet with the 21st century pedagogy of teaching and learning.

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