Enhancing Academic Performance of Science Education Undergraduates in Atmospheric Photochemistry using Print and Electronic Instructional Resources in Akwa Ibom State University, Nigeria

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Abstract

Teaching and learning in science education have been linked to availability of resources and reading. Recently, it is assumed printed materials have been replaced by electronic or online materials. This study examined using print and electronic resources to enhance Science Education Undergraduates' performance in the concept of atmospheric photochemistry in Akwa Ibom State University. Two hypotheses guided the study. Quasi-experimental research design was adopted for the study and a sample size of 76 undergraduate chemistry education students was randomly drawn from a population of 122 year two - four chemistry education students in the department of science education, faculty of education. A researcher constructed instrument tagged: Atmospheric Photochemistry Performance Test (APPT) was used for data collection. The instrument contained twenty (20) multiple choice test items and was validated by two assessors. A reliability index of 0.80 was obtained using Kuder-Richardson's formula 20. Independent t-test statistics was used to test the hypotheses at 0.05 level of significance. The findings of the study showed that there is a significant difference in the mean performance score of science education undergraduate taught atmospheric photochemistry using electronic and print instructional resources in favour of those that were taught using electronic resources; and there is no significant difference in the mean performance scores of males and female students taught using electronic and print resources. It was concluded that electronic instructional resources enhanced students' academic performance more than print resources and that instructional resources when properly used, enhanced interest and creativity in the students and hence their performance irrespective of gender. It was recommended among others that teachers should integrate electronic instructional resources into teaching.

Keywords: **Print, Electronic, Instructional resources, Atmospheric-photochemistry**

Introduction

Science education is an interdisciplinary field with contributions from cognitive and development psychology, curriculum studies, education policy studies, history of science, informal learning, innovation, technology studies, sociology, as well as the traditional subjects of methods of teaching science, philosophy of science and laboratory practices. Science education is essential as it helps students develop answers to important questions about the natural world and a scientific approach to questions and issues that matter in their lives and the world around. At the university level, science education advances scientific knowledge and specialization, promotes research and innovation, develops skilled manpower for national development, supports industrial and technological manpower (FRN, 2013), enhances problem solving and critical thinking skills and encourages interdisciplinary collaboration (Akpan, *et al*. 2023).

However, the success of teaching and learning in science education has been linked to availability of resources and students' reliance on reading (Udofia, Babayemi & Sambo, 2024). Students are expected to purchase books and materials required for the classes, some of the required materials maybe available on reserve in the library for limited use. Today's electronic technologies also make instructional materials for class readings available online and on course webpage, thereby allowing and providing free and convenient access

(Akpan, Udofia & Thomas, 2016). The use of both print and electronic resources in science plays a crucial role in enhancing teaching, learning and research. They provide access to scientific knowledge, supports curriculum delivery, as well as help students stay up to date with scientific advancement and help students with effective information, communicate and meaningfully communicate (Akpan, 2022, Paul, *et al.*, 2024).

Globally, promoting gender equality in science is currently used as a developmental strategy for socio economic development of any nation (Akpan & Akpan, 2017). Gender refers to a range of physical, biological and behavioural characteristics pertaining to and differentiating the masculine and feminine population (Itighise, *et al* 2023). Its influence as regards performance has remained a debatable issue. Some studies show that male students achieve and retain higher than their female counterparts, while others have contrary opinions.

Conceptual Review

Print resources refer to the means of communication in the form of printed publications like textbooks, newspaper, magazines, brochures, flyers, reference books, as well as scientific journals, laboratory manuals, charts, diagrams, posters and bulletins. Generally, the basic benefits of the print instructional resources include informing, educating, as well as influencing opinions of students on political, social, economic and cultural development (Idiegbeyan-ose, *et al.,* 2019). Not only pieces of information or news are conveyed to readers, there are also printed resources in all fields of life education, medicine, environment, economics, religious writings (Gautam, *et al.* 2020). Perhaps one major advantage of print resources is that it offers readers access to the text in its entirety, this is built up on both visual and tactile cues. Meaning, the reader can see all, as well as tactilely feel the spatial and physical dimension of the text. It helps improve reading habit, enrich new vocabulary, and comprehension skills, particularly skimming and scanning (Obilor & Ikpa, 2021).

Studies have found that students prefer printed resource material than resources in electronic format. Mizrachi (2014) found that undergraduate students prefer reading their academic texts in print format when they want to achieve a deep learning outcome and acknowledge they comprehend materials better when they learn in print. Magnen, *et al* (2013) observed that students who read works on print scored significantly higher than those who read the PDF version electronically. Ubong, *et al* (2024) found that the use of prints instructional resources in teaching secondary school students significantly improved their academic achievement more than those taught using audio instructional resources.

Another study, Gonca, *et al* (2013) probing into the preference of e-books over printed resources and its effect on learning, unraveled that student generally prefer printed materials and there is no significant difference between the two formats. Tatfeng, *et al* (2024) found that as course materials, students prefer printed textbook rather than e-books. However, Idiegbeyan-ose, *et al* (2019) found both print and electronic resources are complementary in meeting the information needs of undergraduates, as respondents from both groups had the same percentage score.

Electronic resources have expanded from use as technology for communication and online entertainment to tools in education, for developing cognitive thinking and enriching academic activities (Akpan, *et al*, 2025). Examples of electronic resources include, but are not limited to e-books/ online journals, educational websites, multimedia videos, animations, virtual laboratory, augmented reality tools and online courses (Atabang, 2024), as well as internet, computers, mobile phones. Electronic resources have become increasingly popular learning approaches in education system due to the vast growth in technology (Neji & Ntibi, 2021). E-resources have brought sporadic learning opportunities that removes teaching and learning

barriers in science, making learning interactive and enjoyable. However, low interactive e-learning devices, insufficient resource materials, lack of technical skills by the teachers, unstable internet, frustrations faced by less tech-savvy students (Itighise & Akpan, 2023) could be a bane to students' performance.

Neji and Ntibi (2021) posit that students taught with e-learning devices significantly out-performed their counterparts taught with conventional methods. Ihejiamaizu and Ochui (2019) also found that utilization of electronic instructional materials significantly influenced students' academic performance. Etiubon, *et al*, (2021) observed that students taught using computer tutorials achieved and retained significantly better than hose taught using drill practice and lecture strategies. Akpan, et al (2025) noted that students taught with virtual field trip (e-resource) performed better than students taught with physical field trip. Umoetuk and Akpan (2023) also found that students gained better when taught with flipped classroom than their counterpart taught with graphics. Likewise, Essien and Akpan (2017) found that students taught using computer simulation strategy performed better than those taught using expository strategy. However, Itighise, *et al* (2023) found no significant difference in students' utilization of web 2.0 technology in learning.

According to Akpan, *et al*., (2018), atmospheric photochemistry is the study of chemical reactions in the atmosphere driven by sunlight, particularly ultraviolet (UV)) radiation. It involves i). photo dissociation, where sunlight breaks chemical bonds creating free radicals. ii). formation of ozone (O_3): in the stratosphere free oxygen atom (O) reacts with O_2 to form ozone. iii). Smog formation: in the lower atmosphere, sunlight interacts with pollutants like nitrogen oxides (NOx) and volatile organic compounds to produce ozone (Akpan & Udo, 2016), peroxyacetyl nitrate -PAN and smog (Ikpe, *et al*, 2025). iv). Formation of free radicals (OH, NO_3, HO_2), these radicals drive many atmospheric reactions, helping to clean the atmosphere by breaking down pollutants. Atmospheric photochemistry is important in explaining ozone layer formation and destruction, it helps in the understanding of air pollution, climate change, acid rain, global warming, as well as green effects and atmospheric cleansing processes (Akpan *et al*, 2019)

On gender, Etiubon, *et al;* (2021) and Umoetuk, *et al* (2023) found that female students performed better than the male students in Chemistry and Basic science and technology. Gambari *et al* (2018) observed that female students performed better than male counterpart when taught using virtual field trip. While Akpan (2024) found that there is a great gender gap in computer proficiency and other technological devices with the males being more proficient than females. Ukpai and Fomsi (2023) and Olatunde-Aiyedun (2021) also found that male students perform better than their female counterparts and are more likely to take difficult subject areas and challenging problems. Umar, *et al* (2020) and Ado, *et al.* (2017) observed that using innovative computer simulated instructions and ICT showed no significant difference in the performance of male and female students. Likewise, Sunday, Umanah and Udofia (2025); Umanah and Akpan, (2025), Akpan, *et al* (2025), Atabang *et al* (2024) and Oyakhirome and Akpan (2024) found no significance in the mean performance scores of male and female students and gender a non-significant factor in academic achievement of students.

Statement of the Problem

Reading was a major way for students to gain knowledge, develop their reading habits and become more self-aware and knowledgeable in the past; since the advent of technology and electronic resources, it is assumed printed materials have been replaced by electronic or online materials and the habit related to reading has undergone changes. The unique qualities of electronic resources and the need to integrate them into

education have been recognized. With the continuous low academic performance among university students, despite the fact that electronic resources abound, and provide students the chances to transcend the limits of printed materials in terms of time and location is worrisome. Integration of electronic resources into education is laudable, but also has challenges such as institutions not equipped with electronic resources, most students do not have enough internet access, because higher institutions in Nigeria are not networked or connected to the internet, possibly due to high cost or outright neglect. As a result, most students are unable to make use of the benefit or rewards offered by electronic resources resulting in lower learning achievement. This study is significant as there is scarcity of combined print and electronic instructional resources on students' academic performance, especially with limited empirical evidence in Akwa Ibom State. The question is, will the use of print and electronic instructional resources enhance academic performance of science education undergraduates? The study therefore sought to investigate enhancing academic performance of science education undergraduates in atmospheric photochemistry using print and electronic instructional resources in Akwa Ibom State University.

Hypotheses

The following null hypotheses were formulated to guide the study.

1. There is no significant difference in the mean performance scores of science education undergraduates taught atmospheric photochemistry using electronic and print instructional resources.
2. There is no significant difference in the mean performance scores of male and female science education undergraduates taught atmospheric photochemistry using electronic and print instructional resources.

Research Methods

The research design adopted in this study was quasi-experimental design. The design was specific with only posttest and two experimental groups. The study was undertaken among undergraduates in the Faculty of Education (Chemistry, Biology, Integrated Science, Mathematics and Physics Education) Akwa Ibom State University, with a population of two hundred and sixty-two (262) year one students taught the concept atmospheric photochemistry. Multistage sampling technique was used to draw samples for the study. Simple random sample technique was used to draw 116 year one students in their intact classes from the five programmes. The students were randomly assigned into two groups. Group one had 67 students across the five programmes (18 males and 49 females) taught using electronic resources, while Group two, had 49 students across the five programmes (20 males and 29 females) taught with print resources.

The instrument for data collection was the Atmospheric Photochemistry Performance Test (APPT). The test had two sections A and B, Section A contained demographic information on unit and gender, while section B contained twenty(20) multiple choice test items. Each question had four options lettered A-D, with one correct option among three distracters. The instrument was validated by two assessors in order to check for appropriateness, clarity and adequacy in addressing the objectives of the study. The reliability index of the instrument was determined by administering the APPT to 20 students within the population that were not used for the main study, using Kuder-Richardson's formula 20, and a reliability coefficient of 0.80 was obtained. After two weeks of lesson delivery, using both instructional resources, the test was administered to the two groups. Data collected were analyzed using mean, standard deviation and independent t-test.

Results

Hypothesis One

There is no significant difference in the mean performance scores of science education undergraduates taught atmospheric photochemistry using electronic and print instructional resources. Independent t-test was used for testing this hypothesis; the result of the analysis is as presented in Table1.

Table 1: Independent t-test analysis of the difference in the mean performance scores of undergraduates taught atmospheric photochemistry using electronic and print instructional resources (N = 116)

Instructional resources	N	Mean	SD	df	t-cal	t-crit	Remarks
Electronic	67	17.60	1.82	114	4.99*	1.98	Significant
Print	49	15.80	2.05				

*significant at 0.05 level of significance

The result in the table 1 above shows that students taught using electronic instructional resources had a higher mean score of (17.60) than those taught using prints resources (15.80). It also revealed that the calculated t-value of 4.99 was greater than the critical t-value of 1.98 at 0.05 level of significance under 114 degrees of freedom. With this result, the null hypothesis was rejected. This implies there is significant difference in the mean performance scores of science education undergraduates taught atmospheric photochemistry using electronic and print instructional resources.

Hypothesis Two

There is no significant difference in the mean performance scores of male and female Science Education undergraduates taught atmospheric photochemistry using electronic and print instructional resources. Independent t-test was used for testing this hypothesis; the result of the analysis is as presented in Table 2.

Table 2: Independent t-test analysis of the difference in the mean performance scores of male and female science education undergraduates taught atmospheric photochemistry using electronic and print instructional resources (N = 116)

Instructional resources	Gender	N	Mean	SD	df	t-cal	t-crit	Remarks
Electronic resources	Female	49	17.94	1.77	65	1.43*	1.99	Not significant
	Male	18	17.31	1.83				
Print	Female	29	16.20	2.08	47	1.42*	2.01	Not significant
	Male	20	15.38	1.97				

*Not Significant at 0.05 level of significance

The result in Table 2 revealed that the calculated t-value of 1.43 was less than the critical t-value of 1.99 at 0.05 level of significance under 65 degrees of freedom. With this result, the null hypothesis was retained. This implies there is no significant difference in the mean performance scores of male and female science education undergraduates taught the concept of atmospheric photochemistry using electronic instructional resources. In the case of print instructional resources, Table 2 also showed that the calculated t-value of 1.42 was less than the critical t-value of 2.01 at 0.05 level of significance under 47 degrees of freedom. With this result, the null hypothesis was retained. This implies there is no significant difference in the mean performance scores of male and female students taught atmospheric photochemistry using print instructional resources.

Discussion of Findings

The result of analysis of the difference in the mean performance scores of Science Education Undergraduates taught atmospheric photochemistry using electronic and print instructional resources, revealed that there is significant difference in the mean performance scores of undergraduates in favour of those taught with electronic resources. Though both are tasks structured, this result could be attributed to the fact that with electronic instructional resources, learners get excited, can visualize abstract concepts and link them to prior knowledge, as e-resources gives first-hand experiences to the learners, facilitate their understanding of the subject matter taught, thereby fostering conceptual learning leading to good academic performance. Today's students are digital natives, and electronic devices, packages and resources are easily available and accessible for their use in learning (Akpan, 2024). They utilize videos, simulations on computers and hand-held devices with downloaded apps The finding is in line with that of Akpan *et al* (2025) that students had a high knowledge of online resources, therefore can access different materials. It was also in agreement with Neji and Ntibi (2021), Ihejiamaizu and Ochui (2019), Etiubon, et al (2021), Essien and Akpan (2017) and Itighise, *et al* (2023) that students taught with various electronic resources performed better than those taught with the conventional methods. It was at variance with Tafeng *et al*, (2024), Paul, *et al* (2024), Mizrachi (2013) who reported that students preferred printed materials to e-resources.

The result of analysis of the difference in the mean performance scores of male and female science education undergraduates taught the concept of atmospheric photochemistry using electronic instructional resources revealed that there is no significant difference in the mean performance scores of male and female students taught using electronic instructional resources. The finding is in line with that of Umar, et al, (2020); Lasisi, et al (2021), Umanah and Akpan (2025), Akpan, *et al* (2025), Atabang, *et al.* (2024) and Oyahkirome and Akpan (2024) who found that there was no significant difference in the mean scores of male and female students exposed to electronic resources during teaching and learning. The finding could be attributed to the fact that when both male and female students are exposed to the same instructional resources, they are likely to perform at the same level.

On the result of analysis of the difference in the mean performance scores of male and female science education undergraduates taught the concept atmospheric photochemistry using print instructional resources revealed that there is no significant difference in the mean performance scores of male and female students. The finding lends credence to that of Magnen, *et al* (2013); Paul, *et al* (2024) insignificance variation in gender difference in academic performance of students taught using print resources. It was found that gender did not influence students 'academic performance and that Instructional resources when properly used, engender interest and creativity in the students and hence their performance.

Conclusion

Based on the findings of the study, it was concluded that using both instructional resources got the students actively involved during the teaching learning process but electronic resources facilitated their understanding of the concept atmospheric photochemistry taught better than using print resources, and that gender had no statistically significant influence on the students' performance. This therefore implies that instructional resources used in instructional delivery are significant determinants of learners' learning outcomes; and that if female students are exposed to the same instructional resources, will perform excellently well as their male counterparts.

Recommendations

Based on the findings and conclusion drawn, the following recommendations were made:

1. Teachers should adopt electronic resources for teaching at all levels of education, instead of depending solely on the use of print resources.
2. All students should be encouraged to the sciences irrespective of their gender.
3. Government and schools should sponsor their science teachers to conferences, workshops and seminar organized to acquaint them with the use of modern digital resources.
4. Curriculum planners should ensure incorporation of electronic resources in teaching and learning.

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