Education Annals (2025), 2(5):147-157
https: doi.org /10.5281/zenodo.15423941
Research Article

Effectiveness of Multimedia Instructional Strategy on Academic Performance of Senior Secondary School Students in Chemical Kinetics in Benue State

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Received 3 April 2025; Acceptance 15 April 2025; Published 15 May 2025.

Abstract

This study investigated the effectiveness of multimedia instructional strategy on secondary school 2 students' performance in chemical kinetics in Benue State, Nigeria. Two research questions and two hypotheses were guided the study. The study adopted quasi experimental research design of non – randomized pretest posttest control group type. The population of the study was 1,050 while a sample of 162 (88 male, 74 female) SS2 students who offer Chemistry were drawn from four secondary schools using multistage sampling technique. The research instruments were: Multimedia Instructional Package (MIP) and Chemistry Performance Test (CPT). The CPT was trial-tested on 40 students. Kuder - Richardson 20 formula was used to determine the reliability coefficient of CPT which was 0.97. The research questions were answered using mean while hypotheses were tested at 0.05 level of significance using ANCOVA. The findings of the study revealed that there was a significant difference between the mean performance scores of students taught chemical kinetics using MIS and students taught with the conventional chalk and taught strategy. There was no significant difference between the mean performance scores of male and female students taught Chemistry using MIS. The study recommends among others that since multimedia instructional strategy has been found to enhance students' performance in chemical kinetics, Chemistry teachers should be encouraged to adopt the instructional strategy for teaching chemical kinetics in Chemistry.

Keywords: Multimedia, Chemical Kinetics, Academic Performance, Gender.

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Introduction

Science is very significant in the technological development of every nation. This accounts for why science is seen as the bedrock of human development. Ode and Eriba (2019) affirm that the developed nations have achieved their status of development through science and technology application and education. This implies that the knowledge of science by citizens of a nation is a vital factor in the development of the nation. Therefore, the curriculum content of science education stands as a life wire through which learners are trained to attain goals of scientific and technological advancement to bring about the desired development and change (Agbidye, 2019). Science education can therefore be beneficial in making life useful, meaningful and easy for humanity. At the secondary school level, science education is implemented through subjects such as Mathematics, Physics, Chemistry and Biology. Effective teaching and learning of Chemistry is key to preparing students for employment in industries that deals with refining of oil, production of drugs, paper, textiles, paints, beverages, perfumes and agricultural inputs like pesticides, insecticides and herbicides.

Despite the importance of Chemistry to national socio-economic development, West African Examination Council (WAEC) and National Examination Council (NECO) Chief Examiners' report from 2015-2024 have reported students' poor academic performance in chemical kinetics aspect of the subject regardless of gender. Several reasons have been advanced by researchers for the persistent poor performance in science subjects and prominent among them is teaching strategies used by teachers. Ode and Tartenge (2021) identified the instructional strategy employed by teachers as one of the major factors responsible for the poor performance of learners in science. The persistent poor performance in science subject has been attributed to the use of the conventional strategy of teaching that only appeals to learners' auditory sense and by extension auditory learners because knowledge is transmitted verbally. Therefore learners who are visual or kinesthetic in learning are at a great disadvantage when conventional chalk and talk strategy of teaching is used and are forced to practice rote learning which could lead to poor performance in Chemistry regardless of gender.

Gender according to Wood and Eagly (2015) is a socially ascribed attribute which differentiates between masculine and feminine group. Considerable research efforts have been expended on trying to see how gender effect can be a factor in the seemingly poor performance of students in Chemistry and science other subjects. However, research efforts seem not to produce definite trends from findings as they are mixed findings on students' performance with respect to gender (Ode & Tartenge, 2021). Hence, the inclusion of gender as a moderator variable in this research to ascertain the performance of students based on gender when multimedia instructional strategy is used.

Instructional strategies provide a vital context for an interface between the teachers and the students; hence, the strategy adopted to facilitate effective teaching and learning of school subjects, including Chemistry is essential. Chemistry teachers are expected to actively engage the students in the learning

process with effective teaching strategies which are student-centered. Innovative teaching strategies have been prescribed by the National Policy on Education (FGN, 2014) to ensure that teaching is practical, activity-oriented and student-centered. The aim is to facilitate active participation of learner during teaching and learning processes. Some of such innovative strategies include inquiry/discovery learning, concept mapping, hands-on minds-on, advanced organisers, 5Es and 7Es learning strategies, assertive questioning, collaborative and multimedia instructional strategies.

In contemporary teaching and learning, students' leaning of scientific concepts could be simplified with the technologies and media employed to ensure maximum knowledge construction and concrete learning among learners. Multimedia aids in education are the various electronic and technological devices employed by the teacher or learner to enhance the attitude, acquisition critical thinking skills and retention of knowledge. These include print media like newspapers, magazines, journals and books. Electronic media include; Television, Radio, Slide, CD Rom, Projectors, CDs, DVDs and interactive media like cell phones and the internet. Multimedia combines five basic types of media into the learning environment: text, video, sounds, graphics and animation, thus providing a powerful new tool for education (Nwanekezi & Kalu, 2012).

Researchers (Furo, 2015; Nwafor & Okoi, 2016) have found that the quality of learning can be significantly enhanced when Information and Communication Technology (ICT) is used as an intellectual multi-tool adaptable to learners' needs. Gambari and Yusuf (2017) has observed that average school age child spends much time watching television; playing video games and exploring other electronic media devices, including the cell phones. These enhance their critical thinking, information skill, higher level conceptualization which could improve students' performance in chemistry when deployed in teaching the subject through multimedia instruction. The advent of Information Communication Technology (ICT) have made Chemistry even more popular as its teaching is no longer restricted to classroom or text book. Multimedia is the combination of many media which are integrated in other to bring about better usage. It is the exciting combination of computer hardwares and softwares which allows the integration of video, animation, graphics, audio, and test resources to develop effective presentations on an affordable computer (Satyaprakashai & Sunitha, 2014).

When more than two modes of instruction are used to present information which involves the use of words and pictures, it becomes a multimedia. Multimedia presenting both words (such as printed text as or spoken text) and pictures (such as illustrations, animation, photos, or video) together (Mayer, 2014).

Multimedia Teaching Strategy (MTS) involves the use of appropriate and carefully selected learning experiences which are presented to the learner through selected teaching strategies which strengthen and reinforce each other so that the learner will achieve predetermined and desired behavioural objectives (Satyaprakashai & Yaspal. 2014). If teachers move from the traditional means of passing instruction to multimedia instructional strategy in the Chemistry classroom, teaching and learning could be better enhanced and students' attention and interest could be better sustained. Multimedia is made up of different

component, which could include: sound/audio, video/movie, animation, texts and graphic, great care must be taken while planning it for classroom lesson so that each of the component will be represented adequately without being mixed up.

Sound or audio can be in form of music clip, voice over, background music and transitional music. Oladele, (2019) noted that the sound effect gives life to the whole teaching process when it is becoming dull or un appealing, it engages the interest of the students when used properly, it can also come in form of a narration to the graphics or animation that is being displayed which actually gives more meaning to the presentation. Sound can also provide emphasis on some important information to the students; it can be used as a means of transition from one page to another. Teachers can as well present a lot of information at once when the sound is well adjusted to screen display (Angadi & Ganihar, 2015). Video clip has been viewed to be real to students because of its ability to present the information in actual form. Videos are more beneficial to students for its ability to take the students beyond the classroom experience. They can be used to give examples of phenomena or issues referred to in the text with animation (Angadi & Ganihar. 2015). Animation is another form that multimedia can be presented to improve students' performance in Chemistry. Text makes a multimedia presentation adequate and understandable by its users. If texts are well-arranged, written and programed and made to come in to the mode of presentation at the adequate time, it gives better understanding to the students than using sounds and animation in the presentation.

In multimedia instruction, pictures or objects are made to move in a way that can give meaning to students. This movement can be timed to accommodate the students pace of learning; it presents the object of study to the students in a drawing movement form that best illustrates the demonstrated concept (Gambari, Yaki., Gana, & Ughovwa, 2014). Graphics make room for the most creative possibilities for a learning session in multimedia. They can be photographs, drawings, graphs from a spreadsheet, materials downloaded from the internet, or pictures from CD-ROM (Angadi & Ganihar. 2015). Graphics gives the pictorial view to the whole process and communicate the idea better to the student in picture.

Multimedia instructional strategy (MIS) helps students to process the same information in different media at the same time bring about meaningful learning, which help learners to build adequate mental model, analyze the information and retain it properly better than they do in the traditional classroom sessions (Oladele, 2019). The use of multimedia instructional strategy in teaching Chemistry provides opportunities for experiential learning which could improve students' conceptual understanding that will lead to enhanced performance in chemical kinetics. However, based on literature evidence available to the researchers, studies on the effectiveness of multimedia instructional strategy on students' performance in chemical kinetics are scarce. It therefore became pertinent to find out the effect of Multimedia Instructional Strategy (MIS) on academic performance of students in chemical kinetics in Benue State.

Research Questions

The following questions were raised to guide the study:

1. What is the difference between the mean performance scores of students taught chemical kinetics using MIS and those taught with conventional chalk and talk strategy?

2. What is the difference between the mean performance scores of male and female students taught chemical kinetics using MIS?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant difference between the mean performance scores of students taught chemical kinetics using MIS and those taught using conventional strategy
2. There is no significant difference between the mean performance scores of male and female students taught chemical kinetics using MIS.

Research Method

This study adopted the quasi-experimental design, using the non- randomized pretest- posttest, non-equivalent control group design. The population of the study consists of 1050 senior secondary school II students who offer Chemistry (SS 2) in Gboko Local Government Areas of Benue State. The SS 2 students were chosen because they were not preparing for any external examination, they were also familiar with chemical kinetics component of Chemistry unlike SSI students. Purposive sampling technique was use to select 162 (88 male and 74 female) students from four schools in the study area. The criteria used for selection of the schools were that: they must have a qualified chemistry teacher of not less than five years teaching experience and at least a B. Sc or B.Sc (Ed) in Chemistry, the school must have WAEC or NECO external examination center and coeducational because of the gender variable. The one intact class each in the four sampled schools were used and out of the four, two each were randomly assigned to experimental and control groups for the study.

The students in the experimental groups were taught with the multimedia instructional package while the control groups were taught using the conventional teaching strategy or lecture strategy. The instrument used for data collection was Chemistry Performance Test **(**CPT) which was adapted from WAEC past questions on topics that are related to the content covered in the lesson plans (chemical kinetics). The CPT consists of two sections, section A contains the background information on the respondents (class, time allowed and sex) while section B contains the questions. CPT consists of 30 items which are multiple-choice objective questions with four options (A, B, C, & D) in which the students are expected to pick one they consider as the correct option. The total mark obtainable from CPT is 30 marks.

The trial-testing was carried out 40 students in a school within the study are that was not part of the sampled schools to determine the internal consistency of the instrument. The result collected from CPT was analyzed using Kuder-Richardson 20 formula which yielded a reliability coefficient of 0.97, this formula was used because the items are scored dichotomously. Multimedia Instructional Package **(**MIP) was designed using

the software package Scratch mBlock version (3.2.2) developed by the Massachusetts Institute of Technology (MIT) media laboratories (2014). The MIP was used in teaching the experimental group after the pre-test. The package includes content on chemical kinetics topics of Chemistry curriculum for SS2 students. Text, sounds, narration and images were the elements of Multimedia used in designing the package.

The MIP was given to Educational technologist expert in Benue State University, Makurdi for validation. Also, three Chemistry Education specialists were given the instrument and the CPT for face and content validity. The suggestion from their observation was effected, on the package before taking it to the field. Trained research assistants (Chemistry teachers in the sampled schools) administered the pre – test to the students that participated in the study. Thereafter, the research assistants taught chemical kinetics topics with MIP to the experimental group and conventional teaching strategy was used for the control group. The treatment lasted for four weeks after which a post- test (CPT) was administered to the students. Mean was used to answer the research questions, because it is a discreet data. Inferential statistics of Analysis of Covariance was used to test the formulated hypotheses at $p \leq 0.05$ level of significance. The choice of ANCOVA is due to the fact that it statistically removes the initial differences across the non- randomized groups.

Results and Discussion

Research Question 1: What is the difference between the mean performance scores of students taught chemical kinetics using MIS and those taught with conventional chalk and talk strategy?

Table 1. Mean Performance Scores of Students Taught Chemical Kinetics using MIS and those Taught with Conventional Chalk and Talk Strategy.

Group	Sample (n)	Pretest		Posttest		Mean gain
		Mean	Std. D.	Mean	Std. D.	
MIS	84	7.94	1.56	23.21	0.99	**15.27**
Conventional	78	6.94	1.55	10.83	1.62	**3.89**
Mean Difference		**1.00**		**12.38**		**11.38**
Total	**162**					

Table 1 shows that the mean performance scores of students taught chemical kinetics using MIS strategy was 7.94 with standard deviation of 1.56 at pre-test. It also shows mean value of 23.21 with standard deviation of 0.99 in the post-test. The mean performance of students taught chemical kinetics using conventional strategy was 6.94 with standard deviation of 1.55 during pre-test. It also shows mean value

of 10.83 with standard deviation of 1.62 in post-test. Table 2 also revealed that the mean gain of students taught chemical kinetics using MIS was **15.27**, while those taught using conventional strategy had a mean gain of **3.89**. The mean difference between the two teaching strategy was **11.38** in favour of MIS.

Research Question 2: What is the difference between the mean performance scores of male and female students taught chemical kinetics using MIS?

Table 2. Mean Performance Scores of Male and Female Students Taught Chemical Kinetics using MIS.

Gender	Sample (n)	Pretest		Posttest		Mean gain
		Mean	Std. D.	Mean	Std. D.	
Male	48	8.00	1.56	23.27	0.57	**15.27**
Female	35	7.97	1.44	23.09	1.36	**15.12**
Mean Difference		**0.03**		**0.18**		**0.15**
Total	**73**					

Table 2 shows that for the experimental group, the mean performance scores of male students was 8.00 with standard deviation of 1.56 at pre-test. It also shows mean value of 23.27 with standard deviation of 0.57 in post-test. Table 2 also indicates that the mean academic performance scores of female taught chemical kinetics using MIS was 7.97 with standard deviation of 1.44 at pre-test. It also shows mean value of 23.09 with standard deviation of 1.36 in post-test. The mean gain of male students taught was 15.27, while that of female students was 15.12. The mean difference male and female was 0.15 in favour of male students.

Hypothesis 1: There is no significant difference between the mean performance scores of students taught chemical kinetics with MIS and those taught conventional chalk and talk strategy.

Table 3: Result of ANCOVA of Performance Scores for Students Taught Chemical Kinetics Using MIS and Those Taught with Conventional Chalk and Talk Strategy.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6146.504[a]	2	3073.252	1761.037	.000	.957

Intercept	2028.096	1	2028.096	1162.141	.000	.880
Pretest	4.017	1	4.017	2.302	.131	.014
Strategy	5583.118	1	5583.118	3199.243	.000	.953
Error	275.732	158	1.745			
Total	54080.000	161				
Corrected Total	6422.236	160				

The analysis of data in Table 3 shows that the probability value associated with the calculated value of F (3199.243) for the effect of strategy on the performance of students in chemical kinetics is 0.000. Since this value (0.000) is less than the 0.05 level of significance, the null hypothesis is rejected. Hence there is a significant difference in the mean performance scores of students taught chemical kinetics using MIS strategy and those taught using conventional strategy in favour of the students taught chemical kinetics using MIS strategy. The partial Eta Squared value of 0.953 indicates that 95.3% of students performance in chemical kinetics can be attributed to the strategy used.

Hypothesis 2: There is no significant difference between the mean performance scores of male and female students taught chemical kinetics with MIS.

Table 4: ANCOVA Result of Performance Scores of Male and Female Students taught Chemical Kinetics using MIS.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1.896[a]	2	.948	.985	.378	.024
Intercept	1589.107	1	1589.107	1650.603	.000	.954
Pretest	1.203	1	1.203	1.249	.267	.015
Gender	.711	1	.711	.738	.393	.009
Error	77.019	80	.963			
Total	44725.000	83				

Corrected Total	78.916	82

Table 4 shows that the probability value of F (0.738) on the effect of MIS on students' performance based on gender is greater than 0.05 level of significance, the null hypothesis is therefore, not rejected. Thus, there is no significant difference between the mean performance scores of male and female students taught chemical kinetics using MIS strategy. The partial Eta Squared value of 0.009 indicates that 0.09% of variance in students' performance in chemical kinetics can be accounted for by gender.

Discussion of Findings

The result of the study in Table 1 and 3 reveals that there is a significant difference in the mean performance of SS 2 students taught chemical kinetics with MIS and those taught conventionally. This implies that the experimental group improved on their performance in v than the control group. This could be due to the fact that multimedia is made up of different component, which includes sound/audio, video/movie, animation, texts and graphic, great care must be taken while planning it for classroom lesson so that each of the component will be represented adequately without being mixed up. Sound or audio can be in form of music clip, voice over, background music and transitional music. Oladele, (2019) noted that the sound effect gives life to the whole teaching process when it is becoming dull or un appealing, it engages the interest of the students when used properly, it can also come in form of a narration to the graphics or animation that is being displayed which actually gives more meaning to the presentation and enhanced understanding of concepts. This finding concord with that of Satyaprakasha and Sunitha (2014), Oladele (2019) that students taught with multimedia improve more in their performance than their counterparts taught conventionally. This finding is also agrees with that of Musa, Ode, Ona and Gundepuun (2023) who reported that computer based instruction bring about a higher gain in performance when compared with the conventional teaching strategy.

Findings also indicates no difference between the mean performance score of male and female students taught chemical kinetics using the MIS. These might be because multimedia instructional strategy offered captivating and concrete learning experiences to students irrespective of gender. The finding agrees with the findings of Katcha and Wushishi (2015), Oladele, (2019) who found that there was no significant difference in the performance of male and female students exposed to MIS. This finding suggests that gender disparity in students' performance could be bridged with the use of multimedia instructional strategy.

Conclusion

Based on the findings of this study, it is concluded that the use of MIS enhances students' performance. This implies that the consistent poor performance of students in chemical kinetics can be improved upon if Chemistry teachers adopt the use of multimedia instructional strategy in the teaching chemical kinetics. It

is concluded that the use of MIS enhances student's performance irrespective of gender. Therefore, the use of conventional strategy alone in teaching chemical kinetics should be discouraged. Based on these results, it was recommended among others that Chemistry teachers should incorporate MIS in teaching chemical kinetics so as to enhance students' performance in chemical kinetics and engender gender equity in students' performance. School Administrators and inspectors should ensure Chemistry teachers incorporate the use of MIS in teaching of chemical kinetics. Furthermore, Ministries of Education, State Secondary school Education Boards and other Educational stakeholders are encouraged to promote the use of MIS in schools by organizing conferences, seminars and workshops for serving Biology teachers to learn or update themselves on the use of MIS to improve students' performance in chemical kinetics.

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