

Improving Students' Written Communication Skills in Biology Using Four-Modes of Enhanced Flipped Classroom in Enugu-North Senatorial District, Nigeria

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Abstract

Lapses in written communication skills of students in Biology as reported by the West African Examination Council chief examiner over the years in Nigeria, shown by indicators such as inability to use technical terms to describe some processes, poor expression in questions requiring explanation and inability to spell technical terms correctly among others prompted the need for the present study. The study employed the non-equivalent comparison group design. The study was guided by three specific purposes, with a population of 5,839 biology students. The sample size of 114 participants (M=36; F=78) was drawn using a multi-staged sampling procedure. Data were collected with a validated Biology Written Communication Skills Assessment Test (BWCSAT) that has a reliability value of 0.91, determined using Kendall coefficient of concordance (W). Mean and standard deviation were utilized to answer the research questions while ANCOVA was used to test the null hypotheses at 0.05 significant level. Results revealed that students taught with four-modes of enhanced flipped classroom as seen in their mean differences, improved in their written communication skills in Biology with EGBFC mode being favoured most, followed by EMFC mode before EFFC and ECFC modes. Gender has no significant influence on senior secondary school students' written communication skills in Biology. There is no significant interaction effect of teaching modes and gender on students' written communication skills in Biology.

Keywords: *Flipped Classroom Modes, Written Communication, Gender, Biology.*

INTRODUCTION

The rise in persistent use of traditional teaching methods by Biology teachers in Nigeria on the premise that they hasten coverage of the curriculum contents has continued to reduce the amount of students' active participation during Biology instructional processes and it is likely going to affect students' written communication skills in Biology. The nature of Biology as a science subject requires that its teaching actively involves students and prepares them completely for useful life in the society. This has become an illusion as the WAEC Chief Examiner (West African Examinations Council [WAEC], 2015 to 2023) has stated that Biology students show weaknesses in answering questions that require detailed explanations among others which is an indicator of poor written communication skills in Biology. Ibe et al. (2022) stated that communication skills are poorly acquired by science students globally. This is a serious concern in Biology learning across secondary schools in Nigeria as it could be among the causes of poor students' achievement in Biology (Ebonam, 2023) which has also been

noticed in Sub-Saharan Africa and globally (Kiilu et al., 2022; Ncheke et al., 2021). Improving poor communication skills of students in Biology using four-modes of enhanced flipped classroom is essential in ensuring effective learning of Biology in Nigerian secondary schools and will promote the Smart Green Schools Initiative of the Enugu State government (Mbah, 2025) that is aimed at promoting the integration of digital technology among others for transforming students' learning for sustainable development and global competitiveness.

Communication in science classroom requires communication skills. Communication skills are the abilities of an individual to communicate ideas or information effectively. Communication skills occur in various ways. In Biology for instance, a student who draws accurately, measures or classifies correctly is directly or indirectly communicating an idea or information about the said objects (Folorunso, 2015). Folorunso further maintained that measuring, classifying, and drawing accurately can be classified as communication skills. Therefore, communication skills enable the Biology students to communicate what they have learnt for optimal achievement in Biology. This is because for students to achieve optimally, they need to communicate ideas in clear terms thereby making communication skills essential in Biology learning. When students possess communication skills, they are able to receive and transmit ideas or information clearly; transfer scientific knowledge, and skills towards solving problems in their workplaces or in their daily lives. Thus, they become globally relevant and employable as effective communication skills are among the skills employers seek in employees (Nwosu, 2015). Nwagbo (2022) affirmed that effective communication skills form basis for proper integration of people and ideas as there is increased diversity in today's learning and workplaces. Thus, vital and resourceful ideas that are not made known via communication with requisite and appropriate communication skills suppress the growth and development of any establishment.

Different communication skills exist. Mercer-Mapstone and Kuchel (2016) stated that the core communication skills for effective science communication are language, content, context, style and mechanical accuracy. Some of the above stated core communication skills for effective science communication are appropriate for oral communication while some are for written communication or both. This study focuses on written communication skills as Biology students could need such skills to write well in their Biology essay and practical examinations. The University of New Mexico ([UNM], 2023) explained that written communication skill is the ability to relay information or ideas clearly using written text. Written communication skills are important for the individual's success in life. Students write examinations, report experiments or experiences after field trip, write home works and prepare speeches on any issue in Biology. All these activities and more require effective written communication skills. Nwagbo (2022) upheld that students need to be trained to see the connection between classroom writing and practical application in workplaces as it takes written communication to write memos, emails, and reports among others.

Additionally, written communication skills involve the ability to use appropriate language/technical terms, ability to use correct spelling, ability to make clear sentences, ability to make relevant points regarding the content and appropriate organization of ideas (Studysmarter, 2024). With reference to the communication skills stated by MercerMapstone and Kuchel (2016) and Studysmarter (2024), at senior secondary school level, written communication skills for science communication could be categorized under content, organization, expression, and mechanical accuracy. Content has to do with the ability to clearly state the number of relevant points required; ability to use good graphs or drawings where

necessary with title, size, neat labels guided by ruled guidelines to support points; and ability to support explanations with relevant examples. Organization is the ability to use paragraphs appropriately to arrange or organize the ideas or points or answers. It is an individual's ability to arrange answers in the correct order. It also involves good paragraph linkage. Expression is the ability to write answers using correct sentences. It encompasses the use of appropriate Biology terminologies to explain ideas clearly.

Where a specimen is observed or an experiment is conducted, expression deals with the ability to use correct sentences to write down the features observed, write the dimensions of a specimen or object measured using correct unit and reporting experiment accurately. Infomediang (2022) stated that mechanical accuracy measures the ability to use correct punctuation marks and correct spelling. In this study, mechanical accuracy measures the ability to spell technical terms correctly as well as ability to use punctuation marks where necessary. Thus, written communication skill in this study is the ability of a learner to communicate organized ideas clearly in a written format using necessary technical terms as well as being mindful of spelling and other mechanics. Although very essential for students' wholistic success in examinations and in their places of work, students show lapses in written communication skills in Biology external examinations.

Students exhibit lapses in written communication skills in Biology as could be seen from the reports of the Biology West African Examination Council (WAEC) Chief examiner. For instance, the WAEC Biology Chief examiners reports (WAEC, 2015, 2016, 2017, 2018, 2019, 2022 & 2023) revealed some of the following weaknesses demonstrated by students: poor attempt in answering questions requiring detailed explanation, poor drawing and not drawing to scale, inability to use technical terms to describe some processes, poor expression in questions requiring explanation and inability to spell technical terms correctly. Also, scientists have cited communication skills, or lack thereof, as impacting their work in public engagement and communication in science (Rose et al., 2020). In addition, one of the most important factors inhibiting effective teaching and learning of Biology is students' poor communication skills (Daworiye et al., 2015; Adeuya, 2020). Poor communication among students is caused by lack of motivation, personality factors (such as shyness and anxiety among others), little opportunity provided to practice communication through speaking or writing, poor-quality material and poor-quality teaching (Richards, 2023). Since science students including those in Biology need communication skills to be able to effectively transfer scientific knowledge, processes, insights and other important information as opined by Amin et al. (2022), there is an urgent need to find out if Biology teaching through the use of the enhanced flipped classroom modes could assist in improving students' written communicating skills in Biology irrespective of student' gender.

Gender is a concept that is culturally conceived which defines the role that the society allocates to a male or female. It is culturally dependent because the assignment of masculine and feminine roles varies according to different cultural backgrounds. Gender is defined as a social and cultural construct, which distinguishes the attributes of men and women, girls and boys, and accordingly refers to the roles and responsibilities of men and women (United Nations Children's Fund [UNICEF], 2017). It is also the social attributes and opportunities associated with being male and female, the relationships between women and men, girls and boys, as well as the relations between women and those between men (UN, 2024). The gender roles so stated are those roles given to men or women in line with the traditions or cultural beliefs of the society. Gender though not biologically determined, could influence how people interact, behave or even perceive themselves leading to stereotype. Gender stereotype attributes

certain roles to masculinity and others to femininity. Gender stereotype tends to shape students' choice of career in life. For example, most male students might prefer choosing careers in Mathematics, Engineering and their likes to Arts, Humanities and Education. Conversely most female students could opt for Arts, Humanities and Education than Mathematics, Engineering and their likes. In an ideal situation, an individual's choice of career is not supposed to be dependent on the person's gender. Studies have been conducted on the influence of gender on students' learning outcomes in sciences and their results appear inconsistent as some were in favour of males or female in science (Akani, 2015; Femi-Adeoye, 2021; Udo & Ubana, 2016; Algarni, 2024). However, Nwosu (2015) advocated that science teaching should be carried out with teaching methods that enable students to learn equally irrespective of gender. As such, teaching methods adopted by the teacher during instructional delivery becomes essential.

Teaching methods are routes via which prepared lessons are imparted to students during instructional processes by an expert or a more knowledgeable person. It is the approach by which the teacher communicates knowledge and skills during teaching process in which the learner realizes the knowledge and attains the skills in the process of learning (Kumari et al., 2015). Jumat (2015) defined teaching method as a systematic plan for achieving an instructional goal. Through them, learning contents are made known to learners. Teaching methods are grouped into teacher-centred teaching methods and student-centred teaching methods (Alessa & Hussein, 2023). The teacher-centred also known as traditional teaching methods are those teaching methods in which teachers are seen as authority figures that play key role of transferring knowledge to learners who receive such information passively. The learners make little or no inputs during instructional processes. The examples of traditional teaching methods are lecture and teacher-led demonstration methods among others (Pedagogy, 2018). The traditional teaching methods are commonly used by teachers across schools as they foster easy coverage of the curriculum contents.

Conversely, the student-centred which is also known as innovative teaching methods are those that provoke activities in classroom interactions whereby attention is moved from the teacher to the learners. In this group of teaching paradigm, both teachers and learners are actively involved in the instructional process. The teacher is active in guiding the students and providing necessary instructional management in order to facilitate learning as well as ensuring total understanding of the material presented to the learners in the instructional episode. The learners remain active by engaging in different cognitive, affective and psychomotor activities. In the instructional process where innovative teaching methods are adopted, the learners actively carry out different learning activities, and hardly experience passivity during classroom interactions. Thus, the students who are learning science by doing tend to have adequate opportunity to practice science, ask questions, develop their communication skills, and social interaction. Some of the teaching methods classified as being innovative are inquiry method, guided discovery, project method, multimedia approaches, and flipped classroom among others (Pedagogy, 2018). The consideration of teaching method is necessary because inadequate teaching methods used by teachers, insufficient resources, and overloaded content which does not correspond to the time allocated to the subject content are the factors that cause poor learning outcomes of students in Biology (Manishimwe et al., 2023). In recent times in different academic disciplines, emphasis tilts towards the application of ICT (information and communication technology) devices or their integration in service delivery. This is not different during classroom instruction as there seems to be a paradigm shift to ICT based teaching methods that improve students' learning outcomes and make them globally relevant. Such application of ICT could be entirely virtual or blended. Flipped classroom either blends

conventional teaching approach with the use of ICT or does not blend (that is, becomes entirely virtual) depending on the mode of flipped classroom adopted.

Flipped classroom is a method of teaching that occupies students outside the classroom time such as at home, and during the classroom time which is utilized for expansion of the same content/topic under the guidance of a teacher or a more knowledgeable person. A flipped classroom is an educational pedagogy that has two parts which include the online-based instruction outside the classroom and active learning activities inside the classroom (Bishop & Verleger, 2013). The online-based instruction usually involves students engaging with the lesson using ICT devices. Thus, it is a teaching method that enables students who are learning new lesson topic to initially engage with it using ICT tools before the actual classroom time/lesson period that is used to elaborate the topic as guided by the teacher. Some tools such as textbook reading, printable PowerPoint slide, animation with voice and lecture videos (Rai et al., 2020) are available to engage the students during the outside or pre-lesson period. Flipped classroom is generally characterized by healthy interaction between members, eliminates a large amount of teacher-centredness and ensures that students carry out more active role in the learning during class times. However, there are uniqueness among the different types or modes of flipped classroom and such are dependent on the variation in the distribution of study materials, use of classroom time, tasks involved or type of students (Thakare, 2018). Thus, the knowledge of the different modes of flipped classroom becomes necessary.

The different modes of flipped classrooms include the conventional or standard inverted flipped classroom, faux-flipped classroom, group-based flipped classroom, micro-flipped classroom, discussion-oriented flipped classroom, debate-focused flipped classroom, virtual flipped classroom and role-reversal 2.0/flipping the teacher (Thakare, 2018; Education, 2021). Each of the stated mode of flipped classroom has its uniqueness.

In the conventional flipped classroom for instance, the students individually go through the prepared lecture videos or study materials that are conditions for the next class first at home or outside the actual classroom time without any accompanying short assignment (Thakare, 2018). The class time is meant for practicing the topic already studied at home to improve the students' understanding through one-on-one interaction with the teacher. Most studies conducted on flipped classroom were on the conventional flipped classroom and scarcely on other modes of flipped classroom (Rai et al., 2020; Ugwuanyi et al., 2020; Adonu et al., 2021). Johnson et al. (2015) posited that the conventional flipped classroom is the most recognized as well as the most commonly used mode of flipping the classroom. This makes it commonly studied in the literature. In this study, the conventional flipped classroom in addition to its above-stated peculiarities, was enhanced by giving students few minutes during the introduction of the day's lesson to comment briefly on the lesson video that they have watched, showing them all the behavioural objectives of the lesson after introducing the topic in a cardboard paper, showing them individual behavioural objective at each stage of the lesson as well as asking the learners at the end of each classroom practice to briefly summarize in not more than a page what they have learnt from the day's lesson. The teacher will examine their outputs and give them feedback before the next lesson episode.

The micro-flipped classroom is another mode of flipped classroom. It involves the distribution of lesson video or pre-learning material along with short assignment (Thakare, 2018; Education, 2021). This part is carried out before the actual class time in which the students individually study the lesson material or video with the accompanying short assignment at home or outside the actual classroom time. The remaining part of the lesson or

practice is performed during instructional processes in the classroom. Thakare maintained that this type of flipped classroom is not subject dependent. The study carried out by Fidalgo-Blanco et al. (2017) showed that the micro-flipped classroom mode has a direct impact on students' learning. The enhanced micro-flipped classroom in addition to its above-stated features was enhanced in this study as was done in the conventional flipped classroom.

The faux flipped classroom otherwise called in-class flipped classroom is another mode of flipped classroom. Denotatively, faux means false or fake or artificial. Thus, the usual pattern of flipped classroom where the learners first watch the pre-lesson video at home before coming to classroom is altered. According to Education (2021), this mode solves the problem of technology divide that occurs when students do not have reliable and equal access to the requisite technology for pre-class episode that occurs at home. As such, the pre-class learning video or material otherwise known as initial learning is done using the computers available in the school under the guidance of the teacher without any accompanying assignment. The teacher may decide to shortly show the entire class the instructional video/material before the actual lesson period begins. Alternatively, students may use the computers available in the school as the teacher directs before the actual lesson period to watch the pre-lesson video. During class time, there is one-on-one guidance. When probing questions are asked by the teacher, individual students are asked to make attempts with the teacher reinforcing. In addition to the features of the faux flipped classroom, it will be enhanced in this study as was done in the conventional flipped classroom mode above. The idea of asking individual students to respond to questions asked by the teacher is unlike what is obtained in the group-based flipped classroom where students respond to questions according to their groups.

The group-based flipped classroom upholds the group learning style. Thakare (2018) stated that after students have studied the pre-class lesson video/material without an accompanying assignment, they work in group during classroom time on tasks that may be given by the teacher. In addition to its above-stated features, the grouped-based flipped classroom was enhanced in this study as stated above in the enhanced conventional flipped classroom mode except that class activities are done in heterogeneous (mixed) groups and at the end of the classroom practice, they are asked to briefly summarize in not more than one page in a paper what they have learnt from the day's lesson as a group instead of individually as seen in other modes.

The discussion-oriented flipped classroom is another mode of the flipped classroom. In the discussion-oriented flipped classroom, assignments do not accompany short lesson videos which students watch during the pre-class stage of the lesson (Education, 2021). Discussions are done during classroom time where the topic in question is further explicated via discussion. So, by having the pre-class basics of the lesson, students can as a class, contribute meaningfully to the discussion. Education (2021) further maintained that this type of flipped classroom is valuable for subjects where context plays a vital role and questions may not have a simple or correct answer as seen in English Language, Politics, Arts and History. As such, this mode of flipped classroom will not be examined in this study. Another type of flipped classroom is the debate-focused flipped classroom whereby students take the pre-class information at home before attending class lesson. During class lesson, they engage in debate with their fellow students (Education, 2021). The use of debate helps to reinforce information already learned at home and strengthens understanding by exposing different viewpoints in the topic. Just like in the discussion-oriented flipped classroom, the debate-focused is valuable for subjects where context plays a vital role and questions may not have a simple or correct answer as seen in

English Language and Politics (Education, 2021). Debate-focused flipped classroom was not explored in this study.

The virtual flipped classroom is yet another mode of flipped classroom. The virtual flipped classroom eliminates physical classroom time (Education, 2021). Students carry out the pre-class activity by studying the instructional video at home. The classroom time is virtually carried out. This type of flipped classroom is utilized where physical classroom attendance is not possible or where there is stable network via Wi-Fi and personal data. This mode of flipped classroom is commonly employed in higher institutions of learning such as universities, polytechnics and colleges of education that are capable of having school Wi-Fi.

In public secondary schools in Nigeria, hardly could one boast of Wi-Fi. Thus, virtual flipped classroom mode was not explored in this study. Another mode of flipped classroom is role-reversal 2.0 or flipping the teacher. It is also called a double flipped classroom. In this mode, students are asked to create video or other learning materials demonstrating their understanding of the topic (Thakare, 2018; Education, 2021). For instance, the students can film their activities which the teacher uses to evaluate their progress. Creating such videos by students require some substantial financial inputs from the students.

Since secondary school students are not working yet to support such project, adopting this mode was not feasible by the individual participants unless there is financial support or grant from government or a grant-awarding institution. As a result, it was not used in this study. The forgoing shows the different modes of flipped classroom as well as few studies on the use of flipped classroom to improve students' learning outcomes in Biology. However, most of the studies were usually on conventional flipped classroom. Although the conventional flipped classroom has been tried in some areas by some researchers and found effective yet, the problem of lapses in written communication skills of students in Biology still persist. That is why this study sought to find out if enhanced conventional, micro, faux and group-based flipped classroom modes would be efficacious in improving students' written communication skills in Biology irrespective of gender. The following research questions were addressed:

- 1) What are the mean scores of written communication skills of students taught Biology using enhanced conventional flipped classroom modes?
- 2) What is the influence of gender on mean scores of written communication skills of senior secondary school students in Biology?
- 3) What is the interaction effect of teaching modes and gender on students' written communication skills in Biology?

METHOD

Design of the Study

The study adopted a non-equivalent comparison group design. The study was conducted in Enugu-North Senatorial District of Enugu State. The population of the study consisted of 5,839 (M=2,482; F= 3,357) SS2 Biology students in Enugu-North Senatorial District.

The participants for the study were 114 (M=36; F=78) SS2 Biology students drawn using purposive sampling technique, proportionate stratified random sampling technique and simple random sampling technique.

Instrument for Data Collection

The instrument for data collection was Biology Written Communication Skills Assessment Test (BWCSAT) designed by the researchers. It comprised two sections namely: A and B. The section A elicited information about the biographic data of the participants such as gender. The section B of Biology Written Communication Skills Assessment Test (BWCSAT) contained three essay questions that involved writing activities which would make participants to show their written communication skills in Biology. The writing activities contained in the Test were assessed using four elements of written communication skills in science (Biology) such as content, organization, expression, and mechanical accuracy. Participants' exhibition of written communication skills in Biology as tested using this instrument was rated by the researchers using researchers-designed marking scheme that contained answers to the Biology Written Communication Skills Assessment Test (BWCSAT). In scoring this instrument, content was scored 10 marks, expression was scored 20 marks, organization was given 10 marks while mechanical accuracy was scored 10 marks making the overall marks for this instrument to be 50 marks which is the standard for West African Examination Council for assessing essays. Each participant's written communication skills in Biology were obtained by scoring the participant's output in the BWCSAT using the Marking Scheme for the Biology Written Communication Skills Assessment Test (MSBWCSAT). In addition to the above stated major instrument for data collection, there were lesson plans with lesson videos for the four-modes of enhanced flipped classroom used in this study.

Validity and Reliability of the Instrument

The instrument was face-validated by four experts in Biology Unit, one expert in English Unit and two from Measurement and Evaluation Unit. The internal consistency reliability of the Biology Written Communication Skills Assessment Test (BWCSAT) was established using inter-rater/scorer reliability. The trial-tested BWCSAT were photocopied into three sets and given out to three independent scorers/raters using the MSBWCSAT. Later, the scores from the three raters were subjected to Kendall's coefficient of concordance (W) and it yielded a reliability index of 0.91 and this according to (Nworgu, 2015) shows that the instrument was reliable.

Experimental Procedure

The experiment which lasted for two months and three weeks (11weeks) commenced with six days training of the four research assistants (Biology teachers) only for teaching of the selected Biology curriculum contents and for the purpose of administration of the instruments to the participants. In the second week, there was formation of class WhatsApp groups only in the sampled schools where enhanced conventional flipped classroom (ECFC), enhanced micro flipped classroom (EMFC) and enhanced group-based flipped classroom (EGBFC) modes were experimented using the parents' WhatsApp numbers as supplied by the participants who may not have their personal WhatsApp numbers. It was through the created class WhatsApp group that the teacher shared the pre-lesson videos to participants. A situation where any participant had functional android phone with WhatsApp number, their WhatsApp number was used instead. Again, it was within this week that the research assistant in the enhanced faux flipped classroom EFFC mode would ensure that the computers and other ICT facilities to be used are in good working condition. Also, it was within this week that the research assistant in the enhanced group-based flipped classroom formed four heterogeneous groups. The formation of the four mixed groups was based on gender and student's ability as determined by the

research assistant based on their experience with the students. The group members appointed the leader in each of the four groups and the formed groups remained intact until the six lessons (treatment) were exhausted in six weeks.

The third week was used for the conduct of pretest in the sampled schools using the BWCSAT. The fourth, fifth, sixth, seventh, eighth and ninth weeks were used for treatments in the four sampled schools. Participants from sampled schools A, B, C and D were taught six Biology lessons for six weeks using enhanced micro-flipped classroom, enhanced faux flipped classroom, enhanced group-based flipped classroom and enhanced conventional flipped classroom modes respectively. For instance, in the enhanced conventional flipped classroom (ECFC) mode, during the Pre-Classroom Episode, the teacher shared the pre-lesson video (e.g., Carbon Cycle) to the students via the class WhatsApp group a day before the lesson was taught in the classroom for students to watch at home individually before coming to school. There was NO short assignment attached to the pre-lesson video. The In-the-Classroom Episode occurred in stages. In Stage 1 of the In-the-Classroom Episode, the teacher introduced the lesson by allowing participants to individually and briefly comment on the pre-lesson video that they had watched among which was in terms of the major things explained in the pre-lesson video. This was expected to be done in 5 minutes wait time. There was NO group work in this mode. As such, students carried out their activities individually.

In Stage 2, the chart containing the specific objectives of the lesson was displayed by the teacher at a corner of the chalkboard. This was expected to serve as an enhancement and guide for their learning. The participants were given little wait time to individually observe and study the specific objectives of the lesson and were asked to think critically about those specific objectives in respect of the tasks those objectives demanded from them for the total and effective learning of the lesson's topic. The teacher thereafter removed the chart. In Stage 3, the first specific objective was taught. The teacher asked them individually to recall and state the first specific objective of the lesson. A situation in which the students were unable to recall and state it, the teacher showed them chart/cardboard containing only the first specific objective of the lesson as enhancement and asked them to state it. The teacher would guide the students towards learning the first objective of the lesson. The students would ask questions about their difficulty for the teacher to further explain.

In Stage 4, the above stage-three would be repeated for the second specific objective of the lesson, and so on until the four specific objectives of the lesson were taught. The teacher would evaluate and summarize the lesson. The final stage of the lesson involved the teacher asking the students to use five minutes individually to write in not more than one page of a paper, what they had learnt from the lesson's topic and submit immediately (written communication exercise) which the teacher examined and supplied feedback to the students before the next lesson. The above stated stages were repeated for the remaining five lessons in the enhanced ECFC mode.

In the enhanced micro-flipped classroom (EMFC) mode, participants were taught their lessons following the same steps as established in the ECFC except that in the pre-classroom episode, the teacher shared the pre-lesson video through the class WhatsApp group with a short follow-up assignment. The follow-up assignment was submitted to the teacher the next day who marked and gave feedback later. There was also no group work during the in-the-classroom episode as seen in the ECFC mode. Using the enhanced faux flipped classroom (EFFC) mode to teach participants the selected topics involved the stages as declared in the ECFC above except that in the pre-classroom episode, the pre-lesson video for each lesson was

watched in the school or class by the learners without any short follow-up assignment before the day's lesson commenced using the computer facilities available in the school instead of the idea of watching it at home. This solves the problem of technology divide among participants. There was also no group work during the in-the-classroom episode as practised in the ECFC mode.

Applying the enhanced group-based flipped classroom (EGBFC) mode in teaching the participants the selected lesson topics adopted the stages as outlined in the ECFC above except that in-the-classroom episode, there was group work as students carried out their class activities in four mixed groups formed by the research assistant (Biology teacher) in the second week they created the class WhatsApp with the group members appointing the leader in each of the four groups. It occurs in steps. For instance, in the pre-classroom episode, the teacher shared the pre-lesson video to the students via the class WhatsApp group a day before the lesson is taught in the classroom for students to individually watch at home before coming to school. There was NO short follow-up assignment attached to the pre-lesson video.

During the Stage 1 of the in-the-classroom episode of the enhanced group-based flipped classroom mode, the teacher introduced the lesson by giving the groups 5 minutes wait time to briefly comment on the pre-lesson video that they had watched among which was in terms of the major things explained in the pre-lesson video. This they did according to groups. The group members quickly brainstormed on the pre-lesson video watched at home and the group leader took note and briefly on behalf of their groups presented each group's comments as the teacher gave each of the four groups a minute for the comments. At stage 2, the teacher displayed the chart containing the specific objectives of the lesson at a corner of the chalkboard and this was expected to serve as an enhancement and guide for their learning. The groups were given little wait time to observe and study the specific objectives of the lesson and think critically about those specific objectives in terms of the tasks those objectives demanded from them for the total and effective learning of the lesson's topic. The teacher thereafter removed the chart. In Stage 3, the first specific objective was taught. The teacher asked group 1 to recall and state the first specific objective of the lesson. If group 1 was unable to recall and state it, the teacher showed them chart/cardboard containing only the first specific objective of the lesson as enhancement and asked group 1 to state it. The teacher guided the students in groups towards learning the first objective of the lesson. The students would from their groups, asked questions about their difficulties for the teacher to further explain. In Stage 4, the above stage 3 was repeated for the second specific objective of the lesson, and so on until the four specific objectives of the lesson were taught. The teacher would evaluate and summarize the lesson.

In the final Stage, the teacher asked the groups to use five minutes to write in not more than one page of a paper, what they had learnt from the lesson's topic and submit immediately which the teacher examined and gave feedback to the groups before the next lesson. The above stated stages were repeated for the rest of the five lessons in the EGBFC. The 10th week was used for conducting posttest across the sampled schools. The 11th week was for scoring of the responded instruments and analysis. While conducting this study, the researchers controlled some extraneous variables such as situational variable, Hawthorne effect and teacher variable to prevent them from having confounding influence on the results of the study.

Data Analysis Techniques

The data collected in this study were analyzed quantitatively using Statistical Package of Social Sciences (SPSS) version 22. The research questions were answered using mean and

standard deviation. The null hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 significant levels. In testing the hypotheses, the null hypotheses was rejected if the p-value for the test statistic is less than the stated alpha level ($P < 0.05$) and fail to be rejected if the p-value for the test statistic is greater than the stated alpha level ($p > 0.05$).

RESULTS

Data in Table 1 shows the pretest and posttest mean scores for written communication skills and the standard deviation scores for students in the four groups taught Biology with EMFC, EFFC, EGBFC and ECFC modes. The mean differences between the posttest and pretest scores of EMFC, EFFC, EGBFC and ECFC are 30.58, 25.75, 32.09 and 17.80 respectively. The mean differences indicate that students in the four groups taught Biology with the four enhanced flipped classroom modes improved in their written communication skills. However, Biology students taught with the EGBFC mode had the highest mean difference, followed by those taught with the EMFC mode, followed by those taught with the EFFC mode while the least are those taught with the ECFC mode.

Table 1: Mean and standard deviation scores of written communication skills of students taught Biology using enhanced conventional flipped classroom modes

Treatment Group	Sample (n)	Pretest		Posttest		Mean Difference
		Mean (X)	Std. Dev. (SD)	Mean (X)	Std. Dev. (SD)	
EMFC Mode	38	11.76	4.21	42.34	2.77	30.58
EFFC Mode	20	10.65	2.54	36.40	4.03	25.75
EGBFC Mode	22	10.91	4.36	43.00	4.78	32.09
ECFC Mode	34	13.82	4.97	31.62	5.97	17.80

EMFC Enhanced Micro-Flipped Classroom **EFFC** Enhanced Faux Flipped Classroom **EGBFC** Enhanced Group-Based Flipped Classroom **ECFC** Enhanced Conventional Flipped Classroom **Total n= 114**

Table 2 with regards to null hypothesis one reveals that ($F(3,105) = 37.547, p = 0.000 < 0.05, \eta^2_p = 0.518$). Since the associated probability value of 0.000 is less than the 0.05 level of significance; the null hypothesis one (H_{01}) which states that there is no significant difference in the mean scores of written communication skills of senior secondary school students taught Biology using enhanced conventional, micro, faux and group-based flipped classroom modes is rejected. The effect size ($\eta^2_p = 0.518$) shows that 51.8 percent variance in students' written communication skills in Biology was attributed to the treatment. As such, the inference drawn is that students in the four groups taught Biology using EMFC, EFFC, EGBFC and ECFC modes significantly improved in their written communication skills in Biology.

To determine the group(s) where the significant difference essentially comes from, a post hoc test was run using Dunn-Bonferroni multiple comparison method. The pairwise comparisons are shown in the table below.

Table 2: ANCOVA on the effect of enhanced conventional flipped classroom modes on the mean scores of written communication skills of students in Biology

Tests of Between-Subjects Effects						
Dependent Variable: Posttest BWCSAT						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared (η^2_p)
Corrected Model	2869.474 ^a	8	358.684	18.136	.000	.580

Intercept	14806.604	1	14806.604	748.674	.000	.877
PretestBWCSAT (covariate)	32.587	1	32.587	1.648	.202	.015
Treatment	2227.717	3	742.572	37.547	.000	.518
Gender	73.103	1	73.103	3.696	.057	.034
Treatment * Gender	29.892	3	9.964	.504	.680	.014
Error	2076.596	105	19.777			
Total	171544.000	114				
Corrected Total	4946.070	113				

a. R Squared = .580 (Adjusted R Squared = .548)

Table 3 summarizes the post hoc test that compares the difference between means of the four-modes of enhanced flipped classroom on the written communication skills of students in Biology. It is observed that the comparison between the EMFC mode and EFFC mode is significant at 0.000 in favour of the EMFC mode (Mean difference is 5.546). Furthermore, the comparison between EMFC mode and EGBFC mode is not significant at 1.000. The mean difference between the EMFC and EGBFC modes is -1.079. This means that the EMFC and EGBFC modes function at similar level. In addition, the comparison between EMFC mode and ECFC mode is significant at 0.000 in favour of the EMFC mode. The mean difference between the EMFC and ECFC modes is 10.565. Similarly, it is observed that the comparison between the EFFC mode and EMFC mode is significant at 0.000 in favour of the EMFC mode as the mean of EMFC is higher than the EFFC which yielded a difference of -5.546. The comparison between EFFC mode and EGBFC mode is significant at 0.000 with a mean difference of -6.626 in favour of the EGBFC mode. In addition, the comparison between EFFC mode and ECFC mode is significant at 0.003 in favour of the EFFC mode with a mean difference of 5.019.

Finally, the comparison between the EGBFC mode and EMFC mode is not significant at 1.000. This indicates that EGBFC mode and EMFC mode function at the same level. The comparison between EGBFC mode and EFFC mode is significant at 0.000 with a mean difference of 6.626 in favour of the EGBFC mode. The comparison between EGBFC mode and ECFC mode is significant at 0.000 in favour of the EGBFC mode with a mean difference of 11.644. Only the EMFC mode and the EGBFC mode function at the same level in improving the written communication skills of students in Biology. That is why there is no significant difference between them. However, the intervention from other modes created varying impacts on the students.

Table 3: Post hoc comparison of the significance difference between the mean scores of written communication skills of students taught Biology using enhanced conventional flipped classroom modes

Pairwise Comparisons						
Dependent Variable: Posttest BWCSAT						
(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
EMFC Mode	EFFC	5.546*	1.352	.000	1.910	9.183
	EGBFC	-1.079	1.273	1.000	-4.501	2.343
	ECFC	10.565*	1.159	.000	7.449	13.681
EFFC Mode	EMFC	-5.546*	1.352	.000	-9.183	-1.910
	EGBFC	-6.626*	1.466	.000	-10.567	-2.684
	ECFC	5.019*	1.401	.003	1.250	8.787
EGBFC Mode	EMFC	1.079	1.273	1.000	-2.343	4.501
	EFFC	6.626*	1.466	.000	2.684	10.567
	ECFC	11.644*	1.323	.000	8.087	15.202

ECFC Mode	EMFC	-10.565*	1.159	.000	-13.681	-7.449
	EFFC	-5.019*	1.401	.003	-8.787	-1.250
	EGBFC	-11.644*	1.323	.000	-15.202	-8.087
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Bonferroni.						

Data in Table 4 on the influence of gender on students' written communication skills in Biology shows that the mean difference between the posttest and pretest scores of the male and female students are 25.92 and 26.34 respectively showing that the female students taught Biology with enhanced four flipped classroom modes had a slightly higher mean difference in their written communication skills than their male counterparts in Biology.

Results shown in Table 2 with regards to null hypothesis two which determines if there is significant influence of gender on the mean scores of written communication skills of students in Biology revealed that ($F(1,105) = 3.696$, $p = 0.057 > 0.05$, $\eta^2_p = 0.034$). Since the associated probability value of 0.057 is greater than the 0.05 level of significance; the null hypothesis two (H_{02}) which states that there is no significant influence of gender on the mean scores of written communication skills of senior secondary school students in Biology is not rejected. In addition, the effect size ($\eta^2_p = 0.034$) shows that 3.4 percent variance in students' written communication skills in Biology was attributed to the treatment. As such, gender has no significant influence on the mean scores of written communication skills of senior secondary school students in Biology.

Table 4: Mean and standard deviation scores of students' written communication skills in Biology as influenced by gender

Treatment Group	Gender	n	Pretest		Posttest		Mean Difference
			Mean (\bar{x})	SD	Mean (\bar{x})	SD	
EMFC Mode	Male	36	13.75	5.03	39.67	6.09	25.92
EFFC Mode	Female	78	11.22	3.82	37.56	6.78	26.34
EGBFC Mode							
ECFC Mode							

EMFC Enhanced Micro-Flipped Classroom **EFFC** Enhanced Faux Flipped Classroom **EGBFC** Enhanced Group-Based Flipped Classroom **ECFC** Enhanced Conventional Flipped Classroom, **Total n= 114**

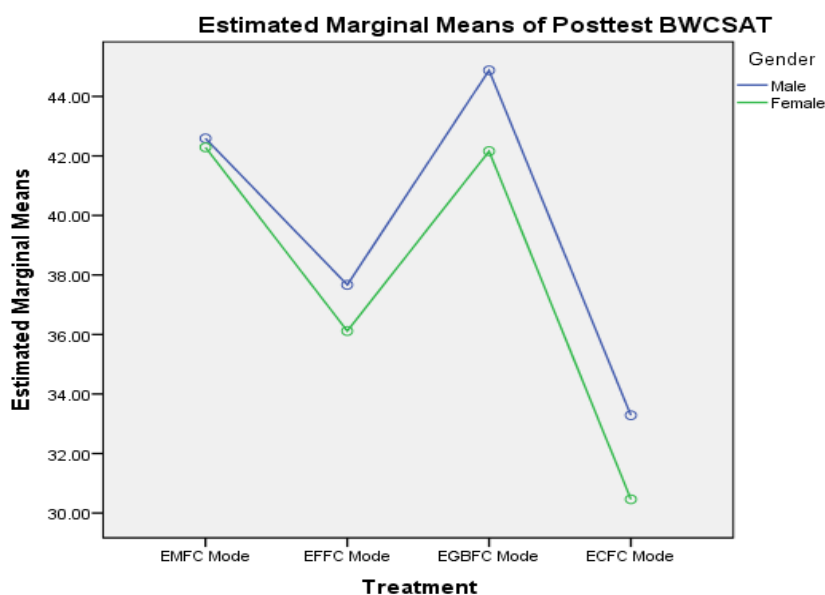
Table 5 on the interaction effect of teaching modes and gender on students' written communication skills in Biology reveals that the mean differences between the posttest and pretest scores for male and female in EMFC mode are 29.09 and 31.19 respectively; in EFFC mode are 25.67 and 25.79 respectively; in EGBFC mode are 32.88 and 31.64 respectively; and in ECFC mode are 17.82 and 17.79 respectively. Results shown in Table 2 with regards to null hypothesis three which determines if there is significant interaction effect of teaching modes and gender on students' written communication skills in Biology when taught using four modes of enhanced flipped classroom revealed that ($F(3, 105) = 0.504$, $p = 0.680 > 0.05$, $\eta^2_p = 0.014$). Since the associated probability value of 0.504 is greater than the 0.05 level of significance; the null hypothesis three (H_{03}) which states that there is no significant interaction effect of teaching modes and gender on students' written communication skills in Biology is not rejected. In addition, the effect size ($\eta^2_p = 0.014$) shows that 1.4 percent variance in students' written communication skills in Biology was attributed to the treatment. As such, it is inferred that there is no significant interaction effect of teaching modes and gender on students' written

communication skills in Biology when taught using four modes of enhanced flipped classroom. This is further illustrated in the interaction graph in Figure 1 below.

Table 5: Mean and standard deviation scores of students on the interaction effect of teaching modes and gender on students’ written communication skills in Biology

Treatment Group	Gender	N	Pretest		Posttest		Mean Difference
			Mean (\bar{x})	SD	Mean (\bar{x})	SD	
EMFC Mode	Male	11	13.73	5.39	42.82	3.63	29.09
	Female	27	10.96	3.42	42.15	2.39	31.19
EFFC Mode	Male	6	12.00	2.00	37.67	2.07	25.67
	Female	14	10.07	2.59	35.86	4.59	25.79
EGBFC Mode	Male	8	12.00	4.96	44.88	3.83	32.88
	Female	14	10.29	4.05	41.93	5.06	31.64
ECFC Mode	Male	11	16.00	5.53	33.82	5.64	17.82
	Female	23	12.78	4.43	30.57	5.95	17.79
EMFC Mode EFFC Mode EGBFC Mode ECFC Mode	Female	78	11.22	3.82	37.56	6.78	26.34

EMFC Enhanced Micro-Flipped Classroom **EFFC** Enhanced Faux Flipped Classroom **EGBFC** Enhanced Group-Based Flipped Classroom **ECFC** Enhanced Conventional Flipped Classroom



Covariates appearing in the model are evaluated at the following values: Pretest BWCSAT = 12.0175

Figure 1: Graph showing the interaction effect of teaching modes and gender on students’ written communication skills in Biology

DISCUSSION

Biology students taught with the four-modes of enhanced flipped classroom improved in their written communication skills in Biology. Nevertheless, Biology students taught with the EGBFC mode had the highest mean gain in their written communication skills in Biology, followed by those taught with the EMFC mode, followed by those taught with the EFFC mode

while the least are those taught with the ECFC mode. The ANCOVA result of the first null hypothesis further demonstrates that the students in the four groups taught Biology using EMFC, EFFC, EGBFC, and ECFC modes significantly improved in their written communication skills in Biology. The improvement in the participants' written communication skills as noticed across the four-modes, could be attributed to the written communication exercises as enhancement given to the participants at the end of each Biology lesson in which they were asked to summarize in not more than a page, what they had learnt in each lesson. Through this exercise done at the end of every Biology lesson and submitted immediately as a group or individually depending on the mode of enhanced flipped classroom, participants obtained appropriate feedback from their teachers which guided them subsequently in their written communication exercise and improved their written communication skills in Biology. However, the greatest improvement in the written communication skills as observed in the EGBFC mode could be because of the group interaction among students that is being encouraged in this mode which is lacking in the other enhanced modes. Also, students in this mode had their written communication exercises written and submitted according to groups. Such scenario promoted explicit collaboration; group interaction and exchange of ideas during the written communication exercises that improved their written communication skills in Biology. This agrees with the studies of Indayani et al. (2022); Altas and Mede (2021); Gürlüyer and Elkılıç (2020); and Leis et al. (2017) though in other subject areas that flipped classroom improves students written communication skills. The findings are in also in tandem with Michaelsen and Knight (2023) as well as Blyznyuk and Kachak (2024) that collaborative learning through groupwork enhances communication skills, fosters critical thinking through discussion and promote effective learning outcomes. It is also in line with Cordova et al. (2019) as well as Hong (2024) that assignments improve students' performance.

A significant difference in the mean scores of written communication skills of senior secondary school students taught Biology using enhanced conventional, micro, faux and group-based flipped classroom modes noticed in the findings led to a post hoc test. The post hoc test revealed that only the EGBFC and the EMFC interventions function at the similar level in improving students' written communication skills in Biology. This means that in the enhanced flipped classroom modes, it is more encouraging for Biology students to watch pre-lesson videos along with short assignments during the pre-classroom segment and then work in heterogeneous groups during the classroom episode. Such practices are assumed to engage the learners immensely in their Biology lessons. This also suggests that the written communication skills exercises given to participants by the teacher at the end of each Biology lesson which are written and submitted individually or as a group are useful. By marking the learners' written communication exercises in the form of Biology essays and giving them feedbacks, the learners become more dedicated and improve in their written communication skills in Biology.

The finding upholds Vygotsky's social constructivism theory of zone of proximal development (Vygotsky, 1962) which believed that there are some skills or knowledge a learner can do independently whereas other skills can be done only if such a learner receives assistance from another person known as more knowledgeable other. The enhanced flipped classroom modes experimented in this study enabled learners to understand those things they could not have understood on their own when they watched the pre-lesson videos but understood same through the interaction with the more knowledgeable others (MKO) such as their Biology teachers and their fellow participants during the classroom stage of the flipped classroom modes. The improvement in the written communication skills of students across the four-modes of enhanced flipped classroom also gave credence to Mayer's cognitive theory of

multimedia learning (Mayer, 1997) which believed that deeper learning occurs when words (audio) and images (visual) are combined than with either words or images alone. The short pre-lesson videos watched by learners in the four-modes of enhanced flipped classroom used in this study had both audio and images combined which were believed to help the learners learn profoundly as the theory maintained. Furthermore, by watching the pre-lesson videos before the classroom stage as practised in the four-modes of the enhanced flipped classroom as well as by having enhancements through knowledge of specific objectives of the Biology lessons, learners tend to become prepared in advance and relate the learning materials to their existing knowledge thereby making them to learn meaningfully as Ausubel's theory (Ausubel, 1963) explains.

Female students taught Biology with enhanced flipped classroom modes had a slightly higher mean difference in their written communication skills than their male counterparts in Biology. However, the ANCOVA result of the second null hypothesis shows that gender has no significant influence on the mean scores of written communication skills of senior secondary school students in Biology. This could be because both male and female participants are uniformly engaged in the activity that require strong literacy skills such as the written communication exercise taken at the end of every Biology lesson as fostered by the four-modes of the enhanced flipped classroom. Again, both male and female students tend to respond uniformly across the four-modes of the flipped classroom experimented in this study by watching the pre-lesson videos via WhatsApp platform or computer. Perhaps, such equal responses of watching the pre-lesson videos through WhatsApp platform or computer; jotting down salient points in the videos and by telling their siblings or parents about what they have watched in the pre-lesson videos, make the students more inclined towards learning the Biology lesson contents shown in the videos. These additional efforts coupled with the written communication exercise at the end of each Biology lesson and specific objectives' enhancement could help both male and female students improve in their written communication skills in Biology. This finding supports the results gotten by Zamista and Azmi (2024); and Gürlüyer and Elkılıç (2020) though in other subject areas that there was no significant difference in the improvement of writing performances and written communication skills of students regarding the flipped classroom model by gender. Therefore, the impact of the intervention given using the four-modes of enhanced flipped classroom is alike across gender thereby substantiating that the enhanced flipped classroom modes experimented in this study are not gender biased.

The ANCOVA result of third null hypothesis indicates that there is no significant interaction effect of teaching modes and gender on students' written communication skills in Biology. This was further demonstrated in the interaction graph in figure 1 where there was no intersection between the gender lines in the profile plots. This could be because the four-modes of enhanced flipped classroom compared in this study integrated technology which likely engaged both male and female Biology participants uniformly during learning process. Thus, gender does not appear to determine how the four-modes of enhanced flipped classroom affect the written communication skills of students in Biology. The finding agrees with Ugwoke et al. (2018) though in another subject area that there is no significant interaction effect of teaching methods on the basis of gender. This clarifies that the effectiveness of the enhanced conventional, micro, faux and group-based flipped classroom teaching modes does not differ based on the gender of the participants. Consequently, both male and female students who participated in the study almost responded in the same way to the teaching modes used; signifying that the effect of the teaching modes is the same across gender.

CONCLUSION

Assignments and group works are very necessary in classroom instruction as respectively seen in EMFC and EGBFC modes that integrated them among the four-modes of enhanced flipped classroom that were compared in this study to ascertain their effect on students' written communication skills in Biology after being enhanced by the learners' knowledge of instructional objectives of the lessons in charts and by their embarking on written communication skills' exercise at the end of each Biology lesson. Thus, enhanced micro, group-based, faux and conventional flipped classroom modes improved students' written communication skills in Biology without being gender biased with enhanced group-based and micro flipped classroom modes being glaringly efficacious because of their incorporation of group works and assignments respectively during instructional processes. Teachers should adopt the enhanced micro, group-based, faux and conventional flipped classroom modes during instructional delivery as they help learners to improve in their written communication skills in Biology.

References

- 1) Adeuya, V. O. (2020). Effect of guided inquiry teaching strategy on academic performance of secondary school students in biology in Ekiti State, Nigeria. *Euro Afro Studies International Journal*, 1(4), 44–54.
- 2) Adonu, C. J., Nwagbo, C. R., Ugwuanyi, C. S., & Okeke, C. I. O. (2021). Improving students' achievement and retention in biology using flipped classroom and PowerPoint instructional approaches: Implication for physics teaching. *International Journal of Psychosocial Rehabilitation*, 25(2), 234–247.
- 3) Akani, O. (2015). Impact of instructional scaffolding on students' achievement in chemistry in secondary schools in Ebonyi State of Nigeria. *International Journal of Education, Learning and Development*, 3(7), 74–83.
- 4) Alessa, I. A., & Hussein, S. (2023). Using traditional and modern teaching methods on the teaching process from teachers' own perspective. *Educational & Social Science Journal*, 10(2), 65–92.
- 5) Algarni, A. (2024). Biomedical students' self-efficacy and academic performance by gender in a flipped learning haematology course. *BMC Medical Education*, 24(443), 1–12.
- 6) Altas, E. A., & Mede, E. (2021). The impact of flipped classroom approach on the writing achievement and self-regulated learning of pre-service English teachers. *Turkish Online Journal of Distance Education*, 22(1), 66–88.
- 7) Amin, A. M., Karmila, F., Pantiwati, Y., Adiansyah, R., & Yani, A. (2022). The communication skills profile of pre-service biology teachers. *Jurnal Penelitian Pendidikan IPA*, 8(4), 2109–2115.
- 8) Ausubel, D. (1963). *The psychology of meaningful verbal learning*. Grune & Stratton.
- 9) Bishop, J. L., & Verleger, M. A. (2013). The flipped classroom: A survey of the research [Paper presentation]. 120th ASEE Annual Conference & Exposition.

- 10) Blyznyuk, T., & Kachak, T. (2024). Benefits of interactive teaching for students' critical thinking skills improvement. *Journal of Vasyl Stefanyk Precarpathian National University*, 11(1), 94–102.
- 11) Cordova, C., Pagtulon-an, E. A., & Tan, D. A. (2019). No assignment policy: A boon or a bane. *International Journal of English and Education*, 8(1), 144–160.
- 12) Daworiye, P. S., Alagoa, K. J., Enaregha, E., & Eremasi, Y. B. (2015). Factors affecting the teaching and learning of biology in Kolokuma/Opokuma L.G.A, Bayelsa, Nigeria. *International Journal of Current Research in Bioscience and Plant Biology*, 2(4), 151–156.
- 13) Ebonam, C. R. (2023). Effect of interpretative construction-based teaching method on academic achievement of secondary school biology students in Awka South Local Government Area of Anambra State. *Unizik Journal of Educational Research and Policy Studies*, 16(3), 33–54.
- 14) Ebrahim, A. H., & Naji, S. A. B. (2021). The influence of flipped learning methods on high school learners' biology attainment and social intelligence in Kuwait. *EURASIA Journal of Mathematics, Science and Technology Education*, 17(8), 1–17.
- 15) Education. (2021). *8 flipped classroom examples*. Retrieved June 26, 2023, from <https://www.viewsonic.com/library/education/8-flipped-classroom-examples/>
- 16) Femi-Adeoye, K. O. (2021). Effect of flipped classroom strategy on senior secondary school students' achievement in biology. *International Journal of Innovative Social & Science Education Research*, 9(3), 208–212.
- 17) Fidalgo-Blanco, A., Martínez-Nuñez, M., Borrás-Gene, O., & Sanchez-Medina, J. J. (2017). Micro flip teaching – An innovative model to promote the active involvement of students. *Computers in Human Behavior*, 72, 713–723.
- 18) Folorunso, O. (2015). Effect of argument-based inquiry approach on acquisition of skills and interest in biology (Unpublished Ph.D. thesis). Department of Science Education, University of Nigeria, Nsukka.
- 19) Gürlüyer, M., & Elkılıç, G. (2020). Examining EFL students' achievements and perceptions in terms of writing skills in flipped classroom environment. *Kastamonu Education Journal*, 28(3), 1471–1486. <https://doi.org/10.24106/kefdergi.4190>
- 20) Hong, D. (2024). Using in-class group assignments to improve low-achieving students' performance in an introductory accounting course. *Accounting Education*, 33(1), 66–83.
- 21) Ibe, E., Aniaku, O. L., Aham, A. C., Ugwu, T. U., Ngwu, A. N., Ugwu, C. B. A., Abamuiche, J. A., Oyetola, F., & Anyaegbunam, N. (2022). Gender and communication skills acquisition of students exposed to argument-based inquiry instructional approach. *International Journal of Early Childhood Special Education*, 14(3), 4888–4896.
- 22) Indayani, W. R., Arifani, Y., & Ma'rifah, U. (2022). The use of flipped classroom to improve students' writing skill using WhatsApp group. *Journal of English Teaching, Literature, and Applied Linguistics*, 6(1), 19–24.

- 23) Infomediang. (2022). *WAEC English marking scheme (how SSCE essays are marked)*. Retrieved January 29, 2024, from <https://informediang.com/waec-english-marking-scheme/>
- 24) Johnson, L., Adams-Becker, S., Estrada, V., & Freeman, A. (2015). *The NMC Horizon Report: 2015 Higher Education Edition*. Retrieved August 11, 2023, from <https://files.eric.ed.gov/fulltext/ED559357.pdf>
- 25) Jumat, J. (2015). *The difference between approach, strategy, method, technique and model*. Retrieved January 18, 2024, from <http://englishmanagement17.blogspot.com/2015/07/the-difference-between-approach.html?m=1>
- 26) Kiilu, C. N., Nwanya, P., & Muo, R. M. (2022). Challenges facing the performance in biology in public secondary schools in Kilungu Sub-County, Makueni County, Kenya. *Journal of Popular Education in Africa*, 6(11), 28–40.
- 27) Kumari, P., Arora, S., & Tiwari, S. (2015). Academic achievements in social science subject of 9th class students of secondary schools located in urban area. *International Journal of Science Education*, 42(13), 2126–2144.
- 28) Leis, A., Cooke, S., & Tohei, A. (2017). The effects of flipped classrooms on English composition writing in an EFL environment. In *IGI Global* (pp. 1272–1273). <https://doi.org/10.4018/978-1-5225-0783-3.ch062>
- 29) Manishimwe, H., Shivoga, W. A., & Nsengimana, V. (2023). Enhancing students' achievement in biology using inquiry-based learning in Rwanda. *International Journal of Evaluation and Research in Education*, 12(2), 809–817.
- 30) Mayer, R. E. (1997). Multimedia learning: Are we asking the right questions? *Educational Psychologist*, 32(1), 1–19.
- 31) Mbah, N. L. (2025). *Enugu state's education transformation: A vision realized, and a nation inspired*. Retrieved April 20, 2025, from <https://dailynewsngr.com.ng/enugu-states-education-transformation-a-vision-realized-and-a-nation-inspired/>
- 32) Mercer-Mapstone, L. D., & Kuchel, L. J. (2016). Integrating communication skills into undergraduate science degrees: A practical and evidence-based approach. *Teaching & Learning Inquiry*, 4(2), 1–14. <https://doi.org/10.20343/teachlearning.4.2.11>
- 33) Michaelsen, L. K., Knight, A. B., & Fink, D. (2023). *Team-based learning: A transformative use of small groups in college teaching*. Taylor & Francis.
- 34) Ncheke, D. C., Enejedu, E. E., Egenti, N., & Nwosu, N. (2021). Social media sites as correlates of academic achievement of secondary school students in Nsukka education zone of Enugu state. *The Educational Psychologist*, 14(1), 13–22.
- 35) Nwagbo, C. R. (2022). *Teaching or cheating in science education practices: The twenty-first century experience* (174th inaugural lecture). University of Nigeria Senate Ceremonials Committee.
- 36) Nworgu, B. G. (2015). *Educational research: Basic issues & methodology* (3rd ed.). University Trust Publishers.
- 37) Nwosu, A. A. (2015). *Science education for life in a dynamic world*. University of Nigeria.

- 38) Pedagogy. (2018). *What is pedagogy?* Retrieved July 10, 2020, from <https://www.tes.com/news/what-is-pedagogy-definition>
- 39) Rai, B., Zhu, J. Y., Koh, D. C., Xiaojuan, K., Krishnaswamy, L., Chandramohanadas, R., Shi, O. E., & Leong, P. K. (2020). An investigation into the impact of the flipped classroom with active learning on the perception and performance of biology non-major students at the undergraduate level. *Research and Teaching*, 50(2), 27–39.
- 40) Richards, J. (2023). *Reasons for poor speaking skills*. Retrieved July 31, 2023, from <https://www.professorjackrichards.com/reasons-for-poor-speaking-skills/>
- 41) Rose, K. M., Markowitz, E. M., & Brossard, D. (2020). Scientists' incentives and attitudes towards public communication. *Proceedings of the National Academy of Sciences*, 117, 1274–1276.
- 42) Studysmarter. (2024). *Written communication skills*. Retrieved January 29, 2024, from <https://www.studysmarter.co.uk/explanations/business-studies/organizational-communication/written-communication>
- 43) Thakare, R. (2018). *Eight types of flipped learning classroom and tools to build them*. Retrieved September 10, 2022, from <https://elearningindustry.com/flipped-learning-classrooms-tools-build-types/amp>
- 44) Udo, N. N., & Ubana, A. U. (2016). Impact of prior knowledge of behavioural objectives on students' academic achievement in physics. *International Journal of Science and Technology*, 5(1), 95–104.
- 45) Ugwoke, K. O., Edeh, N. I., & Ezeema, J. C. (2018). Effect of flipped classroom learning management systems and face-to-face learning environments on students' gender, interest and achievement in accounting. *Library Philosophy and Practice*, 1875, 1–35.
- 46) Ugwuanyi, C. S., Nduji, C. C., Elejere, U. C., & Omeke, N. E. (2020). Effect of flipped classroom and think-pair-share strategy on achievement and retention among senior secondary school physics students. *International Journal of Sciences: Basic and Applied Research*, 52(2), 136–148.
- 47) UN. (2024). *Concepts and definitions*. Retrieved February 19, 2024, from <https://www.un.org/womenwatch/osagi/conceptsanddefinitions.htm>
- 48) UNICEF. (2017). *Gender equality: Glossary of terms and concepts*. South Asia.
- 49) UNM. (2023). *Five essential communication skills*. Retrieved September 15, 2023, from <https://unm5.unm.edu/5-research-COMMUNICATION-skills.html>
- 50) Vygotsky, L. S. (1962). *Thought and language*. MIT Press.
- 51) WAEC. (2015–2023). *WAEC Chief Examiner's reports for the May/June WASSCE*. Retrieved May 30, 2024, from <https://waeconline.org.ng/e-learning/biology/biomain.html>
<https://www.waeconline.org.ng/e-learning/Biology/Bio255mc.html>
<https://www.waeconline.org.ng/e-learning/Biology/Bio240mc.html>
- 52) Zamista, A. A., & Azmi, K. (2024). Bridging the gender gap: Investigating disparities in students' communication skills in the digital education era. *An-Nisa Journal of Gender Studies*, 17(1), 1–11.