EFFECT OF KELLER SYSTEM OF INSTRUCTION ON FEMALE AND MALE STUDENTS' ACADEMIC ACHIEVEMENT IN BIOLOGY IN ABAKALIKI EDUCATION ZONE, EBONYI STATE

Dr. Odimkpa Christiana Ogonna[a], Dr. Anudu Adaora Phina[a], & Dr. Chibueze Utum Mgboro[b]

[a] Department of Science Education, Alex Ekwueme Federal University Ndufu-Alike
Ebonyi State, Nigeria. odimkpa.ogonna@funai.edu.ng
[b] Department of Educational Foundations, Ebonyi State University, Abakaliki
Corresponding author: Email: odimkpa.ogonna@funai.edu.ng

Abstract
The study investigated the effect of the Keller system of Instruction (KSI) on secondary school female and male students' academic achievement in biology. One research question guided the study and one null hypothesis was tested. A quasi-experimental research design was adopted. The study sample comprised three hundred and thirty-two (332) students drawn from the population of 7612 students in four schools in Abakaliki Education Zone using a multistage sampling technique. The instrument for data collection was the Biology Achievement Test (BAT). Data collected from the research questions were analyzed using mean and standard deviation, and Analysis of Covariance (ANCOVA) was used to test the formulated hypotheses at a 0.05 level of significance. Though the female students had higher achievement mean scores than the male students in biology when KSI was used, the difference in their biology achievement mean scores was not statistically significant. In line with the study's findings, recommendations were proffered among others that science teachers should adopt the Keller system of Instruction in teaching.

Keywords: Biology; Keller System of Instruction; lecture method; male and female; students' academic achievement.

Introduction
Teaching is a complex process that requires a high level of flexibility, adaptability, and nobleness of mind to bring about observable changes in the learner (Muema et al., 2018). Teaching is a process of transferring knowledge and skills from the teacher to the learner in order to help the learner develop the required ability to make the right decisions and choices (Reuben & Ogheneakoke, 2021). It is, therefore, not surprising that the aim of teaching is not only to convey information to learners but also to instill in the students the skills of learning how to understand what is being taught. To achieve the above aim, teachers, therefore, use various Instructional methods.

Instructional methods are variously called teaching styles (Abdulrahman & Hassan, 2016), teaching approaches (Audu, 2018), or techniques (Reuben & Ogheneakoke, 2021). Notwithstanding the different names, the present study uses the term instructional method. Instructional methods can be described as the main functional procedure of the educational process. Instructional methods are sets of tactics teachers use to present information and skills to the students (Audu, 2018). According to Ugwoke and Ude (2022),

methods of instruction include all sets of deliberately and systematically arranged procedures that are exchanged between students and students, teachers and students, and instructional experiences in order to cause changes (behavioral, psychological, and intellectual) that might be permanent on the learners. Consequent to the above definitions, Instructional methods can be expressed as the description of teaching activities and the flow of information between teachers and students in the teaching and learning process. Some of the instructional methods include demonstration, cooperative learning, and lecture.

The lecture method was used for the control group in the present study. The method is a one-way communication channel where an instructor who knows a given subject matter verbally delivers all relevant information to learners (Umeana et al., 2022). Students involved in the teaching method are passive listeners who sometimes pen down some notes and probably ask questions after the delivery (Azih et al., 2022). The lecture method is teacher-centered. Hence, the teacher plans and controls the whole teaching–learning process (Azih et al., 2022; Ugwoke & ude, 2022). According to Ugwoke and Ude (2022), the lecture teaching method is among the most inexpensive as it hardly requires the use of instructional materials or an experienced teacher. The main emphasis of this method is the presentation of the content. For Ugwoke and Ude (2022), Lecturing is a time-tested instructional method, which is the reason most teachers often undermine the length and breadth of where to cover and use it in haste to cover the scheme of work (Reuben & Ogheneakoke, 2021). However, Ugwoke and Ude (2022) noted that instructional delivery using lecture methods does not accommodate students' individual instructional needs and causes students to rely more on the teachers. Students accustomed to lecture methods in biology lack self-directed learning skills as it often leads to rote memorization, thereby not promoting meaningful learning in biology.

Biology is the study of living things and their vital processes. Biology is one of the important science subjects studied in Nigerian senior secondary schools (Ugwoke and Ude, 2022). It is a prerequisite to many science-related professional courses in higher institutions such as Microbiology, Medicine, Pharmacy, Nursing, Dentistry, and other related courses. The innovative biological research on the combinations of living and non-living things has made it possible to use biomaterials (ceramic, polymers, metals, and composites inserted into the human body) to save lives (Adamu, 2016). Biological knowledge has made many contributions to the welfare of humanity in beer brewing, mining, milk processing, bread-making, disease control, organ transplant, and plant breeding to produce high-yielding and disease-resistant crops and animals (Namasaka, 2009). Biological knowledge has also enabled man to appreciate the essence of biodiversity, bio-economy, and environmental conservation for sustainable development (Oguntuase, 2017). According to Umeana et al. (2022), the objectives of the biology curriculum as contained in the National Policy of Education are to prepare students to acquire adequate laboratory and field skills in biology, meaningful and relevant knowledge of the ability to apply scientific knowledge to everyday life in matters of personal and community health and agriculture as well and reasonable and functional scientific attitude (Umeana et al., 2022, 692). However, the student's low achievement in biology in the

external examinations has been a source of worry for teachers, parents, and stakeholders.

Achievement is a functional educational variable used to denote the outcome of a teaching and learning process. Students' achievement demonstrates their abilities to attain certain levels of instructional objectives and the outcome of their classroom instructions and experiences (Nwafor & Oka, 2021). Therefore, achievement is not only a measurable index that depicts a student's ability in educational domains but also a yardstick for ascertaining the capability of students. Achievement is expressed by receiving grades from tests, assignments, examinations, classroom attendance, and classroom interaction. This enables the examiner to determine the level to which a particular student can be adjudged to have passed or failed after being exposed to a condition requiring a response. (Reuben & Ogheneakoke, 2021).

Many researchers ((Ude & Ebuoh, 2019; Nwafor & Oka, 2021; Audu, 2018) have stated that biology students have yet to show from their achievement in WASSCE that biology is relevant to them. WAEC results in biology for Nigerian students have been consistently poor (Nwafor & Oka, 2021). Unsurprisingly, the results for the study area between 2014 and 2020 indicate poor achievement in biology. The poor students ' achievement in biology is linked to the method of instruction being used to teach biology (Ude & Ebuoh, 2019; Ugwuoke & Ude, 2022), which is usually a teacher-centred method of teaching and learning (Nwafor & Oka, 2021; Audu, 2018). It stifles creativity and active participation and does not encourage the students to acquire science process skills (Yaduvanshi & Singh, 2018). Ugwuoke and Ude (2022) also attributed poor academic achievement in biology to the abstract theoretical contents and complex practical nature of certain biology concepts apart from the teaching method adopted by instructors. Because of the above challenges facing teaching and learning biology in secondary school, there is a need for teachers to have a paradigm move from the conventional teacher-centered to innovative instructional strategies like Keller System of instruction (KSI), that engage the students actively while supporting them to learn how to learn at their own pace (Umeana, et al 2022), space, interacting with both human and material resources to discover facts for themselves leading to meaningful learning (Iroriteraye-Adjekpovu & Osimala, 2020).

KSI is a teaching method whereby the learners are taught based on their abilities and needs to enable them to acquire knowledge and skills in addition to self-learning skills. Keller System of Instruction was developed by Fredrick Keller, Gil Sherman, Rodolph Azzi, and Carolina MartuscelliBori in 1963 when the Department of Psychology at the University of Brasilia, was founded (Khawla & Ibtisam, 2018). Keller was the most passionate advocate of KSI (Medici & Carmo, 2018); hence, in his honor, the system is sometimes called the "Keller Plan" or "Keller System of Instruction." However, the method is commonly called the 'Personalized System of Instruction (Friskawati, et al. 2017; Khawla & Ibtisam, 2018). According to Paiva, et al. (2017), Keller and Sherman taught psychology at Arizona State University but were dissatisfied with the teacher-centered teaching methods used to teach Psychology. Since they were specialists in learning theories, they developed a teaching method based on the application of Skinner's theory of learning called the 'Keller System of Instruction' (KSI). The teaching method, KSI, encouraged students of Arizona State University to master the course content and

increase the amount of interpersonal interaction between them and their teachers (A1-Zaboun et al. 2016). KSI was later used to teach Morse code at the University of Brasilia in 1964 by Azzi and Bori, and in 1968, Keller and Sherman used it at Arizona State University (Medici & Carmo, 2018). Medici and Carmo further stated that KSI's wide application led to its use in teaching a wide range of courses.

KSI has the following features (Khawla and Ibtisam, 2018; Young, 2019): Stress on the written word, Student Self-pacing, Unit mastery requirement, Use of proctors, and Use of lectures and demonstrations for motivational purposes. The features are briefly examined as follows:

Stress on the written word: The instructional content (material), according to Medici and Carmo (2018), is presented in written form and called a study guide. Such texts allow students to study at all times because they are portable and can be read at one's pace and convenience. The KSI teachers prepare the written study guide, which contains the objectives and questions that focus students' attention on essential learning materials and indicate what students are expected to do. The study guide might also include suggested textbooks, and instructors' comments, which are used to elucidate difficult points, and practice problems which help to prepare students for the unit quiz (Khawla & Ibtisam, 2018; Medici & Carmo, 2018). The instructional material (study guide) for the present study is uploaded online and can be accessed using the https://odimkpachristy.com using the link- https://odimkpachristy.com/courses/study-guide-for-keller-system-of-instruction-group-experimental-package/

Students' Self-Pacing: Students' self-pacing means they can study the course materials at their own pace. Students' self-pacing is a method that combines students' academic learning skills and students' ability to control themselves (Fauzi & Widjajanti, 2018). According to Boninger, Molnar and Saldana (2019), it is assumed that students can develop and articulate their own motivation and personal goals with little guidance. Thus, the course instructor might state the order for the learning of the units and their completion, but the learners decide when, how, and at what speed they learn. Therefore, no student is discouraged from using self-pacing by a teacher who might teach faster than the students' pace and ability or use a teaching method that the student is uncomfortable with (Al-Zaboun et al., 2016) because the students are learning at their own pace. However, some students might fall victim to procrastination and cheating.

To avoid procrastination, the present study used a target deadline as a modification of KSI. This was due to the already stipulated period of instruction and learning, which lasts for a term and session in the academic calendar. However, the sad truth is that today, students come up with creative techniques to cheat in an examination, be it an online or an offline examination (Eklavvya, 2021). This is of great concern to the user of KSI because the Keller System of Instruction, being a self-paced method of learning, is prone to have some students who may not read and might want to take the unit assessment in order to proceed to the next unit. They may likely cheat because they are in remote places, in the comfort of their instructional resources. Cheating, therefore, makes such unit assessment ineffective. The assessment in the present study was designed in line with restricted examination timer for each question. In this case, the students would be

unable to navigate questions. Each question was allotted a specified time of 10 seconds for an attempt. The system moved on to the next question if the student could not attempt the question in the specified time. Apart from the above, the questions were personalized with randomization of the questions, variable marking, and instant scoring. This was due to the demand for immediate feedback to allow students to proceed to the next unit.

Unit mastery requirement: To advance from one unit to the other, the students must demonstrate mastery of the units' materials. KSI requires students to demonstrate unit mastery by taking an assessment quiz that requires a minimum score of 80% (Medici & Carmo, 2018). However, if the students could not score 80% on the assessment quiz, they would be allowed more opportunities to undergo remedial instructions and tests to demonstrate mastery (Tukur, 2018; Kampen, 2019). These steps were adopted in the present study and were clearly explained at the Experimental procedure stage.

Use of Proctors: A proctor is a person who helps the teacher in clarifying ideas when the Keller System of Instruction is being used. Proctors can be those brought from outside the school environment to help students learn the course material (external proctor). They may be classmates or older students who have mastered the unit course (internal proctor) (Medici &Carmo, 2018). The proctors certify mastery, discuss areas of weakness, and direct students to the next unit. Interactions with the proctors provide student–teacher natural and genuine bonding and encouragement, which motivate students to persevere in the course (Friskawati et al. 2017).

Use of lectures and demonstrations for motivational purposes: Motivation is the state of mind that arouses, directs, and sustains one's ability to achieve a goal. In short, when students are academically motivated, their teachers often become motivated professionally, working hard to provide students with all possible educational experiences (Namasaka, 2009). In the present study, lecture and demonstration methods of teaching being used by the proctor are just to motivate, encourage, certify confusion, discuss areas of weakness, and direct students to the next unit

KSI can be applied while teaching in primary, secondary, and tertiary institutions (Al-Zaboun et al., 2016; Friskawati et al., 2017; Khawla & Ibtisam, 2018). Grant and Spencer (2003) also explained that due to its universality and flexibility, it can be used to teach not only in formal schools but also in informal schools, such as in bank training and medical training. Unsurprisingly, KSI is a vital tool in distance learning Programmes. Many researchers have noted the administration of a series of assessments in KSI classrooms as a tedious task (Foss, Foss, et al, 2014; Medici & Carmo, 2018). However, Instructor's use of computer-based assessment in KSI classrooms has automated the process of quiz administration, and students can thus take their quizzes online and get immediate feedback and corrections (Colman, 2020; Kimberley, 2020; Cohen & Sasson, 2016), thereby making learning lively and students' academic achievement enhanced.

Available studies (Al-Zaboun et al., 2016; Medici & Carmo, 2018) stated that KSI might affect male and female students' achievement differently. Iserameiya and Agbonghale, (2018) indicated that the problem of gender effect on the achievement of science concepts is also a factor in low achievement. Gender has remained a relevant and

captivating issue in education because it has been linked to students' achievement and participation (Iserameiya & Agbonghale, 2018; Yaduvanshi & Singh, 2018). Gender is a sociocultural concept that imputes some characters and roles to males and females (Godpower-Echie & Ihenko, 2017). Some vocations and professions appear to be assigned to men (agriculture, technology, arts and crafts, engineering, and more), and others to women (nursing, teaching, catering, typing, and more). Moreover, Parents give their sons chores like car washing, grass mowing, bulb replacement, scaling ladders, and repairing or removing items. Females, on the other hand, are assigned jobs such as dishwashing, cooking, and cleaning. As a result of this style of thinking and action, the general public views girls as "weaker sex." Due to gender stereotyping, the efforts of the girls to achieve excellence in the subjects perceived as male subjects could be reduced. They can excuse their low performance in science subjects on the grounds that such subjects are not meant for girls (Areji & Onuba, 2022). Because it is believed that a student's gender impacts their academic performance, the present study investigated whether there is a link between the two.

However, there are diverse views among researchers about the link between gender and academic achievement in biology, while some are of the view that male students achieve higher than their female students (Amao, et al, 2016; Naboth-Odums (2014), others do not agree with this position (Nnamani & Oyibe, 2016; Audu, 2020). Audu reported that there is no significant difference in the mean achievement score of male and female students taught biology using a personalized learning strategy, while Reuben and Ogheneakoke (2021) stated that there exists a significant disparity in the mean scores of male and female students taught with mastery learning instructional strategy.

It is noted that there were not enough empirical studies on using KSI compared with the traditional lecture method of teaching strategies in improving students' Biology achievement. Therefore, this study aimed to investigate the effect of the KSI method of teaching and learning on senior secondary school students' achievement in biology in the Abakaliki Education Zone.

Statement of the Problem

It is worth noting that students' achievement in NECO, West African Senior School Certificate (WASSC), and other 0' level external examinations in biology have been persistently poor. According to Chief examiner report on May /June West African Senior School Certificate Examination (WASSC) for 2016- 2022, students' academic achievement in biology has been poor at each year. The blame has been placed on the ineffective teaching methods by some authorities. Some doubts have also been cast on the right choice of pedagogy for biology in order to transfer necessary knowledge, skills, and mastery to the students, which are the precursors for meaningful achievement in the subject. Research has previously been carried out to establish the correct teaching methods to promote students' achievement in science subjects to no avail. Biology has been a vital subject for all categories of students and a vast science subject in Nigeria's Educational Curriculum. It becomes imperative that the appropriate teaching and learning process be put in place to promote students' academic achievement, especially in external examinations, if students are able to acquire the necessary knowledge, skills,

and competence needed to meet the scientific and technological demands of the nation (Umeana et al., 2022). Although the Keller System of Instruction has wide commendation for its efficacy, especially in developed nations, its usage in Ebonyi State classrooms for biology has not been recorded and calls for urgent investigation. Consequently, the present study investigated the effect of the Keller System of Instruction on senior secondary school students' achievement in biology.

Purpose of the Study
The study investigated the effect of the KSI strategy on SSI students' achievement in biology in the Abakaliki Education Zone. Specifically, it sought to determine the difference in the achievement mean score of female and male biology students when taught using KSI as measured by the Biology Achievement Test (BAT).

Research Question: What is the difference in the achievement mean score of female and male biology students when taught using KSI?

Hypothesis
One null hypothesis was formulated and tested at an alpha level of 0.05:
$H0_1$: The difference in the academic mean score of male and female biology students taught using KSI is not statistically significant.

Methods
Research Design
The research design is a quasi-experimental design of pre-test, post-test, non-equivalent control group design. This design, in line with Abonyi et al. (2021), is considered appropriate because it establishes a cause-and-effect relationship between the independent and dependent variables. The independent variables are KSI and conventional teaching methods, while the dependent variable is students' achievement. A quasi-experimental design is considered ideal for the study because students are already registered into intact classes; hence, it would disrupt the school timetable to randomly select students individually for experimental purposes. Pre-test and analysis of covariance were used to establish group equivalents.

Population for the Study
The population of the study comprised all the seven thousand six hundred and twelve (7,612) SSI students in Abakaliki Education Zone of Ebonyi State for 2021/2022 academic session (Secondary Education Board, 2022).

Sample and Sampling Techniques
The study sample was three hundred and thirty-two (332) SS1 students (141 males and 191 females) from four senior secondary schools in the Abakaliki education zone. The multistage sampling technique was adopted to draw the sample. Balloting was employed at the first stage to draw five co-educational secondary schools from each of the five local government areas comprising Abakaliki education zone. The purposive sampling technique was adopted in the second stage to draw one school with a functional e-library from the five schools drawn from each local government area. The total number of schools

drawn was four. The simple random sampling technique involving the toss of a coin was used in the third stage to assign the four schools into experimental and control groups. Two schools were assigned to the control group, while the other two were allocated to experimental groups. All the intact classes of SS I in the schools drawn were used to assign the subjects into experimental or control groups. Subjects were not randomly assigned to experimental and control groups. This helped to avoid disruption of class lessons and school programs. For the Experimental group, a total of one hundred and eighty-one (73 males and 108 females) S. S. 1 students were used, while for the control group, a total of one hundred and fifty-one (68 males and 83 females) S. S. 1 students were used.

Instrument for Data Collection
The instrument for data collection is the Biology Achievement Test (BAT), as adapted from WASSCE past question papers by the researchers. The BAT is a 45–item, multiple-choice test item; each has four options: A, B, C, and D, with only one correct answer among the options, based on the SSI biology syllabus. The items in the test are constructed using a test blueprint. The test items and multiple choice objective questions were carefully drawn to ensure that they fall within the scope of the SSI syllabus and the specific area selected for the study.

Validation of Research Instrument
The Biology Achievement Test (BAT) was face-validated by two lecturer s in biology education from Alex Ekweme Federal University Ndufu-Alike and two experts in measurement and evaluation from Ebonyi State University. Initially, BAT had 60 test items, but after the validation, BAT was restructured and reduced to 50 test items. The lecturers who validated the instrument vetted the test blueprint used in constructing the test items to ensure content validity and to ascertain the levels of Bloom's educational objectives being tested by BAT. The lecturers also vetted the language clarity of the test items, the marking guide, and lesson plans regarding language clarity for the students, content coverage, and relevance of the items to stated specific objectives.

Reliability of the Instrument
After validation, BAT was administered to 50 SS1 students from non-target schools in the Enugu Education zone in Enugu State for pilot testing. The scores from the pilot testing of BAT were used for item analysis (discriminating power and difficulty index). After item analysis, some items with a difficulty index of 0.3 to 0, 7, and a discrimination power of 0.4 to 1 were accepted. In contrast, others were rejected in line with Abonyi, et al., (2021). BAT items were further reduced to 45 and were subjected to a reliability test by applying Kuder Richardson- 20 (K-R-20) for internal consistency. KR-20 was chosen because it is most suitable for determining the internal consistency of data scored dichotomously. A reliability coefficient index of 0.80 was obtained. This result shows high internal consistency for BAT.

Experimental Procedure
Two instructional methods were used for the study. The first method was the Keller System of Instruction method, while the second was the lecture method. The contents of

the study were drawn from the Senior Secondary school Biology curriculum of the Federal Ministry of Education. The Keller System of Instruction method was used for the experimental group, while the Lecture method was used for the control group. The Experimental procedure was done in two stages: Stage one was the briefing of the research assistants (regular biology classroom teachers of the class in the drawn schools), while stage two was the treatment stage- teaching using the instructional methods to the experimental and control groups.

Stage one: The researchers introduced themselves to the research assistants and explained vividly the objective of the research to the research assistants.
The Experimental Groups: The researchers introduced the KSI method to the research assistants and the school E-library librarian. The school E-library librarian was involved because the study was done through an online website using the computers in the E-library. The briefing lasted for one week. The researchers emphasized that the assistants should focus on unit testing, immediate feedback, and the modality for preventing procrastination and cheating (target stipulated deadline and Specified time allotted to a question, respectively). The researchers provided a Generator set and Wi-Fi for one of the experimental schools. This was to solve the problem of unsteady power supply while using the school computers and the unavailability of data, as reported by the school librarian.
The Control Group: The lecture teaching method was used to teach the control groups. The research assistants were intimated on the skills of the lecture teaching method for one week. A week before the commencement of the experiment, the biology teachers were given the extracts, which contained the contents and the lesson plans on each of the concepts for the four (4) weeks of an instructional unit. The lesson plans specified the teachers' and students' activities during instruction.
Before the teaching began, the researchers provided the BAT to the research assistants of both the experimental and control groups, who administered it to the students as a pre-test. The scripts were collected and submitted to the researchers, who marked them and kept the scores for analysis.

The treatment stage: teaching the experimental and control groups using the instructional methods. The experimental group: The researchers provided a structured study guide based on the Keller System of Instructional method on the topics for the study. The study guide was a package built into a website https://odimkpachristy.com using the link- https://odimkpachristy.com/courses/study-guide-for-keller-system-of-instruction-group-experimental-package/ which contained what and how the students were to learn the topics (Plant nutrition, Animal nutrition, and Ecological Management) in the modules, which were broken down further into units. The objectives of each unit were spelled out. The website link was shared with the research assistants, who logged it into the school computers at the E-library. Each student connected to the website link during biology periods to access the Keller System of Instruction study guide. The implementation of the study involved studying biology subtopics on Plant nutrition, Animal nutrition, and Ecological Management) in the modules, which were broken down further into units. KSI software which was developed by the researchers with the aid of program developers. The software is titled 'Study guide for Keller system of instruction" which was designed in

a linear form and responded to instruction. The software was developed using the Rapid Application Development (RAD) model of James Martins' approach of 1980. The Study guide for Keller system of instruction package runs on WordPress, a content management system (CMS) developed in 2003 by Matt Mullenweg and Mike Little.

The model consisted of five operational stages:

i. The requirement planning

ii. User design phase/ titles.

iii. Lesson Implementation phase

iv. Take a Quiz phase

v. View result phase.

The students could only access the study guide using their password (their names). The students studied the short comprehension passage on the topic treated in the unit. After each unit, they answered the corresponding questions in multiple choice test formats with four options and one answer among the options, as in that unit's quiz. The teaching lasted for the same period of four weeks.

Steps used in the study in line with KSI.

Step One: The topic contents were divided into small manageable Modules of material. The Modules' contents were further divided into units according to learning objectives. The students studied the contents unit after unit.

Step Two: The researchers adjusted unit course pacing to suit students' convenience by giving students suggested completion dates on a course calendar. This was due to the already stipulated period of instruction and learning, which lasted for a term in the academic calendar. The stipulated period for biology on the school's timetable, during which the students move to the E-library for the study, was used to suit students' convenience and avoid disruption of the school program.

Step Three: Students took a unit quiz to show their mastery of the unit. They were required to achieve an 80 percent (80%) pass on the unit quiz or attempt the quizzes three times before proceeding to the next unit. The next unit lesson content would open automatically at each unit quiz if the student scores up to 80% or above. In a situation where the score was less than 80%, that unit's lesson content in the study guide reopened automatically for the student to restudy it before taking the second version of that unit's quiz.

Step Four: Unit quizzes composed of ten multiple-choice questions based on the learned content for that unit. Each question was allotted a specified time of 10 seconds for an attempt. If the student was unable to attempt the question in the specified time, the system moved on to the next question. Apart from the above, the questions were personalized with randomization. Three versions of the quiz were created for each unit in case one fails in the first attempt.

Step Five: Students' unit quizzes were graded instantly following their completion of the unit quiz, and feedback was shown on their individual screens to allow students to proceed to the next unit if successful.

Step Six. When the four versions of each quiz formulated for each unit were attempted by the students and the students still failed to score the required mark, they had to be taught using the lecture method in order to motivate them, after which they were allowed to reaccess that unit's quiz. At this step, the research assistants performed the role of Facilitators and Proctors.

Control of Extraneous Variables

To take care of possible extraneous variables, the researchers properly trained the classroom teachers who administered the instruments for the control and experimental groups in order to ensure the homogeneity of instruction across the groups and that teacher variable issues did not occur. Intact classes were used in the study, which means that the initial equivalence was not achieved in the two groups, as there was no randomization of subjects to the experimental and control groups. In order to control these inter-group differences, the researchers used Analysis of Covariance (ANCOVA) for data analysis. The Hawthorn effect was controlled by intact classes, with the class teachers being used as research assistants and trained for the experiment. The researchers did not select experimental and control groups from the same school in order to ensure that the students from the different groups did not interact during the course of the study, and ideas were not shared among the research subjects.

Method of Data Collection

Before the treatment in each group, BAT was administered as pre–tests to the students in both experimental and control groups. Scores of the pre-tests were recorded and kept for use at the end of the experiment. At the end of the experiment, the items of BAT were reshuffled and put on a different colour of paper and administered as post-tests. The two recorded scores (pre-tests and post-tests) were analyzed to answer the research questions and to test the formulated hypotheses.

Method of Data Analysis

The research question was answered using mean and standard deviation, while the hypothesis was tested using Analysis of Covariance (ANCOVA) at a 95% confidence level.

Results

The results of data analysis based on one research question that guided the study and one null hypothesis tested are presented as follows:

Research question: What is the difference in the achievement mean score of female and male biology students when taught using KSI?

Table 1: Pretest and Posttest Achievement Mean Scores and Standard deviation of Male and Female Students taught Biology with the Keller System of Instruction

Experimental Method (KSI)	Pre-test			Post-test		Gain Score
	N	Mean	SD	Mean	SD	
Male	74	31.93	8.93	59.91	18.18	27.98
Female	108	31.73	9.11	62.10	15.60	30.37
Total/Gain Score Difference	182	31.81	9.02	61.21	16.68	-2.39

Table 1 shows the post-test and pre-test mean scores with standard deviations of the male and female students of the experimental group taught with the Keller System of Instruction (KSI). The Table shows that the male students had a post-test mean score of 59.91 with a standard deviation of 18.18 and a pre-test mean score of 31.93 with a standard deviation of 8.93 and a mean gain score of 27.98. In contrast, the female students had a post-test mean score of 62.10 with a standard deviation of 15.60, a pre-test mean score of 31.73 with a standard deviation of 9.11, and a mean gain score of 30.37. The result shows that the female students taught with the KSI had a higher mean achievement gain score than their male counterparts, with a numerical difference of -2.39. Moreover, the standard deviation score of the female students in the post-test scores was lower than that of their male counterparts. This shows that the individual scores of the female students were more clustered to their overall mean score than those of their male counterparts.

However, the Table could not show the statistical significance or otherwise of the observed difference. Hence, the result was subjected to inferential statistics with ANCOVA to test the corresponding null hypothesis, as shown in Table 2 below.

Hypothesis: There is no significant difference in the male and female students' achievement mean scores in biology when taught with the Keller System of Instruction.

Table 2: Summary of Analysis of Covariance Result of Achievement Mean Scores of Male and Female Students taught Biology with the Keller System of Instruction

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4234.61ᵃ	2	2117.30	8.22	0.00	0.08
Intercept	26382.93	1	26382.93	102.37	0.00	0.36
Pre-test	4022.76	1	4022.76	15.61	0.00	0.08
Gender	232.58	1	232.58	0.90	0.34	0.01
Error	46133.46	179	257.73			
Total	732234.00	182				
Corrected Total	50368.07	181				

a. R Squared = 0.084 (Adjusted R Squared = 0.074)

Table 2 shows the summary of ANCOVA conducted on the male and female students' mean academic achievement scores in the experimental group. The Table shows that no statistically significant difference (F (1,179) = 0.90, P = 0.34 > 0.05) was found in the mean achievement scores of the male (M = 59.91, SD = 18.18) and female (M = 62.10, SD = 15.60) students taught biology with the Keller System of Instruction. The mean difference was -2.39. Therefore, the hypothesis, which states that there is no statistically significant difference in the male and female students' achievement mean scores in biology when taught with the Keller System of Instruction as measured by their mean post-test scores in BAT, was, therefore, accepted at a 0.05 alpha level. This means that the earlier observed difference in the mean academic achievement scores of the two groups, as shown in Table 1, was not significant. This further shows that there was no statistically significant influence of gender on students' academic achievement in biology when taught with the Keller System of Instruction. This implies that the effectiveness of

the Keller System of Instruction in improving students' academic achievement in biology could not be influenced by gender.

Discussion of the Findings

The result of the study on effect of KSI on male and female students in biology showed that gender had no effect when KSI was used. The insignificant levels of achievement between males and females could be attributed to the manageable units of the study guide which is devoid of masculinity and femininity of instruction, and the students demonstrated mastery over before proceeding to the next unit.

The finding aligns with earlier findings by Yaduvanshi and Singh (2018) and Iserameiya and Agbonghale (2018), who found that the achievement mean scores of male and female students were not statistically significant. Okafor-Obi (2016) noted that KSI is one of the gender-inclusive teaching methods, which creates a gender-friendly learning environment and facilitates mastery learning; therefore, no significant difference was observed.

Conclusion

The study's findings showed that the use of KSI significantly enhanced students' achievement in biology. The difference between the achievement mean scores of male and female students was not significant. KSI, therefore, effectively bridges the gap between male and female students' achievement in biology.

Recommendations

Based on the findings of this study and their implications, the following recommendations are made.
1. The federal government should supply ICT facilities to schools so that teachers and students can use them for teaching and learning.
2. Schools should take the computer literacy program introduced by the Ministry of Education seriously so that online tutorials will benefit teachers and students.
3. Teacher training and tertiary institutions should include KSI in their biology curriculum and impart knowledge of its usage to the students.
4. Ministry of Education should encourage and sponsor professional bodies like the Science Teachers Association of Nigeria (STAN) to organize in-service training, seminars, conferences, and workshops to familiarize teachers with KSI.

Consent

As per international or university standards, the authors has collected and preserved participants' written consent.

Competing Interests

The authors have declared that no competing interests exist.

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