Article

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EFFECT OF COMPUTER-BASED PROGRAMMED INSTRUCTION ON STUDENTS' ACHIEVEMENT IN BIOLOGY

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Abstract
The study investigated the effect of Computer-Based Programmed Instruction Teaching Strategy (CBPITS) on students' achievement in biology. Three null hypotheses were formulated and tested at the 0.05 level of significance. The design for the study was a quasi-experimental, pretest and posttest non-equivalent control group design. A total of eighty-three (83) students drawn from intact classes of two co-educational secondary schools in Nsukka Education Zone of Enugu State were sampled for the study using a multistage sampling technique. One school was randomly assigned to the experimental group while the remaining school was assigned to the control group. The Experimental group was taught biology with CBPITS while the control group was taught with the conventional method (lecture method). The instrument used to collect data for the study was the researchers' compiled Biology Achievement Test adopted from the West African Senior School Certificate Examination past questions. The proposed hypotheses were tested using Analysis of Covariance (ANCOVA). The findings of the study revealed that there is a statistically significant difference between the achievement mean scores of students taught biology with CBPITS and those taught with the Conventional method. The study also revealed that the two-way interaction of methods of teaching and gender had no statistically significant effect on the academic achievement of the students in biology in secondary schools.

Keywords: Computer – Based Programmed Instruction Teaching Strategy, Biology, Achievement, Gender

Introduction

Computer-Based Programmed Instruction Teaching Strategy (CBPITS) is a method in which new subject matter is presented to students in a controlled sequence. In the Computer-Based Programmed Instruction method of teaching, online instructional materials are arranged in a series of successive frames that lead the learner from a body of known to unknown concepts, from simple to complex concepts within the same topic (Azih et al., 2022). The idea of the Computer-based Programmed Instruction method of teaching comes from Skinner's theory of Operant Conditioning (Wangila et al., 2015; Sambasivarao, 2020),

which involves the analysis of subject matter in teaching, active participation, small steps of instruction, and immediate reinforcement of successive responses (Anyasi, 2023). Students study the CBPITS materials at their own pace and test their assimilation of the content using fill-in-the-gap questions (Olafare et al., 2021). There are two types of programmed instruction, namely: linear and branching programmed instructions (Igwe et al., 2022). It was the linear type that was explored in this study.

Computer-based Linear programmed instruction allows students to advance through the instructional process sequentially. Features of linear programmed instruction include self-pacing; the content materials in small steps called frames and presented in a logical sequence; student testing; active response; and immediate confirmation (Olafare et al., 2021). Frame connotes small units of content and a sentence with a blank space for students to fill in (Sambasivarao, 2020). The students then answer the question correctly before studying the next frame (Igwe et al., 2022), as presented in the figure below.

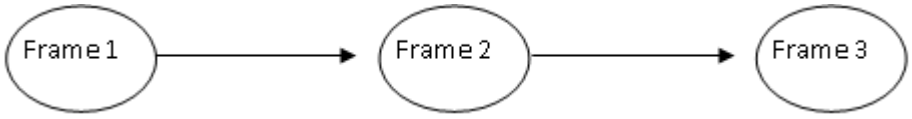

Fig. 1: Computer-based Linear Programmed Instruction Teaching Strategy.

Frame 1 contains a comprehension passage on a subtopic of Animal nutrition with a fill-in-the-blank space question. One is expected to read the comprehensive passage and fill in the answer to the corresponding question. Filling in the right answer in the blank space provided allows Frame 2 to be opened. One is also expected to read the comprehension in Frame 2 and fill in the right answer to the question attached to it before Frame 3 can be accessed. One needs to move from Frame 1 to Frame 3 and more to study all the contents that need to be studied.

In Computer-based Linear Programmed Instruction Teaching Strategy, the students complete the same sequence of frames. When a student provides the answer to the present frame, the next frame opens, but if not, the student is presented with the corresponding frame to be read again to make more attempts. Errors are not allowed by the students because they are expected to provide correct responses to every question (Adekunle & Umoru, 2019). Each student progresses individually without the threat of being exposed to any humiliation that may arise if one does not progress with their mates. CBPITS is a student-centered teaching method which encourages curiosity, active learning, and mastery of the contents taught, thereby improving students' achievement in the topic or subject (Wangila et al., 2015). The application of Computer software proffers solutions to educational problems. Computer hardware and software support teaching and learning in education systems either offline or online. According to Sambasivarao (2020), teaching and learning can be improved by initiating teaching methods to foster self-paced, self-assessed, and self-directed learning. The above ideas might be achieved through the applications of CBPITS.

Achievement is the manifestation of students' abilities after exposure to instructional objectives. Achievement might be a measurable index that depicts students' ability in educational domains and a yardstick for ascertaining the capability of students from which abilities could be inferred, and intellectual abilities as ascertained by grades obtained from evaluations, whether standardized or teacher made (Ugwuoke & Ude, 2022). Academic Achievement in the context of the present study is the outcome of one's ability to express what has been learnt in a written or practical form of assessment in biology. Biology can be said to be the scientific study of living things, including their structure, function, development, interactions, evolution,

distribution, and taxonomy. That is why Biology is sometimes known as Life Science (Bagley, 2017). Biology studies explain that all living things have cells; which arise from pre-existing cells. Furthermore, biology helps one to know that the sun is the primary source of energy; that all living things require energy; and that energy flows between organisms, and also between organisms and the environment (Michael, 2012).

Biological knowledge has made a lot of contributions to the welfare of mankind and is needed in many establishments such as biotechnology, Genetic engineering, agriculture, and pharmaceutical industries (Arokoyu & Chukwu, 2017; Dajal & Adamu, 2019). A sound theoretical and practical knowledge of biology is very necessary for the management of our natural resources, provision of good health facilities for the masses, adequate food supply, and a favourable environment. Notwithstanding the importance of biology to humans and their environment, biology students appear not to have shown from their achievement in WASSCE that biology is relevant to them. WAEC results in biology for Nigerian students have been consistently poor (Audu, 2018). The results for the study area between 2016 and 2020 also indicate a low level of achievement in biology.

Academic achievement is a product of education or learning which also shows the extent students have achieved either short or long-term goals. It is commonly measured using examinations or continuous assessment and stated using students' scores or grade point average (Gupta, 2017). Academic achievement means knowledge, skill, and understanding which result from a particular course taught in school. Academic achievement depends on value judgments, opinions, and standards set for the outcome of the attainment of educational goals (Ikwuka & Adigwe, 2021). Okwara and Upu (2017) explained that the achievement of students is the demonstration of their abilities to attain certain levels of instructional objectives, outcomes of their classroom instructions, and experiences. According to Mautushi (2023), academic achievement is important because it is through actualizing it that students feel a sense of accomplishment, acquire opportunities to be admitted into good colleges, get better job opportunities, and develop lifelong skills. It is essential for the production of the labour force for sustainable national development.

Academic achievement is the foundation for the production of scientifically and technologically literate citizens that bring about the desired changes in society (Okwara & Upu, 2017). The students' low achievement might be linked to the method of instruction being used to teach biology, which is usually a teacher-centered method of teaching (Ugwoke & Ude, 2022). Teacher-centered methods include all teaching methods in which the teacher is the circulator of knowledge. An example is the lecture method of teaching. The lecture method was used as the conventional method used to teach the control group in the study. The Lecture Method is the teaching method in which the teacher does all the talking while the students listen and take down notes when necessary. It might be the easiest and cheapest method used to cover the syllabus and teach large groups of students (Azih et al., 2022); however, Igwe et al. (2022) explained that using the method discourages the acquisition of critical thinking skills and students' active participation in lessons.

The teacher-centered methods of instruction seem not to foster students' high academic achievement (Olafare et al., 2021); hence, student-centered teaching methods are sought in teaching biology. The student-centered teaching methods are methods where the teacher acts as the facilitator while the students take responsibility for their learning. Student-centered teaching methods can also be called child-centered teaching methods (Audu, 2018). They enhance students' academic achievement and their acquisition of mastery of the content taught in biology (Ugwoke & Ude, 2022). Some examples of student-centered teaching methods include simulation games, cooperative learning strategies, and CBPITS, among others. It is the CBPITS that this paper studied to find its effect on females' and males' achievement in biology.

Gender is a socio-cultural constructed characteristic and roles that are ascribed to males and females in society. Gender describes the characteristics, power, influence, roles, and

expectations of femininity and masculinity (Azih et al., 2022). This implies that gender is a psychological term and cultural construct developed by society to differentiate between the roles, behavior, and mental and emotional attributes of males and females. Teachers tend to conform to the traditional gender roles taught by society (Ugwuoke & Ude, 2022). For instance, boys are praised for their knowledge, and girls are praised for their obedience. Also, Igwe et al. (2022) revealed that in a mixed classroom, teachers interact more with boys than girls, which might make boys more active than girls in the classroom. Some researchers (Okorie & Ezeh, 2016; Ugwuoke & Ude, 2022) observed that the effect of gender on achievement was not significant.

On the contrary, Ajiboye (2015) revealed a significant difference in achievement in favor of females, while Ajayi and Ogbeba (2017) stated that male students achieved higher than female students. The above diverse views make it imperative to seek an appropriate innovative learning strategy that could encourage students' active participation, enhance and sustain students' mastery of the subject, and enhance the achievement and interaction of all students in biology. CBPITS might help students achieve the above skills (Igwe et al., 2022). Notwithstanding the effectiveness of CBPITS, its effect on the achievement of students in Nsukka Education Zone has not yet been ascertained. There was, therefore, a need for investigating and understanding the effect of CBPITS on the achievement of students in biology. Due to the diverse views on the effect of gender, the researchers ascertained the interplay of gender in biology achievement in this study. The main aim of the current study is to learn the effect of CBPITS on biology students' achievement. Specifically, the study determined the:

1. Difference in achievement mean score of students taught biology with CBPITS and conventional teaching method.
2. Difference in female and male students' achievement mean score using CBPITS.
3. Effect of interaction of gender and teaching methods on the achievement mean score of biology students.

Hypotheses:

1. There is no significant difference in the achievement mean score of biology students taught biology with CBPITS and Conventional methods.
2. There is no significant difference between female and male biology students' achievement mean scores when taught using CBPITS.
3. The interaction effect of gender and teaching methods on the achievement mean score of students is not statistically significant.

Methods

A pretest-posttest, non-equivalent control group quasi-experimental design was adopted. The population comprised 6,610 senior secondary I biology students from the 59 public secondary schools in Nsukka Education Zone of Enugu State (Post-primary Schools Management Board Enugu, July 2023). Multistage sampling was adopted. Purposive sampling was used to select ten (10) public secondary schools with functional E-libraries because the instructional software developed for the study required computers. Only co-educational schools were chosen to control for gender as an intervening variable. The selected schools included seven (7) schools from Nsukka Local Government and three (3) schools from Igbo-Etiti Local Government Area. No public school in Uzo-Uwani Local Government Area had a functional E-library. Simple random sampling was employed to select two (2) secondary schools from the ten schools. One was assigned as the experimental group, and the other served as the control group. The sample comprised 83 senior secondary 1 students, including fifty-five (55) females and twenty-eight (28) males, from intact classes in the two schools. The experimental group consisted of forty-three students (30 females and 13 males), while the control group had forty students (15 males and 25 females). The instrument used for data collection was a

researcher-compiled Biology Achievement Test (BAT), which contained thirty (30) multiple-choice test items adopted from past question papers of the West African Senior School Certificate Examination (WASSCE), and validated. The data collected from the 30 items of BAT were subjected to a reliability test using Kuder-Richardson–20. It yielded a reliability coefficient index of 0.89, as shown in the result below, indicating that BAT was suitable for the study. BAT was administered as the pretest and the posttest instrument to determine students' achievement.

The researchers introduced the CBPITS to the intact class biology teacher of the experimental group and explained how to use it. The class teachers were used as research assistants. The lecture teaching method was applied to the control group, so no explanation was given to the control group research assistant. The researchers provided the experimental group research assistant with the website for CBPITS while the lesson plans were provided for the control group research assistant. The website is the link: https://odimkpachristy.com/courses/programmed-instruction-package/ . The implementation of the study involved studying biology subtopics on Animal nutrition, using CBPITS software which was developed by the researcher with the aid of program developers. The software is titled 'Programmed Instruction Package" (PIP) 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 programmed 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 lesson implementation phase has frames which contain short comprehension passages on the subtopic of study with a"take the quiz" command button at the end of the comprehension. At the take the quiz phase, a corresponding question to the comprehension in the form of fill-in-the-blank spaces in a frame is obtained after which the "view the result" button is obtained. During the biology period in the sampled intact class, the students access the biology content chosen for the study using the computers in their E-library. The students studied a short comprehension passage in the frame and clicked on the corresponding 'take a quiz' button to access the question, then provided the correct answer(s) and clicked on the 'view the result' button to upload their answer(s). Correctly answered questions would automatically give the students access to the subsequent frame. Incorrect answer(s) gave feedback that sent the students back to the passage for thorough re-reading and understanding. The research assistant only attended to students' problems when necessary but did not teach them.

Students (research subjects) in the control group were taught using the lecture method in the sampled school. The research assistant (their classroom teacher) used verbalization for relevant concepts and principles in Animal nutrition during the knowledge transfer using the lesson plan prepared by the researchers. The students watched and listened attentively during the teaching-learning process and took down notes. The research (teaching) lasted for six weeks. During the period of the study, the researchers monitored the schools used to ensure that the research assistants (their classroom teachers) adhered strictly to the instructions given to them. The pretest scores were used as covariates for the posttest scores. The dependent variable in the study was the students' academic achievement (posttest scores), while the independent variables were the teaching methods and gender. The two-way ANCOVA was employed to check the initial difference that might exist between the experimental and control groups because there was no randomization of subjects into experimental and control groups (Abonyi et al., 2022), as well as to compare the mean gain of the conventional teaching method to the CBPITS measured before and after the

treatment. The hypotheses were tested at 0.05 level of significance using the two-way Analysis of Covariance (ANCOVA). The calculations were done using the Statistical Package for Social Sciences (SPSS) software version 23. Where $p<0.05$, the result of the hypothesis was rejected and where $p>0.05$, the result of the hypothesis was upheld.

Results

Testing of the Null Hypotheses

Table 1: Summary of Analysis of Covariance (ANCOVA) Result of Achievement Mean Scores of Students taught Biology with CBPITS and Conventional method.

Tests of Between-Subjects Effects
Dependent Variable: Post-test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	495.87[a]	4	123.97	4.95	0.00	0.20
Intercept	2198.69	1	2198.69	87.82	0.00	0.53
Pre-test	0.00	1	0.00	0.00	0.99	0.00
Method	305.47	1	305.47	12.20	0.00	0.14
Error	1952.81	78	25.04			
Total	30763.00	83				
Corrected Total	2448.68	82				

a. R Squared = 0.203 (Adjusted R Squared = 0.162)

Table 1 shows the summary of ANCOVA which was conducted to establish the significance or otherwise of the observed difference in the achievement mean score of students taught biology with the CBPITS and the conventional method while controlling for the pre-test effect. A statistically significant difference ($F(1,78) = 12.20$, $p = 0.00 < 0.05$) between the achievement mean score of the experimental ($M = 20.65$, $SD = 4.34$) and control groups ($M = 16.13$, $SD = 5.62$) with a mean difference of 2.55. Therefore, the null hypothesis, (Ho1) which states that there is no statistically significant difference between the achievement mean score of students taught biology with CBPITS and those taught with the Conventional method was, therefore rejected. This means that CBPITS was more effective in improving the academic achievement of the students in biology than the Conventional method. The rejection of the null hypothesis suggests that there is a meaningful difference in achievement mean scores between students taught with CBPITS and those taught with the conventional method. This implies that CBPITS, with its structured, self-paced approach, was more effective in enhancing students' understanding and mastery of biology concepts than the traditional lecture-based approach. Therefore, educators and policymakers may consider integrating CBPITS or similar student-centered teaching methods into their pedagogical practices to improve learning outcomes in biology and potentially other subjects as well.

Table 2 shows the summary of ANCOVA conducted on the achievement mean scores of the male and female biology students taught using CBPITS. The Table shows that there was no statistically significant difference in the mean achievement scores ($F(1,40) = 2.96$, $P = 0.09 > 0.05$) between the male and female biology students taught using CBPITS.

Table 2: Summary of Analysis of Covariance Result of Achievement Mean Scores of Male and Female Biology Students taught using CBPITS.

Tests of Between-Subjects Effects
Dependent Variable: Post-test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	55.52[a]	2	27.76	1.51	0.23	0.07
Intercept	1379.74	1	1379.74	74.96	0.00	0.65
Pre-test	4.72	1	4.72	0.26	0.62	0.01
Gender	54.44	1	54.44	2.96	0.09	0.07
Error	736.24	40	18.41			
Total	19130.00	43				
Corrected Total	791.767	42				

a. R Squared = 0.070 (Adjusted R Squared = 0.024)

This means that there is no statistically significant difference in the academic achievement of female and male students in biology when taught using CBPITS. The acceptance of the null hypothesis (Ho2) indicates that gender did not have a statistically significant effect on the achievement mean scores of students taught with CBPITS. This suggests that CBPITS is equally effective for both male and female students in enhancing their understanding and mastery of biology concepts. Therefore, educators can implement CBPITS confidently as a teaching method that promotes equitable learning outcomes regardless of gender. Additionally, this result emphasizes the importance of employing student-centered teaching strategies that accommodate the diverse learning needs and styles of all students, regardless of their gender.

Table 3: Summary of One-way Analysis of Covariance Results of Interaction Effect of Method and Gender on Academic Achievement of Students

Tests of Between-Subjects Effects
Dependent Variable: Post-test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	495.87[a]	4	123.97	4.95	0.00	0.20
Intercept	2198.69	1	2198.69	87.82	0.00	0.53
Pre-test	0.00	1	0.00	0.00	0.99	0.00
Gender	3.63	1	3.63	0.15	0.71	0.00
Error	1952.81	78	25.04			
Total	30763.00	83				
Corrected Total	2448.68	82				

a. R Squared = 0.203 (Adjusted R Squared = 0.162)

Table 3 shows the results of the ANCOVA statistics and explains the interaction effect of method and gender on students' academic achievement in biology. The Table shows that there was no statistically significant interaction effect of method and gender on the students' academic achievement in biology (F (1,78) = 0,15, $P = 0.71 > 0.05$). Therefore, null hypothesis 3 which states that there is no statistically significant interaction effect of method and gender on the students' academic achievement in Biology was accepted. This implies that the methods of instruction and the students' gender did not interact significantly to

influence the students' academic achievement scores in biology. Therefore, the two-way interaction of method and gender had no statistically significant effect on students' academic achievement in biology. The acceptance of null hypothesis 3 indicates that there was no meaningful interaction between the instructional methods and students' gender in influencing academic achievement scores. This suggests that regardless of whether students were taught using CBPITS or the conventional method, and irrespective of their gender, there was no significant difference in their academic achievement in biology. A major lesson readers can derive from our results is that the effectiveness of teaching methods, such as CBPITS, may not be influenced by students' gender. It underscores the importance of selecting instructional strategies based on their overall effectiveness in enhancing student learning, rather than tailoring methods based on gender stereotypes or assumptions. Additionally, educators can be reassured that student-centered teaching approaches like CBPITS can provide equitable learning opportunities for all students, regardless of gender, in the biology classroom. This result highlights the need for inclusive and effective teaching practices that prioritize student engagement and understanding, regardless of gender differences.

Discussion and Conclusion

The result of hypothesis 1 revealed a significant difference in the students' achievement mean scores using CBPITS and conventional teaching methods. This means that there was a statistically significant difference between students' achievement mean scores using CBPITS and Conventional method of teaching at $p < 0.05$ and might not be attributed to other factors. The higher achievement mean score of the CBPITS group implies that CBPITS provided activities that attracted the attention of the students and motivated them to learn. It might have also provided a learning environment which reduced anxiety and embarrassment as each of the students participated actively, without the threat of being exposed to the humiliation that may arise when one fails to progress alongside their mates. Also, the teaching-learning materials being in frames with small information may have facilitated the recall of information which enhanced their achievement. Opportunity to learn independent of the teacher and to master what they learnt to enhance their achievement found in CBPITS, was not embedded in the Conventional method of teaching, and may have contributed to the higher achievement mean score by students exposed to CBPITS. The finding of this study is in agreement with Udeh et al. (2017), Adekunle and Umoru (2019), and Anyasi (2023) who found that Programmed Instruction improved students' achievement mean scores.

The results of hypothesis 2 showed no significant difference between the female and male students' achievement mean scores using CBPITS, even though the females had a higher achievement mean score than male students when taught with CBPITS. This may be due to the ability of CBPITS to present materials step by step that might have created a gender-free environment which reduces anxiety, shyness and psychological insecurity for the females. The above finding is in line with that of Ajiboye (2015), Okorie and Eze (2016) and Godpower-Echie and Ihenko (2017) who reported that the achievement mean score of female students in sciences was greater than those of the male students and that there is no significant difference in female and male students' academic achievement in sciences. The finding from the present study does not agree with Ajayi and Ogbeba (2017) who found that male students achieved higher than female counterparts in sciences and that there is no significant difference in female and male students' academic achievement in sciences.

The results in Table 3 showed that gender and teaching methods (CBPITS and the conventional method) have no significant interaction effect on the achievement mean scores of biology students. The lack of interaction effect may be because CBPITS enabled equal participation of students and active interaction. The logically sequenced programed was tailored to their level of comprehension, mastery and recall which

enhanced their achievement in biology. The difference in the achievement mean scores was therefore systematic and not a chance occurrence. The difference can be rightly attributed to the effects of the treatment. The finding is consistent with that of, Igwe et al. (2022) and Azih et al. (2022) who found no significant interaction effect of gender and teaching methods on students' achievement scores in sciences. Overall, this finding underscores the effectiveness of CBPITS as a student-centered teaching approach that promotes equal participation, personalized learning, and improved academic achievement in biology, regardless of students' gender. It highlights the importance of utilizing instructional strategies that cater to diverse learning needs and promote equitable outcomes for all students.

Implications for Educational Practice

The findings of this research carry significant implications for educational practice, particularly in the field of biology instruction. Firstly, the effectiveness of the CBPITS in improving academic achievement underscores the importance of incorporating student-centered and technologically enhanced teaching methods into biology classrooms. Educators should consider integrating CBPITS or similar interactive instructional approaches that allow for personalized learning experiences, fostering active engagement, and facilitating mastery of subject content. Moreover, the absence of a significant interaction effect between gender and teaching methods suggests that CBPITS promotes equitable learning outcomes for both male and female biology students. This highlights the need for educators to adopt inclusive teaching practices that address diverse learning needs and eliminate gender biases in the classroom. Furthermore, the systematic difference in achievement mean scores between CBPITS and conventional methods reinforces the notion that instructional strategies play a pivotal role in shaping students' academic success. Therefore, educators should prioritize evidence-based teaching methodologies that promote student participation, comprehension, and retention of biology concepts. Overall, these findings emphasize the importance of implementing innovative and student-centered approaches to enhance learning experiences and academic achievement in biology education.

Limitations and Future Research Directions

While this study provides valuable insights into the effectiveness of CBPITS in enhancing academic achievement in biology, several potential limitations should be acknowledged. Firstly, the quasi-experimental design employed in this research may limit the generalizability of the findings, as it lacks the random assignment of participants to experimental and control groups. Additionally, the sample size of 83 students from two secondary schools may not fully represent the diversity of students and instructional contexts within the broader educational landscape. Moreover, the focus on only one geographical area, the Nsukka Education Zone of Enugu State, may restrict the applicability of the findings to other educational settings. Furthermore, while efforts were made to control for confounding variables such as gender, other factors such as prior knowledge, motivation, and instructional quality may have influenced the outcomes. Lastly, the reliance on a single instrument, the researcher-compiled BAT, for assessing academic achievement may limit the comprehensiveness and validity of the measurement.

Despite these potential limitations, this study provides valuable insights into the effectiveness of CBPITS and offers a foundation for future research to explore its applicability in diverse educational contexts. Building on the findings of this study, several potential future research directions can be identified to further investigate the effectiveness and implications of CBPITS and related instructional approaches in biology education. Future research can employ a longitudinal research approach to examine the long-term effects of CBPITS on students' academic achievement, retention of biology knowledge, and transfer of learning to real-world contexts. Tracking students over an extended period would provide valuable insights into the sustainability and durability of the observed improvements in learning

outcomes. Also, future researchers can conduct comparative studies to compare the effectiveness of CBPITS with other student-centered teaching methodologies, such as inquiry-based learning, flipped classrooms, and problem-based learning. Investigating how different instructional approaches influence student engagement, motivation, and learning outcomes in biology could inform educators' decision-making processes. Researchers can utilize mixed-methods research designs to gain a deeper understanding of the mechanisms underlying the effectiveness of CBPITS. Combining quantitative analyses of academic achievement data with qualitative inquiries into students' perceptions, attitudes, and learning experiences could provide a more comprehensive understanding of the instructional process and its impact on student learning.

Future studies can explore the contextual factors that may influence the implementation and outcomes of CBPITS in diverse educational settings. Investigating how factors such as school culture, teacher characteristics, technological infrastructure, and student demographics interact with instructional methods could help tailor interventions to specific contexts and populations. Future studies can investigate the role of teacher professional development programs in supporting the effective implementation of CBPITS and similar instructional approaches. Research could examine how training programs can enhance teachers' pedagogical skills, technological proficiency, and ability to create supportive learning environments conducive to student-centered instruction in biology classrooms. And lastly, future studies can investigate the effectiveness of CBPITS for students with diverse learning needs, including those with disabilities, English language learners, and students from disadvantaged backgrounds. Examining how CBPITS can be adapted and differentiated to meet the needs of special populations could promote inclusive practices and equitable access to high-quality biology education. By pursuing these future research directions, scholars can deepen our understanding of the potential benefits, challenges, and implications of integrating CBPITS into biology education, ultimately contributing to the ongoing efforts to enhance teaching and learning in this critical field.

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Appendix

Biology Achievement Test (BAT)

SECTION A: Personal Data

Sex: Male Female

SECTION B:

Instruction:

The multiple-choice Biology Achievement Items are designed to assess the students ' achievement on Animal nutrition. The students are to tick on the correct options from the A, B, C, and D options for each test item.

1. When proteins are broken down, they also provide ___ a. oxygen b. Carbohydrate c. energy d. amino-acid
2. Adaptive feature of Cassytha is its possession of …… which normally penetrates another plant. a thin, thread-like stem b. thread-like tap roots c. broad-like branches d. coiled thread-like leaves.
3. Human being require vitamins in their diet because vitamins ___a. contain carbohydrate and fats b. prevent kwashiorkor c. stimulate the alimentary canal d. Influence many important chemical processes in the body.
4. Two different organisms living together and benefiting from each other are known as ___ a. saprophytic b. heterotrophs c. parasitic d. symbionts
5. Vitamins are required by man in _____ a. small quantity b. large quantity c. moderate quantity d. high quality
6. The vitamin which is important in the formation of the retina pigment is ___ a. vitamin A b. vitamin B c. vitamin C d. vitamin D
7. If an organism obtains its food using hausteria, it is said to be _a. holophytic b. heterotrophy tic c. saprophytic d. parasitic.
8. Example of water soluble vitamins are these except: a. vitamins A b. vitamin D c. vitamins B-complex d . vitamin E
9. The mode of nutrition of sundew and bladderwort can be described as _a. saprophytism b. holozoic c. chemosynthetic d. autotrophic
10. Plants that have special device for trapping and digesting insects are _____ a. symbiotic b. parasitic c. saprophytic d. carnivorous
11. The condition known as cretinism is caused by the deficiency of _a adrenalin b. vitamin A c. insulin d. Thyroxin
12. Milk protein is hydrolysed by _____ a. renin b. amylase c. lipase d. pepsin
13. What is the nutrient that is lacking in the place Carnivorous plants usually grow ……..
a. nitrogenous salts b. calcium salt c. potassium salt d. aluminium salt
14.The bacterium can fix …… directly into the plant while the plant in turn provides …….. for the bacteria.
a. aquatic sulphur, space b. soil carbon, offspring c. inorganic oxygen, water d. atmospheric nitrogen, shelter and food
15. Saprophytic nutrition is the type of nutrition in which certain organisms feed on …….a. green leaves b. freshly cooked food c. dead and decaying organic materials d. fresh flesh
16. Suckers in Cassytha absorb already manufactured food from the host's …….. a. xylem tissue b. phloem tissue c. collenchyma tissue d. sclerenchyma tissue
17. The parasite gains from the parasitic association while the host ……a. gain too
b. is harmed or suffer losses c. is upgraded d. is not disturbed
18. Endoparasites and Ectoparasites can be attributed to …… a. symbiotic nutrition b. saprophytic nutrition c. parasitic nutrition d. holozoic nutrition
19. Hydrogen and oxygen are the only components of the class of food called ….. a. carbohydrate b. water c. protein d. fats and oil

20. Organisms in Saprophytic mode of nutrition are called the….. a. conjugants b. saprophytes c. colleagues d. sypronium.
21 Water is very important to animals in the following ways except: a. Water is required for metabolic activities in the body. B. It is necessary for the digestion of food. c. It can be used for the maintenance of body temperature, d.it is needed for the repair of worn-out tissues
22. The heat used for maintenance of body temperature is obtained through a oxidation of carbohydrate b. reduction of fat c. oxidation of protein d. reduction of vitamins
23. Mode of nutrition in Nitrobacter, ascaris and homo sapiens respectively are __
a. chemosynthetic, parasynthetic and holozoic b. Chemosynthetic, Parasitic and Holozoic
c. photosynthetic, parasynthetic and Heterotrophic d.holozoic,photosynthetic, parasynthetic
24. Pyridoxine and Cyanocobalamins are another names for vitamins … a. B2 and B3 b. B6 and B12 c. B1 and B5 d. B7 and B8
25. The breakdown of proteins during digestion takes place in the following stages: a. protein —> protein —> polypeptides —> amino acids. B. protein —> peptones —> polypeptides —> amino acids. C. peptones —> protein—> polypeptides —> amino acids d. amino acids —> peptones —> polypeptides —>protein.
26. Milk, egg, fish, cheese, meat and chicken are …… a. Animal sources of proteins
b. plant source of protein c. fats and oil d. types of carbohydrate
27. Thiamine, Riboflavin, Niacin, Pantothenic acid, are examples of a. vitamin
b. carbohydrate c. protein d. roughage
28. The enzymes secreted by Saprophytic organisms can digest some portions of the substrate outside the body of the saprophyte by a process called **……..** a. exocellular digestion b. extracellular digestion c. procellular digestion d. psydocellular digestion
29. Monosaccharides, Disaccharides, and Polysaccharides are examples of a. proteins b. mineral salt c**.** Glucose d. carbohydrate
30. Except for sodium chloride (table salt) and few medicines like iron tablets, other mineral salts are usually taken in minute quantity through a. the food we eat b. water we drink c. clothes we wear d. places we visit.

Marking Guide

Questions	Options	Correct Answers to the correct options
1	C.	energy
2	A.	thin, thread-like stem
3	D.	Influence many important chemical processes in the body.
4	D.	symbionts
5	A.	small quantity
6	A.	vitamin A
7	C.	saprophytic
8	C.	vitamins B-complex fixating micro-organism
9.	C.	chemosynthetic
10.	D.	carnivorous
11.	B.	vitamin
12.	A.	Renin
13.	A.	nitrogenous salts
14.	D.	atmospheric nitrogen, shelter and food
15.	C.	dead and decaying organic materials
16.	B.	phloem tissue
17.	B.	is harmed or suffer losses
18	C.	parasitic nutrition
19	B.	water
20	B.	saprophytes
21.	D.	it is needed repair of worn-out tissues
22.	A.	oxidation of carbohydrate

23.	C.	photosynthetic, parasynthetic and Heterotrophic
24.	B.	B6 and B12
25.	B.	protein —> peptones —> polypeptides —> amino acids.
26.	A.	Animal sources of proteins
27.	A.	vitamin
28.	B.	extracellular digestion
29.	D.	carbohydrate
30	A.	the food we eat

PROGRAMMED INSTRUCTION PACKAGE ONLINE QUESTIONS

Module 1 Animal nutrition
Unit 1 Food substances
Unit 2 Modes of Nutrition
Breakdown of units
Unit 1: Food substances
Content
(i) Introduction
(ii) Objectives
(iii) Main content
3.1 Food substances and Classification of Food substances
4.0 Conclusion
5.0 Summary
1.Introduction
The foods that animals feed on are composed of carbohydrate, protein, fat and oil, mineral salt, vitamins and water.
2. Objectives
By the time the students had studied and mastered this unit, they should be able to
1. Explain the classes of food and their importance in a balanced diet.
2. Discuss the importance in a balanced diet

Unit 1 Frame 1
Food substances and Classification of Food substances
All the food eaten or taken in by an animal can be classified or divided into seven groups food substances. These food substances are(ii) Carbohydrates (ii) Proteins (iii) Fats and oils
(iv) Mineral salts (v) Vitamins (vi) Water and(vii) Roughages.

1
Questions: All the food eaten or taken in by an animal can be classified into (i) Carbohydrates (ii) Proteins (iii) Roughages (iv) Mineral salts (v) Vitamins (vi) Water and(vii) ----------
Answers

fats and oils

Unit 1 Frame 2

Carbohydrate
Composition: Carbohydrate is made up of carbon, hydrogen and oxygen. The ratio of hydrogen to oxygen is 2:1 as in the case with water. They have a general formula of $C_x(H_2O)_y$. The main sources of carbohydrate include yam, rice, maize, millet, guinea corn, potatoes, bread, garri etc.

Types of Carbohydrates

There are three major types of carbohydrate. These are:

(a)Monosaccharides (Simple sugars): They are the simplest sugar and have only one unit of simple sugar. They have a general formula $C_6H_{12}0_6$

Examples are glucose, fructose and galactose.

(b)Disaccharides (Reducing sugars): These contain two units of simple sugars and are represented by the formula $C_{12}H_{22}O_{11}$. Examples are sucrose, maltose and lactose.

(c)Polysaccharides (Complex sugars): These consist of more than two simple sugars or several simple sugars joined together. They are represented by the general formula $(C_6H_{10}O_5)n$, where n represents a large number. Examples are starch, cellulose, chitin and glycogen (animal fat). Excess carbohydrate is stored in the body in form of glycogen(animal fat) especially in the muscles and liver and it can be reconverted to glucose during starvation.

2

Questions: Three major types of carbohydrate are Monosaccharides, Disaccharides and ----------

Answer:

Polysaccharides

Unit 1 Frame 3

Importance of Carbohydrate

1. Carbohydrate provides energy required by animals for their daily activities,
2. It also provides heat during its oxidation, used in maintaining the body temperature,
3. Carbohydrates are also used to build certain body parts, e.g. exoskeleton of arthropods.

Mucus, an important lubricant in our bodies is composed of carbohydrates.

3

Question:

Carbohydrate provides ---------- required by animals for their daily activities

Answer:

Energy

Unit 1 Frame 4

Proteins

Proteins are complex molecules and are made of smaller units called amino acids. Proteins have to be digested to amino acids before they are absorbed in the bodies of animals. The breakdown of proteins during digestion takes place in the following stages: protein —> peptones —> polypeptides —> amino acids.

Protein is composed of carbon, hydrogen, oxygen, nitrogen and sometimes phosphorus and sulphur. Animal sources of proteins are milk, egg, fish, cheese, meat and chicken while plant sources are beans (cowpea), groundnut, soybeans etc.

4

Question: The breakdown of proteins during digestion takes place in the following stages: protein —> peptones —> …… —> amino acids .

Answer:

Polypeptides

Unit 1 Frame 5
Importance of Protein
(i) Protein is used for the growth of young ones. (ii) It is used for the repair of worn-out tissues or cells. (iii) It aids reproduction. (iv) It is used for the production of enzymes.
(v) It is also used for the production of hormones. (vi) It is used for tissue and cell formation (bodybuilding).

5
Question: Protein is used for the repair of worn-out ---------- or cells
Answer:

Tissues

Unit 1 Frame 6
Fats and Oils
Fats and oils are also called *lipids*. Fats are solid lipids at room temperature while oils are liquid lipids at room temperature. They are hydrolyzed during digestion to fatty acids and glycerol which can be absorbed into the lymphatic system. Fats and oils are composed of Carbon, Hydrogen and Oxygen. Sources of fats and oils include palm oil, groundnut, soybean oil, melon oil, butter, fish, cheese, margarine, lard etc.

6
Question:
Fats are solid lipids at room temperature while oils are …….. lipids at room temperature.
Answer:

liquid

Unit 1 Frame 7

Importance of Fats and Oil
Fats and oils provide more energy to animals than carbohydrates. (ii) Fats supply essential fatty acids to animals. (iii) Fats and oils also provide fat soluble vitamins. (iv) They help in the maintenance of body temperature.

7
Question:
Fats and oils provide more energy to animals than ……

Answer:

carbohydrates

Unit 1 Frame 8
Mineral salts
Animals require various mineral salts for metabolic activities within the body. Except for sodium chloride (table salt) and few medicines like iron tablets which can be taken directly by man, other mineral salts are usually taken in minute quantity through the food we eat.

8
Question:
Except for …….. and few medicines like iron tablets which can be taken directly by man, other mineral salts are usually taken in minute quantity through the food we eat
Answer:

sodium chloride

Unit 1 Frame 9

Vitamins

Vitamins are organic food substances required by man and other animals only in small amount for normal growth and healthy development. Inadequacy or lack of these vitamins generally leads to nutritional deficiency in animals.

Groups of Vitamins

Vitamins are grouped into (i) Fats soluble vitamins: These are vitamins that are soluble only in fats, e.g. vitamins A, D, E and K.

(ii) Water soluble vitamins: These are vitamins that are soluble only in water, e.g. vitamins B-complex and vitamin C. Some members of the vitamin B-complex are vitamins B_1 (Thiamine), B_2 (Riboflavin), B_3 (Niacin), B_5 (Pantothenic acid), B_6 (Pyridoxine), B_{12} (Cyanocobalamins), Folic acid etc.

9

Question:

Lack of vitamins generally leads to …….. in animals.

Answer:

nutritional deficiency

Unit 1 Frame 10

Water

Composition of water: Water is composed of two elements-hydrogen and oxygen. Sources of water: Sources of water available to animals include metabolic water from food, drinking water from rivers, taps, rain, pond etc.

Importance of Water : Water is very important to animals in the following ways:

(i) Water is required for metabolic activities in the body.(ii) It is necessary for the digestion of food,

It can be used for the maintenance of body temperature, (iv)Water is the main component of plants and animals, e.g. it forms about 75% of man's body. (v) It acts as a solvent for soluble food substances in digestion,

10

Question:

Water is composed of two elements-**.**…… and oxygen.

Answer:

Hydrogen

Unit 1 Frame 11

Roughages

Roughages consist of indigestible fibrous materials derived from vegetables, fruits carbohydrates and proteins. Roughages are easily digested by micros-organisms in the intestinal tract. Lack of roughages in the diet can cause constipation.

11

Question:

Roughages are easily digested by …… in the intestinal tract.

Answer:

microorganisms

Unit 1 Frame 12

Balanced Diet

Balanced diet is a diet containing the correct proportion or the right amount of all the six food substances required by an organism or man.

In terms of the percentage composition of the food substances, balanced diet should contain 15% of proteins, 15% of fats and oils, 10% of vitamins, minerals and water, and 60% of carbohydrates. Balanced diet must be taken at these proportions for normal growth, development and all activities of the body.

12

Question: Balanced diet should contain ……..of proteins, 15% of fats and oils, 10% of vitamins, minerals and water, and **b** 60% of carbohydrates.

Answer:

15%

Unit 1 Frame 13

Importance of Balanced Diet

Balanced diet is important to the body in the following ways:

(i) Balanced diet makes us healthy and by so doing makes us to be resistant to diseases.

(ii) It also provides energy required for normal activities.

(i) Balanced diet prevents malnutrition deficiency or diseases.

13

Question:

Balanced diet makes one ……and by so doing makes one to be resistant to diseases.

Answer:

healthy

Unit 2: Modes of nutrition

Content

1. Introduction
2. Objectives
3. Main content

3.1 Definition and Types

3.2 Autotrophic mode of nutrition

3.3 Heterotrophic nutrition

.

Introduction

All living organisms have a way of taking in nutrients. Some organisms like plants can make their food from inorganic raw materials, while some can only take in already made food directly by feeding on plants, or indirectly by feeding on the animals that had fed on the plants. Some plants can feed on animals while some animals feed on dead or decaying plants. These types of feeding are called modes of nutrition.

Objectives

By the time you had studied and mastered this unit, you should be able to:

i. State the different modes of nutrition and their subgroups.

ii. Outline the activities of these subgroups

iii. State at least three organisms that exhibit these modes of nutrition.

3. Main content

Unit 2: Frame 1
Autotrophic mode of nutrition. This is made up of:
(i) Holophytic (Photosynthetic) nutrition:
Holophytic nutrition is the type of nutrition in which all green plants can manufacture their food making use of carbon dioxide and water in the presence of sunlight. This process is called photosynthesis.
Popular examples of organisms that carry out or exhibit photosynthetic nutrition are all green plants such as flowering plants, Spirogyra, Euglena, blue-green alga (nostoc) etc.

14
Question: Holophytic nutrition is the type of nutrition in which all green plants can manufacture their food making use of ……. and water in the presence of sunlight.

Answer:

carbon dioxide

Unit 2: Frame 2
(ii) Chemosynthetic nutrition: Chemosynthetic nutrition is another mode of nutrition in which certain bacteria can synthesis organic compounds from simple inorganic materials such as carbon (iv) oxide, ammonia, water or nitrite to manufacture their food. The energy used for the synthesis comes from the oxidation of the inorganic materials or chemicals, hence the process is called chemosynthesis. Examples of organisms or bacteria that exhibit chemosynthetic nutrition are:
(a) Nitrosomonas which converts ammonia to nitrite

$2NH_3 +$ 30_2 Nitrosomonsas $2HNO_2 + 2H_20 +$ Energy
(Ammonia) (Oxygen) ⟶ (Nitrite) (Water)

(b) Nitrobacter which converts nitrites to nitrate.

15
Question: The energy used for the synthesis in Chemosynthetic comes from the …….of the inorganic materials or chemicals,

Answer:

Oxidation

Topic 2: Frame 3

Heterotrophic nutrition
Organisms in this group cannot manufacture their food but depend directly or indirectly on plants (autotrophs) for their food. They are called heterotrophs. Most animals, fungi, protozoa and some bacteria belong to this group. Heterotrophic nutrition is also sub-divided into the following groups or types:
(i) Holozoic nutrition: Holozoic nutrition involves the feeding on other organisms or solid organic substances synthesized by green plants. The organisms ingest, digest and assimilate these foods into their bodies. Examples of organisms that exhibit holozoic mode of nutrition are:
(a) Carnivores like cats, dogs, lions feed on flesh;
(b) Herbivores like sheep, goats, and rabbits feed on plants;
(c) Omnivores like man, pig feed on both flesh and vegetables or plants;
(d) Scavengers like vulture feed on dead

16
Question:

Organisms in the Heterotrophic nutrition group cannot ……..their food but depend directly or indirectly on plants (autotrophs) for their food.

Answer:

manufacture

Topic 2: Frame 4

ii. Parasitic nutrition: Organisms in this type of nutrition feed on another organism to derive nourishment from it. The association is called parasitism and it's between two organisms, usually of different species in which one called the parasite gains from the association while the other called the host is harmed or suffer losses. Examples of parasites are:

a. Animal parasites: Animal parasites are classified as endoparasites and ectoparasites.

i)Ectoparasites: They live outside the body of the host where they derive food and shelter from, e.g. flea, body louse, bed bug and ticks. Ticks are usually found in cattle and sheep. Ticks and fleas may be found on dogs, chickens and rats also carry lice on their bodies.

(ii) Endoparasites: These are parasites which live inside the body of their hosts such as man and other animals. Examples include: Tapeworm (Taenia solium) (fig 3.1), plasmodium, roundworms, liver flukes, etc.

Tapeworm (*Taenia solium*): Tapeworm is associated with pigs which are the secondary host and man which is the primary host. It has a flattened tape-like body. It has a head called scolex on which are found rostellum, hook and sucker which enable it to fasten itself to the lining of the host's intestine. It also has a body cuticle which resists digestive enzymes of the host. Tape worm has a flat body surface which ensures a large surface area for absorption of already digested food. The entire body consists of numerous proglottids which aids the absorption of digested food from its host

17

Question:: Organisms in Parasitic type of nutrition feed on another organism in order to derive nourishment from it. The association is called ……and it's between two organisms, usually of different species in which one called the parasite gains from the association while the other called the host is harmed or suffer losses.

Answer:

Parasitism

Topic 2: Frame 5

b) Plant parasites like Dodder (Cassytha filiformis) and mistletoe

Cassytha filiformis (Dodder): Cassytha is a thin, thread-like stem which normally curls round the stem of the host, another plant. At intervals, Cassytha sends out suckers which grow through the stem of the host until it reaches the phloem tissue of the host from which it absorbs already manufactured food from the host. Cassytha is usually regarded as a complete parasite because it absorbs already made food from its host. It has no roots, no chlorophyll; hence it cannot manufacture its food.

18

Question: Cassytha is a thin, thread-like stem which normally curls round the stem of the host another plant. Cassytha sends out suckers which grow through the stem of the host until it reaches the **……** tissue of the host from which it absorbs already manufactured food from the host

Answer:

phloem

Topic 2: Frame 6

(iv)Saprophytic nutrition: This is the type of nutrition in which certain organisms called the saprophytes feed on dead and decaying organic materials. This type of nutrition is called saprophytic nutrition and the association involving this type of nutrition is called saprophytism. The saprophytes, generally, can secrete enzymes into the substrate of dead and decaying organic materials on which they grow. The enzymes so secreted are able to digest some portions of the substrate outside the body of the saprophyte by a process called extracellular digestion. The digested food material on the substrate is then absorbed into the body through the rhizoids. Examples of organisms which exhibit saprophytic mode of nutrition are the fungi such as Rhizopus, mushroom, mucor, Toad stool and penicillium

19

Question:

Saprophytic nutrition is the type of nutrition in which certain organisms called the saprophytes feed on dead and decaying organic materials. The enzymes so secreted are able to digest some portions of the substrate outside the body of the saprophyte by a process called ……digestion

Answer:

extracellular

Topic 2: Frame 7

(iv) Symbiotic nutrition-.This is the type of nutrition in which two organisms of different species called symbionts live together and derive nutrients or food from each other. In this case, both organisms gain from such association and none is harmed. This type of nutrition is called symbiotic nutrition while the association between the two organisms in which both derive benefits is called symbiosis. Apart from nutritional benefits, the symbionts can derive other benefits like protection, shelter and reproduction during such association.

Example of organisms that exhibit symbiotic nutrition is:

Nitrogen fixing bacteria and root nodules of leguminous plants: An example of a symbiotic association is the one between the nitrogen fixing bacteria, Rhizobium spp and the root nodules of leguminous plant. The bacterium is able to fix atmospheric nitrogen directly into the plant while the plant in turn provides shelter and food for the bacteria.

20

Question:

Symbiotic nutrition-. This is the type of nutrition in which two organisms of different species called symbionts live together and derive nutrients or food from each other. The bacterium is able to fix **…...**…… directly into the plant while the plant in turn provides shelter and food for the bacteria.

Answer:

atmospheric nitrogen

Topic 2: Frame 8

v) Carnivorous or insectivorous plants: Carnivorous plants usually grow in places with little nitrogenous salts and then use insects or other smaller animals as their sources of nitrogen. Carnivorous or insectivorous plants are equipped with devices for trapping, digesting and absorbing nutritive compounds from the bodies of insects and other small organisms. They have green leaves to help them carry out photosynthetic nutrition.

Example of carnivorous or insectivorous plants is: Bladderwort (Utricularia): These are aquatic plants without roots. Some of the leaves are modified to form hair-like bladders. Each bladder has a trap door hinged on only one edge, so that it can only open inward and tends to remain closed. In this arrangement, a trapped insect finds it difficult to escape. The captured insect eventually dies of starvation and its nutrients are then absorbed by the plant.

Other examples of carnivorous plants are:

(d) Venus fly-trap (Diosaneamuscipula)
(e) The butterwort (Pinguicula)

21
Question: Carnivorous plants usually grow in places with little ……. salts and then use insects or other smaller animals as their sources of nitrogen. Carnivorous or insectivorous plants are equipped with from the bodies of insects and other small organisms.

Answer:

Nitrogenous

THANK YOU.

LESSON PLAN FOR THE CONTROL GROUP

LESSON PLAN ONE
Subject: Biology
Class: Secondary School one (SSI)
Topic: Animal nutrition
Duration: 40 minutes
Average Age: 17 years
Sex: Mixed
Method: Lecture
Instructional Objective: At the end of the lesson the students should be able to:

1. Explain the classes of food.
2. Discuss the importance the classes of food.
3. Outline the classes and their percentage in balanced diet..

Entry Behavior: The students have learnt the plant nutrition.
Introduction: The teacher introduces the lesson by asking the students to mention three experiments to show that light is necessary for photosynthesis.
Presentation: The teacher presents the lesson in steps.
Step I: The teacher explain the classes of food and their importance with balanced diet.
Step II: The teacher discuss the importance the classes of food and gives examples of each.
Step III: The teacher mentions the classes of food that make up a balanced diet and their percentage in a balanced diet.
Evaluation: The teacher evaluates the lesson by asking students the following questions.

1. Name two classes of food and their importance with balanced diet

The teacher summarizes the lesson by explaining the classes of food and their importance with balanced diet, and concludes by asking the students to copy the chalk board summary.
Assignment: The teacher gives the following assignment.

1. Carry out experimental test for the classes of food

Further readings:
Iloeje, S.O. (2007). Senior Secondary certificate Practical Biology. BHS Printing Bhd Malaysia Michael, M.C. (2012) Essentials of Biology for Senior Secondary Schools TONAD Publishers, Ibadan, Fifth edition
Oguniyi, M. B. ,Adebisi, A.A. and Okojie, J.A. (2000). Biology for Senior Secondary Schools. Boos 1-3, Macmillan Ramalingam, S. T. (2013). Modern Biology for Senior Secondary Schools. Revised by: Akunwa, L. I, and. Obidiwe, J.B.C. African First publishers plc. Onitsha, Nigeria Sixth
S.T.A.N.(2004), Biology for Senior Secondary Schools. Revised Edition, Ibadan: Heinemann
Stone, R.H. and Cozen, A.B.C. (1982) Biology for est African School. Longman

LESSON PLAN TWO

Subject: Biology
Class: Secondary School One (SSI)
Topic: Modes of nutrition
Duration: 40 minutes
Average Age: 17 years
Sex: Mixed
Method: Lecture

Instructional Objective: At the end of the lesson the students should be able to:

1. State the different modes of nutrition and their subgroups
2. Outline the activities of these subgroups
3. State at least three examples of these subgroups of modes of nutrition.

Entry Behavior: The students have learnt a balanced diet.

Introduction: The teacher introduced the lesson by asking the students to state the function of different kinds of food

Presentation: The teacher presented the lesson in steps.

Step I: The teacher State the different modes of nutrition and their subgroups

Step II: Using a suitable example the teacher explained the activities of these subgroups.

Step III: The teacher gives examples of these subgroups of modes of nutrition

Evaluation: The teacher evaluates the lesson by asking students the following questions**.**

1. Explain the different modes of nutrition and their subgroups.
2. Outline the activities of these subgroups.

Summary and Conclusion

The teacher summarizes the lesson by explaining the different modes of nutrition, their activities and examples of their subgroups.

The teacher concludes by asking the students to copy the chalkboard summary.

Assignment: The teacher gave the following assignments.

1. Outline the activities of organisms in different modes of nutrition.

Further readings:

Iloeje, S.O. (2007). Senior Secondary certificate Practical Biology. BHS Printing Bhd Malaysia Michael, M.C. (2012) Essentials of Biology for Senior Secondary Schools TONAD Publishers, Ibadan, Fifth edition

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