Effect of the Task Hierarchy Analysis Model of Instruction on the Biology Students' Performance and Attitudes in Osun State

[1]K. A. OMOTAYO and Ogechi Rita OSUALA[*]
[1]Department of Science Education, Ekiti State University, Ado-Ekiti
[2]Osun State College of Education, Ilesa
[*]Corresponding author: ogechirita2015@gmail.com

Abstract
The study examined the impact of the task hierarchy analysis model of instruction on the Biology students' performance and attitudes. The study employed a quasi-experimental pre-test and post-test control group design. Using a multistage sampling technique, the sample consists of 379 senior high school two Biology students from 12 public secondary schools in three Local Government Areas (LGAs) in Osun State.There were experimental and control groups in the sample. Two research instruments, the Biology Performance Test (BPT) and the Biology Attitude Scale (BAS), with respective reliability values of 0.83 and 0.76, were employed to collect pertinent data for the study.The research questions posed were answered with descriptive statistics, and the results were illustrated with bar charts and at a significance level of 0.05 while the hypotheses were tested using appropriate inferential statistics such as the t-test and Analysis of Covariance (ANCOVA).The results of the study indicated that there is a statistically significant difference between the mean achievement scores of students exposed to the task hierarchy analysis model of instruction and their counterparts in the control group.The results of the study demonstrated that students taught the notion of biology using the task hierarchy analysis style of instruction have a significantly different attitude than their counterparts in the control group. The task hierarchy analysis approach of education was advocated, among others, for use in the secondary school Biology classroom.

Keywords: Model, Task Hierarchy Analysis, Biology Academic Performance, and Attitude

Introduction

Biology has been defined as one of the natural disciplines that focus on living things. Biology is concerned with the study of life, thus it is no surprise that it is usually referred to as the study of life, Adubi (2015).Biology also investigates the structures, functions, growth, origin, evolution, distribution, inter-relationships, and adaptations of living species, among other things and Biology frequently overlaps with other sciences, such as biochemistry, which combines biology and chemistry, and astrobiology, which combines biology and astronomy. Biology, according to Adubi (2015), is a broad discipline with several branches. The continuous inability of scientific students to acquire high results on external tests poses a threat to the achievement of the objectives of science education in particular. The failure is indicative of a process issue in secondary education and the problem of poor performance and poor attitude has caused concern in the educational system of Nigeria. The majority of students have not attained the level of proficiency required to enroll in certificate courses in Biology and science in general. The transmission of facts, the tyranny of abstractions, and the cluster of lifeless ideas have dominated biology education.

Many students today passively learn Biology in classrooms where knowledge is structured and given by the teacher.This harmful trend has prompted the quest for alternate ways of science instruction that stimulate students' intellects and ensure a standard educational system. In light of these recurrent issues, the following general question was posed: Will the Task Hierarchy Analysis Model of Instruction aid in reducing or eliminating the challenges students have when learning Biology and enhancing their performance? Therefore, the purpose of this study is to analyze the impacts of the Task Hierarchy Analysis Model of Instruction on the academic performance of Biology students.

Many reasons contribute to pupils' low performance in sciences, particularly biology, among which are teachers' instructional tactics, according to Ojebisi (2015).Effective Biology teaching is the process by which a Biology teacher uses all feasible methods of teaching in the classroom to ensure that students understand and can respond positively during assessment to produce a good outcome. Biology can interact with social sciences such as geography, philosophy, psychology, and sociology. Biology education is critical for any developing economy like Nigeria and many biology graduates can be self-employed and labor employers, so helping to reduce the level of employment (Aina, 2013).

Globally speaking, science and technology education is a real tool for sustainable development and the cornerstone of socioeconomic progress. It is also regarded as one of the most potent tools that empower people to take on new tasks and circumstances and plays roles as contributing members of society (Ibrahim, Adamu & Ibrahim 2018).In

order to improve knowledge transfer to problems encountered in daily life, science instruction in schools should help students develop a profound understanding of science. The approaches used in the teaching and learning of biology, have been seen to contribute to students' negative attitudes about science in general and biology in particular fensham, in (Ajaja, 2013).

In order to develop scientifically informed citizens with increased economic production, biology education must be of high quality, this willraise students' achievement and increases community trust in educational institutions. Science education has been said to be significantly influenced by one's attitude toward the subject. In Nasr (2011), Simpson and Oliver defined attitude as the emotional tendencies in response to things like people, places, events, or ideas. Having a positive outlook on science can inspire learning and lead to better performance in George (Nasr, 2011). Students' perceptions are influenced by their attitudes; therefore a positive perception reflects a positive attitude.

It has been observed that students'with positive attitude towards a subject perform better than those who have a negative attitude. Numerous researches have revealed an association between subject attitudes and academic success (Sarwar, Bashir & Alam, 2017; Ajayi, Kassim, Adewale & Abayomi, 2016; Ogunyemi & Hassan, 2011). Multiple research investigations have found that a positive attitude is vital for an individual's education since it reveals a person's inner perspective. Therefore, the key to achieving high performance scores in Biology is a positive mindset. Positive school attitude is not only vital for averting negative events such as dropping out of school, but it is also related with good performance and achievement, according to the researcher's own observations. According to Alaje (2019), attitude develops in a variety of ways and can be transmitted from one person to another. An individual can also acquire an attitude in an effort to adapt and cope with his or her surroundings.

Task Hierarchy Analysis Model is a crucial component of the instructional design procedure and it represents the educational process's steps. Job Hierarchy Analysis Model analyses all important topics pre-requisite to the set objectives or terminal task of a particular course. After a thorough investigation of these pre-requisite themes and sub-topics, a hierarchical model is developed in accordance with the identified pre-requisite topics to serve as a guide for the teacher throughout instruction. Task Hierarchy Analysis Model will tend to condense and de-clutter the entire Biology curriculum, making it easier for teachers to teach and for students to retain and retrieve information.

In most Biology classrooms, teachers pay little or no attention to what the student already knows about the concept taught, they only convey the knowledge included inside the textbooks and curriculum materials.Ajaja (2013) argues that the transmission of experience appropriately to the learner enables him to acquire meaningful knowledge. The Learning Hierarchy Analysis developed by Gagne serves as the theoretical foundation for this investigation. According to Rao (2007), task analysis is the breakdown of a complex task into its component subtasks and it is of utmost importance to determine which prerequisites need to be fulfilled in order to support learning at each level. According to the work, pre-requisites are carefully discovered by performing a straightforward task analysis process. The sequencing of teaching is supported by the learning hierarchy. One of the main concepts of Gagne's instructional design theory is the Learning Hierarchy and that approach states that without first identifying a quantifiable learning outcome and designing for it, one cannot effectively plan instruction and made available for use in the future through the sharing of experience.

According to Sabiru (2013) research, Gagne's learning hierarchy is crucial to the teaching process because it enables students to learn in a meaningful way by moving from concrete to abstract material. For instance, a pupil must be familiar with other concepts or prerequisites before they can understand the concept of excretion. In order to improve student academic performance in the subject as well as lower their anxiety level about the topic presented, this learning hierarchy was used as a guide for teaching the idea of excretion in biology. Ugwu (2015) in her study observed that task hierarchy analysis model of instruction enhanced students performance in chemistry. Ifeyinwa (2013) noted in his study that two factors must be considered for meaningful learning to take place. First is a psychological analysis of the component skills and their assembly required for a pupil to achieve sophisticated educational skills?

According to Gagne's theory of hierarchical learning, the optimal acquisition of a new task needs the preceding learning of subordinate tasks and the relevance of this theory for learning is that the mastery of prior concepts is necessary for the acquisition of new concepts when they are ordered hierarchically. Gagne referred the arrangement of learning activities from simple to complex desired tasks as learning hierarchy. According to Gagne's idea of learning hierarchy, intellectual skill-related learning tasks can be categorized based on their complexity. According to this approach, the abilities acquired through learning are organized hierarchically, with one job relying on the acquisition of

a simpler one and the relevance of the hierarchy is that it identifies prerequisites that must be met to facilitate learning at each level and provides a foundation for the instructional sequence. The lecture/expository technique, demonstration, and direct instruction are only a few of the conventional teaching methods frequently employed by Biology professors. These techniques emphasize the transfer of information in a manner that encourages memorization; consequently, they have been labeled by some educators as ineffective techniques for teaching biology and other science disciplines.

The conventional/traditional teaching approaches support the acquisition of procedural skills that are necessary for a proper comprehension of biology principles, concepts, and facts but require a one-way flow of information/knowledge from teacher to pupils. Due to the standard teaching method's unidirectional information flow, pupils become inert and are unable to build significant biology knowledge. In order to create a classroom climate where students are treated as active learners, a teacher must be aware about biology learning and scientific teaching and other scientists have previously conducted a number of studies on the best strategies to enhance biology teaching and learning.

According to preliminary research conducted by the researcher, no studies on the Task Hierarchy Analysis Model of Instruction on the topic of excretion in Biology have been done in the selected Local Government Areas in Osun State. This is in accordance with the ardent plea made by Adejoh and Idachaba (2010), who emphasized the requirement, that biology teacher's switch from traditional teaching approaches to student-centered ones. Therefore, it is legitimate for teachers to model all the foundational knowledge that students need to master utilizing effective teaching techniques to improve biology performance.

Conceptual Framework

This model can be represented diagrammatically as shown in Fig. 1:

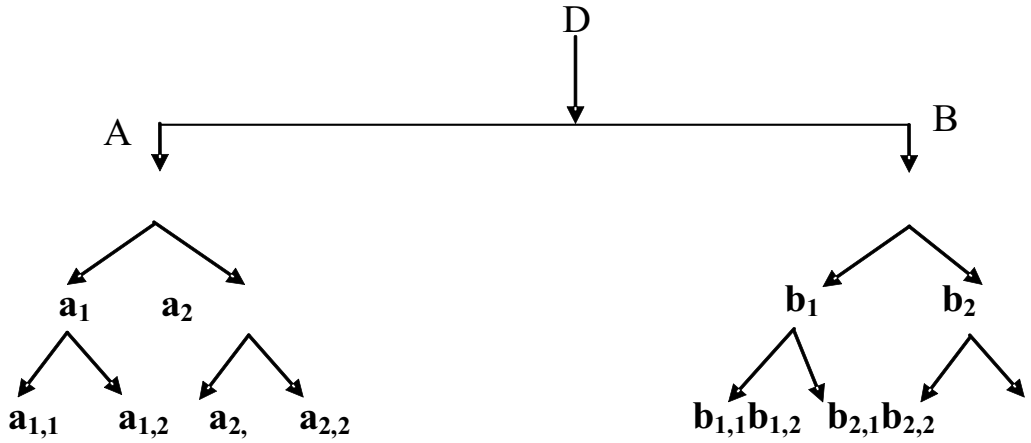

Figure 1: *Summary of Gagne's Task Analysis Model: Adapted from Gagne, 1965*

Key:

D – Terminal Task or Desired Knowledge

A and B – Are necessary pre-requisites concepts for the terminal task or Desired Knowledge (D)

a_1, a_2, b_1, b_2, etc. are the sub tasks or sub-ordinates for the terminal task

Objectives of the Study

The goal of this study is to look at the impact of the Task Hierarchy Analysis Model of Instruction (THAMI) on the performance and attitudes of senior secondary biology students.

The study's specific aims are as follows:

Determine the effect of the Task Hierarchy Analysis Model of Instruction on students' performance in Biology concepts.

To look into the impact of Task Hierarchy Analysis Model Instruction on students' attitudes towards Biology concepts.

Research questions

The following questions were raised to lead the study based on the problem statement:

1. What effect does the Task Hierarchy Analysis Model of Instruction have on students' performance in the

Biology concept?

2. Will using the Task Hierarchy Analysis Model of Instruction improve students' attitudes towards biological concepts?

Research Hypotheses

The following null hypotheses were developed to guide the research,

1. There is no significant difference in the mean achievement score of students taught Biology concepts utilizing the Task Hierarchy Analysis Model of Instruction and the control group after treatment,
2. There is no statistically significant difference in attitudes between students taught Biology concepts using the Task Hierarchy Analysis Model of Instruction and those taught using the traditional technique.

Methodology

This study adopted a quasi-experimental pre-test and post-test control group design. All public Senior Secondary School two (SSS11) students enrolled in Biology in Osun State, Nigeria, constitute the study's population. There are 27,693 Senior Secondary two students in 253 public senior secondary schools in the three senatorial districts of Osun State. There are 14,028 males and 13,665 females. The sample for this study consists of 379 SSS11 Biology students drawn from 12 public secondary schools in the three senatorial districts of Osun State using a multistage sampling technique. Simple random sampling technique was used to assign experimental and control groups. The study employed two instruments for data gathering purposes. The initial instrument was a Biology Performance Test (BPT) comprised of 30 objective multiple-choice questions with four possible answers. The BPT created questions based on the taught Biology concepts and BPT was used to evaluate students' performance in Biology. The second instrument was the Biology Attitudinal Scale (BAS), a 20-item scale devised by the researcher to measure positive attitudes toward the study of Biology. The validity of the instruments was carried out by experts in test and measurement to ensure the face and content validity of the instruments while reliability coefficients were 0.83 and 0.76, respectively. The Biology Performance Test (pre-test) was given to students in both the experimental and control groups prior to the start of treatment. The experimental group was taught Biology concept Excretion using the Task Hierarchy Analysis Model of Instruction, whereas the control group was taught the same Biology concepts using the Conventional Method throughout the same length of time. After six weeks, the BPT and BAS items were reshuffled and delivered to the students to ascertain the impact of the teaching strategy. The data was collected for the study was analysed using appropriate descriptive and inferential statistics. All of the questions raised were answered using descriptive statistics such as mean, standard deviation, and bar chat while all the hypotheses were tested using inferential statistics at 0.05 threshold of significance.

Results

Research Question 1: What is the Effect of Task Hierarchy Analysis Model of Instruction on the Performance of Students on Biology concept taught?

The results of the Task Hierarchy Analysis Model of Instruction on Students'Performance in Biology Concepts are shown in Table 1.

Table 1: Effects of Task Hierarchy Analysis Model of Instruction on Students' Performance in Biology concepts

	N	Pretest		Post test		Mean Difference
		Mean	SD	Mean	SD	
Task Hierarchy Analysis Model of Instruction	188	11.00	3.87	23.50	2.14	12.50
Conventional	191	11.39	3.20	14.77	2.48	3.38
Total	379	11.20	3.55	19.10	4.94	7.90

Table 1 reveals that prior to treatment; Biology students in the Task Hierarchy Analysis Model of Instruction group had a mean score of 11.09, whereas those in the conventional group had a score of 11.39. After the treatment, Students exposed to the Task Hierarchy Analysis Model of Instruction had a higher mean score of 23.50 than their counterparts in the control group, who had a mean score of 14.77.This suggests that the Task Hierarchy Analysis Model of Instruction has an impact on students' performance in the Biology concept. Figure 2 depicts the effect of the Task Hierarchy Analysis Model of Instruction on students' performance in the Biology concept.

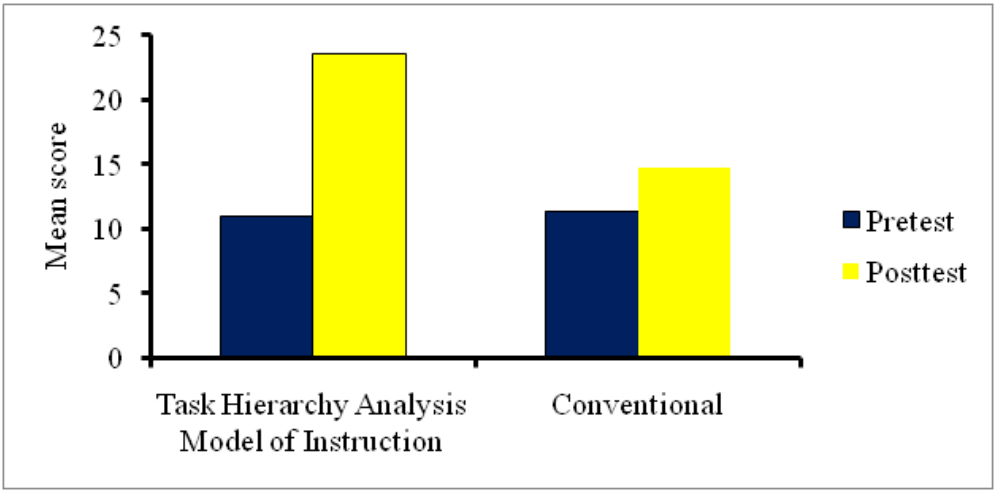

Figure 2: Effect of Task Hierarchy Analysis Model of Instruction on students 'performance in Biology concept
Table 2 displays Task Hierarchy Analysis Effects of Instructional Model on Students' Views of Biology Concepts

Research Question 2: Will the use of task hierarchy analysis model of instruction improve students' attitude towards biology?

Table 2: Effect of Task Hierarchy Analysis Model of Instruction on students' attitude towards Biology concepts

	N	Pretest		Posttest		Mean Difference
		Mean	SD	Mean	SD	
Task Hierarchy Analysis Model of Instruction	188	39.09	7.85	67.25	6.26	28.16
Conventional	191	39.96	7.33	46.62	5.35	6.66
Total	379	39.53	7.60	56.85	11.85	17.32

According to Table 2, the pre-attitudinal mean score for biology students in the Task Hierarchy Analysis Model of Instruction group was 39.09, compared to 39.96 for the conventional group. After treatment, students in the Task Hierarchy Analysis Model of Instruction group had a mean score of 67.25, which was greater than the mean score of 46.62 achieved by students in the conventional group. This suggests that implementing the Task Hierarchy Analysis Model of Instruction will improve the way in which students see biological concepts and Figure 3 further illustrates the impact of the Task Hierarchy Analysis Model of Instruction on students' attitudes about biological ideas.

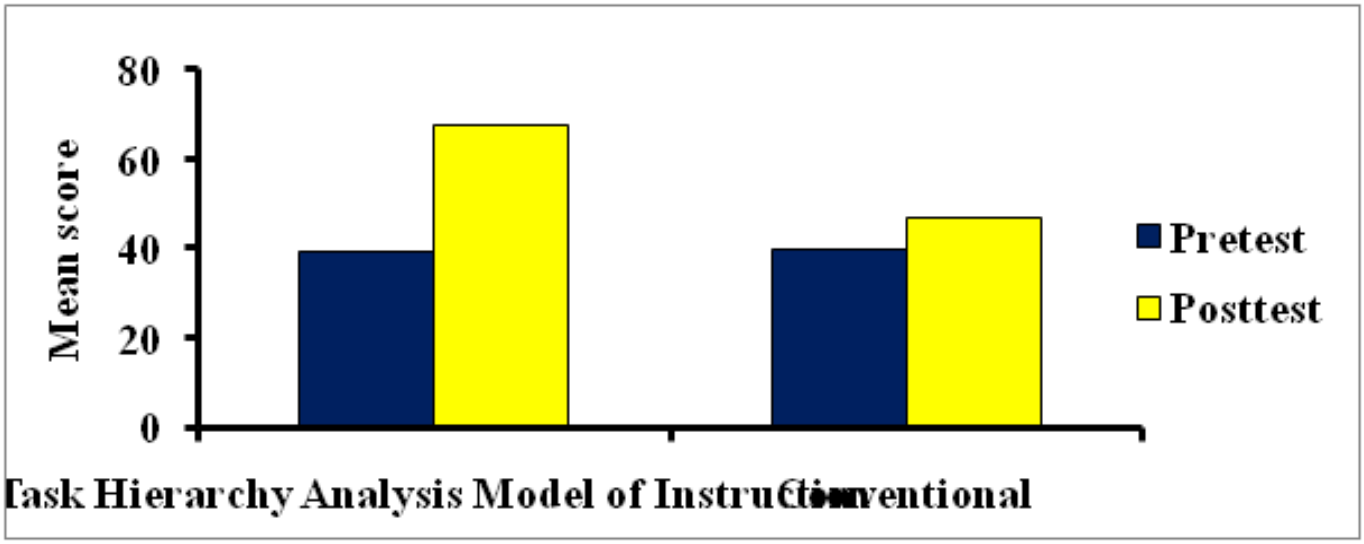

Figure 3 The Task Hierarchy Analysis Model of Instruction on students' attitudes about biological ideas.

Research Hypothesis 1

There is no significant difference in the achievement mean score of students taught Biology concepts using Task Hierarchy Analysis Model of Instruction and those exposed to the Conventional method after treatment. Achievement after treatment, the mean scores of students taught Biology using the task hierarchy analysis model and those exposed to the Conventional approach were calculated and compared for statistical significance using the t-test at a significance threshold of 0.05.The outcome is shown in Table 3.

Table 3: t-test of students' achievement in Biology concept after treatment

Group	N	Mean	SD	Df	t_{cal}	P
Task Hierarchy Analysis Model	188	23.50	2.14			
Conventional	191	14.77	2.48	377	36.722*	.000

*p<0.05

Table 3 demonstrates that there is a significant difference in the achievement mean score of students taught Biology concepts using the Task Hierarchy Analysis Model of Instruction and those who were not exposed to the model after treatment (tcal= 36.722, p0.05) at the 0.05 level of significance. The null hypothesis was rejected, and the hypothesis was rewritten as follows: there is a substantial difference in the mean achievement scores of the two groups following treatment.

Research Hypothesis 2

There is no significant difference in attitudes between students who were taught Biology concepts using the Task Hierarchy Analysis Model of Instruction and those who were taught using the traditional technique. Table 4 shows the ANCOVA of students' attitudes toward the Biology Concept by therapy.

Table 4: ANCOVA of students' attitude towards Biology Concept by treatment

Source	SS	Df	MS	F	P
Corrected Model	40395.399	2	20197.700	599.129	.000
Covariate (Pretest)	84.489	1	84.489	2.506	.114
Group	40389.745	1	40389.745	1198.091*	.000
Error	12675.619	376	33.712		
Total	1278180.000	379			

*p<0.05

Table 4 reveals that at the 0.05 level of significance, there is a significant difference in the attitude of students taught Biology concepts using the Task Hierarchy Analysis Model of Instruction and those taught using the conventional technique (F1,376=1198.091, p0.05).As a result, the null hypothesis is rejected. Itfollows that there was sufficient evidence to conclude that there is a substantial difference in the attitudes of pupils in the two groups. Multiple Classification Analysis (MCA) was performed to measure the effectiveness of treatment in improving students' attitudes regarding Biology concepts. Table 5 depicts the outcome.

Table 5: Multiple Classification Analysis (MCA) showing attitude of students towards Biology concepts by treatment

		Grand mean=56.85			
Variable + Category	**N**	**Unadjusted Devn'**	**Eta^2**	**Adjusted For Independent + Covariate**	**Beta**
Task Hierarchy Analysis Model	188	10.40	.76	10.39	.01
Conventional	191	-10.23		-10.22	
Multiple R					0.010
Multiple R^2					0.000

A cursory examination of Table 5 reveals that students exposed to the Task Hierarchy Analysis Model had a higher adjusted mean score of 67.24 (56.85+10.39) on attitude toward Biology topics than their counterparts in the conventional group, who had an adjusted mean score of 46.62 (56.85+). (-10.22).This suggests that the Task Hierarchy Analysis Model is an effective instructional method for improving students' attitudes toward Biology concepts. The treatment accounts for approximately 76% (Eta2=0.76) of the observed variance in students' attitudes regarding Biology concepts.

Discussion of findings

The results of the study indicate a substantial difference between the experimental and control groups' post-test mean scores and standard deviations. It is claimed that exposure to the treatment led to a remarkable improvement in the academic performance of students and those who were exposed to the Task Hierarchy Analysis Model of Instruction had greater post-test mean achievement scores than those who were subjected to the conventional method. This finding regarding the exceptional performance of students in the experimental group was consistent with the findings of Sabiru (2013) and Ugwu (2015), who, in separate studies, discovered that students taught chemistry using the Task Hierarchy Analysis Model had higher mean scores for academic achievement than those taught using the Conventional method.

In addition, their research demonstrated that the enhanced performance was due to exposure to the treatment and the researcher is of the opinion that great instruction will aid students in attaining a profound conceptual understanding characterized by adequate subject matter expertise. The researcher significantly confirms the study's findings as well as the claims of earlier researchers regarding the efficiency of the task hierarchy analysis model. Students exposed to the Task Hierarchy Analysis Model had a higher adjusted mean score of 67.24 on attitudes toward biology topics than their counterparts in the conventional group, who had an adjusted mean score of 46. This suggests that the Task Hierarchy Analysis Model of Instruction can be recommended as an educational strategy for fostering a favorable attitude towards Biology among students. This result was consistent with Alaje's (2019) conclusion that there is a substantial association between students' attitude and academic achievement.On the basis of these statements, attitude as a crucial notion in scientific decision-making must be enhanced for optimal performance. This is predicated on the premise that a student's accomplishment is proportional to his or her attitude toward a subject or work. According to the results of this study, the application of the Task Hierarchy Analysis Model of Instruction has a significant favorable effect on the students'

attitudes and this observed positive attitude is what the researcher attributed to the experimental group's higher performance in Biology topics.

Conclusion

The Task Hierarchy Analysis Model of Instruction was shown to be a successful approach for teaching and learning biology in the public secondary schools in Osun State, according to the study's findings. The approach had a sizable educational impact on the mean achievement scores of the students in the two groups. Based on the findings of the study, it was concluded that location significantly influences biology students' achievement mean scores. The experimental group showed enhanced attitudes for learning biology as a result of the task hierarchy analysis model of instruction and the analyses' findings demonstrated the value of the Task Hierarchy Analysis Model as a teaching and learning tool for biology.

Recommendations

The following suggestions were made according on the study's findings,

1. For better student performance, biology teachers should apply the Task Hierarchy Analysis Model of Instruction to optimize their instructional processes.
2. To improve and maintain the attitude of students toward learning biology, there should be more awareness raised about the use of the model through trainings and workshops.
3. School administrators and other education stakeholders should create a more welcoming learning atmosphere that will support the deployment of innovative biology teaching techniques like the Task Hierarchy Analysis Model and other science courses should be taught using the Task Hierarchy Analysis Model of Instruction

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