# Effects of Video-Assisted Instructional Package on Secondary School Students' Achievement in Photosynthesis in Omu-Aran, Nigeria

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## Abstract

Photosynthesis has been identified as a difficult biology topic for students due to their inability to visualize the stages and experimental procedures associated with it. Therefore, this study investigated the effects of video-assisted instruction on senior secondary school students' achievement in photosynthesis in Omu-Aran, Nigeria. The study investigated whether or not there will be gains in students' achievement in photosynthesis when taught using video-assisted instruction, and the interaction effect of gender and cognitive style on the achievement. The study was a quasi-experimental research. The sample for the study was 109 and consisted male and female students from two co-educational schools. Two tests (pre- and post-) designed by the researchers were validated by three lecturers in science education. The instruments were found to have a high reliability as the reliability index obtained was 0.72. Data were analyzed using t-test and Analysis of Covariance (ANCOVA) at 0.05 level of significance. The findings of the study revealed that video-assisted instructional package improved students' academic achievement in photosynthesis. Also, gender and cognitive style were observed to have no effect on students' achievement when taught photosynthesis using the package and there were no interaction effects among the cognitive style and gender categories on achievement in photosynthesis. The study concluded that the use of video assisted instructional package was effective in improving the achievement of students in photosynthesis irrespective of gender and their cognitive style. Based on the findings of the study, Biology teachers should be encouraged to use video-assisted instructional package for teaching photosynthesis in senior secondary schools to improve learning outcomes.

Keywords: video-assisted instructional; students' achievement; photosynthesis.

## Introduction

Science plays fundamental roles in the development and productivity of any nation. Abimbola (2013) stated that science is a body of knowledge, a way of investigation and thinking in pursuit of an understanding of nature. Biology is defined as the scientific study of living organism (William, 2015). It centers on the study of living organisms, how the organisms interact with one another and their non-living components in the environment. Biology is an essential part of science taught to secondary school students in Nigeria (FRN, 2009).

Biology is fundamental to the understanding and finding solution to most pressing issues from many challenges arising from population growth, human impacts on ecosystems and services to

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 DOI: https://dx.doi.org/10.4314/ajesms.v20i1.1

climatic change (Kim & Diong, 2012). However, some research results have shown that teachers and students perceived some topics of biology as difficult to teach and to learn. Some of those topics are cell division (Ansuman, 2012; Cimer, 2011); ecology, genetics and hereditary (Agboghoroma & Oyovwi, 2015); ecological management, conservation of natural resources, pests and diseases of crops, nutrient cycling in nature as well as reproductive system in plants (Etobro & Fabinu, 2017), among others, were considered difficult concepts by secondary school students.

Biology covers a collection of topics among which are; cell, ecology, evolution, genetics, reproduction, skeletal system and photosynthesis. Photosynthesis is the process whereby green plants utilize carbon dioxide ($CO_2$) and water ($H_2O$) in the presence of light energy and chlorophyll to synthesize sugar (organic materials) (Ambuno, Egunyomi, & Osakwe, 2008). The process of Photosynthesis helps in the purification of the atmosphere through the absorption of carbon (IV) dioxide being released during respiration by animals and releasing oxygen to the environment. The knowledge of biology helps us to know how the atmosphere is purified through photosynthesis. Despite the usefulness of photosynthesis to human existence, students still find it difficult to comprehend. Some of the reasons adduced to this includes teaching strategies, students' attitude, students' learning habits and inadequate learning resources one of which is video-assisted instructional package (Abimbola, 1998; Okoli & Okoli, 2014; Olorundare & Oni, 2007).

The applications of innovative strategies might be able to resolve the issue of poor performance in photosynthesis. One of such innovative strategies is the use of technological tools called video-assisted instructional strategies. Video-Assisted Instructional Package, like Computer Assisted Instruction (CAI), Protocol Packages (PP) and Audio-Tutorial Training Models (ATTM), among others. Individualized methods of instruction, is a student-centered activity-oriented teaching strategy which allow students' to learn through self-learning while the teacher acts more as a facilitator to the students learning and not as the which allow students' to learn through self-learning while the teacher acts more as a facilitator to the students learning and not as the provider of information or knowledge. Hence, Video-Assisted Instructional Package is an instructional approach that makes teaching and learning more precise (Olelewe *et al.,* 2023).

Video-Assisted Instruction is an educational tool that uses recording, reproducing or broadcasting moving video-images to complement other classroom instructions (Wikipedia, 2019). Video-based learning is becoming more prominent in the world of education. Videos in education make it possible to overcome practical real-world constraints and explore the far greater possibilities provided by digital spaces. It promotes student-centered learning within the classroom and home.

Videos can also be integrated in online learning systems (Learning Management System (LMS), portal, e-class, among others) and can be combined with other services. For instance, learners can use in parallel video and an online chat room,

forum or even video conferencing to communicate with their instructors. The combination of video with other learning services has great potential to provide to students with an integrated online learning space (Giannakos *et al.,* 2014).

Adedamola (2018) investigated the effectiveness of using Multimedia on students learning outcomes in biology. The results indicated a statistically significant difference between students learning outcomes and modes of instruction. Students under Multimedia Aided Instructions had better outcome than their colleagues in traditional teaching method. Donkor (2010) compared the instructional effectiveness of the video-based instructional materials and convectional print-based instructional materials. The findings revealed video-based instructional materials are pedagogically superior to the convectional instructional method when used as distance education materials. In addition, research findings of Donkor (2011) showed that when the quality of the instructional video materials such as content, text, images, and sound appear good and visible, online learners responded positively to the video-based instructional materials. According to Donkor (2011), the use of video-based instructional materials is likely to increase learners' motivation, interest, and practical skills acquisition.

In addition, Gambari *et al.,* (2016) examined the effects of video-based cooperative, competitive and individualized instructional strategies on the performance of senior secondary schools' students in geometry in Nigeria. The study also examined the influence of gender on students' achievement. Findings of the study revealed that there was significant difference in the performance of the groups in favour of cooperative group. The study revealed that, students' gender had no influence on students' performance in cooperative and individualized groups. However, male performed better than female in competitive instructional strategy.

However, there are some salient variables that could influence students' performance among which is gender. Gender issue in recent years has brought about a strong point of view as regards to the influence of gender on student achievement in Biology. Gender could be a concept that distinguishes the roles, behaviors, mental and emotional characteristics between males and females developed by a society. Azibaolanari, John and Mumuni (2016); Otor (2013) found that females achieved better than males in science subjects. On the contrary, Adeoye and Abimbola (2016) and lkeh, Ugwuanyi and Orji (2016) findings found that there was no significant difference in science achievement between male and female students. Based on the prior studies by (Adeoye & Abimbola, (2016); Azibaolanari, John & Mumuni, (2016); Ikeh, Ugwuanyi & Orji (2016); Otor, 2013), the results on gender influence on students' achievement in science and Biology are inconclusive, and therefore, it is essential to investigate its significance.

Aside from gender, cognitive style may also influence students' performance, cognitive style is a term that refers to the individual methods of organizing, processing, interpreting and thinking about information and experience. Akhtar & Arif (2010) referred to cognitive style as the individual way of perceiving, organizing, processing and recalling information received from the environment. It is the personal feelings, emotion, and attitude towards the teaching and learning process (Kenth, 2011). It affects the process of decision-making that subsequently affects the social attitude,

thinking and responses to life events (Riding, 2000). It also influences the academic achievement of university and secondary school students (Altun & Cakan, 2006; Carolina *et al.,* 2012). Hence, this study determined the effects of video-assisted instructional package on senior secondary school students' achievement in photosynthesis in Omu- Aran, Nigeria.

*Research Questions*

The main purpose of this study was to determine the effects of video- assisted instructional package on senior secondary school students' achievement in photosynthesis. Specifically, the following research questions were raised and answered in this study:

(i) What is the difference in achievement of students taught photosynthesis using video-assisted instructional package and those taught without using the package;

(ii) What is the effect of gender and cognitive style on the differences in achievement of students' taught photosynthesis using video-assisted instructional package and those taught without using the package?

(iii) What is the interaction effect of students' gender on their cognitive style in their achievement in photosynthesis? (Research Question 4)

*Research Hypotheses*

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

$H_{o1}$: There is no statistically significant difference in the achievement of students' taught photosynthesis using video-assisted instructional package and those taught without using the package.

$H_{o2}$: There is no statistically significant differences achievement of students based on gender and cognitive style, when taught photosynthesis using video-assisted instructional package and those taught without using the package?

$H_{o3}$: There is no statistically significant differences in interaction effect of students' gender and cognitive style on their achievement in photosynthesis when treated with or without the video-assisted instructional package?

**Methodology**

This study adopted a 2×2×2 quasi-experimental research design. Specifically, the study applied a pre-test, post-test, non-randomized control group design. The independent variable was the video-assisted instructional package (VAIP) and conventional instructions. The dependent variable was the students' achievement while the moderating variables were students' gender and cognitive styles.

The study involved all senior secondary schools' students in Omu-Aran, Kwara State, Nigeria. The target population was all senior secondary schools one (SS1) students offering Biology in Omu- Aran, Kwara State, Nigeria. A total of 109 (36 males and 73 females) senior secondary schools one (SSI) students offering Biology were drawn from two intact classes, randomly selected from two purposively sampled co-educational senior schools with equipped and functioning computer

laboratories. The two schools sampled were assigned to experimental and control groups respectively using simple random sampling technique.

The research instruments used in this study were Photosynthesis Achievement Test (PAT), Cognitive Style Checklist (CSC) and Video-Assisted Instructional Package on Photosynthesis (VAIPP).

The Photosynthesis Achievement Test (PAT) was a researcher designed instrument which consisted of 40 multiple-choice objective test questions on Photosynthesis with four options (A-D) in which one has the correct option. The duration of the test was 20 minutes and each question carry 1 mark and the total mark was 40 marks. The PAT was also used as pretest and reshuffled as posttest for participants in both experimental and control groups.

The Cognitive Style Checklist (CSC) was developed and used by a University professor, Robert Wyss (2002) in his work on Field dependence/Independence. For this study, the CSC was adapted, modified and revalidated for use in photosynthesis. The checklist was used to categorize the participants based on their cognitive styles. Each of the 10 items is divided into two (2) sub-statements i.e. (A) or (B). Sub-statement A represents the characteristics of the Field independent while sub-statement B represents those of Field dependent. The participants specified from the statements the ones which best applied to their cognitive styles. Participants who indicated up to seven (7) A's are categorized as Field independent while the rest are regarded as Field dependent. The total time allotted for the CSC was 30 minutes.

The Video-Assisted Instructional Package on Photosynthesis (VAIPP) was developed by the researcher. The VAIPP covered lessons on Photosynthesis for Senior Secondary One (SSI) in the national Biology curriculum. The content is structured into small segment in clear and understandable manner. The contents include definition of the concept of photosynthesis with pictures of live plants that are still photosynthesizing and dead ones that that can no longer undergo photosynthesis. It also includes a description of various stages of photosynthesis with animations of how the processes are progressing. A video showing the light and the dark phases of photosynthesis is also included. The VAIPP also entails video on the benefits of photosynthesis. Included in the video is the scientific formula or equation portraying each of the photosynthesis process among other things that are contained in the secondary school Biology curriculum. The videos are synchronized with sound and images which occur on different platform of browsers. Presentation of information on VAIPP captivates attention of the students. The package provides opportunities for interaction and progressive evaluation of the students. The structure of the package permits learners to advance, review, see examples in the unit and also explore other units. The content of this instructional package caters for psychomotor domain. The instructional package has durability overtimes and provides feedback to verify correctness of answers. VAIPP served as treatment for the experimental group.

The tests were validated by three Biology experts from the Department of Science Education, Educational Technology and Life Science, University of Ilorin, Ilorin, Nigeria, and two Biology teachers from two secondary schools in Omu-Aran, Nigeria. The validators check for the content coverage, language, technology interaction

and quality of production of the video. Their comments were used for final version of the instruments for this study. The reliability of PAT was established through trial testing (test and retest) on a group of participants in an intact class in a school within the population but outside the sampled area. The data obtained from the trial testing was analyzed using Kuder-Richardson 21 (KR-21) and reliability index of 0.72 was obtained.

The research instruments used in this study were the Photosynthesis Achievement Test (PAT) and the Cognitive Style Checklist (CSC) and The PAT was designed by the researcher while the cognitive style checklist was adapted from Robert Wyss (2002). The tests were validated by three Biology experts from the Department of Science Education, Educational Technology and Life Science, University of Ilorin, Ilorin, Nigeria, and two Biology teachers from two secondary schools in Omu-Aran, Nigeria. The reliability of PAT was established through trial testing (test and retest) on a group of students in an intact class in a school within the population but outside the sampled area. The data obtained from the trial testing was analyzed using Kuder-Richardson 21 (KR-21) and reliability index of 0.72 was obtained.

Based on ethics in the conduct of research, the consent of students and Biology teachers who participated in the study was sought through an informed consent form. The students participated fully in the study in which the experimental group was taught photosynthesis using video-assisted instructional package and control group was taught with the conventional method.

The Biology teachers who participated in the study were trained on how to use the VAIPP before the treatment. The teachers were trained to guide the students in the experimental group in using VAIPP, which was used for teaching the participants in the experimental group while the teacher for the control group used the conventional instruction. The participants for both the treatment and control groups were given Photosynthesis Achievement Test (PAT). The PAT was used as pre-test to determine the participants' prior knowledge of Photosynthesis while the CSC was used to group the participants into field-dependent and field-independent cognitive style. After the pre-test, the research assistant in the experimental group exposed the participants to Video-Assisted Instructional Package on Photosynthesis (VAIPP) installed on their school computers while participants in the control group were taught photosynthesis using the conventional instructions (i.e., without VAIPP). Participants in each school were taught double periods a week and each of the content lasted for 80 minutes (double period) which runs for four weeks. In week 1, the schools sampled were visited. During the visitation, the consent forms were given to principals, teachers and participants in order to seek their consent to participate in the study. Also in week I, the research assistants were trained. In week 2, pretest administration was conducted while week 3-4 was used to teach the participants photosynthesis in both experimental and control groups respectively using Video-Assisted Instructional Package on Photosynthesis (VAIPP) and Conventional methods and this was followed by posttest administration.

The treatment in both groups took place during the period scheduled on the school scheme of work and school time table to avoid disruption of school activities. At the end of the experiment, PAT earlier giving as pre-test was reshuffled and administered to students in both the treatment and control groups as post-test in order to determine their achievement. Participants in experimental group exposed to Video-Assisted Instructional Package on Photosynthesis (VAIPP) show greater attention, interest, interaction among the groups and better performance in PAT than participants taught using conventional method. The differences in classroom experiences between students treated with the VAIPP and those taught without it might as a result of influence of video containing activities on Photosynthesis inform of animations, pictures and sounds.

The research questions for the study and the corresponding research hypotheses were tested using t-test and Analysis of Covariance (ANCOVA). All hypotheses generated were tested at 0.05 level of significance.

**Results**

*Difference in achievement of students taught photosynthesis using VAIPP and those taught with the conventional method (Research Question 1)*

The independent t-test analysis in Table 1 shows that the experimental group students exposed to VAIPP had a mean gain score of (8.10) and the control group students taught using the conventional method had a mean gain score of (4.08).

The independent t-test analysis results (i.e., t-value ($t_{(107)}$) = 5.75, at $p < 0.05$), indicate at an alpha level of 0.05, implying the mean achievement score of the experimental group [M = 15.07, SD = 4.08] was statistically significantly higher than in the mean achievement score of the control group [M = 12.98, SD = 4.61]. This suggests there is a statistically significant difference in the achievement of students taught photosynthesis using the VIAPP and those taught using conventional method. This implies that the students taught photosynthesis using the VIAPP performed better than those taught using conventional method, and as such, the null hypothesis was rejected. Thus, the students in the experimental group outperformed their counterparts in control group who taught using conventional method.

*Effect of gender and cognitive style on the achievement of the experimental group taught photosynthesis using VIAPP (Research Question 2)*

The independent t-test analysis in Table 2 shows the results (i.e., t-value ($t_{(58)}$) = -1.08, at $p > 0.05$), which indicate the mean achievement scores of male and female participants taught photosynthesis using the VIAPP were not statistically significantly different.

**Table 1 Independent t-test analysis of scores obtained by the experimental and control groups**

| | | Pretest | | Posttest | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Variable** | **N** | M | SD | M | SD | Mean Gain | *Df* | T | Sig.(2-tailed) |
| Experimental | 60 | 15.07 | 4.08 | 23.17 | 4.52 | 8.10 | 107 | 5.75 | 0.00 |
| Control | 49 | 12.98 | 4.61 | 17.06 | 4.86 | 4.08 | | | |

**Table 2 Independent t-test analysis the experimental group scores by gender and cognitive style**

| Experimental group category | N | Pretest M | Pretest SD | Posttest M | Posttest SD | Mean Gain | *Df* | t | Sig.(2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| Male | 17 | 16.41 | 5.68 | 24.18 | 6.12 | 7.77 | 58 | -1.08 | .28 |
| Female | 43 | 14.53 | 3.18 | 22.77 | 3.72 | 8.24 | | | |
| Field Dependent | 24 | 16.58 | 4.89 | 24.71 | 5.30 | 8.13 | 58 | .10 | .92 |
| Field Independent | 36 | 14.06 | 3.12 | 22.14 | 3.63 | 8.08 | | | |

Similarly, the analysis in Table 2 shows the results (i.e., t-value ($t_{(58)}$) = .10, at $p > 0.05$), which indicate the results were not statistically significantly different, and hence accept the null hypothesis that the mean achievement scores of the field-dependent and field-independent cognitive style learners taught photosynthesis using the VIAPP were not different. Though the results revealed gains in mean scores from the pre-test and the posttests suggesting all the categories benefitted from the VAIPP experiment, there was no statistically significant differences in achievement of participants in the experimental group based on gender and cognitive style.

*What is the interaction effect of students' gender on their cognitive style in their achievement in photosynthesis? (Research Question 4)*

Table 3 shows the results of the interaction effect among the treatment categories of gender and cognitive style. The results suggest no interaction since there was unstable differences in the adjusted means and the unadjusted means of all the groups. The male field-dependent, the unadjusted mean value is 20.40 and unadjusted 23.06 showed a difference of -2.66. While for the female field-dependent, the unadjusted mean value is 24.79 and unadjusted 22.42 showed a different of -2.37. Therefore, the mean differences were increasing - decreasing and vice-versa.

**Table3 Results of the interaction effect among the treatment, students' gender, and cognitive style**

| | Intervention Groups | | | |
|---|---|---|---|---|
| | Male | | Female | |
| **Cognitive Style** | Field Dependent | Field Independent | Field Dependent | Field Independent |
| Mean | 20.40 | 21.08 | 24.79 | 23.50 |
| Std. Dev. | (5.86) | (4.14) | (4.95) | (3.56) |
| Adjusted Means ($M_{adj}$) | 23.06 | 23.22 | 22.42 | 23.75 |
| Standard Errors (SE) | (.66) | (.43) | (.35) | (.29) |

Table 4 revealed that there was no statistically significant interaction effect among the treatment, cognitive style and students' gender on their achievement. The table reveals that ($F_{(1.55)} = 1.65$, $p>0.05$). This could be because the video-assisted instructional package is multimedia in nature, the structure of the package permits learners to advance, review and promote collaborative learning. Also, screens are

**Table 4 Two-Way ANCOVA Computation Based on Interaction Effect among the Treatment, Students' Gender, and Cognitive Style**

| Source | Type III Sum of Squares | *Df* | Mean Square | *F* | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 1086.288[a] | 4 | 271.572 | 128.712 | .000 | .90 |
| Intercept | 169.198 | 1 | 169.198 | 80.192 | .000 | .59 |
| Pretest | 943.229 | 1 | 943.229 | 447.046 | .000 | .89 |
| Cognitive Style | 5.810 | 1 | 5.810 | 2.753 | .103 | .04 |
| Gender | .024 | 1 | .024 | .011 | .916 | .00 |
| Cognitive Style* Gender | 3.496 | 1 | 3.496 | 1.657 | .203 | .02 |
| Error | 116.045 | 55 | 2.110 | | | |
| Total | 33404.000 | 60 | | | | |
| Corrected Total | 1202.333 | 59 | | | | |

a. R Squared = .903 (Adjusted R Squared = .896)

This indicate that there was no significant interaction effect among the treatment, cognitive style and students' gender on their achievement. Hence, the hypothesis was not rejected.

## Discussion

The study focused on the effects of video-assisted instructional packages on senior secondary school students' achievement in photosynthesis in Omu-Aran, Nigeria. According to the result obtained from the analysis, there was a significant difference in the achievement of the experimental group taught photosynthesis using video-assisted instructional package and their counterparts taught using conventional methods in favour of the former. This implies that the video-assisted instructional package significantly improved students' achievement in biology especially for teaching photosynthesis.

design in clear and understandable manner, the presentation of information in form of video can captivate the attention of students, when audio is clear and effectively assists in communicating the subject matter, it is self-explanatory to achieve the stated objectives. Hence, provides the opportunity for students to learn and acquire skills visually and promotes the processes of encoding, storage and recovery of information from last lesson memory. This study is in conformity with the findings of similar studies (Omer, 2013& Adedamola, 2018) which found that video- assisted instructions increased the students' achievement in science. However, the finding of the study contradicts (Fernan & Milagros, 2017; Gambari, Shittu, Daramola & James, 2016) who found that students' achievements were not significantly different when taught science with video-assisted instructions.

The finding of the study also revealed no gender difference in students' achievement when taught photosynthesis using video-assisted instructional package. Therefore, gender has no influence on the achievement of students taught photosynthesis using video-assisted instructional package. The finding implies that both male and female students benefitted equally from the use of video- assisted instructional package. This finding corroborates the findings of Adeoye and Abimbola (2016), Ikeh, Ugwuangi and Orji (2016), who established no considerable difference in the achievements of female and male students. However, the study is in contrary to the findings of Azibaolanari, John and Mumuni (2016), Otor (2013) who revealed gender difference in students' achievement in biology.

The study also found no significant difference in the achievement of students taught photosynthesis with video-assisted instructional package based on cognitive style. Cognitive style has no influence on students' achievement scores when taught photosynthesis with the use of video-assisted instructional package. Hence, the video-assisted instructional package was very effective in the teaching of biology topics regardless of the students' categories of cognitive style. This finding is contrary to the findings of Akhtar and Arif (2010) and (Idika,2017) who found that cognitive style influences students' achievement.

In addition, the finding from this study revealed no interaction effect among video-assisted instructional package, cognitive style and students' gender in the teaching of photosynthesis. This could be because the treatment was not controlled by the interaction effects of gender and score levels but rather improved students' achievement in photosynthesis without the moderating variables having any effect on the achievement. The finding agrees with Badmus, Bello, Hamzat and Gulaiman (2019) and Alabi (2016) who found no significant interaction effect of WebQuest, gender and score levels on students' achievement in cell division and also no significant interaction effect among text structures, gender and score levels on students' achievement in genetic studies. The finding contradicts what of Ahmad and Munawar (2013) found that there was a significant interaction between a treatment and variables such as gender.

## Conclusion

The study concluded that the use of video-assisted instructional package was effective in improving the achievement of students in photosynthesis. But gender and cognitive style had no significant influence on the achievement of students taught photosynthesis with video- assisted instructional package.

## Recommendations

Based on the findings of this study, the following recommendations were made:

1. Biology teachers and students should be encouraged to use video-assisted instructional package for teaching photosynthesis and other related biology concepts as their learning tool to bring about effective learning of biology.
2. Video-assisted instructional package should be used in presenting instructions to students' irrespective of their gender because it is gender friendly. Therefore governments, school administrators and other

stakeholders should discourage the issues of gender bias or inequalities when it comes to biology learning.

3. Biology teachers should employ better teaching/learning strategies and consider the effective use of video-assisted instructional package to improve individual cognitive styles (field-independent and field-dependent).

4. The Ministry of Education (MOE) and other stakeholders involved in science education should organize regular workshops and in-service training sessions for biology teachers on the development and uses of video-assisted instructional package in the teaching of difficult biology topics.

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