



EFFECTS OF WEBQUEST ON SECONDARY SCHOOL BIOLOGY STUDENTS' ACHIEVEMENT IN CELL DIVISION IN ILORIN

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ABSTRACT

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This study investigated the effects of the WebQuest Instructional Package (WQIP) on senior secondary school biology students' achievement in cell division in Ilorin, Nigeria. A quasi-experimental design was adopted for the study. Two classes from two secondary schools were purposively sampled. The instruments used were the Cell Division Achievement Test (CAT) and the WebQuest Instructional Package on Cell Division (WQIPC). Four research questions guided the study and four corresponding research hypotheses were tested at the 0.05 significance level. The study observed that using the WQIP significantly improved students' achievement in cell division. However, no significant difference was found between the achievements of male and female students taught cell division using WQIP. There was also a significant difference in the achievement of high, medium and low scoring students taught cell division using WQIP in favour of the low scorers. There was no significant interaction effect among WebQuest, gender and score levels on students' achievement in cell division. It was recommended, among others, that biology teachers should try to use the WebQuest Instructional Package (WQIP) in the teaching of cell division and other similar hard to teach concepts in biology.

Contribution/Originality: This study contributes to the existing literature and discourse on the integration of modern ICTs in the teaching and learning of biology at the secondary school level. The study's primary contribution is the finding that the WebQuest Instructional Package significantly enhanced students' achievement in cell division, a hard-to-teach and hard-to-learn biology topic.

1. INTRODUCTION

Biology is an essential science subject taught in Nigerian secondary schools, which aims at equipping students with the appropriate scientific skills, attitudes, competences and ability to apply scientific knowledge to every challenges of life. It is a life process or characteristic phenomenon of a group of living organisms (Hellweg, 2000). The knowledge of biology is brought to play in the production of improved drugs and vaccines against deadly infectious human and animal diseases, conservation of the environment and crop production among others. Despite the importance of biology to humanity, research findings and reports from external examinations revealed that senior school students' performance in biology still remains unimpressive (Ahmed, 2008; Egbunonu and Ugbaja, 2011; Abimbola, 2013; Ali *et al.*, 2014; Cetin *et al.*, 2015).

To this end, factors such as the teachers' usage of inappropriate teaching methods (Ahmed and Abimbola, 2011; Auwalu *et al.*, 2014; Jimoh, 2015) and the abstract nature of biological concepts such as cell division (Sungur *et al.*, 2001; Cimer, 2011; Ansuman, 2012) which are often hindrances to learning Biology, have prompted science educators and researchers to find alternative ways to make biology teaching and learning more efficient in senior secondary schools. One such alternative strategies of teaching, which especially does not require the physical presence of the teacher, is the use of WebQuest, a student-centered, web-based learning tool that may be used to enhance the teaching and learning of biology.

WebQuest is an inquiry-oriented activity in which the resources that learners interact with are sourced mainly from the Internet (Dodge, 1995). March (2003) defines WebQuest as a scaffold learning structure that uses links to access resources on the World Wide Web and an authentic task to motivate students' investigation of a central, open-ended question, development of individual expertise and participation in a final group process that attempts to transform newly acquired information into a more sophisticated understanding.

Dodge (1997) identified two types of WebQuest; which are short-term and longer-term. The aim of short-term WebQuest is for knowledge acquisition and integration. It is designed to be completed in one to three class periods or be given as homework along with other assignments. Longer-term WebQuest is an extended program that refines knowledge which usually lasts for a period of one week to one month in a classroom setting. It requires the learner analyzing a body of knowledge, deeply deducing and then sharing their interpretations with their peers (Dodge, 1997).

WebQuest was designed to integrate meaningful resources in the internet to support students' critical thinking skills in the analysis, synthesis, and evaluation of information as the students worked individually or cooperatively to provide solutions to a problem (Dodge, 2001). A WebQuest strategy being learner-centered is a constructivist approach to learning. It can be used for different subject areas across different age levels, from young children to adult learners (Ezell *et al.*, 2003). WebQuest enhances teaching and learning in the classroom, as it guides students' activities and facilitates the introduction of the Internet (Mentxaka, 2004). This implies that WebQuest improves classroom learning, presenting even the most difficult concepts in small steps that students can achieve at their own pace. The whole course of learning is students-centered. The teacher only serves as the facilitator guiding the students through learning activities to construct new knowledge (Dodge, 2001).

The WebQuest model contains six essential sections: the introduction, tasks, process, resources, evaluation and conclusion. This model functions as a framework for teachers in developing student-centered learning while using the internet (Mac Gregor and Lou, 2005). March (2005) also stated that WebQuest enhances students' motivational power, reasoning abilities and offers cooperative learning opportunities. Basically, the ideology of creating WebQuest is for students to be in charge of the learning procedure and to create ways for students to guide themselves through the discovery of new knowledge. This statement underlines the importance of actively involving students in science lessons. Thus, WebQuest is an ideal strategy with activities to make students active participants during the instruction.

Studies have been carried out on the use of WebQuest to bring about improvements in the teaching and learning of science (Muhammed, 2011; Mustafa *et al.*, 2011; Olarewaju, 2015; Safiah *et al.*, 2015). Osman (2014) evaluated the suitability of WebQuest in biology teachers' training. 48 senior high school biology teachers from four randomly selected, senior high schools in Palangkaraya, central Kalimantan Tengah, Malaysia, constituted the sample for the study. The survey study also examined the differences in teachers' perceptions of WebQuest on the topic of therapeutic stem cell cloning based on their teaching experience. Data was gathered using a 44-item Likert scale questionnaire adapted from Dodge (2001) and Hong (2006)'s previous studies. The results of the analysed data analyzed using Mean, Standard Deviation and Analysis of Variance (ANOVA) showed that teachers had good perceptions of WebQuest for teaching and learning. However, there was no significant difference on teachers' perceptions of WebQuest based on their teaching experience.

Muhammed (2011) examined the effects of WebQuest based instruction on ninth grade students' achievement and attitude towards force and motion subject in physics. The results of a Multivariate Analysis of Covariance (MANCOVA) of the data showed a significant mean difference of the achievement in favor of the experimental groups. However, no significant difference was found for attitudes towards force and motion between the groups. Mustafa *et al.* (2011) examined the effects of WebQuest in science education on success, self-efficacy and the web-based education attitudes of primary school students in Turkey. Three instruments were used for data gathering. The findings revealed that the WebQuest technique in web-based teaching methods had important effects on academic success, self-efficacy of students and their attitudes for web-based teaching methods.

Olarewaju (2015) investigated effects of the WebQuest instructional strategy on senior school students' performance in chemistry in Ilorin, Nigeria. In the two schools selected, 104, senior secondary two (SSII) students offering chemistry were sampled. Data was collected using Chemistry Performance Test (CPT) and was analyzed using *t*-tests and Analysis of Covariance (ANCOVA). The results showed that the WebQuest instructional strategy had a significant impact on the performance of students.

In addition, Safiah *et al.* (2015) examined the effectiveness of learning chemistry based on a WebQuest model. The results showed that WebQuest enhanced the students' achievement. However, no significant difference was found when learning through traditional methods and WebQuest on students' achievement.

From the previously mentioned research, it can be concluded that there is a paucity of research on the effects of using the WebQuest Instructional Package (WQIP) for the teaching and learning of biology. Hence, there is a need for further studies on the effects of the WebQuest Instructional Package on senior secondary school biology students' achievement on the topic of cell division.

Gender is one relevant factor in students' achievement in science and specifically in biology. It is worthy of note that opinions and findings about the influence of gender have been diverse. Adedamola (2015); Aniaku (2012); Daniel and Githui (2011) contend that gender had no significant influence on students' achievement in science. While on the contrary, Azibaolanari *et al.* (2016); Nwagbo and Okoro (2011); Odagboyi (2015); Olarewaju (2015); Safiah *et al.* (2015) reported a significant difference in achievement between male and female students in science.

Similarly, students varied in the rate at which they understood science concepts and in their score levels which tends to be impacted by the degree to which they are affected by particular teaching and learning strategies. In their own submission, Alabi (2016) affirmed that there was no significant difference in the achievement of low, medium and high scorer students when taught using text structures and analogies respectively. However, Olarewaju (2015) had a contrary result when WebQuest was used.

It therefore seems that WebQuest revealed the keys towards improving learning outcome. It is, therefore, against this background, that this study focused on the use of WebQuest and students' achievement in biology.

2. METHOD

This study was a quasi-experimental research design. The study applied a pre-test, post-test, non-randomized, control group design. Thus, it employed a 2x2x3 factorial research design, where first 2 indicates two levels of instructional strategies (with WebQuest instruction and without WebQuest instruction), the second 2 describes the two levels of students' gender (male and female), while the 3 illustrates the three levels of students' scores levels (high, medium and low).

The schematic representation of the design for the research is as shown in the figure below:

Group	Pre-test	Treatment	Post-test
Experimental	O ₁	X	O ₂
Control	O ₁		O ₂

Where: Experimental = means the group using the WebQuest Instructional Package;

Control = means the group not using the WebQuest Instructional Package;

O₁ = means the pre-test for the experimental and control groups;

X = means the treatment for the experimental group; and,
O₂ = means the post-test for experimental and control groups.

The target population for the study was all senior secondary school students' studying biology in Ilorin, Nigeria. The sample for the study involved classes of 53 senior secondary school one (SSI) students (20 males and 33 females) drawn from two purposively selected co-educational senior secondary schools in Ilorin, Nigeria.

Two research instruments developed by the researchers for this study were the "WebQuest Instructional Package on Cell Division (WQIPC)" and the "Cell Division Achievement Test (CAT)". The WQIPC which served as the treatment for the experimental group, is an interactive web-based package designed by the researchers (assisted by a web programmer). It covered lessons on cell division as contained in the Nigeria senior school biology curriculum.

In designing the package, Dreamweaver version 8.0 was used as the program editor. Hypertext Manual Language (HTML) (programming language) was used as the program code. Corel Draw 9.0 was also used in the graphic editing, while animations and other multimedia were designed using Banner Maker Pro.

The WQIPC which was designed to work both online and offline followed a WebQuest model put forward by Dodge (1995). The instrument used for data gathering was the "Cell Division Achievement Test (CAT)". It covered questions on cell division as contained in the SSI Biology curriculum. The CAT which was administered as the pre-test and post-test in the study, encompasses two sections: Section A and B. Section A contains the bio-data of the students, while Section B consisted of 40 multiple-choice objective test questions on cell division with four options (A-D) in which one was the correct option.

The WQIPC and CAT were subjected to both face and content validation by senior school Biology teachers in Ilorin, Biology lecturers from the Department of Science Education, Life Science, and educational technology lecturers from the Department of Educational Technology, University of Ilorin, Ilorin, Nigeria, respectively. The reliability of CAT instrument was established through trial testing on a group of SSI students not involved in the study. The data collected were analysed using Pearson Product-Moment Correlation (PPMC) and a reliability coefficient of 0.87 was obtained.

Before the treatment, the researchers paid a visit to the sampled schools with a written document to solicit the permission and assistance of the appropriate authorities'. The support of the biology teachers as research assistants was sought and they were later trained with the WQIPC instrument. The researchers also sought the consent of the students' parents through an informed consent form indicating the students' willingness and voluntary participation in the study. It was made known to the students in the consent form that their identity, contributions and any data obtained would be treated confidentially and used wholly for the purpose of this study only. The health risks and benefits of the research were also stated in the consent form. Only trained research assistants were involved in the study. They were required to help, mostly in the aspects of the administration of treatment and supervision of the pre-test and post-test. The school's lesson periods and other protocols were carefully taken into consideration to avoid disruption to school activities. Thus, the treatment took place during the period officially scheduled on the school scheme of work for biology lessons.

The research subjects were given a pre-test before the main treatment, where they were exposed to cell division using two methods (the WQIPC and conventional method). The experimental group learned using the WQIPC (which worked in an off-line mode), while the control group was taught by the biology teacher of the sampled school using the (without using WQIPC) conventional method. Instructions on how to navigate the WQIPC and to solve the tasks were specified for the students to follow while using the package. Thus, with the exception of technical difficulties, the experimental group interacted with the package without additional explanation from the researchers or the research assistant. After the treatment, a post-test of CAT was administered to the subjects in both the experimental and control groups. These procedures lasted for two weeks.

The research questions raised and answered in this study had four corresponding research hypotheses that were tested using *t*-test statistics and Analysis of Covariance (ANCOVA) at the 0.05 Alpha level of significance with the Statistical Package for Social Science version 20.0 program.

3. FINDINGS

Research Hypothesis 1

There is no significant difference in the achievement of biology students' taught cell division using the WebQuest Instructional Package and those taught without using the WebQuest Instructional Package.

This hypothesis was generated from research question one and was tested using the *t*-test. The result of the analysis indicated that the *t*-value ($t_{(51)} = 11.91, p < 0.05$) was significant at the 0.05 alpha level as shown on Table 1. The result suggested that there was a significant difference between the achievements of the experimental and control groups in favour of the experimental group and it provided the answer to research question one. Hence, hypothesis 1 was rejected. This implies that the use of WebQuest improved students' achievement in cell division.

Table-1. The *t*-test Analysis of Significant Difference between the Achievement of the Experimental and Control Groups.

Groups	N	M	SD	Df	<i>t</i>	Sig.(2-tailed)
Experimental	24	21.00	2.70			
				51	11.91	.00
Control	29	11.48	3.11			

$P < 0.05$.

Research Hypothesis 2

There is no significant difference in the achievement of male and female students' taught cell division using the WebQuest Instructional Package.

This hypothesis was generated from research question two and was tested using the *t*-test. The result of the analysis indicated that the *t*-value ($t_{(22)} = 2.03, p > 0.05$) was not significant at the 0.05 alpha level as shown on Table 2. The result suggested that there was no significant difference between the achievement of male and female students' taught cell division using the WebQuest Instructional Package and it provided the answer to research question two. Therefore, hypothesis 2 was not rejected. This implies that students' achievement irrespective of their gender type improved significantly when taught using WebQuest.

Table-2. The *t*-test Analysis of Significant Difference between the Achievements of Male and Female Students in the Experimental Group.

Gender	N	M	SD	Df	<i>T</i>	Sig.(2tailed)
Male	9	22.44	2.96			
				22	2.03	.06
Female	15	20.13	2.20			

$P > 0.05$.

Research Hypothesis 3

There is no significant difference in the achievement of students' with different score levels when taught cell division using the WebQuest Instructional Package.

This hypothesis was generated from research question three and was tested using ANCOVA. The result of the analysis indicated that the *F*-value ($F_{(2,20)} = 3.72, p < 0.05$) was significant at the 0.05 alpha level as shown on Table 3. The result suggested that there was a significant difference in the achievement of high, medium and low scoring students taught cell division using WebQuest in favour of the low scorers and it provided the answer to research question three. Hence, hypothesis 3 was rejected. This implies that the use of WebQuest helped the low scoring students improve greatly in cell division.

Table-3. Summary of Analysis of Covariance of Significant Difference among the Achievement of High, Medium and Low Scorers in the Experimental Group.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	879.014 ^a	3	293.005	6.908	.00
Intercept	698.234	1	698.234	16.462	.00
Pretest	53.348	1	53.348	1.258	.27
Groups	315.165	2	157.582	3.715	.04
Error	848.319	20	42.416		
Total	110000.000	24			
Corrected Total	1727.333	23			

a. R Squared = .509 (Adjusted R Squared = .435).

Research Hypothesis 4

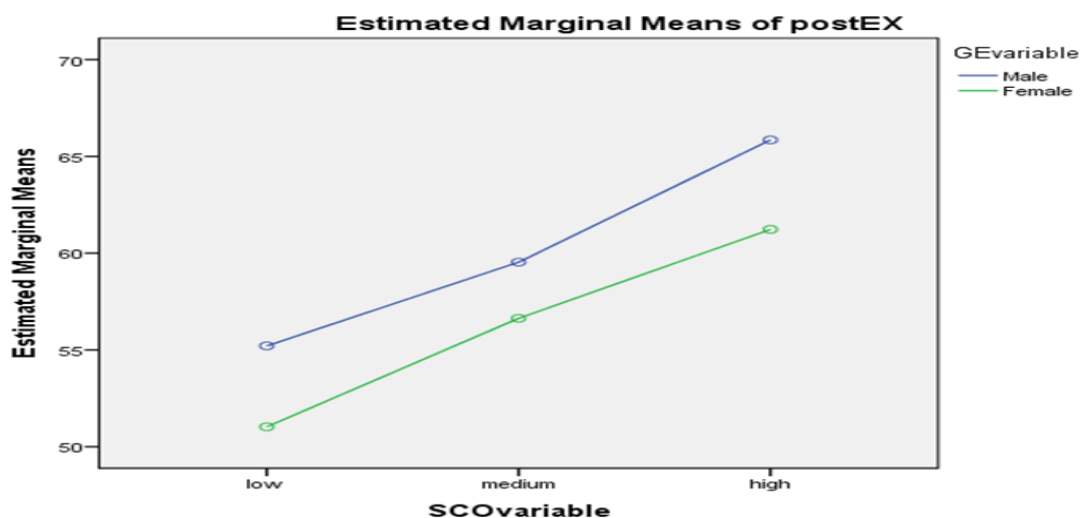
There is no significant interaction effect among using WebQuest, gender and score levels on students' achievement in cell division.

This hypothesis was generated from research question four and was tested using Two-way ANCOVA. The result of the analysis indicated that the *F*-value ($F_{(2,17)} = 0.37, p > 0.05$) was not significant at the 0.05 level of significance as shown on Table 4. The result suggested that there was no significant interaction effect among the treatment, gender and score levels on students' achievement in cell division and it provided the answer to research question four. Hence, hypothesis 4 was not rejected. This implies that there was no influence of students' gender and score levels (moderating variables) on results from using WebQuest (the treatment). Therefore, the WebQuest Instructional Package which served as main treatment had strong effect on students' achievement.

Table-4. Two-way ANCOVA of Interaction Effect of Treatment, Gender and Score Levels on Students' Achievement in Cell Division.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1730.364 ^a	6	288.394	86.058	.000
Intercept	277.521	1	277.521	82.814	.000
Treatment	219.030	1	219.030	65.360	.000
Gender	48.155	1	48.155	14.370	.001
Scoring Levels	68.350	2	34.175	10.198	.001
Treatment* Gender * Scoring levels	2.477	2	1.239	.370	.696
Error	56.970	17	3.351		
Total	82988.000	24			
Corrected Total	1787.333	23			

a. R Squared = .968 (Adjusted R Squared = .957).



Covariates appearing in the model are evaluated at the following values: preEX = 37.17

Figure-1. Graph showing interaction effect of students' gender and score levels.

Source: Experimental Data.

Figure 1 depicts the interaction effect among the low, medium and high scorers students based on gender. The graph shows that the lines are parallel which indicates that the gender variable does not necessarily depends on the scoring level in order to determine the students' achievement. Hence, there was no interaction effect. This implies that the use of WebQuest is not a variable interaction determinant.

4. CONCLUSION, DISCUSSION AND SUGGESTIONS

The study concludes that using WebQuest enhanced students' achievement in cell division. However, students' achievement improved irrespective of their gender as there was no obvious gender bias effect in using WebQuest. It was also concluded that a significant difference was found in the achievement of students' with different score levels in favour of the low scorers. The findings did not find any interaction effects among the treatment (WebQuest), gender and on score levels when taught cell division. The WebQuest Instructional Package can, thus, be used to improve students' achievement and understanding in biology especially among the low scorers and irrespective of gender.

Findings from this study revealed that a significant difference existed between the achievement of experimental and control groups in favour of the experimental group. This difference may be ascribed to some of the attributes of the WebQuest learning platform as the features such as animations, pictures and practice questions that most probably helped the students to learn the content easily and meaningfully. Exposure to different off-line internet resources on cell division in the WebQuest module, have equally enriched the students' knowledge and consequently improved their achievement. In addition, the experimental group also had the opportunity to interact with the content of the WebQuest as many times as they wanted or needed to.

This result therefore, agreed with that of Muhammed (2011); Mustafa *et al.* (2011) and Olarewaju (2015) who revealed that students taught using WebQuest performed better than their counterparts taught with conventional methods. However, the result is contrary to the finding of Safiah *et al.* (2015) who reported that no significant difference was found when learning through traditional methods and WebQuest on students' achievement. The reason for this contrary result may be due to the fact that Safiah *et al.* (2015) purposively selected exceptional brilliant (science stream form 4 students who scored 8A and 9A in the PMR examination) students, while this present study involved mixed ability students.

In this study, it was found that no significant difference existed between the achievements of male and female students in the experimental group. This could be ascribed to the fact that both male and female students had access to the same package and the content of the package did not contain gender biased statements, activities or questions. Hence, both genders were on the same level. Similarly, cell division is not a gender sensitive topic unlike controversial and gender sensitive biology topics such as family planning. Cell division as taught in this study is a gender neutral topic. The pictures and illustrations in the WebQuest Instructional Package did not represent either the male nor female gender for this topic.

This finding is consistent with Safiah *et al.* (2015) who found out that there was no significant difference in the achievement of male and female students taught matter using WebQuest learning. Conversely, the result negates the findings of Olarewaju (2015) who revealed a significant difference in the performance of male and female students exposed to WebQuest instructional strategies with female students performing better than male students. Perhaps the female students performed better than the male as a result of imbalance (in favour of the female) in the gender representations of the pictures, illustrations, masculine and feminine words used in the WebQuest Instructional Package on IUPAC nomenclature. It is also possible that in the conventional teaching method class, male students get more help and attention than their female counterparts from their science teachers thereby forcing female students to learn by themselves. When WebQuest is used, each student has to learn by themselves

without assistance from the teacher hence, the higher performance of the female students may be due to their experience in learning by themselves.

Another finding from this study revealed that a significant difference existed in the achievement of high, medium and low scorers' students' in the experimental group in favour of the low scorers. The use of WebQuest may have allowed many of the low scorers to learn in a way that suited them better that was different from the usual conventional teaching methods that to the high and medium scorers were able to learn better from. The implication is that WebQuest can be used to enhance the academic achievement of academically weak students (low scorers). The result agrees with Olarewaju (2015) who found that the effect of WebQuest on performance of students' with different score levels in the post-test were significant, where the low scorers benefited most.

In addition, findings from this study revealed no interaction effect among WebQuest, gender and score levels on students' achievement in cell division. This could be ascribed to the fact that the package for treatment (WebQuest) was not controlled by the interaction effects of gender and score levels but rather enhanced students' achievement in cell division regardless of the moderating variables. Therefore, the WebQuest instructional package is an ideal package that enhances students' achievement in cell division. The findings corroborate with Alabi (2016) and Olarewaju (2019) who found no significant interaction effect among text structures, gender and score levels on students' achievement in genetic studies and no significant interaction effect of WebQuest, gender and score levels on students' performance in thermochemistry respectively.

This study should be replicated using other difficult topics in Biology, in different locations and time, and in other academic levels such as Colleges of Education and Universities. Other researchers can investigate the influence of other variables such as retention, attitude and student perceptions of using WebQuest in future studies.

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