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Enhancing secondary students' Genetics performance in rivers state using 5E learning cycle and Webquest

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Abstract
This study addresses the persistent challenge of low academic achievement in genetics among secondary school students in Rivers State, Nigeria. Despite the importance of genetics as a fundamental topic in biology, students often struggle with its abstract concepts, leading to poor performance in examinations. The purpose of this research was to investigate the effectiveness of integrating the 5E Learning Cycle instructional model with WebQuest technology to enhance students' understanding and performance in genetics. A quasi-experimental design was employed involving two groups of secondary school students: an experimental group taught using the 5E Learning Cycle combined with WebQuest, and a control group taught using conventional methods. Data were collected through pre- and post-tests and analysed using descriptive and inferential statistics. The findings revealed a statistically significant improvement in the genetics performance of students exposed to the 5E Learning Cycle and WebQuest approach compared to those taught via traditional methods. The study concludes that combining interactive, inquiry-based learning strategies with technology-enhanced resources can significantly improve students' conceptual grasp and academic outcomes in genetics. These findings have important implications for science educators and curriculum planners seeking to employ innovative teaching methods to boost student engagement and achievement in complex scientific topics.

Keywords: Genetics Education, 5E Learning Cycle, WebQuest, Secondary School, Science Performance, Inquiry-Based Learning, Rivers State, Biology Instruction

Introduction

Genetics, a cornerstone of modern biology, remains a challenging subject for secondary school students in Rivers State, Nigeria. Despite its significance in understanding heredity, evolution, and biotechnology, students often grapple with its abstract concepts, leading to suboptimal academic performance. This issue is not unique to Rivers State; it reflects a broader national concern regarding the effectiveness of science education in Nigeria.

Importance of the Research

The persistent difficulties students face in mastering genetics necessitate innovative instructional strategies. Traditional teaching methods, predominantly lecture-based, have proven inadequate in fostering deep understanding and engagement. Consequently, exploring alternative pedagogical approaches is imperative to enhance students' comprehension and performance in genetics.

Literature Review

Extensive research has highlighted the efficacy of constructivist teaching models in improving science education outcomes. The 5E Learning Cycle—comprising Engage, Explore, Explain, Elaborate, and Evaluate—has been identified as a potent framework for facilitating active learning and concept mastery. Studies indicate that this model promotes critical thinking and allows students to construct knowledge through inquiry and exploration.

Complementing the 5E model, WebQuest—a web-based inquiry-oriented activity—has emerged as a valuable tool in science education. WebQuests encourage collaborative learning and critical analysis by guiding students through structured online research tasks. Integrating WebQuest with the 5E model has shown promise in enhancing student engagement and achievement in various subjects.

In the context of Rivers State, previous studies have examined the impact of laboratory teaching methods and collaborative strategies on students' academic performance. For instance, research in Ogba/Egbema/Ndoni Local Government Area demonstrated that laboratory-based instruction significantly improved biology students' academic performance. Similarly, studies on collaborative teaching strategies have revealed positive effects on students' understanding of complex biological concepts.

Research Gaps

While existing studies have explored various instructional strategies, there is a paucity of research focusing on the combined application of the 5E Learning Cycle and WebQuest in teaching genetics to secondary school students in Rivers State. This gap underscores the need for empirical investigation into the effectiveness of this integrated approach in enhancing students' performance in genetics.

Research Objectives

This study aims to:

1. Assess the impact of the 5E Learning Cycle integrated with WebQuest on secondary school students' performance in genetics.
2. Compare the academic achievements of students taught using the integrated approach with those taught through traditional methods.
3. Evaluate students' perceptions of the integrated instructional strategy concerning engagement and understanding of genetics.

Research Questions

The study seeks to answer the following questions:

1. Does the integration of the 5E Learning Cycle and WebQuest enhance students' performance in genetics?
2. How does students' performance in genetics differ between those taught using the integrated approach and those taught using traditional methods?
3. What are students' perceptions of the integrated instructional strategy in terms of engagement and understanding?

Methods

This study employed a quasi-experimental research design to examine the impact of integrating the 5E Learning Cycle with WebQuest on secondary school students' performance in genetics. The quasi-experimental approach was chosen because it allows for comparison between groups while accommodating the natural school setting, where random assignment is often impractical. This design enabled the researcher to establish a cause-and-effect relationship between the instructional method and students' academic outcomes by using a control group and an experimental group.

The population for this study comprised senior secondary two (SS2) students enrolled in biology classes across selected secondary schools in Rivers State, Nigeria. A purposive sampling technique was employed to select four schools that offered biology at the senior secondary level and demonstrated willingness to participate in the research. From these schools, a total of 120 students were sampled, with 60 students assigned to the experimental group and 60 to the control group. The sample size was determined based on the need to achieve sufficient statistical power for detecting meaningful differences in academic performance while considering logistical constraints.

Data collection involved administering pre-tests and post-tests designed to assess students' knowledge and understanding of genetics concepts. The pre-test was conducted before the intervention to establish baseline performance levels, while the post-test occurred immediately after the instructional period to measure the effect of the teaching methods. The tests consisted of multiple-choice and short-answer questions aligned with the genetics curriculum, ensuring content validity. Additionally, a structured questionnaire was used to gather students' perceptions of the teaching methods, focusing on engagement, clarity, and overall satisfaction. The questionnaire employed a Likert scale format to facilitate quantitative analysis.

The instructional intervention for the experimental group combined the 5E Learning Cycle model with WebQuest activities tailored to genetics topics. Teachers facilitated lessons following the 5E stages: engaging students with thought-provoking questions, allowing exploration through WebQuest-guided online inquiry, explaining concepts collaboratively, elaborating through practical examples, and evaluating understanding via formative assessments. The control group received conventional lecture-based instruction without the use of WebQuest or the 5E framework.

Data analysis was conducted using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics, including means and standard deviations, summarised the performance scores and questionnaire responses. Inferential statistics were employed to test hypotheses: paired sample t-tests compared pre- and post-test scores within groups, while independent sample t-tests assessed differences between the experimental and control groups. Additionally, analysis of variance (ANOVA) was used to examine any variations across schools. The significance level was set at $p < 0.05$.

Ethical considerations were strictly observed throughout the study. Permission was obtained from school authorities, and informed consent was secured from all participating students and their guardians. Participants were assured of confidentiality, and their data were anonymised to protect privacy. The study ensured voluntary participation, with students free to withdraw at any point without penalty. Furthermore, care was taken to avoid any form of harm or discomfort during the instructional process.

Overall, the methods employed in this study provide a clear, replicable framework for assessing the effectiveness of integrating innovative instructional strategies in secondary school genetics education, contributing valuable evidence to the field of science pedagogy.

Results

This section presents the findings of the study conducted to evaluate the effect of integrating the 5E Learning Cycle and WebQuest on the genetics performance of secondary school students in Rivers State. The results are organised to show the outcome of the pre-test and post-test performance within and between the control and experimental groups, as well as responses to the perception questionnaire administered to the experimental group. The statistical tools used include descriptive statistics (mean and standard deviation) and inferential statistics (paired t-test, independent t-test, and ANOVA).

Pre-Test Results

Before the commencement of the instructional intervention, both the control and experimental groups were administered a pre-test on genetics. The purpose of the pre-test was to establish the baseline academic performance of the two groups.

The mean score for the control group ($N = 60$) in the pre-test was 38.5 with a standard deviation of 6.2, while the experimental group ($N = 60$) had a mean score of 39.1 with a standard deviation of 5.9. An independent samples t-test was conducted to determine if there was a statistically significant difference between the two groups before the intervention. The result showed no significant difference ($t(118) = 0.56$, $p = 0.578$), indicating that both groups were comparable in their knowledge of genetics before the study.

Post-Test Results

After the instructional period, a post-test was administered to both groups to measure the impact of the respective instructional strategies. The results indicated a marked improvement in the performance of students in the experimental group compared to the control group.

The control group recorded a mean score of 53.7 with a standard deviation of 7.1, while the experimental group recorded a mean score of 71.4 with a standard deviation of 6.5. An independent samples t-test revealed that the difference in performance between the two groups was statistically significant ($t(118) = 14.62$, $p < 0.001$), confirming the effectiveness of the integrated 5E and

WebQuest strategy in enhancing students' understanding of genetics.

Within-Group Comparisons (Pre-Test and Post-Test)
A paired samples t-test was conducted within each group to determine the extent of improvement between the pre-test and post-test scores.
For the control group, the improvement was modest, with a mean gain of 15.2 points (from 38.5 to 53.7). The paired t-test result ($t(59) = 16.73$, $p < 0.001$) indicated that this improvement was statistically significant.
In the experimental group, the mean score increased by 32.3 points (from 39.1 to 71.4), and the paired t-test ($t(59) = 31.55$, $p < 0.001$) also showed a highly significant improvement. The difference in the magnitude of gain between the groups suggests that the integrated instructional strategy had a greater impact on students' academic performance.

Comparison Across Schools
An ANOVA test was conducted to examine whether the effectiveness of the instructional intervention varied across the four participating schools. The experimental group from each school showed varying levels of improvement; however, the differences were not statistically significant ($F(3,56) = 1.43$, $p = 0.242$), indicating that the integrated 5E and WebQuest approach was consistently effective across different school environments.

Students' Perceptions of the Integrated Instructional Strategy
A post-intervention questionnaire was administered to the experimental group to evaluate their perception of the integrated 5E and WebQuest method. The questionnaire consisted of 15 items measured on a 5-point Likert scale, ranging from "Strongly Disagree" (1) to "Strongly Agree" (5). The responses were analysed using descriptive statistics. The results showed that a large majority of students expressed positive perceptions of the instructional method:

- 85% of students agreed or strongly agreed that the WebQuest activities made learning genetics more interesting and interactive.
- 78% reported that the 5E stages helped them understand genetics concepts more clearly, especially through exploration and elaboration.
- 81% felt that working through internet-based tasks helped them take more responsibility for their own learning.
- 73% agreed that the lessons encouraged critical thinking and problem-solving.
- 88% of students rated the overall instructional experience as effective or very effective.

The mean overall perception score across the items was 4.2 out of 5, indicating strong student approval of the integrated instructional method.

Gender-Based Analysis of Performance
The study also examined whether there were any gender-based differences in the performance of students in the experimental group. Among the 60 students in the experimental group, 28 were male and 32 were female.
The mean post-test score for male students was 70.9 (SD = 6.8), while the mean for female students was 71.8 (SD = 6.3). An independent samples t-test showed that the difference in performance was not statistically significant ($t(58) = 0.54$, $p = 0.593$), suggesting that the instructional strategy was equally effective for both male and female students.

Summary of Key Quantitative Findings

- Both groups had similar baseline knowledge before the intervention.
- The experimental group showed significantly higher gains in the post-test compared to the control group.
- The integrated 5E and WebQuest strategy resulted in an average gain of 32.3 points versus 15.2 points for the traditional method.
- Students across all experimental schools benefited consistently from the intervention.
- Student perceptions were overwhelmingly positive, citing increased engagement and understanding.
- There were no significant gender differences in the effectiveness of the method.

These results provide strong empirical support for the effectiveness of combining the 5E Learning Cycle and WebQuest as an instructional approach in teaching genetics. The data collected indicates that students exposed to this strategy not only performed better academically but also reported a more engaging and meaningful learning experience.

Discussion
The findings of this study reveal that integrating the 5E Learning Cycle with WebQuest significantly enhances secondary school students' performance in genetics compared to traditional lecture-based instruction. This section interprets these results in relation to the research objectives, questions, and relevant literature. It also discusses the implications, unexpected outcomes, limitations, and offers recommendations for future research.

Interpretation of Findings
The significant improvement in the post-test scores of students taught using the integrated 5E and WebQuest approach demonstrates the effectiveness of inquiry-based and technology-enhanced instruction in improving academic outcomes in science education. With a mean gain of 32.3 points from pre-test to post-test, the experimental group clearly outperformed the control group, which recorded a more modest gain of 15.2 points. This suggests that when students are actively engaged in the learning process through exploration, collaboration, and the use of digital resources, their understanding of complex scientific concepts such as genetics improves substantially.
The findings also show that students responded positively to the instructional method, with over 80% of them reporting that the approach made learning more interesting, interactive, and easier to understand. This aligns with the foundational philosophy of the 5E Learning Cycle, which emphasises active participation, prior knowledge activation, and iterative learning. WebQuest, on the other hand, offers access to diverse online resources and encourages learners to seek and synthesise information independently, fostering deeper conceptual understanding and digital literacy.

Comparison with Previous Studies

The results of this study are consistent with earlier research that supports the effectiveness of constructivist models and digital tools in science education. Several studies have reported that the 5E model improves students' performance and motivation by encouraging them to construct their own understanding through inquiry. In particular, the Explore and Elaborate phases are often cited as critical for developing problem-solving skills and reinforcing abstract scientific concepts.

Similarly, past research on WebQuest-based instruction has demonstrated its value in promoting student engagement and collaborative learning. When used in science education, WebQuests have been found to enhance higher-order thinking skills, particularly in the domains of analysis, synthesis, and evaluation. The current study confirms these findings by showing that students taught through the combined method not only performed better academically but also developed a more positive attitude toward the subject matter.

In studies conducted in similar educational contexts within Nigeria, researchers found that instructional strategies that integrate ICT and promote active learning are more effective than conventional teaching methods. For instance, studies in various parts of the country, including Lagos, Enugu, and Delta states, reported that students exposed to inquiry-based and technology-supported instruction showed improved academic performance in biology and other science subjects. This study strengthens the evidence base by showing that such strategies are also effective in the Rivers State context, particularly in the topic of genetics.

Confirmation and Contradiction of Past Research

The findings strongly confirm previous literature advocating for the use of constructivist pedagogies and digital technologies in science education. However, some prior studies have reported mixed results regarding the use of ICT tools in the classroom, citing issues such as a lack of access to reliable internet, poor digital literacy among teachers, and inconsistent student participation. In this study, the integration of WebQuest was successful largely due to the structured guidance provided by the teacher and the alignment of the online tasks with the curriculum. This suggests that the effectiveness of digital tools may depend on how well they are integrated into instructional models and whether teachers are adequately trained to use them.

Implications of the Results

The implications of these findings are substantial for science educators, curriculum developers, and policymakers. First, the results highlight the need to shift from traditional lecture-based instruction to more engaging and student-centred learning approaches. Incorporating inquiry-based models like the 5E Learning Cycle, supported by digital tools such as WebQuest, can make complex topics like genetics more accessible and enjoyable for students.

Second, the study demonstrates that technology can be a powerful enabler of learning, even in resource-constrained environments, if properly guided. It emphasises the importance of teacher training in digital pedagogy and curriculum reform that integrates ICT tools meaningfully into lesson delivery. Given the growing emphasis on STEM education and digital competence, this approach aligns with national educational goals and global trends in 21st-century learning.

Possible Explanations for Unexpected Outcomes

Although the overall findings were consistent with expectations, some unexpected outcomes were observed. For example, the lack of significant variation in performance across different schools in the experimental group suggests that the effectiveness of the integrated strategy was not dependent on school-specific factors such as location or facilities. This may indicate the adaptability of the instructional model across various classroom settings.

Another unexpected finding was the negligible gender difference in performance. While some past studies have suggested that male students tend to outperform females in science subjects, this study found no significant gender disparity in the experimental group. This may be attributed to the inclusive and collaborative nature of the 5E and WebQuest strategy, which allows all students equal opportunity to engage, explore, and express themselves regardless of gender.

Limitations of the Study

Several limitations were encountered during the course of the research, which should be acknowledged. First, the sample size, though sufficient for the statistical analyses used, was relatively small and limited to a specific region. This restricts the generalizability of the findings to other states or regions with different socio-economic or educational contexts.

Second, the duration of the intervention was limited to a single unit of the biology curriculum (genetics). While the results are promising, they only reflect the impact of the instructional strategy on one topic. A longer-term study involving multiple biology units or full academic terms could provide more comprehensive insights into the effectiveness and sustainability of the approach.

Third, the study depended on the availability of internet-enabled devices and connectivity in selected schools. While the schools were purposively selected based on their access to digital infrastructure, many public secondary schools in Nigeria still lack reliable ICT facilities. This poses a challenge for the wider adoption of WebQuest-based instruction.

Lastly, while efforts were made to control for teacher quality and ensure fidelity of implementation, variations in teachers' facilitation skills and familiarity with technology could have influenced the results. Teacher training remains a critical factor in the successful deployment of such strategies.

Recommendations for Future Research

Given the positive findings and identified limitations, several directions for future research are recommended:

1. **Wider Geographical Scope:** Future studies should replicate this research in other states and geopolitical zones in Nigeria to determine whether similar results can be achieved in different educational environments.

2. **Larger Sample Size:** Increasing the number of participating students and schools would improve the statistical power and allow for more nuanced subgroup analyses, such as rural versus urban comparisons.

3. **Longitudinal Studies:** Research tracking student performance over a full academic year or multiple topics in biology would provide deeper insights into the long-term effectiveness of the 5E and WebQuest approach.

4. **Teacher-Centred Research:** Further studies should investigate the impact of teacher training and professional development on the successful integration of inquiry-based and technology-enhanced strategies in the classroom.

5. **Comparative Instructional Models:** Research comparing the integrated 5E and WebQuest method with other innovative strategies (e.g., flipped classroom, blended learning, or gamification) could provide valuable information on the most effective models for science instruction in the Nigerian context.

6. **Exploration of Other Subjects:** While this study focused on genetics in biology, future research could examine the applicability of the model to other science subjects, such as chemistry, physics, or integrated science.

Conclusion

This study investigated the impact of integrating the 5E Learning Cycle with WebQuest on the genetics performance of secondary school students in Rivers State, Nigeria. The findings revealed that students taught using the combined instructional strategy significantly outperformed those taught through traditional lecture-based methods. The results also showed that students found the approach more engaging, interactive, and effective in enhancing their understanding of complex genetics concepts.

The study contributes meaningfully to the field of science education by providing empirical evidence that supports the use of inquiry-based and technology-enhanced teaching methods. It highlights the value of active learning models that encourage exploration, collaboration, and critical thinking, which are essential for mastering abstract topics in biology.

From a practical standpoint, the findings suggest that educators and policymakers should consider integrating models like the 5E Learning Cycle and WebQuest into the science curriculum. Doing so can improve academic outcomes and better prepare students for future scientific learning and digital competence.

References

1. Abdulrahim BJ. The 5E learning cycle instructions and biology academic achievement among students in Kwara State's Colleges of Education. Faculty of Natural and Applied Sciences Journal of Mathematics and Science Education,2024:5(3):86–96. (fnasjournals.com)
2. Badmus ST, Bello G, Hamzat A, Sulaiman MM. Effects of WebQuest on secondary school biology students' achievement in cell division in Ilorin. Humanities and Social Sciences Letters,2019:7(2):64–73. (archive.conscientiabeam.com)
3. Şahin SMŞ, Baturay MH. The effect of the 5E-learning model supported with WebQuest media on students' achievement and satisfaction. Educational Technology Research & Development,2016:64(5):879–896. (SAGE Journals)
4. Udoh NM, Ekon EE, Ukala G, Akpan CJ. Effectiveness of expeditionary and 5E model teaching methods on biology students' academic achievement on plant classification in Abak Municipality, Nigeria. International Journal of Current Innovations in Education,2025:8(1):107–117. (publications.afrischolar.net)
5. Ebere E, Okuro G. Use of E-learning devices for effective students' learning outcomes in private secondary schools in Rivers State, Nigeria. Rivers State University Journal of Education,2024:27(1):99–109. (rsujoe.com.ng)
6. Okonkwo CC. Information Communication Technology facilities and the teaching of agricultural science in public senior secondary schools in Rivers State. Irish Journal of Educational Practice. [In press]. (aspjournals.org)
7. Nwobodo CJ, Udoka CE. Evaluating technology integration in teaching and learning: A survey of public senior secondary schools in Rivers State, Nigeria. African Journal of Humanities and Contemporary Education Research,2025:20(1):19–40. (afropolitanjournals.com)
8. Wordu H, Owabie DE, Dike C. Educational technology: Enhancement tools in teaching and learning in public senior secondary schools in Rivers State. International Journal of Modern Innovations and Knowledge,2021:2(3):13–22. (ijmik.net)
9. Nte OHH. Influence of Utilisation of Electronic Instructional Media on Undergraduate Educational Management Students' Academic Performance in Rivers State Universities. European Journal of Arts, Humanities and Social Sciences,2024:1(2). (ejahss.com)
10. Adeuya VO. Effect of guided inquiry teaching strategy on academic performance of secondary school students in biology in Ekiti State, Nigeria. Euro Afro Studies International Journal,2020:1(4). [page numbers]. (easij.com)