BIOLOGY EDUCATION

Effects of Peer-led Learning and Interactive Animations on Senior Secondary School Students' Academic Achievement in Evolution in Oyo Metropolis, Nigeria

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Abstract

A foundational topic in senior secondary Biology with past records indicated low achievement in Evolution. This could be attributed to the instruction strategies being used to teach it; hence this study on the Effects of Peer-led Learning (PIL) and Interactive Animations (AI) on Senior Secondary School Students' Achievement in Evolution in Oyo Metropolis, Nigeria. Quasi experimental design was adopted for the study. The population and sample for the study were 19,084 and 238 students in SS 2 respectively, using three intact classes randomly sampled from three public schools and assigned to a treatment each: PIL; AI; and Conventional Teaching Strategy (CTS). Guided by one hypothesis, four instruments were employed for the study; three instructional guides for the three strategies with a 40-item validated and reliable Evolution Achievement Test (EAT) (KR-20 = 0.82) and analysed with Analysis of Covariance (ANCOVA). The result showed that, the treatments had effects on students' achievement in EAT; $F_{(2, 234)}$ = 83.22, $p < 0.005$, partial $\eta^2 = 0.42$. Bonferroni comparisons showed that PIL students outperformed IA students (adjusted mean difference = 3.76) and CTS (16.07), and that IA students outperformed CTS students (12.31; all $p \leq 0.005$). The study concluded that, the two strategies were effective on students' achievement in EAT. It was recommended that, both Peer-led Learning (PIL) and Interactive Animations (AI) strategies should be adopted in teaching Evolution at the Senior Secondary school for improved outcomes.

Keywords: academic achievement; Biology education; evolution; interactive animation; peer-led learning

1 Introduction

Evolution is the unifying framework of Biology, explaining the diversity, adaptation, and relatedness of living things. It is also among the most persistently misunderstood topics in the discipline. Research with secondary students in several countries shows that even after focused instruction, many learners still hold low levels of knowledge and continue to reason with naïve ideas, for example that organisms change because they need to (Aptyka et al., 2022). In Nigeria, chief examiners' reports of the West African Examinations Council (WAEC, 2018; 2019; 2022; 2023; 2024) have repeatedly identified weak candidate performance on Evolution questions, even though the topic is a compulsory part of the senior secondary Biology syllabus. Poor achievement in a topic of this importance limits scientific literacy and weakens preparation for medicine, agriculture, conservation, and biotechnology, fields to which Nigeria's development goals are closely tied.

A frequently cited contributor to this problem is the dominance of teacher-centred lecturing in Biology classrooms. Under this conventional approach, teachers present content at the chalkboard while students copy notes and memorise facts, an arrangement that offers little opportunity to surface, test, and revise misconceptions. Contemporary syntheses of the learning sciences, by contrast, describe learning as an active, social, and constructive process in which learners build understanding through interaction, scaffolding, and meaningful representation (Darling-Hammond et al., 2020). Two learner-centred strategies that put these principles to work are peer-led learning and interactive animations. Both have attracted growing research attention, but they have rarely been compared directly with each other and with conventional teaching in the same study, and even less often for a topic as abstract as Evolution.

Peer-led Learning (PIL) assigns structured instructional roles to students, typically capable peers who facilitate small-group discussion and problem solving under the guidance of the teacher. The strategy is related to peer tutoring, peer instruction, and peer-led team learning, and the evidence for these family members is encouraging. A recent meta-analysis of 24 studies covering 3,311 participants found that peer tutoring in science, technology, engineering, and mathematics (STEM) subjects had a significant positive effect on academic achievement, with a pooled standardised effect of 1.23, and found no significant differences between types of peer tutoring (Hidayat and Saad, 2025). A meta-analysis of 37 studies of formal peer learning in higher education likewise reported moderate positive effects on course performance across supplemental instruction, peer-led team learning, and peer-assisted learning (Bengesai et al., 2023).

Several mechanisms may explain why peers can teach effectively. Peer leaders can explain ideas in the language and with the examples that classmates already understand, and group members may feel freer to ask questions and admit confusion than they would in front of the whole class. However, most of the available syntheses concern higher education or mathematics, and their effect sizes may not transfer to large secondary classes in resource-constrained settings.

Interactive animations (IA) use dynamic, learner-controlled visualisations to depict processes that are too slow, too small, or too large to observe directly, as is the case with natural selection, genetic drift, and speciation. Meta-analyses indicate that animations generally outperform static pictures, with small-to-medium effects that depend on design features such as narration, pacing, and learner control. Mayer's (2021) review of the multimedia learning literature adds that well-designed combinations of words and dynamic pictures support deeper understanding than words alone, provided that the design does not overload working memory.

Studies indicated that secondary school students taught Biology students in Jos North, Plateau State, found no significant difference among students taught with a computer animation package and those taught using the traditional method (Yilshik et al., 2026). Multimedia instructional packages have also been linked to more favourable attitudes toward Biology among Nigerian secondary students (Akinbadewa and Sofowora, 2020). In a study on evolution conducted by Aptyka et al. (2022), it was shown that evolutionary scenarios differ in the cognitive load they impose on learners, with trait-loss scenarios eliciting higher intrinsic and extraneous load than trait-gain scenarios. This report is based on the fact that animations display dynamic processes that learners would otherwise have to simulate mentally, they are plausible ways to reduce such dearth in students' achievement.

The study was grounded on the following theories as revealed here: One of such theory is Vygotsky's (1978) sociocultural theory which holds that learning is most effective within the zone of proximal development, where a more knowledgeable other provides scaffolding. Peer leaders can play this

role, using language and examples familiar to their group. Likewise in this category is the Cognitive load theory by Sweller et al. (2019) which of relevance to the current study. Mayer (2021) also suggested that, animations can lower the extraneous load of mentally simulating dynamic processes, freeing working memory for schema construction. Bandura's (1977) social learning theory submitted that peers are credible models whose success signals that mastery is attainable, which can raise self-efficacy and persistence. Together these perspectives lead to the expectation that both PIL and IA would outperform lecture-based instruction. They make no firm prediction that the strategies would work differently for boys and girls. Despite this promising evidence, the present researchers were not aware of many experimental work from Nigeria that compares peer-led learning and interactive animations with conventional teaching on Evolution achievement that addresses the gap for Senior Secondary II (SS II) students in Oyo Metropolis, hence this study on the Effects of Peer-Led Learning and Interactive Animations on Senior Secondary School Students' Achievement in Evolution in Oyo Metropolis, Nigeria

2 Purpose of the study

The purpose of this study is to investigate the effects of Peer-led learning and interactive animations on senior secondary school students' academic achievement in Evolution in Oyo Metropolis, Oyo State.

Specifically, the study determines the effect of treatments (Peer-led learning, Interactive animations and Conventional Teaching Strategy) on academic achievement of senior school students in Evolution;

3 Hypothesis

The following null hypothesis was formulated for the study at $\alpha = 0.05$.

H_0: There is no significant effect of treatment (Peer led Learning, Interactive Animation and Conventional teaching strategy) on students' academic achievement in Evolution.

4 Methodology

A pretest–posttest, non-equivalent control group quasi-experimental design with three groups (PIL, IA, and CTS) was employed for the study. Pretest scores were entered as covariate to adjust for initial differences between the intact classes. The population comprised 19,084 SS II students in 77 public secondary schools across the four local government areas (LGAs) of Oyo Metropolis: Afijio, Atiba, Oyo East, and Oyo West (Oyo State Ministry of Education, 2025). SS II students were chosen because Evolution is taught in the second term of the SS II Biology curriculum. A multi-stage procedure was used. First, Oyo West LGA, which has 11 public secondary schools, was purposively selected for accessibility. Second, three public schools were purposively selected from it because they had functional electricity, at least two SS II streams, and consenting principals and Biology teachers. Third, the three schools were randomly assigned to treatments by balloting. Fourth, one intact SS II class was used in each school, with all its students included. The final sample was 238 students (that is, 81; 77; and 80 respectively for each group).

The Evolution Achievement Test (EAT) contained a demographic section and 40 multiple-choice items with options A–D. Items covered four content areas (evidence of evolution, theories of

evolution, mechanisms of evolution, and speciation), with 10 items per area. Mechanisms of evolution included natural selection, mutation, genetic drift, and gene flow. A table of specification distributed items across three cognitive levels: knowledge (16 items), comprehension (12 items), and application (12 items). Face and content validity were established by the two experts in science and technology education and two experienced senior secondary school Biology teachers. A pilot administration carried out on sampled schools within the population but were not part of the main sample for the study gave a Kuder–Richardson 20 (KR-20) reliability coefficient of 0.82, which is acceptable for a classroom achievement test. The same instrument served as pretest and posttest, and structured lesson notes were prepared for each group so that content coverage was equivalent across groups.

All groups studied the same content over six weeks, with two 40-minute sessions per week (12 sessions). The conditions differed only in how the content was taught, based on the strategy used in teaching each group. In the PIL condition, students worked in groups of four to six with designated peer leaders who facilitated discussion, guided structured problem-solving tasks, encouraged equal participation, and reported group findings to the class; the teacher acted as facilitator and resource person. In the IA condition, the teacher used pre-downloaded interactive animations in a prediction, observation, and discussion sequence. Students answered structured questions before, during, and after each animation, and the teacher paused at critical points to pose guiding questions and address misconceptions. In the CTS condition, the teacher lectured using textbook diagrams and the chalkboard, students copied notes and answered occasional questions, and individual written assignments followed. No group work or animations were used.

Week 1 was used for permissions, training of research assistants, the Biology teachers in the selected schools. The pretest was administered in Week 2, instruction ran from Week 3 to Week 7, and the posttest was administered in Week 8. Participants were informed of the aim of the study before the pretest, gave consent, and took part voluntarily. Names were not collected, and students were assured that responses would be used only for academic purposes.

Table 1. Distribution of participants by treatment group and gender.

Treatment group	Male	Female	Total
Peer-led learning (PIL)	38	43	81
Interactive animations (IA)	34	43	77
Conventional teaching (CTS)	39	41	80
Total	**111**	**127**	**238**

Note. Each group was one intact SS II class from a different public school.

Source: Researcher's Field Work, 2026.

Table 2. Comparison of the three instructional strategies used in the study.

Feature	Peer-led learning (PIL)	Interactive animations (IA)	Conventional teaching (CTS)
Teacher role	Facilitator and resource person who monitored groups	Guide who paused animations to pose questions and address misconceptions	Sole source of content; lectured from chalkboard and textbook
Student role	Worked in groups of four to six; peer leaders facilitated discussion	Predicted, observed, and discussed; answered structured questions before, during, and after each animation	Copied notes, answered occasional questions, completed individual assignments

Feature	Peer-led learning (PIL)	Interactive animations (IA)	Conventional teaching (CTS)
Materials	Structured problem-solving tasks and lesson notes	Pre-downloaded interactive animations (e.g., peppered-moth simulation, fossil formation, comparative anatomy)	Textbook diagrams and chalkboard
Group work	Central	Whole-class discussion	None

Note. All groups covered the same four content areas in 12 sessions of 40 minutes over six weeks.

Source: Researcher's Field Work, 2026.

5 Results

Posttest scores were analysed with analysis of covariance (ANCOVA), using pretest scores as the covariate, at $\alpha = 0.05$. Bonferroni-adjusted pairwise comparisons followed a significant treatment effect. Partial η^2 was interpreted using Cohen's (1988) benchmarks (0.01 small, 0.06 medium, 0.14 large). Standardised pairwise differences (d) were computed as the adjusted mean difference divided by the square root of the error mean square ($\sqrt{52.54} = 7.25$).

H_0: There is no significant effect of treatment (PIL, IA, and CTS) on students' academic achievement in Evolution.

Table 3. ANCOVA summary for posttest achievement in Evolution.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial η^2
Corrected Model	12786.452	5	2557.290	48.672	0.000*	0.511
Intercept	2841.673	1	2841.673	54.091	0.000*	0.188
Pretest (Covariate)	2341.567	1	2341.567	44.568	0.000*	0.160
Treatment	8745.234	2	4372.617	83.219	0.000*	0.416
Error	12294.678	234	52.541			
Total	791236.000	238				
Corrected Total	25081.130	237				

* Significant at $p < 0.05$. Source: Researcher's Field Work, 2026.

Table 3 summarises the ANCOVA. After controlling for pretest scores, treatment had a significant and large effect on posttest achievement in Evolution, $F(2, 234) = 83.22$, $p < .005$, partial $\eta^2 = 0.42$, so H_0 was nullified, Pretest scores were a significant covariate, $F(1, 234) = 44.57$, $p < 0.005$, confirming that adjusting for initial differences between the intact classes was appropriate.

Table 4. Bonferroni pairwise comparisons of adjusted posttest means.

Comparison	Mean difference	SE	P	95% CI	D
PIL – IA	3.76	1.15	0.004	[1.02, 6.50]	0.52
PIL – CTS	16.07	1.15	< 0.001	[13.33, 18.81]	2.22
IA – CTS	12.31	1.15	< 0.001	[9.57, 15.05]	1.70

Note. PIL = Peer-led Learning; IA = Interactive Animations; CTS = Conventional Teaching. d = mean difference ÷ √MSE.

Bonferroni comparisons displayed in table 4 showed that the PIL group outperformed both the IA group and the CTS group, and that the IA group outperformed the CTS group. Relative to the CTS group, the PIL and IA advantages were very large ($d \approx 2.22$ and 1.70, respectively), whereas the PIL advantage over the IA group was medium ($d \approx 0.52$). All three confidence intervals excluded zero.

6 Discussion of findings

The direction of the treatment effect agrees with earlier evidence favouring structured peer instruction and instructional animation. It also fits the wider synthesis literature, in which peer tutoring in STEM subjects and formal peer learning in higher education both show positive effects on achievement (Bengesai et al., 2023; Hidayat and Saad, 2025). The standardised differences observed in this study exceeded the pooled effect reported in Hidayat and Saad (2025) study on peer tutoring in STEM., and are far larger than the small-to-medium average effects reported in animation meta-analyses and the moderate effects reported for peer learning in higher education (Bengesai et al., 2023). Effects of this magnitude are unusual in field settings, and are reasons for caution rather than confidence.

Several mechanisms consistent with the theoretical framework could explain the advantage of PIL, although the study did not measure them. Peer leaders may have scaffolded classmates within their zone of proximal development using familiar language and examples to teach which may have deepened the leaders' own understanding (Vygotsky, 1978). Group discussion also gives students repeated opportunities to voice, test, and revise misconceptions, which lecturing rarely provides. This matters for Evolution, where misconceptions are persistent and can survive instruction (Aptyka et al., 2022). Observing peers succeed may also have strengthened self-efficacy as propounded by the theory of Bandura (1977).

The advantage of IA over conventional strategy is plausibly linked to the nature of the content of the lesson on evolution being taught. This unfolds over long timescales and at the level of populations; animations are being used dynamically so that students need not simulate them mentally, reducing extraneous load and freeing capacity for schema construction (Mayer, 2021). The prediction, observation, and discussion routine used here may also have prompted learners to confront misconceptions. That PIL exceeded IA by roughly half a standard deviation may indicate that social interaction adds value beyond visualisation. This difference is equally compatible with school and teacher differences, however, and should be treated as tentative.

PIL requires trained peer leaders, structured worksheets, and teacher guidance, but little equipment, which makes it well suited to resource-limited public schools. IA depends on electricity and devices. The participating schools were selected partly for functioning electricity, so the IA results may not transfer to schools without it; authors of recent Nigerian animation work likewise call for reliable power sources, information technology tools, and teacher training (Yilshik et al., 2026). Teacher-education and in-service programmes could therefore prioritise training in selecting and preparing peer leaders, managing small groups in large classes, and integrating pre-downloaded animations into predict–observe–discuss sequences. Examination bodies and curriculum planners might also encourage assessment tasks that reward explanation of evolutionary mechanisms rather than recall, so that classroom practice and assessment reinforce one another.

Several limitations qualify these findings. Most importantly, each condition consisted of one intact class in one school, so treatment is fully confounded with school, teacher, and classroom climate, and random assignment of only three schools does not equate them. Analysing students as independent

units ignores clustering within classes and can overstate statistical significance. Second, the same test served as pretest and posttest, so a testing effect cannot be excluded, and there was no delayed posttest to assess retention. The six-week duration leaves open the role of novelty. Third, the outcome was a multiple-choice achievement test; misconceptions and conceptual change were not measured, and implementation fidelity was not reported. Finally, the sample came from one LGA and from urban schools with functioning electricity, which limits generalisability.

Future studies should include several classes or schools per condition and use multilevel models, add a delayed posttest, and measure misconceptions with validated concept inventories. A factorial design that adds a combined PIL-plus-IA condition would show whether the two strategies are additive or synergistic. Observational or process data, such as recordings of group interaction and animation use, would help identify the mechanisms proposed above. Replication in rural and other regional contexts, and with additional moderators such as prior achievement and attitude toward Biology, is also needed.

7 Conclusion

In this, peer-led learning and interactive animations were each associated with markedly higher achievement in EAT than conventional teaching strategy, with peer-led learning group scoring higher than the students taught with interactive animation and the conventional strategy. Given the single-class-per-condition design, these results are best read as strong preliminary evidence that justifies larger, better-controlled trials rather than as definitive proof of causal superiority.

8 Recommendation

It was recommended that, both Peer-led Learning (PIL) and Interactive Animations (AI) strategies should be adopted in teaching Evolution at the Senior Secondary school for improved outcomes.

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