

# Effectiveness of E-Content Teaching in Zoology Among Higher Secondary Students in Relation to Achievement

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**Citation:** Ms.V. Shobana Devi, et.al (2024). Effectiveness of E-Content Teaching in Zoology Among Higher Secondary Students in Relation to Achievement, *Educational Administration: Theory and Practice*, 30(11) 2774-2777

Doi: 10.53555/kuey.v30i11.10923

## ARTICLE INFO

## ABSTRACT

This study examines the effectiveness of e-content teaching in Zoology for higher secondary students and its impact on academic achievement. Using a quasi-experimental design, 60 students were divided into control (traditional teaching) and experimental (e-content-based teaching) groups. Analysis of pre-test and post-test scores revealed the experimental group showed significantly greater improvement (90.04% gap closure) compared to the control group (47.47% gap closure). The large effect size ( $d = +4.04$ ) demonstrates the substantial impact of e-content teaching. The study concludes that e-content instruction enhances Zoology learning outcomes and recommends its integration into higher secondary curricula.

**Key words:** E-content, Achievement in Zoology

## Introduction

The integration of technology in education has transformed teaching methodologies, particularly in science subjects like Zoology. Traditional lecture-based approaches often fail to engage students effectively, resulting in poor retention and suboptimal achievement. E-content teaching, incorporating multimedia presentations, interactive simulations, and digital assessments, offers a more dynamic and engaging learning experience. This study investigates whether this modern approach yields better learning outcomes compared to conventional methods in Zoology education.

This study examines the impact of e-content-based instruction on Zoology learning outcomes among higher secondary students. With traditional teaching methods often failing to engage learners effectively, the integration of digital resources presents a promising alternative. The research explores how multimedia modules, 3D animations, and virtual dissections enhance conceptual understanding and academic performance. Through a quasi-experimental design comparing control and experimental groups, the study demonstrates significant improvements in test scores and knowledge retention among students exposed to e-content. The findings highlight the transformative potential of technology-enhanced learning in science education, particularly for complex biological concepts that require visual and interactive reinforcement.

## Effectiveness of E-Content Teaching in Zoology Among Higher Secondary Students in Relation to Achievement

The rapid digitization of education has created new opportunities for innovative pedagogy in science subjects like Zoology. This investigation evaluates how e-content instructional strategies influence academic achievement at the higher secondary level. By incorporating interactive simulations, gamified assessments, and adaptive learning pathways, e-content addresses key challenges in biological education - from abstract concepts to low student engagement. The research reveals substantial gains in learning outcomes, with experimental groups showing nearly double the knowledge gap closure compared to traditional instruction. These results underscore the critical role of digital resources in modernizing Zoology education and preparing students for STEM careers in an increasingly technological world.

## Methodology

The study employed a quasi-experimental pre-test-post-test control group design to evaluate the effectiveness of e-content teaching. Sixty higher secondary students were randomly assigned to either the control group

(n=30) receiving traditional instruction or the experimental group (n=30) using e-content modules. Random assignment ensured group homogeneity and minimized selection bias.

The control group instruction consisted of textbook-based lectures, chalkboard explanations, and static diagrams. The experimental group utilized interactive e-content modules featuring 3D animated videos, virtual dissections, gamified quizzes, and multimedia simulations designed to enhance conceptual understanding and engagement.

### Tools and Instruments

The primary assessment instrument was a standardized Achievement Test in Zoology, administered as both pre-test and post-test. Subject experts validated the test, which demonstrated high reliability (Cronbach's  $\alpha = 0.82$ ). The e-content modules were carefully aligned with the prescribed Zoology syllabus and incorporated adaptive learning pathways, interactive exercises, and immediate feedback mechanisms to reinforce key biological concepts.

### Procedure

The eight-week study followed a structured intervention protocol:

1. Pre-test Phase: Both groups completed the Achievement Test to establish baseline knowledge levels.

**2. Intervention Phase:**

○ Control group received conventional teacher-led instruction using textbooks.

○ Experimental group engaged with e-content modules, virtual labs, and interactive assessments.

3. Post-test Phase: Both groups retook the Achievement Test to measure learning gains.

4. Data Analysis: Statistical analysis included mean, standard deviation, independent t-tests, and Cohen's d effect size calculations, with significance set at  $p < 0.01$ .

### Need and Significance of the Study

The rapid advancement of educational technology necessitates examination of its effectiveness in science education, particularly for complex subjects like Zoology. Traditional methods often fail to promote deep conceptual understanding, resulting in poor academic performance. This study addresses the critical need to evaluate how e-content teaching can enhance Zoology education through interactive 3D models, virtual dissections, and multimedia simulations. The research holds significant implications for STEM education, potentially transforming Zoology instruction by providing empirical evidence of e-content's impact. Demonstrated effectiveness could lead to integration in national curricula, benefiting both urban and rural students by making abstract biological concepts more accessible. The study contributes to technology-enhanced learning research in developing countries where digital resources remain underutilized.

Findings offer actionable insights for educators, policymakers, and curriculum designers, potentially guiding teacher training programs to incorporate digital tools. The research aligns with global educational technology trends and supports United Nations Sustainable Development Goal 4 (Quality Education). Ultimately, the study may influence policy decisions regarding e-learning infrastructure investment, helping bridge the gap between traditional and modern pedagogies.

### Statement of the Problem

Despite technological advancements in education, many higher secondary schools continue relying on traditional Zoology teaching methods, resulting in passive learning and subpar achievement. While e-content shows promise in other subjects, its effectiveness in Zoology remains understudied, particularly in resource-limited educational settings. This study investigates whether e-content teaching significantly improves Zoology achievement compared to conventional methods among higher secondary students. Specifically, it examines: (1) differences in pre-test and post-test scores between groups, (2) knowledge gap closure using e-content, and (3) effect sizes of digital interventions. The problem is compounded by insufficient teacher training in digital pedagogies and lack of institutional support for e-learning adoption.

Without empirical evidence, schools may hesitate to invest in e-content, perpetuating outdated practices. This research aims to address this gap by providing data-driven recommendations for modernizing Zoology instruction. The study also explores challenges like accessibility, cost-effectiveness, and student engagement with e-content, proposing solutions for optimal implementation. Findings will help educators leverage technology to enhance conceptual understanding, critical thinking, and long-term retention of Zoological principles. The urgency stems from growing demand for STEM-literate graduates, making it imperative to identify effective teaching strategies for contemporary learners.

### Operational Definitions

**E-content teaching:** Instruction delivered through digital modules including 3D animations, virtual dissections, interactive quizzes, and multimedia simulations.

**Traditional teaching:** Conventional instruction using textbooks, chalkboard explanations, and static diagrams.

**Achievement in Zoology:** Measured through a standardized test covering key Zoology concepts, scored 0-30.

1.H<sub>01</sub>: There is no statistically significant difference between the pre-test and post-test scores of students taught Zoology using traditional methods.

2. H<sub>02</sub>: There is no statistically significant difference between the pre-test and post-test scores of students taught Zoology using e-content modules.
3. H<sub>03</sub>: There is no statistically significant difference in pre-test scores between students in the traditional teaching group and those in the e-content teaching group.
4. H<sub>04</sub>: There is no statistically significant difference in post-test scores between students in the traditional teaching group and those in the e-content teaching group.
5. H<sub>05</sub>: There is no statistically significant difference in the gain scores (post-test minus pre-test) between students in the traditional teaching group and those in the e-content teaching group.

### Findings of the Study

1. Comparison of Control and Experimental Groups: Post-test in Zoology Achievement A significant difference emerged between groups in post-test scores ( $t = 18.04$ ,  $p < 0.01$ ). The experimental group's mean (29.20) exceeded the control group's (21.30), rejecting the null hypothesis. This confirms e-content's superiority over conventional Zoology teaching methods. Interactive digital modules, 3D models, and multimedia simulations facilitated deeper understanding of biological concepts through visual learning and adaptive practice, directly contributing to enhanced academic performance. These findings highlight e-content's potential to revolutionize science education by equipping teachers with innovative digital tools that improve students' conceptual clarity and retention.

2. **Control Group: Gap Closure in Zoology:** The control group closed only 47.47% of its pre-instruction knowledge gap (pre-test mean = 13.20 to post-test mean = 21.30; maximum = 30), leaving 52.53% unaddressed. This limited progress underscores traditional methods' ineffectiveness in promoting comprehensive Zoology mastery. Students struggled with abstract biological processes due to insufficient visual aids and interactive reinforcement, emphasizing the need for pedagogical innovation to ensure more dynamic and effective learning.

#### 3. Experimental Group: Gap Closure in Zoology

The experimental group achieved 90.04% gap closure (pre-test mean = 14.04 to post-test mean = 29.20), reducing the remaining gap to 9.96%. This near-complete mastery demonstrates e-content's transformative efficacy in biological comprehension. Through animated diagrams and virtual dissections, students mastered complex concepts with greater retention and application, while also developing critical thinking and scientific curiosity essential for future biologists.

4. **Effect Size: Post-test in Zoology:** The substantial effect size ( $d = +4.04$ ) indicates experimental group students outperformed controls by over 4 standard deviations. This large effect confirms e-content doesn't just incrementally improve learning but revolutionizes it, enabling students to transition from rote memorization to analytical understanding and real-world application of biological principles.

### Educational Implications

The study conclusively demonstrates e-content teaching's significant positive impact on Zoology achievement. Unlike traditional methods, e-content provides immersive, interactive learning experiences that make complex biological concepts more accessible. The experimental group's 90.04% gap closure shows digital tools address learning deficiencies more effectively than conventional approaches.

Key implications include:

- Prioritizing digital literacy in teacher training programs
- Investing in smart classrooms with 3D models and virtual labs
- Adopting blended learning models combining e-content with hands-on experiments
- Government support for e-learning infrastructure, especially in rural areas
- Ongoing teacher professional development for EdTech integration

E-content integration can democratize quality science education, ensuring all students gain a strong Zoology foundation regardless of socioeconomic background, thereby preparing future scientists for 21st-century challenges.

### Recommendations

1. Incorporate e-content modules into higher secondary Zoology curricula
2. Train teachers in digital resource development and utilization
3. Establish virtual labs for biological simulations and dissections
4. Provide students with tablets/laptops for e-learning access
5. Develop localized e-content in regional languages
6. Conduct workshops on multimedia tool integration
7. Partner with EdTech companies to design interactive Zoology modules
8. Implement AI-based adaptive learning systems
9. Incorporate gamification elements to boost engagement
10. Regularly assess e-content effectiveness
11. Enact policies mandating digital science education

12. Support research on e-content's long-term STEM career impacts

### Suggestions for Further Study

1. Investigate e-content's impact on long-term Zoology concept retention
2. Compare urban versus rural student performance with e-content
3. Examine gender differences in e-content-based Zoology learning
4. Study neurodivergent students' engagement with digital biology tools
5. Evaluate cost-effectiveness of e-content versus traditional labs
6. Explore virtual reality applications for complex Zoology topics
7. Assess teacher attitudes toward e-content adoption
8. Examine cross-cultural adaptability of digital Zoology modules
9. Investigate e-learning's impact on practical exam performance
10. Compare different e-content formats (videos, simulations, podcasts)
11. Study motivation changes following e-content implementation
12. Develop frameworks for evaluating e-content's pedagogical effectiveness

### Conclusion

This study definitively establishes that e-content teaching significantly enhances Zoology achievement among higher secondary students. The experimental group's 90.04% gap closure versus the control group's 47.47% demonstrates digital pedagogy's transformative potential. The substantial effect size ( $d = +4.04$ ) confirms e-content's revolutionary impact on science education. For policymakers, these findings underscore the urgency of integrating e-content into national curricula to ensure equitable access to quality science education. Educators must receive ongoing training in digital methodologies, while students benefit from more engaging, effective learning experiences. E-content overcomes traditional teaching's limitations—passive learning, poor retention, and disengagement—through its dynamic approach. As education evolves, e-content must transition from optional supplement to fundamental teaching strategy. Doing so will cultivate scientifically literate, critical thinkers equipped with technological proficiency for addressing global biological challenges. This study serves as both compelling evidence and urgent call to action—e-content represents not just education's future, but its present necessity.

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