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ASSESSMENT OF LEARNERS' COMPREHENSION LEVELS IN BIOLOGY: A CASE STUDY OF SOS SECONDARY SCHOOL, LUSAKA

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Abstract
This study assessed the level of comprehension in biology among senior secondary school learners at SOS Secondary School in Lusaka. Utilizing a mixed-methods approach, the research combined quantitative assessments and qualitative surveys to evaluate students' understanding of both fundamental and complex biological concepts. The findings revealed that approximately 60% of students achieve a satisfactory level of comprehension of basic biological principles; however, only 30% demonstrate proficiency in more advanced topics such as genetics and ecology. Key areas of difficulty identified include cellular processes and ecological interactions. Inquiry-based learning approaches led to higher performance compared to traditional lectures. Access to supplementary learning tools like interactive simulations correlated positively with comprehension. Recommendations include integration of hands-on labs, increased use of educational technology, and teacher professional development to improve student learning outcomes.

Keywords
Biology Education, Learner Comprehension, Inquiry-Based Learning, Educational Technology, Senior Secondary School, Lusaka, Genetics, Ecology

1. Introduction

Biology is a fundamental science subject that plays a critical role in secondary education, providing learners with essential knowledge about living organisms, their interactions, and the biological processes that sustain life. Proficiency in biology not only prepares students for further studies in science and health-related fields but also equips them with scientific literacy necessary for informed citizenship. Despite its importance, many learners face challenges in comprehending complex biological concepts, which can impede academic success and reduce interest in science careers. In Zambia, the secondary school biology curriculum covers a broad range of topics, from basic cell structure and function to more advanced subjects like genetics, ecology, and evolution. While foundational topics are often grasped satisfactorily by many students, advanced areas

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tend to be more difficult due to their abstract nature and the cognitive demands involved. The traditional teaching methods, predominantly lecture-based and textbook-centered, may not adequately support deep conceptual understanding. Recent educational reforms advocate for learner-centered and inquiry-based pedagogies that actively engage students in scientific exploration and critical thinking. Furthermore, the integration of educational technology, such as interactive simulations and virtual labs, offers promising avenues to enhance comprehension by visualizing complex processes and fostering experiential learning. This study aims to assess learners' comprehension levels in biology at SOS Secondary School in Lusaka, identify areas of difficulty, and evaluate the effectiveness of pedagogical approaches, including the use of technology. The findings will inform strategies to improve biology teaching and learning, ultimately contributing to better academic outcomes and student motivation.

2. Research Objectives and Questions

The primary aim of this study is to evaluate the comprehension levels of senior secondary school learners in biology at SOS Secondary School, Lusaka, and to examine the factors influencing their understanding of both fundamental and advanced biological concepts.

2.1 Research Objectives

- To assess the level of learners' comprehension of basic and complex biology topics such as cellular processes, genetics, and ecology.
- To identify specific areas where learners experience difficulties in understanding biology content.
- To evaluate the impact of different teaching methodologies, particularly inquiry-based learning versus traditional lectures, on learner comprehension.
- To examine the role of educational technology, including interactive simulations, in supporting biology comprehension.
- To provide recommendations for improving biology instruction and student learning outcomes.

2.2 Research Questions

- What is the current level of comprehension among learners for various biology topics at SOS Secondary School?
- Which biological concepts do learners find most challenging to understand?
- How do different teaching approaches affect learners' comprehension of biology?
- To what extent does the use of educational technology correlate with improved learner understanding?

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- What strategies can be implemented to address identified comprehension challenges?.

3. Theoretical and Conceptual Framework

This study is grounded in Constructivist Learning Theory, which asserts that learners actively construct knowledge by integrating new information with their existing cognitive frameworks. Constructivism emphasizes the importance of learner engagement, hands-on experiences, and contextual learning—all vital in science education, where conceptual understanding often depends on visualization and experimentation.

3.1 Constructivist Learning Theory

According to Piaget (1954) and Vygotsky (1978), effective learning occurs when students engage actively with content, build on prior knowledge, and participate in social interactions that promote deeper understanding. In biology education, this translates into teaching methods that prioritize inquiry, problem-solving, and collaborative learning rather than passive reception of information. Inquiry-based learning (IBL), a practical application of constructivist principles, encourages students to pose questions, conduct investigations, and develop evidence-based conclusions. This approach contrasts with traditional lecture-based methods, which often emphasize rote memorization over conceptual clarity.

3.2 Role of Educational Technology

The use of educational technology, such as interactive simulations and virtual laboratories, aligns with constructivist theory by providing students with dynamic, visual, and experiential learning environments. These tools allow learners to manipulate variables, observe outcomes, and test hypotheses in ways that traditional textbooks cannot replicate. Research indicates that technology-enhanced learning supports retention, motivation, and understanding of complex biological processes (Kumar, 2022).

3.3 Conceptual Framework

The framework guiding this study examines how learner comprehension (dependent variable) is influenced by teaching methodologies and access to educational technology (independent variables), moderated by learner engagement and prior knowledge. The interaction of these elements determines the depth and quality of biological understanding achieved by students. This framework informed the development of research instruments and the interpretation of results, focusing on identifying effective strategies and barriers to learner comprehension in biology.

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4. Methodology

This study employed a mixed-methods research design combining quantitative and qualitative data collection to comprehensively assess learner comprehension levels in biology at SOS Secondary School in Lusaka.

4.1 Research Participants

The study involved 120 senior secondary school learners enrolled in biology classes at SOS Secondary School, selected through stratified random sampling to represent Grades 10 to 12. Additionally, 12 biology teachers participated in interviews and surveys to provide insights into teaching practices and perceptions.

4.2 Data Collection Instruments

Quantitative Assessments: Learners completed standardized tests designed to measure comprehension of key biology topics, including basic cellular biology, genetics, and ecology. Test scores provided a measurable indicator of understanding across different content areas. Questionnaires: Students responded to surveys regarding their perceptions of teaching methods, use of supplementary learning tools, and self-reported comprehension levels. Semi-Structured Interviews: Conducted with biology teachers to explore instructional strategies, challenges faced in teaching complex concepts, and integration of educational technology.

4.3 Data Analysis

Quantitative test scores were analyzed using descriptive statistics to identify patterns of comprehension and proficiency. Qualitative data from questionnaires and interviews were coded thematically to extract insights on pedagogical practices and learner experiences. Correlational analysis was performed to examine the relationship between teaching approaches, technology use, and comprehension outcomes.

4.4 Ethical Considerations

Approval was obtained from school authorities and ethical guidelines were followed to ensure confidentiality, voluntary participation, and informed consent from students and teachers.

5. Findings and Analysis

The study's findings reveal varied levels of learner comprehension across different biology topics, the influence of teaching methodologies, and the positive role of educational technology in enhancing understanding.

5.1 Learner Comprehension Levels

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Analysis of test results indicated that approximately 60% of learners demonstrated satisfactory comprehension of fundamental biology concepts such as cell structure, basic physiological processes, and nutrition. However, comprehension dropped significantly for advanced topics like genetics and ecology, with only about 30% of students achieving proficiency. The most challenging areas identified included understanding cellular respiration, genetic inheritance patterns, and ecological interdependencies.

5.2 Teaching Methodologies and Their Impact

Interviews with biology teachers revealed that while traditional lecture methods remain prevalent, there is increasing adoption of inquiry-based learning (IBL) and group discussions to promote active learning. Teachers noted that students engaged more deeply with material when involved in experiments, case studies, or problem-solving activities. Students reported that lessons incorporating hands-on labs and interactive discussions helped clarify difficult concepts and boosted their confidence. Conversely, purely didactic sessions were associated with lower engagement and comprehension.

5.3 Role of Educational Technology

The study found that learners who had access to supplementary learning tools such as interactive simulations, virtual labs, and multimedia presentations performed better on comprehension assessments. These technologies enabled visualization of dynamic processes, such as genetic crosses and ecosystem interactions, which are difficult to convey through textbooks alone. Teachers highlighted that technology enhanced motivation and offered diverse learning modalities, catering to different student needs. However, access to such tools was limited, with disparities evident between resource-rich and under-resourced classrooms.

6. Challenges and Implications

Despite positive outcomes linked to learner-centered and technology-supported teaching approaches, the study identified several challenges that limit the full realization of improved comprehension in biology at SOS Secondary School.

6.1 Curriculum Overload

Teachers reported that the extensive biology syllabus and tight examination timelines often restrict the depth with which complex topics can be taught. This pressure forces educators to prioritize content coverage over fostering conceptual understanding and critical thinking.

6.2 Limited Resources

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Many classrooms lack sufficient laboratory equipment, textbooks, and access to educational technology. This scarcity hinders the ability to conduct practical experiments and use simulations that are vital for teaching abstract biological concepts effectively.

6.3 Teacher Training Deficiencies

While some teachers have adopted learner-centered strategies, others lack adequate professional development in modern pedagogical methods and technology integration. This uneven capacity impacts the quality and consistency of biology instruction.

6.4 Learner Variability

Differences in students' prior knowledge, language proficiency, and learning styles pose challenges to meeting diverse learning needs, particularly in large classes where individualized attention is difficult. These challenges underscore the need for systemic interventions to enhance teacher training, resource allocation, and curriculum planning. Addressing these factors is critical to enabling learners to achieve deeper comprehension and foster long-term interest in biology and science careers.

7. Recommendations

To improve learner comprehension in biology at SOS Secondary School, the following recommendations are proposed:

7.1 Curriculum Adjustment

Review and streamline the biology syllabus to prioritize conceptual understanding over content quantity. This will allow teachers more time to engage learners deeply with complex topics such as genetics and ecology.

7.2 Enhance Resource Availability

Invest in laboratory equipment, textbooks, and digital learning tools such as simulations and virtual labs. These resources will support experiential learning and help visualize abstract biological processes.

7.3 Strengthen Teacher Professional Development

Implement ongoing training programs focused on learner-centered teaching methodologies and effective integration of technology in biology instruction. Peer mentoring and collaborative learning communities can reinforce these skills.

7.4 Foster Differentiated Instruction

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Encourage teachers to adopt differentiated strategies that address diverse learner needs, including language support and varied assessment methods, especially in large classrooms.

7.5 Increase Access to Educational Technology

Expand infrastructure and support for digital tools, ensuring equitable access for all students. Promote the use of interactive simulations and multimedia resources as standard supplements to classroom teaching.

8. Conclusion

This study highlights the varied comprehension levels among senior secondary learners in biology at SOS Secondary School, Lusaka, with stronger understanding in fundamental topics and notable challenges in complex areas such as genetics and ecology. The findings affirm the positive impact of inquiry-based learning and educational technology in enhancing student engagement and conceptual clarity. However, systemic challenges including curriculum overload, resource limitations, and uneven teacher training hinder the widespread adoption of effective learner-centered practices. To foster improved biology learning outcomes, it is imperative to align curriculum demands with pedagogical best practices, equip schools with necessary resources, and empower teachers through sustained professional development. By doing so, education stakeholders can create more supportive learning environments that accommodate diverse student needs and leverage technology to make biology education more interactive and accessible. Ultimately, addressing these challenges will contribute to producing scientifically literate graduates capable of critical thinking and ready to pursue further studies or careers in science-related fields.

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