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Student Performance Dataset from a Quasi-experimental Study on the Use of Virtual Labs in Teaching Biology

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Abstract

This dataset arises from a quasi-experimental study involving Rwandan senior secondary biology students (n = 168), comparing traditional instruction (n = 83) with teaching via virtual laboratory modules (n = 85). Data include pre- and post-intervention test scores on nerve cells, food nutrients, and enzyme activity concepts. The dataset enables replication of statistical analyses on virtual labs' effectiveness and supports meta-analyses exploring ICT in science education in Sub-Saharan Africa.

Value of the data:

- Enables analyses of academic gains attributable to virtual labs
- Supports subgroup comparisons (e.g., gender effects)
- Useful for global meta-studies on digital pedagogies in resource-limited settings

Keywords: Biology, data, dataset, Virtual Labs, quasi-experiment, Rwanda

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Introduction

Recent scholarship has emphasized the potential of virtual laboratories (VLs) to enhance biology education, particularly for abstract and conceptually challenging topics like molecular and cell biology. A comprehensive literature review by Byukusenge et al. (2022) categorized virtual lab usage across 26 studies and found clear evidence of improved conceptual understanding, practical skills, and motivation/attitudes among biology students. Particularly, topics such as nerve cells, enzyme activity, and nutrient metabolism are central themes in this dataset, and they are often cited as well-suited to

virtual laboratories due to their opaque and dynamic nature. These virtualization tools offer interactive 3D visualizations and simulations that facilitate deeper cognitive processing than traditional lectures.
Virtual laboratories have emerged as powerful tools for fostering student engagement and boosting motivation in science education (Lynch & Ghergulescu, 2017). Platforms such as Labster have consistently reported high engagement rates, often exceeding 90% among biology learners. These digital environments promote self-directed exploration and provide immediate feedback, contributing to increased learner confidence and autonomy. By simulating complex biological processes in interactive formats, virtual labs help students approach laboratory tasks with greater clarity and self-efficacy, particularly in settings where access to physical laboratories is limited (Gardner et al., 2019).
Moreover, learning outcomes associated with virtual lab usage are well-documented. Numerous studies have demonstrated that students using virtual labs tend to outperform or perform on par with their peers in traditional lab settings, especially in topics that involve microscopic or molecular-level understanding, such as nerve cell physiology and enzyme kinetics. In the Rwandan context, Byukusenge et al. (2024) found statistically significant improvements in academic performance and student attitudes following a structured virtual lab intervention focused on nerve cells, food nutrients, and enzyme activity. These findings underscore the pedagogical value of virtual labs in enhancing conceptual understanding and student engagement in biology education.
Taken together, this body of evidence positions our dataset as a timely and valuable contribution. It supports existing findings and enables novel secondary analyses such as subgroup evaluations (e.g., gender differences), meta-analytic inclusion, and pedagogical replication in Sub-Saharan Africa contexts.

Methodology

This study employed a quasi-experimental design involving 168 students from two intact senior secondary school biology classes in two schools. The intervention group received instruction through virtual laboratory simulations covering three key biological topics: nerve cells, food nutrients, and enzyme activity. In contrast, the control group was taught the same content using conventional classroom methods without digital enhancements. Both groups completed identical pretest and posttest assessments composed of multiple-choice and open-ended questions to assess learning outcomes. Subject matter experts reviewed and validated these instruments to ensure content relevance and clarity.

Data Description

The dataset is organized in a structured spreadsheet format, with each row representing an individual respondent's answers and each column corresponding mainly to the questions from the test

content in Rows

Row 1: it contains the correct answers to each question (Q)
Row 2: Group (Experimental or Virtual lab)
Row 3-90: contains answers for each student in the Experimental group
Row 91: Group (Control)
Row 92-174: contains answers for each student in the Control group

Variables in Columns

Column A: School
Column B: student_id: unique identifier
Column C: gender: 'male'/'female'
Column D-AS: Answer and corresponding scores. Each true answer was scored 1, and false.

Data collection

Data were collected from 168 students involved in the study. A pretest was given to the control group, which comprised 83 students, and to the experimental group, which comprised 85 students. After the pretest, the experimental group was treated under technology-based instruction using virtual laboratories, while the control group comprised 83 students and was taught with the conventional teaching methods. To assess learning outcomes, both groups completed identical posttests composed of 20 similar questions covering three key biological topics: nerve cells, food nutrients, and enzyme activity. The marks for both the pretest and posttest groups were recorded and analyzed.

Ethics Statement

The University of Rwanda-College of Education granted ethical clearance for the study, and informed consent was obtained from the student's parents or guardians prior to participation.

Data Availability & Access

This dataset is available at the Figshare Repository: https://doi.org/10.6084/m9.figshare.29279270.v1

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References

Byukusenge, C., Nsanganwimana, F., & Tarmo, A. P. (2024). Investigating the effect of virtual laboratories on students' academic performance and attitudes towards learning biology. *Education and Information Technologies*, *29*(1), 1147-1171.

Byukusenge, C., Nsanganwimana, F., & Tarmo, A. P. (2022). Effectiveness of virtual laboratories in teaching and learning biology: a review of the literature. *International Journal of Learning, Teaching and Educational Research*, *21*(6), 1-17.

Gardner, A., Duprez, W., Stauffer, S., Ungu, D. A. K., & Clauson-Kaas, F. (2019). *Labster Virtual Lab Experiments: Basic Biochemistry*. Springer Berlin Heidelberg.

Lynch, T., & Ghergulescu, I. (2017). Review of virtual labs as the emerging technologies for teaching STEM subjects. *INTED2017 proceedings*, 6082-6091.