

NHAVA: An Offline SmartClass System for Low-Resource Learning Environments

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Abstract

Educational inequality in many low-resource regions is exacerbated by limited access to electricity, internet connectivity, and modern instructional resources, particularly in rural schools. While digital learning technologies have demonstrated significant potential to enhance STEM education, most existing solutions assume reliable infrastructure that is not available in many developing areas. This paper introduces Nhava, a portable, solar-powered SmartClass Kit designed to deliver interactive, technology-enabled instruction in offline and low-resource environments.

Nhava integrates a laptop, interactive projection system, document scanner, renewable power supply, and an offline digital learning repository containing globally recognized STEM resources. The system is designed to support interactive teaching, visualization of abstract concepts, and teacher-led instruction without dependence on internet connectivity.

The study adopts a design-based research methodology, combining system design analysis with a proposed pilot deployment framework in rural secondary schools. Data collection focuses on instructional usability, learner engagement, and teacher confidence through classroom observations, structured interviews, and usage analytics. While large-scale learning outcome data is still under development, preliminary observations suggest improved instructional clarity, increased learner participation, and reduced barriers to technology adoption.

The paper argues that infrastructure-aware, teacher-centered digital learning systems such as Nhava offer a practical pathway toward inclusive and equitable education. By aligning technology design with contextual realities, Nhava demonstrates how offline-first educational innovations can bridge the digital divide and support meaningful learning experiences in underserved communities.