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Sopala: An Innovative Model for K-12 Education

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This paper presents an innovative approach to K-12 education that functions effectively in classrooms with or without internet access. The approach prioritizes those with the least access and then scales to all classrooms, regardless of connectivity. AI-enhanced, open-source, offline-first tools deliver high-quality open educational resources and standards-aligned learning experiences to students in remote and underserved areas. The World Bank estimates that nearly nine in ten students in sub-Saharan Africa are living in “learning poverty,” unable to read a simple text by the end of elementary school (Dahill-Brown, 2023).

The project or collaborative that we call "Sopala" (Dagbani for "Innovations") began in Ghana’s Northern Region. Teachers from the rural areas of Ghana, Kenya, and South Africa have since joined. Sopala serves as a model for other countries or regions facing similar challenges in technology access. The strategies and processes can also be used in higher education.

Open-source software and openly licensed materials are the most practical tools for measuring and monitoring learning in K-12 education because they remove the barriers that exist in contexts like the United States, where proprietary tools and proprietary content often restrict access to student learning data**.** Sopala demonstrates how open practices can impact student learning in any setting.

OER Sustainability

The Sopala model of OER (open educational resources) sustainability uses the strength of local communities and institutions to minimize costs and assist the OER development process. The process is documented and openly licensed allowing other communities and institutions to improve the model. The model is replicable at any level and provides an efficient and accountable blueprint for further funding from governments and philanthropy.

Creation, revision, translation, and alignment with local standards of educational materials is crucial to addressing systemic opportunity gaps for learners. When the ability to translate and adapt materials to meet the specific needs of students is the priority of teachers, OER is the only choice. The next logical step is to build local capacity through professional development to support the model's replication at the local level.

OER need not and should not be viewed as separate from any other part of education. OER differs only in offering greater efficiency, cost-effectiveness, inclusivity, and flexibility than non-openly licensed materials. The ability to revise, reuse, and implement educational materials makes Open Education the optimal solution for improving education in underserved regions as well as those with well-resourced infrastructure.

Access to high-quality instructional materials customized to the local context is such a critical need in rural Africa, that an approach that utilizes affordable digital OER materials and builds local capacity in their creation, revision, and distribution is the only practical solution. The question is not whether OER or Open Education is sustainable; the question is whether educational progress can be sustained. If the goal is to sustain

education, digital OER makes that much more feasible because it is affordable and can be efficiently delivered and accessed.

The Humans Centering the AI in Education

Sopala began when Peter Amoabil and Dan McGuire discussed how to increase literacy resources for students in elementary schools in Ghana's Northern Region where the only internet access was via Peter's cell phone data plan. The initial tool explored was MoodleBox, an offline version of the most widely used learning management system, Moodle Coussement (2023). Early in the exploration, Peter noted that the ability to translate and acquire more materials into the students' first language was critical for increasing literacy. First language, or mother tongue materials are also important for providing equity and inclusion. There is a severe shortage of contextually appropriate materials in most of the 1500 languages of sub-Saharan Africa. "Children can't learn to read if they don't have books in a familiar language to practice their reading skills (African Storybook, 2024)".

After demonstrating initial success, other educators, organizations, and foundations joined the project. In 2023, Creative Commons and Siemens-Stiftung generously provided support to include two more schools in Ghana's Northern Region and a Pre-K through 1st grade school in a rural area near Cape Town. S.A. The Sopala project now includes several key contributors including: the founder and development lead of MoodleBox, the founder and CEO of Kiwix, several leading Moodle software developers, and international experts in learning data and analysis.

Several local Ghanaian education leaders with extensive experience in teacher professional development, a climate advisor and scholar, founders of two early literacy initiatives, a founder of a STEM education organization, and the Executive Director of the local language Wikimedian group guide the classroom implementation. These leaders focus on expanding girls' education and implementing technology and literacy resources. Together, they are integrating digital open teaching and learning solutions into the local education systems. (Sopala, 2024).

Sopala focuses on three key areas: 1) increasing teacher skills and professionalism with AI-enhanced OER training courses; 2) real-time access to student learning data through the delivery of OER digital assessments; and 3) translating OER educational materials aligned to standards using AI.

Empowering Teachers Through Professional Development

Participants first join the Sopala online community hosted on a MoodleCloud site where they learn to use Moodle's teaching, assessment, and collaboration capabilities. Then, these skills are transferred to the offline MoodleBox on a Raspberry Pi server. Teachers experiment with the teaching and learning features and gradually implement MoodleBox into their classrooms.

The learning process of the MoodleBox Teacher Professional Development courses focuses first on using Moodle's assessment and collaboration tools - forums and quizzes. Forums facilitate community discussions that are recorded creating a valuable knowledge archive. The asynchronous format allows teachers to share their educational innovations and experiences in a manner that fits their busy schedules. These openly licensed courses will be available when the teachers who are currently enrolled complete the courses. The Sopala Teacher Professional Development process has been ongoing since August of 2022 and is consistent with the process outlined in the 2024 publication by the World Bank,

"TPD (Teacher Professional Development) should be modeling and practice-based, provide secure learning environments, encourage discussion and critical reflection, and be teacher-led.TPD should be sustainably implemented through regular sessions, incorporate time for professional development, and align with national policies, objectives, and assessment frameworks"(Rajasekaran, 2024, p.46).

All teachers participating in Sopala have previous experience delivering professional development programs, locally, nationally, and internationally on topics such as empowerment of girls and women in education and the workforce, STEM, climate sustainability, and first language reading, writing, and translations.

Rural African schools' lack of digital tools currently leads to inconsistencies in teacher training and curriculum implementation. Using MoodleBox offline provides the same features Moodle provides in fully connected settings, allowing for consistent teacher training across regions. This enables education authorities to standardize both training and curriculum and establishes a uniform assessment method, making comparisons at any scale more accurate.

The Sopala Moodlecloud site also serves as a resource hub for teachers to search for digital OER learning materials, share OER materials, share student learning data, and access various AI tools unavailable from their remote locations. This resource hub is open-source, open-access, and easily replicable.

An essential feature of MoodleBox is its ability to provide students with digital materials translated from one language to another. In Ghana's Northern Region, Dagbani is the first language of most people, but educational materials in Dagbani, if they exist, are difficult to acquire. The African Storybook website is a key resource that addresses this Pan-African problem (African Storybook, 2024). The website has thousands of openly licensed free picture storybooks in the languages of Africa for children's literacy, enjoyment, and imagination. It also has tools to translate, adapt, and create picture storybooks for children from early childhood through the first three years of primary school as well as tools for translation. While it's possible to download and print the books on the website, using digital devices is the best method.

Peter Amoabil and Musah Fuseini, two key Sopala teachers, use African Storybook to translate books into Dagbani. Peter serves as an African Storybook ambassador to other schools in Ghana and Musah collaborates with Sopala teachers Khadijia Alhassan and Rukaya Hamidu in the Dagbani Wikimedia group led by Sadik

Shahadu (2024). While African Storybook's translation tools are not currently using AI, they are powerful and effective, with potential for broader application, as seen in interest in their use by U.S. educators.

Quality Learning Data

"The importance of producing good-quality learning data that are comparable at the global level, across countries, and over time" was highlighted in UNESCO's *Reporting learning outcomes in basic education: Country's options for indicator 4.1.1* (UNESCO, 2022).

Currently, in most rural African classrooms, teachers write assessment questions on the chalkboard, with students responding verbally or on paper. This method limits the use of assessments for formative purposes, hindering broader educational progress. Sopala Teacher Professional Development enables teachers to use assessments more effectively, access and reflect on data at any time, and enables educational institutions to deliver comparative assessments across different regions. Models to monitor the progress of individual students, classrooms, schools, districts, and regions are being developed.

MoodleBox's automated scoring enables efficient implementation of both pre- and post-intervention assessments and saves valuable teacher time. The team continues to examine best practices for how AI can enhance Moodle quizzes and forum discussions. Some questions to explore are: whether to modify questions for post-assessments or use identical ones to measure learning growth, what types of multiple-choice questions are most effective, and whether or not quizzes should be timed.

Sopala's overall approach to assessment is consistent with the recommendations of the recent UNESCO Institute for Statistics report on how a country can produce comparable data for the *Strategic Development Goal, Indicator 4.1.1*. The four listed principles to guide the choice of learning measurement are: 1. Build on existing capacity; 2. Allow flexibility to ensure alignment with country needs (not one-size-fits-all.); 3. Foster country ownership through a demand-driven approach; 4. Ensure data is relevant for decision-making (UNESCO, 2022, p.24). Relying on teachers to design and drive the innovations, Sopala's process aligns with all four recommendations. The Sopala community of education practitioners will continue to explore the effective implementation of open-source tools, openly licensed content, and ways that AI can be used to enhance each to determine what works in remote classrooms without internet connectivity.

Translations, Partnerships, and Collaborative Development

Sopala supports using offline repositories like Kiwix, a browser that allows users to access web content, such as Wikipedia, without an internet connection by downloading and locally storing highly compressed copies of websites onto phones or computers. Kiwix, a nonprofit organization, is a free and open-source software project with over 10 million users worldwide (Offline Internet Consortium, 2024). Combining MoodleBox with offline-first repositories like Kiwix adds Moodle's assessment and collaboration tools to the curated content tailored to local standards. Offline-first efforts have traditionally focused on content delivery. When teachers

are familiar with using a remote server, they can now go further with MoodleBox —refining content, assessing student learning, and comparing educational practices across various settings.

Sopala is exploring the most effective AI tools for teacher training, creating student assessments, and translating materials. Due to rapid changes in AI, the project remains adaptable, selecting the best tools for teaching and learning in each context. The focus is consistently on free, open AI tools whenever possible and on developing AI specifically for educational purposes. A key feature being developed is an AI referral resource that guides teachers in choosing the most practical tool for each task. This empowers teachers to match AI tools that will best benefit their students, makes teachers central to AI implementation, and ensures the validity and effectiveness of applications.

Innovations in teaching methods, materials, and technology—open-source or not—can only succeed when teachers drive their design and development. Ensuring quality requires careful attention to local traditions, perspectives, and aspirations. Researching student learning also depends on understanding local contexts, with easy and open access to student learning data essential for gaining meaningful insights.

Sopala teachers are currently using AI tools like ChatGPT and Google Translate to develop additional openly licensed learning materials. Both have been used to create math assessments aligned with Ghanaian education standards. Google Translate has been used to translate a kindergarten book from English to isiXhosa. The example at the top of this Sopala page, *Ingonyama Iyabaleka Kwaye Inkomo Iyahamba*, was translated by Dan McGuire using Google Translate and edited by Nomvuyo Mgoqi, a speaker of isiXhosa and Founder and Director of Khulisani Child Development Academy in Langa Township, Western Cape, South Africa.

An AI plugin for Moodle developed by Digital Umuganda for in-course language translation is being explored as a promising innovation. This would expand teaching and learning capabilities and leverage the ongoing work of Sadiq Shahadu and Musah Fuseini and their projects, Common Voice and Dagbani NLP. The plugin currently supports a machine translation model fine-tuned for English-Kinyarwanda. Still, other contributors can reuse the plugin and multilingual model to change language pairs to their preference and/or target audience (Rutunda, 2024). Sopalla and Digital Umuganda are coordinating this work with GIZ's FAIR Forward-Artificial Intelligence for All; an initiative that facilitates the provision of open, non-discriminatory, equitable, and inclusive training data models and open-source AI applications (GIZ, 2024).

Another development involves collaboration with Philipp Leitner, a learning analytics expert from the Technical University of Graz, Austria. His team has published research on using Moodle to assess students' emotional and attitudinal well-being, which is crucial for monitoring student mental health and guiding both teachers and students to appropriate resources (Barreiros, C., 2023). Sopala, Philipp, and his team are investigating how to modify the application for K-12 students in classrooms without internet access.

Education researchers have found that “technology-related teaching skills are important for teachers to initiate different forms of active learning in students, especially those related to deep learning processes that are necessary for complex skill acquisition,”(Lohr, 2024, p.10) Sopala is developing offline virtual teacher training courses so teachers can practice using the digital tools and provide feedback on AI-generated virtual student work. These OER virtual courses will be able to be varied by grade level, achievement level within grades, and discipline. Teachers will hone their skills using digital tools before implementing the offline technology in their classrooms.

Conclusion

When teachers demonstrate success in their classrooms as Peter has in his classroom, we can document these practices and develop them into shareable policies. Much effort by foundations and philanthropy has been directed at creating policies at various levels of government and institutions. The problem is very few administrators at any level of government or in institutions anywhere, least of all African governments, understand how to implement OER or Open Education in classrooms equitably and effectively. It’s impractical to assume that great policies and strategies created by governments by themselves will lead to practitioners knowing how to implement the policies and strategies especially when the policies and strategies are too often based on what worked in radically different contexts.

Equity and inclusivity can only be achieved by developing solutions that work for everybody. Kiwix and the other offline repositories have begun the necessary groundwork. Now, it’s time to offer a more complete set of capabilities by adding assessment and collaboration on student-centered content aligned to national standards and capable of being validly compared in all settings. Statistics on student learning or the effectiveness of education will only be meaningful when the data is collected from everyone in all locations and when it is representative of all people and cultures. The Sopala collaborative of AI-enhanced OER innovation and professional development makes improving educational outcomes for all students possible, equitable, replicable, sustainable, and culturally meaningful.

The authors used free versions of ChatGPT, Claude, Grammarly, and Otter to assist with sentence revision.

Header image source: Issah, S. (2024). MAIZE [Photograph in Kanvilli Nuriya Primary School] Sopala. Retrieved Jan. 18, 2025 from https://sopala.org/

The photographer is Sulemana Issah - Grade 5 Kanvilli Nuriya Primary School. The picture appears in the book, *Kanvilli Nuriya Primary School*, which centers around students of Peter Amoabil’s class using tablets to respond to the prompt “Tell us a story about the natural environment around your school. The book has been published on African Storybook in Dagbani and printed out with both English and Dagbani on each page. Before Peter handed the students a WiFi tablet, most had rarely held an electronic device in their hands. There are no TVs in any of their homes; most of their parents do not have cell phones, some parents have scooters, most use bicycles. Peter says 'too much screen time' has never been a concern of any of the parents. They recognize that WiFi tablets are how their kids will see and become literate in their language.

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