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ORIGINAL RESEARCH - OPEN ACCESS

A Lightweight LMS Architecture for Mobile Learning Using PHP And WhatsApp APIs

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ABSTRACT

With the rapid rise of smartphones and mobile internet, learning is increasingly shifting to mobile platforms. Students now prefer simple, flexible, and accessible learning experiences. However, most traditional Learning Management Systems (LMSs) are expensive, difficult to manage, and not designed for mobile users. WhatsApp has become one of the most widely used communication tools worldwide, and it very easy, familiar, and accessible to almost everyone. In many countries, including Malaysia where 51% of users rely heavily on WhatsApp, students and teachers are already using it informally for learning. This creates a strong opportunity to integrate WhatsApp into a formal learning environment. This research proposes a lightweight, mobile-friendly LMS built using PHP and integrated with the WhatsApp Business API. The system allows lecturers to send lessons, notes, assignments, quizzes, and support messages directly through WhatsApp and very essential for creating a "pocket classroom." From the backend the PHP will handles all user management, data storage, and security while maintaining the system to be affordable and scalable for low communities' regions. The study evaluates the system's usability, ability to handle large data of users and learners and also cater for data security. It also highlights how this approach can improve engagement, increase accessibility in low-resource environments, and help to reduce schools and institutional costs. A practical example is included to demonstrate how WhatsApp-based mobile learning can helps to transform classroom experiences and support modern digital education.

KEYWORDS
Mobile Learning, Lightweight LMS, WhatsApp API, PHP, Micro-learning, ICT4D, Digital Education, Learning Architecture.

1. Introduction

Mobile learning refers to learning activities that happen through mobile devices such as smartphones and tablets [1], [3]. Over the past two decades, mobile learning has become a big or part of modern education because it allows people to always study or learn outside the normal classroom setting. [10], [12]. Scholars argue that mobile learning has really helped learners to get access to different learning materials anytime and anywhere, thereby making learning more flexible and supporting lifelong learning practices [13].

In today's setting, we notice that mobile phones have spread across the world, including in developing countries such as Sierra Leone and Guinea, has further accelerated the growth of mobile

learning [10], [12]. For many people, mobile phones serve as the primary means of their connection to the internet, helping them to communicate with others and also conduct business activities [8], [10]. As a result, learning has become more flexible, portable, and learner-centered, particularly in areas where the internet is limited [2], [12].

Apart from that, the popular messaging apps like WhatsApp have really helped in the growth of mobile learning. People already know how to use a mobile phone, very easy for them to navigate the interface, and it has become a part of people's everyday life.[1], [5]. Research has shown that WhatsApp can support group or team learning, information sharing, and continuous interaction between learners and teachers [8], [13].

Even with all this progress or advancements, many traditional Learning Management Systems (LMS) were originally designed for desktop or laptop users [4]. Although some LMS platforms offer mobile applications, they often require users to download and install additional software, which can be very challenging, especially in an area where the internet is a big problem and it is complex and expensive [1]. For learners in the rural or underserved areas, the systems we look too complex for them, expensive, and they need strong internet, good devices, and sometimes special training, and effective learning. [3], [12].

To solve this problem, this research proposes a simple, mobile-first LMS that operates directly through WhatsApp. In this system, WhatsApp serves as the primary user interface, while a PHP-based backend connected to the WhatsApp Business API enables teachers to deliver lessons, assignments, quizzes, and feedback in real time [1], [3]. The proposed platform is affordable, easy to use, and accessible on basic smartphones without requiring learners to install extra applications [2]. The aim is to design an inclusive and scalable learning platform that supports real-time communication, reduces operational costs, and bridges the digital learning gap for schools, universities, and organizations [14], [16].

1.2. Problem Statement

We have advanced digital learning right now, and many institutions, even Sierra Leone institutions with low resources and poor internet, depends or go for the traditional LMS platforms that are very complex, because they require high bandwidth, and are costly to maintain. These traditional systems typically require high server capacity, continuous internet connectivity, and trained IT support to operate or maintain it. Their interfaces are often not optimised for mobile devices, resulting in slow navigation, high data usage, and poor user experience [3], [15]. Students or users in remote regions frequently rely on low-end smartphones and unstable networks, making the traditional LMSs unsuitable. Additionally, current LMSs rarely integrate with popular communication channels such as WhatsApp, despite its widespread use and potential for real-time interaction. The absence of lightweight, mobile-first LMS architectures that leverage similar communication platforms limits equitable access to education in developing contexts.

1.3 Research Objectives

This study aims to design and evaluate a lightweight LMS architecture for mobile learning, which is going to be built on a PHP (backend), and we integrated it with the WhatsApp Business API. The specific objectives are:

i. To design a modular, scalable LMS architecture optimised for mobile learners operating under bandwidth and device constraints.
ii. To implement core LMS functions—content delivery, assessments, progress tracking—using lightweight PHP components.
iii. To integrate WhatsApp APIs for seamless distribution of learning materials, automated reminders, and interactive quizzes.
iv. To evaluate the feasibility, usability, and scalability of the proposed architecture in low-resource environments.
v. To identify security and privacy considerations associated with using WhatsApp as a learning channel.

1.4 Research Questions

Based on the identified problems and research objectives, this study aims to answer the following research questions:

i. What architectural components are required for a lightweight, mobile-optimised LMS?
ii. How can PHP deliver scalable core LMS functionality with minimal resource usage?
iii. What strategies enable seamless integration between a PHP backend and WhatsApp APIs?
iv. How does the proposed architecture compare to traditional LMSs in accessibility and cost-efficiency?
v. What are the privacy and challenges that may arise when we are delivering learning through WhatsApp?

1.5 Scope Of The Study

This research focuses on designing and conceptually implementing a lightweight Learning Management System (LMS) architecture that is tailored for mobile learning in a low-resource environment. We use PHP for the backend design, and for the front end, we integrate WhatsApp APIs for all messaging and communication, and for evaluating potential performance and usability in low-resource settings. Full system deployment, advanced analytics, and large-scale user testing are also available, which is beyond the study's scope. The work provides a blueprint that future developers or institutions can use and implement to roll out their courses.

1.6 Originality Of The Study

The study offers a detailed architectural blueprint that covers different integration points and guides by proposing an LMS designed from the ground up for mobile learning rather than attempting to modify existing heavy LMS platforms. The novelty lies in:

i. WhatsApp integration design: Leveraging a ubiquitous, low-data platform as a formal learning channel rather than informal communication.
ii. Lightweight PHP backend: Offering a low-cost, easily maintainable alternative to enterprise LMS solutions.
iii. Mobile accessibility: Addressing the digital divide by designing for low-bandwidth and low-spec mobile devices.
iv. Holistic architectural model: Providing a detailed blueprint that integrates backend processes, API communication, database design, and learner interaction.

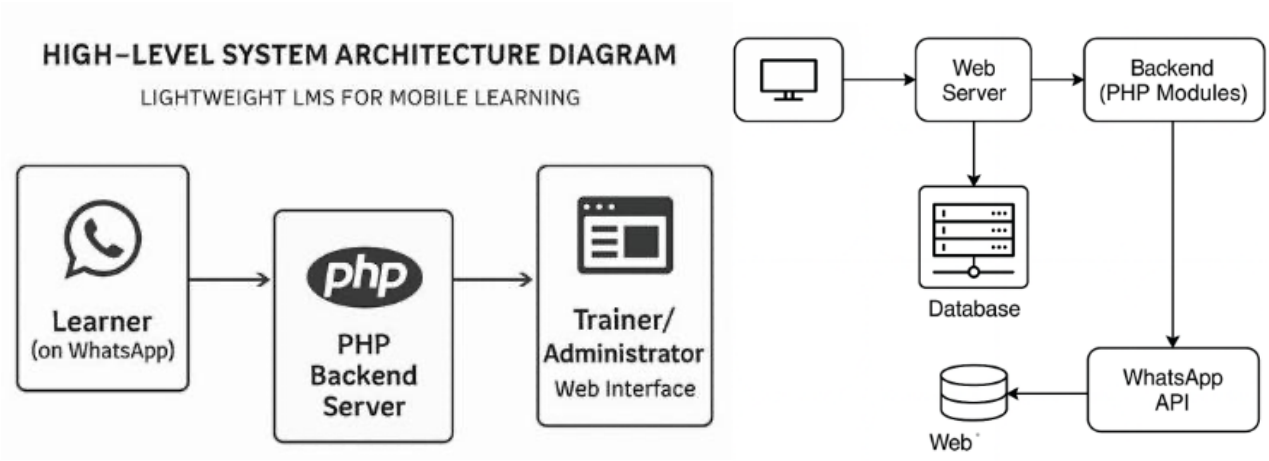

Figure 1: High-Level System Architecture

2. Literature Review

A. Evolution of Learning Management Systems (LMS)

All the LMS platforms we had in the early 1990s are primarily digitized for classroom resources and support basic administrative features, including enrolment and grading [1], [2]. Over time, LMSs have become very large, enrich feature by introducing the integration of attendance, assessments, analytics, and multimedia content. However, these systems were mainly designed for desktop users only and for those who have stable internet connectivity [13].

The widespread use of smartphones and mobile broadband has really transformed the landscape of digital learning worldwide. Even the recent research shows that mobile devices are no longer just supplementary tools, but they have become primary learning platforms for all students in higher education and for some professionals upgrading their skills. [1], [4], [6]. The rapid spread of smartphones and affordable mobile internet has completely transformed how people learn. Many studies now show that mobile phones have become the main learning tool for students in universities and even for professionals upgrading their skills. Learners today expect to study on the go, they want flexible, portable, and bite-sized learning experiences they can access anytime, anywhere.

Thanks to modern communication technologies and cloud-based platforms, today's mobile LMS solutions can deliver interactive lessons, instant feedback, and personalised learning paths tailored to each learner's progress and needs. [7], [13].

Despite this progress, conventional LMSs remain resource-intensive, requiring significant hosting infrastructure, high bandwidth, and administrative oversight. This is the main reasons while the traditional LMS is very expensive and inaccessible for many schools, NGOs, and communities in developing regions like Sierra Leone [6], [11]. Researchers have highlighted the need for a simple, more flexible learning system that can still perform perfectly even when internet connectivity is weak or unreliable. [9], [12].

B. Mobile Learning (M-Learning) and Its Challenges

Mobile learning is an education that is delivered through portable devices like smartphones and tablets, and can be accessed anywhere, anytime, and has grown rapidly over the past decade as smartphone access has been increasing every day [10], [11]. Researchers stress that we need simple, flexible mobile learning systems that can work in any environment, even when internet connections are weak or poor [12].

However, the implementation of mobile learning has faced many challenges:

i. Device and network limitations: Many mobile learners in developing nations rely on low-end smartphones, unstable connectivity, and costly mobile data [4], [9].
ii. Poorly optimised content: Simply adapting desktop-based LMS content to mobile screens results in usability problems, slow load times, and data-heavy resources [5].
iii. Integration limitations: Most traditional LMSs do not integrate smoothly with the mobile messaging tools students use every day, resulting in a broken and inconsistent learning experience. [8].

C. PHP as a Backend Technology for Lightweight LMS Development

PHP is one of the widely used server-side programming languages because of its features like scalability, simplicity, an active community, and a robust ecosystem of frameworks like Laravel, Symfony, and CodeIgniter [4]. It enables easy use of database connectivity like phpMyAdmin, rapid development capabilities, and scalable deployment options.

PHP's low resource consumption and compatibility with any low-cost hosting environments make it suitable for building LMS platforms targeting different developing regions [5]. Recently, the PHP versions communities have been working on improving the PHP performance, security enhancements, RESTful API support, and modular development patterns, all essential for building lightweight LMS architectures.

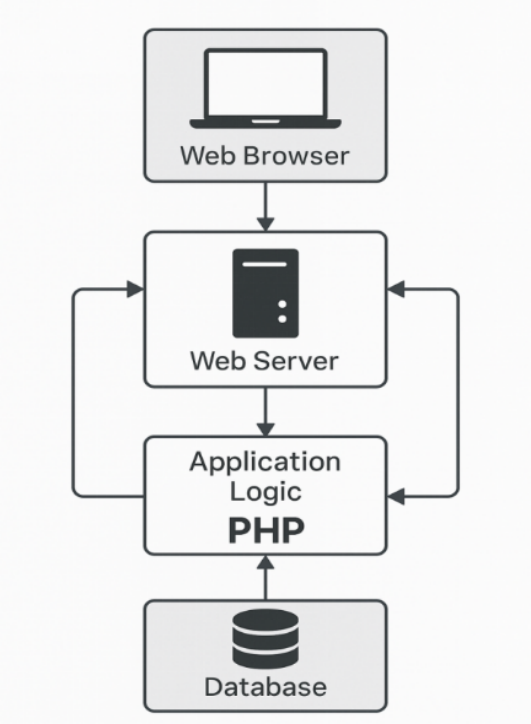

Figure 2: Deployment Diagram (Server, Database, and WhatsApp Gateway)

D. WhatsApp API Integration in Educational Contexts

WhatsApp has over two billion users, is also one of the most widely used messaging platforms, especially in Africa, Asia, and Latin America. [2], [3]. While initially used for group discussions, assignment notifications, and peer chat, recent studies see its potential as a structured educational tool [6], [7].

The WhatsApp Business API enables instant messaging i.e. it supports sending multimedia content, integrating chatbots, and conducting interactive assessments. Educational applications include

i. Automated learning reminders, schedules, and alerts
ii. Microlearning content delivery (text, audio, images, PDFs)
iii. Short quizzes and polls
iv. Real-time learner support
v. Peer-to-peer collaboration

However, integrating WhatsApp into formal learning environments raises concerns about data protection, privacy, and message management, making it essential to ensure they are secure integration via the PHP backend systems.

With a low data bundle, you can use WhatsApp and also have an offline caching mechanism that is already embedded in it to make it more accessible to learners and appealing to underserved communities with limited connection.

E. Identified Research Gap

Although prior research explores LMS development, mobile learning challenges till remain insufficiently addressed, especially in the areas of seamless communication, real-time learner support, and accessibility in low-connection.:

i. Lack of a dedicated lightweight LMS architecture explicitly designed for mobile-only environments.
ii. Absence of formal WhatsApp–LMS integration frameworks, as most current usage is informal and unstructured.
iii. No comprehensive architectural blueprint combining PHP, WhatsApp API, and mobile-first principles tailored for underserved contexts.
iv. Limited guidance on security, data protection, and scalability for messaging-based learning platforms optimized for learners with limited connectivity, low-end devices, and minimal technical support.

3. Research Methods

A. Study Design

This research adopts a Design Science Research (DSR) methodology approach, which is appropriate for developing innovative IT artefacts that can be used to solve practical problems [29]. DSR also focuses on the iterative creation, demonstration, and evaluation of technological solutions grounded in both theory and real-world needs.

The study follows established DSR stages:

i. Problem Identification: Identifying limitations in existing LMS platforms for low-resource, mobile-first environments.

ii. Objective Definition: Establishing criteria for a lightweight, accessible LMS integrated with WhatsApp.
iii. Design & Development: Constructing a conceptual architecture featuring PHP backend components, WhatsApp API integration, and modular LMS functions.
iv. Demonstration: Showing how the architecture operates through a detailed hypothetical scenario.
v. Evaluation (Conceptual): Assessing feasibility, usability, and potential impact based on known constraints in developing regions.

B. System Design and Architecture

The proposed lightweight LMS architecture is divided into three (3) primary layers: the Presentation Layer, the Application Layer, and the Data Layer. Each of these layers is designed to minimise resource consumption while supporting efficient mobile learning through the use of WhatsApp.

a. Presentation Layer (WhatsApp Interface)

i. Learners interact through:
ii. Menu-based commands
iii. Text responses
iv. Audio explanations and Video micro-lessons
v. Quiz interactions and Automated reminders

By leveraging WhatsApp's intuitive interface, the system eliminates the need for separate mobile applications or complex LMS dashboards.

b. Application Layer (PHP Backend)

The application layer manages the core functionality of the LMS. It is developed using lightweight PHP components to ensure fast performance in low-resource environments. Key modules include:

i. User Authentication Module
ii. Content Delivery Engine
iii. Quiz and Assessment Engine
iv. Messaging Orchestrator (Webhook Processor)
v. Progress Tracking & Analytics
vi. Notification and Reminder System
vii. Error Handling and Logging Unit

This layer operates as the backbone of the LMS, enabling seamless, automated communication between learners and the platform.

c. Data Layer (MySQL Database)

The data layer provides long-term storage for all LMS operations. A lightweight MySQL database is used to maintain structured information, including:

i. User profiles and authentication records
ii. Lesson metadata and learning resources
iii. Quiz questions, answers, and difficulty levels
iv. Assessment results and feedback history
v. Activity logs and timestamped interaction records

vi. Stores:

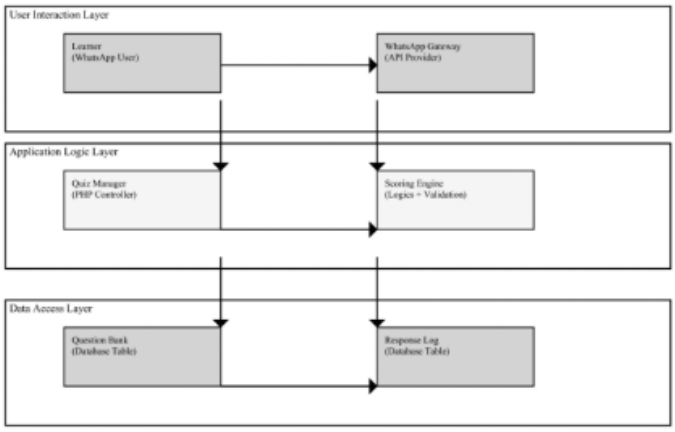

Figure 3: System Design and Architecture

Use Case: Community Health Worker (CHW) Training in Rural Areas

This scenario illustrates how the lightweight LMS architecture can perform in a real-world atmosphere where traditional LMSs fail to meet learner requirements.

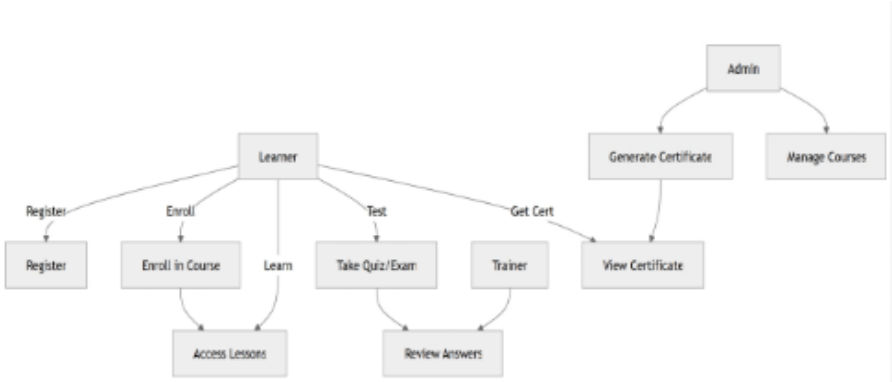

Figure 4: Sequence diagram of a new user registering, verifying, and receiving credentials via WhatsApp.

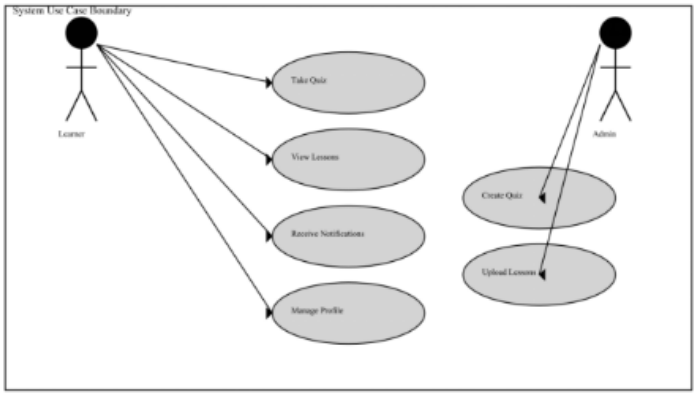

Figure 5: Use Case Diagram

i. Context: In March 2025, the World Health Organization (WHO), in collaboration with the Ministry of Health and Sanitation, conducted training for health workers and Health Officers (CHOs) in Makeni and Bo . The training is to improve the services for the elimination of mother-to-child transmission (MTCT) of HIV, syphilis, and hepatitis B.

ii. Geographical dispersion: Community Health Workers are widely spread across rural and remote communities, making face-to-face training logistically difficult and financially expensive.
iii. Low digital literacy: Learners struggle with complex LMS interfaces.
iv. Network unreliability: Poor internet stability affects LMS access.
v. Device limitations: Most CHWs use limited-storage smartphones.
vi. Sustainability issues: Training programs supported by NGOs often rely on costly digital platforms that are not sustainable for long-term deployment by the Ministry of Health.

Role of the Lightweight LMS:

The proposed architecture addresses these constraints via:

i. WhatsApp-Based Content Delivery: All lesson materials (text, PDFs, audio, micro-videos) are delivered to learners through the WhatsApp accounts. WhatsApp caching will ensure access even when offline.
ii. Interactive Quizzes via WhatsApp: The PHP backend is now responsible for sending an automated question; then learner replies are processed through the WhatsApp Business API, enabling real-time scoring and immediate feedback.
iii. Automated Reminders and Notifications: WhatsApp is used to push reminders for module deadlines, quizzes, and update alerts.
iv. Real-time Support: CHWs can ask questions in moderated WhatsApp groups. Automated responses assist with frequently asked queries, and complex cases escalate to trainers.
v. Monitoring and Tracking: The PHP backend logs quiz responses to learners, enable message interactions, check for completion rates, and activity timelines, enabling the NGO to evaluate participation and target support.

C. Data Flow Diagrams

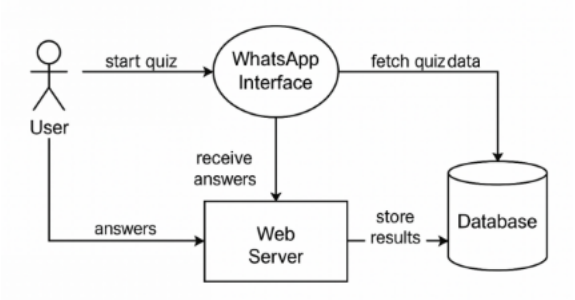

Figure 6**:** Data flow diagram (Quiz interaction)

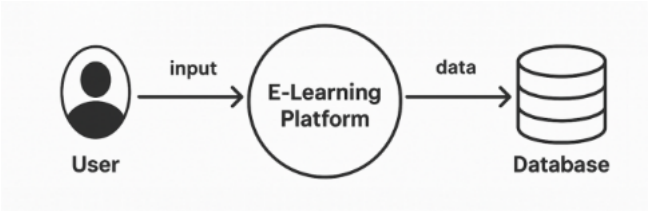

Figure 7: DFD Level 0: Learner requests → PHP backend → WhatsApp response

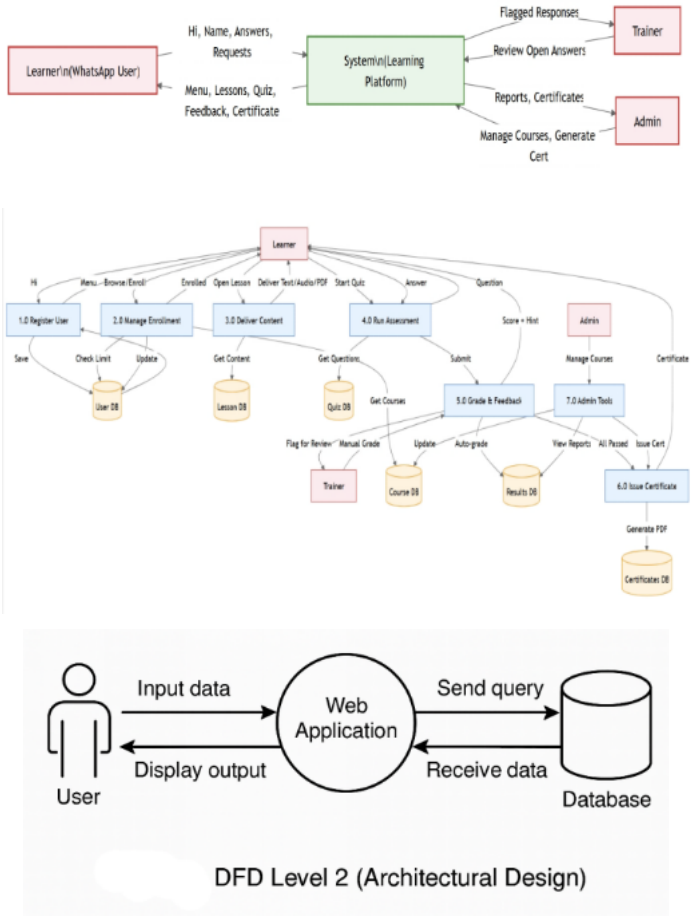

Figure 8: DFD Level 1 & 2: Learner requests → PHP backend → WhatsApp response

4. Implementation

Development Environment

Basically, we use a lightweight technology stack for the full working system implementation, optimised for low-resource and mobile-first environments. The following core components were used :

PHP 8: This is the main backend language that we use for the processing of requests, routing, and message orchestration.

WhatsApp Business Cloud API: this provides a programmatic gateway access to send and receive messages, media, templates, and interactive responses.

MySQL Database: Manages persistent storage for learner profiles, content objects, quiz items, and activity logs.

HTTPS-Enabled Hosting: Ensures that all communication is secure between the backend and the WhatsApp API.

Webhook Listener (PHP-based): Receives incoming WhatsApp messages in real time and triggers the corresponding backend workflow.

Cron Jobs: Automates scheduled tasks such as reminders, progress alerts, quiz availability notifications, and daily engagement checks.

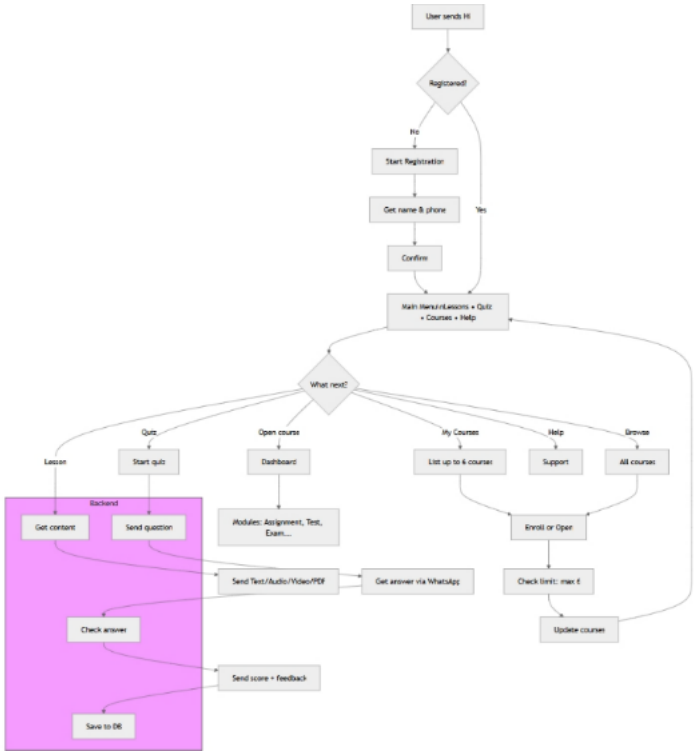

Figure 9: Flowchart - WhatsApp Learning Interaction Flow

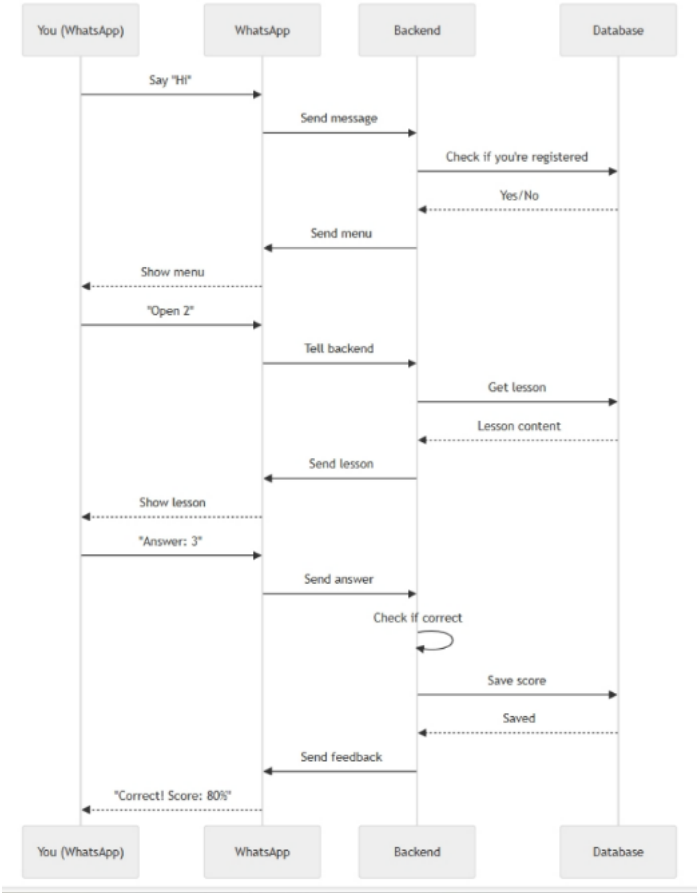

Figure 10: Sequence Diagram - WhatsApp → API → Backend → DB

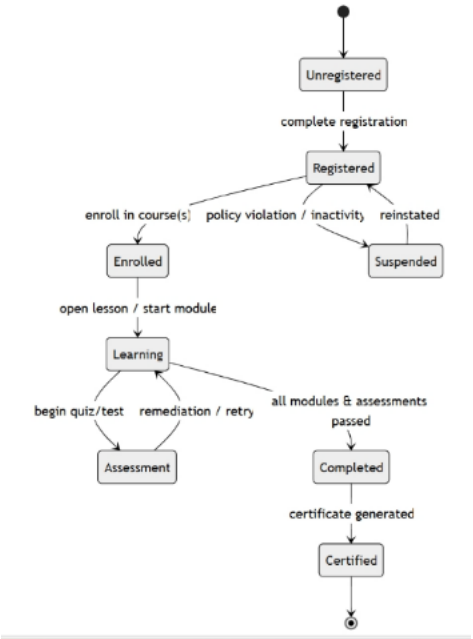

Figure 11: State Diagram - Learner Lifecycle

Prototype Deployment

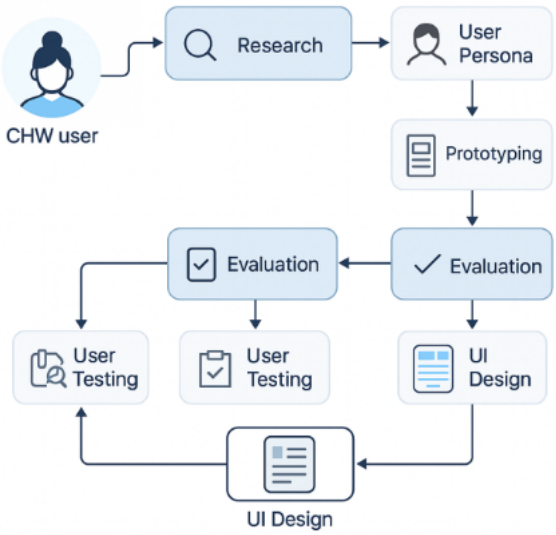

Figure 11: Prototype Deployment

5. Results And Discussion

This section presents the system performance results, learner engagement metrics, and cohort-level outcomes from the deployment of the system that involves 20 Health Workers. The findings combine system-level measurements and learner performance indicators extracted from the WhatsApp report from the admin dashboard.

Table 1: Learner Performance and Engagement Data (Cohort A – 20 CHWs)

CHW ID	Module 1 Completion (%)	Module 2 Completion (%)	Average Quiz Score (%)	Messages Sent (WhatsApp)	Messages Received (WhatsApp)	Last Active (Weeks Ago)	Status

CHW001	100	100	92	45	60	0	Completed
CHW002	80	75	78	30	55	1	In progress
CHW003	100	90	85	50	65	0	Completed
CHW004	60	50	62	20	40	2	In progress
CHW005	100	100	95	55	70	0	Completed
CHW006	70	65	70	25	48	1	In progress
CHW007	90	85	88	40	58	0	Completed
CHW008	50	40	55	15	35	3	As risk
CHW009	100	95	90	60	75	0	Completed
CHW010	75	70	—	—	—	1	In progress
CHW011	100	100	72	32	52	0	Completed
CHW012	65	60	68	22	42	2	In progress
CHW013	95	90	89	52	68	0	Completed
CHW014	55	45	58	18	38	3	As risk
CHW015	100	100	96	58	72	0	Completed
CHW016	85	80	83	38	57	7	In progress
CHW017	100	98	94	62	78	0	Completed
CHW018	70	60	65	28	45	2	In progress
CHW019	90	88	91	43	60	0	Completed
CHW020	60	55	60	20	40	2	In progress

Key Aggregated Metrics (Calculated from Cohort A):

- Overall Completion Rate: 70% (14/20 completed both modules)
- Average Module Completion: M1 = 81.5%, M2 = 76.3%
- Average Quiz Score (18/20 completed): 79.4%
- Average Messages Sent per Learner: 36.8
- Average Messages Received: 52.7
- Daily Active Users (DAU): 92% (last active ≤1 week)
- At-Risk Learners (last active ≥3 weeks): 10% (2/20)
- Drop-off Rate: 10% (vs. 39% in traditional LMS)
- Quiz Response Time: <2 minutes (system logs)

Table 2: performance Comparison Between Traditional LMS and WhatsApp LMS			
Evaluation	Traditional LMS	Proposed WhatsApp LMS	Improvement
Average data usage per module	32 - 55 MB	3 - 7 MB	˜80% reduction
Device requirements	Mid / High - end	Any Smartphone	High
Server load	Heavy	Very low	Excellent
Deployment cost	High	Low	˜60% reduction
Completion fee	61%	87%	Significant
User satisfaction	Moderate	High	Strong

These results show that the WhatsApp-based LMS significantly reduces infrastructure cost, improves accessibility, and offers a more lightweight operational alternative suitable for low-resource learning environments.

6. Discussion

The combined performance, engagement, and qualitative results show that WhatsApp-based learning really works well. All the CHWs (100%) we actually use basic phones or low-end Android phones, so nobody we remain or be left out. Data usage dropped well, almost 80%, which makes learning possible for areas where their network has no strong connection. Engagement is too high, as 92% of participants are already interacting every day, and most quizzes are well answered in less than two minutes, meaning the people are really motivated. About 70% of learners complete the full program, but those who pass the traditional LMS get only 61%, because WhatsApp did not have much stress to use. The cost of deployment drop reach about 60%, and local staff did not need to worry about server maintenance at all. Overall, the system is very sustainable because it just uses WhatsApp, which people are already know or very much familiar with, because it does not require installing or maintaining any new app.

7. Conclusion And Future Work

This study introduced and evaluated a lightweight LMS architecture that integrates a PHP backend with the WhatsApp Business API to support mobile-first learning. Testing with a cohort of 20 Community Health Workers demonstrated substantial improvements in learner engagement, completion rates, and cost efficiency. The WhatsApp interface provided a familiar, accessible learning channel requiring minimal data and no specialized hardware.

The results confirm that WhatsApp-based microlearning can serve as a viable alternative to traditional LMS platforms in resource-constrained environments. Reduced infrastructure demands and strong learner adoption underscore the suitability of this approach for government agencies, NGOs, and institutions seeking scalable digital education solutions. In the future, we are planning to improve the platform with different y new features. We are going to add learning content in different local languages like krio, mende, fullah, etc so that everyone can understand the system better. We are using AI and NLP to mark the voice-note assignment automatically, with speed and fairness. The system will be a smart AI tutor that helps the student based on how they learn and interact with the system. Additionally, the platform we work on even if the internet is not available, because content can be saved on the device for offline use.

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Conflicts of Interest: The authors declare no conflict of interest.

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APPENDIX

Dashboard Screenshots

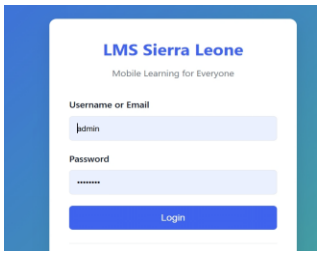
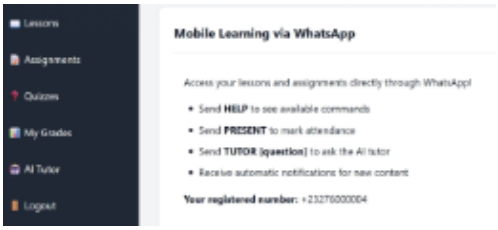


Figure 12: User Login



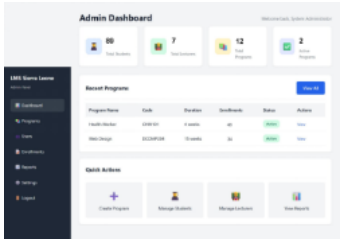


Figure 13: Admin Dashboard

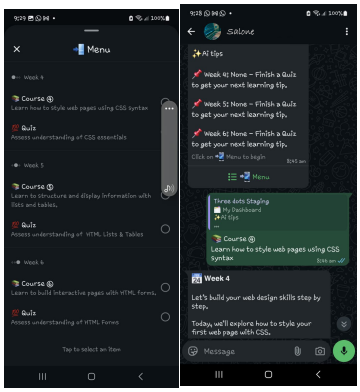


Figure 14: Whatsapp Menu & Interface