NeuroLearn – Implementation Plan

Adaptive Mastery Learning Platform for Rural Education

1. Overview

NeuroLearn is an adaptive, mastery-based learning platform designed for rural and low-resource students. The system uses a React frontend, Spring Boot backend, and JSON file-based storage. It provides personalized quizzes, mastery tracking, adaptive difficulty adjustment, and offline learning support.

2. Objectives

• Provide personalized adaptive learning

• Enable mastery-based progression

• Support offline-first education

• Ensure low infrastructure requirements

• Allow future scalability to database systems

3. System Architecture

Frontend (React) → REST APIs → Backend (Spring Boot) → JSON File Storage

4. Backend Implementation

Dependencies: Spring Web, Lombok (optional), Spring Boot DevTools, JUnit.

Data Persistence: Custom JsonRepository reads and writes data to JSON files such as users.json, quizzes.json, attempts.json, and mastery.json.

Core Services

AuthService: Handles registration and login validation.

QuizService: Calculates Mastery Percentage as the average of the last three quiz scores. Adjusts difficulty based on mastery (>80% increase, 50–80% maintain, <50% decrease).

MasteryService: Computes Growth Index (Current Mastery - Previous Mastery) and schedules retention practice accordingly.

5. Frontend Implementation

Framework: React with Vite.

Styling: Vanilla CSS with responsive modern design.

Offline Support: Quizzes cached in localStorage. Attempts stored offline and synchronized upon reconnection.

6. Testing & Verification

Automated Testing:

• JUnit for backend logic validation and JSON file integrity.

• Jest and React Testing Library for frontend components.

Manual Testing:

• Register/Login and verify JSON updates.

• Complete 3 quizzes and verify mastery calculation.

• Test offline mode and synchronization after reconnection.

7. Scalability Plan

The current JSON-based storage is suitable for prototype deployment. Future upgrades can replace JsonRepository with MySQL or MongoDB without modifying service logic.

8. Expected Impact

NeuroLearn aims to improve engagement, retention, and accessibility of education for rural students through adaptive mastery-based learning and low-cost deployment.