LineByLine: Platform Vision Document

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# LineByLine: A Platform for Real Language Acquisition

**Version 1.0** | October 2025  
*“Language learning that respects science, not engagement metrics.”*

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## Executive Summary

**LineByLine** is a comprehensive language learning platform built on proven acquisition methods, not dopamine loops. Unlike Duolingo’s gamification-first approach, we prioritize:

* **Comprehensible Input** (Krashen’s i+1 hypothesis)
* **Spaced Repetition** (FSRS algorithm for optimal retention)
* **Output Practice** (speaking & writing with immediate feedback)
* **Real-world content** (not isolated sentences)
* **Community learning** (collaborative decks, shared progress)

### Tech Stack

| Layer | Technology | Purpose |
| --- | --- | --- |
| **Frontend** | Next.js (React) | Fast, SEO-friendly, PWA-ready |
| **Backend** | ASP.NET Core | Robust API, auth, data management |
| **ML/AI Engine** | Python (FastAPI + gRPC) | FSRS scheduling, speech processing |
| **Cache/Queue** | Redis | Session state, real-time features |
| **Database** | PostgreSQL | User data, decks, progress |
| **Deployment** | Docker + Compose | Consistent dev/prod environments |

### Key Differentiators

1. **Git-like deck versioning** — fork, commit, merge vocabulary sets
2. **FSRS 4.5 algorithm** — scientifically optimal review scheduling
3. **Modular skill system** — master one skill at a time
4. **Comprehensible input engine** — content adapts to your exact level
5. **Community-driven content** — subscribe to expert-curated decks

## The Problem: Why Traditional Apps Fail

### The Duolingo Trap

| What They Do | Why It Fails | Science Says |
| --- | --- | --- |
| **Gamification > Learning** | Streaks become the goal, not fluency | Extrinsic motivation fades; intrinsic motivation (understanding) lasts |
| **Isolated sentences** | “The apple is red” teaches nothing useful | Languages need context (usage-based theory) |
| **Translation exercises** | Thinking through L1 slows acquisition | Direct L2 → meaning mapping is faster (Krashen) |
| **Fixed review intervals** | Same timing for everyone | Individuals forget at different rates (Ebbinghaus curve varies) |
| **No output practice** | Passive recognition ≠ active recall | Output forces deeper processing (Swain’s Output Hypothesis) |

### What Learners Actually Need

Based on research from: - **Stephen Krashen** (Input Hypothesis) - **Paul Nation** (Vocabulary acquisition) - **Merrill Swain** (Output Hypothesis) - **Robert Bjork** (Desirable Difficulties)

**Successful acquisition requires:**

1. **Massive comprehensible input** (listening/reading at i+1 level)
2. **Spaced, interleaved practice** (not massed repetition)
3. **Forced output** (speaking/writing with feedback)
4. **Emotional engagement** (stories, not sentences)
5. **Autonomous learning** (learner controls content & pace)

## Our Solution: Evidence-Based Learning

### The LineByLine Method

┌─────────────────────────────────────────────────────────┐  
│ INPUT (60% of time) │  
│ ├─ Listening: Podcasts, dialogues (with/without subs) │  
│ └─ Reading: Graded texts, authentic articles │  
├─────────────────────────────────────────────────────────┤  
│ VOCABULARY (25% of time) │  
│ └─ FSRS-scheduled flashcards with context sentences │  
├─────────────────────────────────────────────────────────┤  
│ OUTPUT (15% of time) │  
│ ├─ Speaking: Shadowing, conversation practice │  
│ └─ Writing: Sentence construction, journaling │  
└─────────────────────────────────────────────────────────┘

### Why This Works

1. **Input-driven** — 60% focus on listening/reading builds intuition
2. **Context-rich** — vocabulary taught in sentences, not isolation
3. **Personalized spacing** — FSRS adapts to YOUR memory
4. **Output forces consolidation** — speaking/writing reveals gaps
5. **Intrinsic motivation** — progress measured in comprehension, not XP

## Core Philosophy & Learning Principles

### 1. Comprehensible Input (i+1)

**Definition:** Expose learners to content slightly above their current level.

**Implementation:** - **Reading Module:** Texts auto-graded by known vocabulary % - Green: 98%+ known words (easy practice) - Yellow: 90-97% known (optimal learning zone) - Red: <90% known (frustration zone) - **Listening Module:** AI adjusts speech rate (0.7x → 1.3x) - **Vocabulary Module:** New words appear in familiar sentence structures

**Example:**

Current level: A2 (knows ~1500 words)  
  
✅ Good input: "Yesterday, María went to the market and bought fresh vegetables."  
❌ Bad input: "The photosynthetic process converts solar energy into chemical energy."

### 2. Spaced Repetition (FSRS Algorithm)

**Why not Anki’s SM-2?**

| Algorithm | Release | Strengths | Weaknesses |
| --- | --- | --- | --- |
| SM-2 (Anki) | 1988 | Simple, proven | Fixed formula, no personalization |
| **FSRS 4.5** | 2023 | Machine learning, adapts per user | Requires initial calibration |

**FSRS learns:** - How quickly YOU forget specific card types - Your optimal review intervals (not averages) - Which cards need more frequent review

**Implementation:** - Python service (@inclusive) handles scheduling - Redis caches due cards for instant response - ASP.NET backend (@personal-vocab) logs reviews

### 3. Comprehensible Output

**Theory (Swain, 1985):** Producing language (speaking/writing) helps learners: - Notice gaps in knowledge - Test hypotheses about grammar - Develop fluency (automaticity)

**Our Output Tools:**

| Tool | Skill | Method |
| --- | --- | --- |
| **Shadowing** | Speaking | Repeat native audio with 0-1s delay |
| **Voice Journaling** | Speaking | 2-min daily audio diary (AI feedback) |
| **Sentence Mining** | Writing | Write 3 sentences using new vocabulary |
| **Conversation Simulator** | Speaking | AI partner adapts to your level |

### 4. Shadowing: The Ultimate Pronunciation Tool

**What is Shadowing?**

Listen to audio (speech, podcast, dialogue) and simultaneously repeat what you hear—matching: - Pronunciation - Intonation - Rhythm - Emotion

**Cognitive Benefits:** 1. **Phonological loop training** — improves working memory 2. **Prosody acquisition** — natural speech patterns 3. **Automaticity** — reduces cognitive load over time

**Implementation:**

User flow:  
1. Select audio (30s-2min clip)  
2. Listen 1x without speaking (comprehension check)  
3. Shadow 3x:  
 - First: Focus on pronunciation  
 - Second: Match rhythm/intonation  
 - Third: Add emotion/naturalness  
4. Record yourself (optional)  
5. AI compares your audio to native (pronunciation score)

**Content Library:** - Movie/TV dialogues (Friends, Breaking Bad, etc.) - TED Talk snippets - Podcast clips (news, storytelling) - Shadowing-specific lessons (minimal music, clear speech)

### 5. Desirable Difficulties (Bjork)

**Principle:** Learning should feel challenging, not easy.

**What We Avoid:** - ❌ Multiple choice (too easy, encourages guessing) - ❌ Translation crutches (prevents direct L2 thinking) - ❌ Immediate hints (robs opportunity to struggle)

**What We Embrace:** - ✅ Production (type/speak the answer) - ✅ Interleaved practice (mix vocab, grammar, listening) - ✅ Delayed feedback (think before seeing answer)

## Technical Architecture

### System Overview

┌──────────────────────────────────────────────────────────────┐  
│ FRONTEND (Next.js) │  
│ ┌────────────┐ ┌────────────┐ ┌────────────┐ │  
│ │ Vocabulary │ │ Speaking │ │ Reading │ │  
│ │ Module │ │ Module │ │ Module │ + 2 more │  
│ └────────────┘ └────────────┘ └────────────┘ │  
└────────────────────────┬─────────────────────────────────────┘  
 │ REST/WebSocket  
┌────────────────────────▼─────────────────────────────────────┐  
│ BACKEND (ASP.NET Core) │  
│ • User auth (JWT) │  
│ • Deck management (CRUD, versioning) │  
│ • Progress tracking (XP, streaks, badges) │  
│ • Social features (leaderboards, friends) │  
└────────────┬──────────────────────────┬──────────────────────┘  
 │ │  
 │ gRPC │ Redis pub/sub  
 │ │  
┌────────────▼──────────────┐ ┌───────▼──────────────────────┐  
│ AI ENGINE (Python) │ │ REDIS │  
│ • FSRS scheduling │ │ • Session cache │  
│ • Speech-to-text │ │ • Real-time updates │  
│ • Text difficulty calc. │ │ • Due card queue │  
│ • Pronunciation scoring │ │ │  
└───────────────────────────┘ └──────────────────────────────┘  
 │  
 │ PostgreSQL  
┌────────────▼──────────────┐  
│ DATABASE │  
│ • Users, decks, cards │  
│ • Review history (FSRS) │  
│ • Progress logs │  
└───────────────────────────┘

### Service Responsibilities

#### 1. Frontend (Next.js)

**Location:** line-by-line-ui/

**Features:** - Server-side rendering for SEO - PWA (offline study mode) - Real-time updates via WebSocket - Responsive design (mobile-first)

**Key Pages:**

/dashboard → Module selector, daily goal  
/vocabulary/study → Flashcard review (FSRS)  
/vocabulary/browse → Deck marketplace  
/speaking/shadow → Shadowing practice  
/reading/library → Graded texts  
/profile/stats → Progress graphs, streaks

#### 2. Backend (ASP.NET Core)

**Location:** personal-vocab/

**Endpoints:**

/api/auth → Register, login, JWT refresh  
/api/decks → CRUD, fork, commit, merge  
/api/cards → Add, edit, bulk import  
/api/study → Get due cards, submit review  
/api/progress → XP, badges, streaks  
/api/social → Friends, leaderboards  
/api/content → Texts, audio files (CDN proxy)

**Database Schema (Key Tables):**

Users → id, email, xp, streak\_count, settings  
Decks → id, owner\_id, parent\_deck\_id (for forks), visibility  
Cards → id, deck\_id, front, back, context\_sentence  
Reviews → id, card\_id, user\_id, rating, fsrs\_state  
Subscriptions → user\_id, deck\_id (following public decks)  
Content → id, type (text/audio), difficulty, language

#### 3. AI Engine (Python + gRPC)

**Location:** inclusive/

**Services:** 1. **FSRS Scheduler** - Calculates next review date per card - Updates card parameters (difficulty, stability) - Library: open-spaced-repetition/py-fsrs

1. **Speech Processing**
   * Speech-to-text (Whisper API or Azure)
   * Pronunciation scoring (phoneme comparison)
   * Voice activity detection
2. **Content Analysis**
   * Text difficulty scoring (based on frequency lists)
   * Sentence mining (extract example sentences)
   * Vocabulary extraction

**gRPC Proto Definition:**

service FSRSService {  
 rpc ScheduleCard(CardState) returns (NextReview);  
 rpc BatchSchedule(CardList) returns (ReviewSchedule);  
}  
  
service SpeechService {  
 rpc TranscribeAudio(AudioData) returns (Transcript);  
 rpc ScorePronunciation(PronunciationRequest) returns (Score);  
}

## Module Ecosystem

### Navigation Structure

┌─────────────────────────────────────────┐  
│ SIDEBAR (Persistent) │  
│ ┌─────────────────────────────────┐ │  
│ │ 📚 Vocabulary │ │  
│ │ 🎤 Speaking │ │  
│ │ ✍️ Writing │ │  
│ │ 📖 Reading │ │  
│ │ 🎧 Listening │ │  
│ │ ──────────────────── │ │  
│ │ 📊 Progress │ │  
│ │ 👥 Community │ │  
│ │ ⚙️ Settings │ │  
│ └─────────────────────────────────┘ │  
└─────────────────────────────────────────┘

## Vocabulary Module

### Overview

The foundation of language learning—spaced repetition flashcards powered by FSRS.

### Features

#### 1. Deck Management

**Personal Decks:** - Create custom decks (e.g., “Business Spanish”, “Anime Vocabulary”) - Import from CSV, Anki (.apkg), or text files - Tag cards (grammar, slang, formal, etc.)

**Public Deck Marketplace:** - Browse community-created decks - Preview first 10 cards before subscribing - See creator’s study stats (credibility)

**Git-like Versioning:**

linebyline/spanish-1000-words (master)  
├─ kamil/spanish-1000-words-modified (fork)  
│ └─ Added 50 regional words  
│ └─ Fixed 3 translation errors  
└─ maria/spanish-1000-words-business (fork)  
 └─ Specialized for business contexts

**Actions:** - **Fork:** Copy deck to your account - **Commit:** Save changes with message (“Added medical terms”) - **Pull Request:** Suggest changes to original deck - **Merge:** Original creator accepts your changes

#### 2. Study Session

**Review Flow:**

1. Show card front (e.g., "La manzana")  
2. User recalls meaning (mental effort)  
3. Flip card → see back ("The apple" + example sentence)  
4. Self-rate difficulty:  
 - Again (complete blank)  
 - Hard (struggled to recall)  
 - Good (recalled correctly)  
 - Easy (instant recognition)  
5. FSRS calculates next review (30m → 3d → 2w → 4mo...)

**Card Types:**

| Type | Front | Back | Use Case |
| --- | --- | --- | --- |
| **Vocab → Meaning** | L2 word | L1 definition + sentence | Recognition |
| **Meaning → Vocab** | L1 definition | L2 word (type it) | Production |
| **Audio → Text** | Audio clip | Written word | Listening |
| **Image → Vocab** | Picture | L2 word | Direct association (no L1) |
| **Cloze** | “I \_\_\_\_ to school” | “I **went** to school” | Grammar/usage |

**Contextual Learning:** Every card includes: - Example sentence (shows word in use) - Audio pronunciation (native speaker) - Mnemonic hints (optional, user-created)

#### 3. Advanced Features

**Sentence Mining:** - Import sentences from reading/listening content - Auto-generate flashcards from highlighted words - AI suggests best context sentence

**Leech Detection:** - Cards reviewed 8+ times without progress → flagged - Suggests: rewrite card, add mnemonic, or suspend

**Heatmap Progress:**

GitHub-style contribution graph:  
  
 M T W T F S S  
 ██ ██ ░░ ██ ██ ██ ░░ ← Week 1  
 ██ ██ ██ ██ ░░ ██ ██ ← Week 2  
  
Dark = >20 cards reviewed  
Light = 1-20 cards  
Empty = 0 cards (streak broken!)

## Speaking Module

### Overview

Move from silent learner to confident speaker through progressive output practice.

### Tools

#### 1. Shadowing Studio

**Purpose:** Master pronunciation, intonation, and rhythm.

**Content Types:** - **Dialogues:** Movie/TV scenes (2-person conversations) - **Monologues:** TED Talks, speeches (1-person) - **Music:** Songs with clear lyrics (karaoke mode) - **Podcasts:** News clips, storytelling

**Interface:**

┌────────────────────────────────────────────┐  
│ 🎬 Friends S01E01 - Coffee Shop Scene │  
│ ──────────────────────────────────────────│  
│ │  
│ [====●================] 0:32 / 1:45 │  
│ │  
│ 🔊 "How you doin'?" │  
│ 👂 Listen │ 🎤 Shadow │ 📊 Compare │  
│ │  
│ Transcript (Toggle): │  
│ Rachel: "How you doin'?" │  
│ Joey: "How YOU doin'?" │  
└────────────────────────────────────────────┘

**Shadowing Modes:**

1. **Chorus Mode:** Audio + your voice simultaneously
2. **Delay Mode:** Hear phrase → repeat 1s later
3. **Solo Mode:** Muted audio, you fill the silence

**AI Feedback:** - Pronunciation score (0-100) - Highlighted mispronounced phonemes - Rhythm match (visual waveform comparison)

#### 2. Conversation Simulator

**Purpose:** Practice real dialogues without human pressure.

**How It Works:**

AI Persona: Maria (Spanish teacher, friendly, patient)  
  
Maria: "Hola! ¿Cómo estás hoy?"  
 ↓  
[You speak your response via microphone]  
 ↓  
AI transcribes + analyzes your Spanish  
 ↓  
Maria: "¡Bien! Escuché que dijiste 'estoy cansado'.   
 ¿Trabajaste mucho hoy?"

**Difficulty Levels:** - **A1:** Simple Q&A (name, hobbies, weather) - **B1:** Roleplay (restaurant, shopping, directions) - **C1:** Debate topics (politics, philosophy, ethics)

**Adaptive Conversation:** - AI detects hesitation → simplifies next question - AI detects fluency → increases complexity

#### 3. Voice Journaling

**Purpose:** Build speaking confidence through daily reflection.

**Prompt Examples:** - “Describe your day in 2 minutes.” - “What’s a childhood memory?” - “Convince me to visit your hometown.”

**AI Analysis:** - Speech rate (words per minute) - Filler words (um, uh, like) frequency - Grammar errors (auto-detected) - Vocabulary diversity (unique words used)

**Progress Graph:**

Speaking Fluency Over 30 Days  
  
150 wpm ┤ ╭─●  
 │ ╭───╯  
100 wpm ┤ ╭──●──╯  
 │ ╭──●───╯  
 50 wpm ┤ ●─●───╯  
 └────────────────────────────  
 Day 1 10 20 30

## Writing Module

### Overview

Develop written fluency from sentence construction to essay composition.

### Tools

#### 1. Sentence Builder

**Purpose:** Learn grammar patterns through guided construction.

**Exercise Types:**

**Scrambled Sentences:**

Words: [el, manzana, comí, ayer, la]  
Build: "Ayer comí la manzana."  
Feedback: ✅ Perfect! (Subject-Verb-Object order)

**Fill-in-the-Blank:**

"Gestern \_\_\_\_ ich einen Apfel." (essen)  
Answer: "Gestern aß ich einen Apfel."  
Feedback: ✅ Correct past tense (Präteritum)

**Translation (Input → Output):**

L1: "I would have gone if I had known."  
L2: [User types French translation]  
AI: Checks grammar + suggests alternatives

#### 2. Composition Studio

**Purpose:** Write longer texts (paragraphs, essays) with AI feedback.

**Workflow:**

1. Choose topic: "Describe your ideal weekend"  
2. Write freely (200-500 words)  
3. Submit for analysis  
4. Receive feedback:  
 - Grammar errors (highlighted)  
 - Vocabulary suggestions (synonyms for overused words)  
 - Structure critique (intro-body-conclusion)  
5. Revise + resubmit

**AI Feedback Example:**

Original: "I like very much pizza. Is delicious."  
  
Feedback:  
❌ Word order: "I like pizza very much." (adverb placement)  
❌ Article missing: "It is delicious."  
💡 Richer vocabulary: "I adore pizza. It's delectable."

#### 3. Daily Writing Challenges

**Purpose:** Build writing habit through micro-tasks.

**Examples:** - **Monday:** Write 3 sentences using today’s vocabulary - **Wednesday:** Describe this image in 50 words (photo provided) - **Friday:** Write a letter to your future self (100 words)

**Gamification:** - 7-day writing streak = +500 XP - Monthly challenge winner = Badge + featured on homepage

## Reading Module

### Overview

Massive comprehensible input through graded texts and authentic content.

### Features

#### 1. Library (Graded Readers)

**Content Categories:** - Short stories (5-10 min reads) - News articles (adapted for learners) - Book chapters (Harry Potter, classics in L2) - Blog posts (travel, tech, lifestyle)

**Difficulty Grading:**

AI analyzes text:  
- Known vocabulary % (based on your vocab cards)  
- Sentence complexity (clauses per sentence)  
- Grammar structures (tenses, subjunctive, etc.)  
  
Result:  
🟢 Comfortable (98%+ known words)  
🟡 Learning Zone (90-97% known)  
🔴 Challenging (<90% known)

**Reading Interface:**

┌─────────────────────────────────────────────┐  
│ 📖 El Principito - Capítulo 1 │  
│ Level: B1 | 📊 92% known words │  
├─────────────────────────────────────────────┤  
│ │  
│ Cuando yo tenía seis años vi una vez una │  
│ magnífica [lámina] en un libro... │  
│ ▲ │  
│ └─ Click word → see definition │  
│ + Add to deck (one tap) │  
│ │  
│ [Previous] [Bookmark] [Next] │  
└─────────────────────────────────────────────┘

**Interactive Features:** - **Click-to-define:** Hover any word → instant translation - **Add to deck:** Save unknown words → auto-creates flashcard - **Text-to-speech:** Hear entire text (adjustable speed) - **Progress tracking:** Bookmarks, reading time, words learned

#### 2. Sentence Mining Tool

**Purpose:** Extract vocabulary from authentic content YOU care about.

**Workflow:**

1. Paste text (article, lyrics, book passage)  
2. AI highlights words not in your deck  
3. Select words to learn  
4. AI generates flashcards with:  
 - Word + definition  
 - Original sentence (context)  
 - Audio pronunciation  
5. Cards added to deck "Mined from [Source Name]"

**Example:**

Input text: "Le chat noir dormait sur le canapé."  
  
Unknown words: canapé  
  
Generated card:  
Front: "canapé"  
Back: "sofa / couch"  
Context: "Le chat noir dormait sur le canapé."  
Audio: [🔊 native speaker]

#### 3. Parallel Texts

**Purpose:** Read L2 text with optional L1 translation side-by-side.

**Interface:**

┌──────────────────┬──────────────────┐  
│ Spanish (L2) │ English (L1) │  
├──────────────────┼──────────────────┤  
│ Era una noche │ It was a dark │  
│ oscura y │ and stormy │  
│ tormentosa. │ night. │  
│ │ │  
│ [Hidden by default → │  
│ Click to reveal if stuck] │  
└──────────────────┴──────────────────┘

**Best Practice:** - Read L2 paragraph first (comprehension test) - Only check L1 if completely lost - Goal: Wean off L1 over time

## Listening Module

### Overview

Train your ear through progressive listening challenges—from scripted dialogues to authentic podcasts.

### Tools

#### 1. Dialogue Practice

**Purpose:** Master conversational listening.

**Content:** - Coffee shop orders - Doctor appointments - Job interviews - Casual friend chats

**Exercise Flow:**

1. Listen to 30s dialogue (no text)  
2. Answer comprehension questions:  
 - "What did Maria order?"  
 - "Why is Carlos late?"  
3. Listen again with transcript  
4. Repeat until 80%+ comprehension

**Difficulty Adjustments:** - Speed: 0.7x (beginner) → 1.0x (intermediate) → 1.3x (advanced) - Accent: Standard → regional dialects - Background noise: Clean audio → café ambiance

#### 2. Podcast Library

**Purpose:** Consume authentic content for advanced learners.

**Categories:** - **Learner Podcasts:** Slow speech, clear enunciation (Coffee Break Spanish, etc.) - **Native Content:** True crime, comedy, news (real-world listening)

**Features:** - Transcript toggle (on/off) - Adjustable playback speed - Bookmarking (save position + timestamp note) - Vocabulary extraction (mine words from episodes)

**Recommended Strategy:**

Beginner (A1-A2):  
 └─ Learner podcasts only (100% comprehension goal)  
  
Intermediate (B1-B2):  
 └─ 70% learner, 30% native content (focus on gist)  
  
Advanced (C1-C2):  
 └─ 100% native content (full comprehension + idioms)

#### 3. Dictation Exercises

**Purpose:** Test listening precision.

**How It Works:**

1. Hear sentence: "Je voudrais un café, s'il vous plaît."  
2. Type what you heard (no replay)  
3. Submit  
4. AI compares:  
 ✅ Correct: 100%  
 ⚠️ Minor typo: "Je voudrais un cafe" (95%, missing accent)  
 ❌ Significant error: "Je voodray un café" (60%)  
5. Replay + see correct text

**Difficulty Levels:** - **L1:** Single sentences (8-12 words) - **L2:** Short paragraphs (50 words) - **L3:** News clips (200 words, normal speed)

## Design System: Quiet Immersion

### Philosophy

**“Learning should feel like breathing — effortless, private, and deeply satisfying.”**

**Goals:** 1. **Zero eye strain** → Dark mode default, low blue light 2. **Zero distraction** → Single-focus layouts, no clutter 3. **Zero friction** → Keyboard shortcuts, instant load times 4. **Maximum immersion** → Floating cards, spatial depth

### Color Palette

| Role | Color | Hex | Usage |
| --- | --- | --- | --- |
| **Background** | Void Black | #0a0a0a | Main canvas |
| **Card Base** | Deep Indigo Glass | rgba(30, 27, 75, 0.6) | Content containers |
| **Text (Primary)** | Frost White | #f8fafc | Body text |
| **Text (Secondary)** | Slate Gray | #94a3b8 | Labels, metadata |
| **Accent (Success)** | Soft Cyan | #67e8f9 | Correct answers, progress |
| **Accent (Warm)** | Muted Amber | #fbbf24 | XP, achievements |
| **Accent (Error)** | Soft Coral | #fb7185 | Wrong answers (not harsh red) |
| **Borders** | Dark Slate | #1e293b | Subtle dividers |

**Glassmorphism Effect:**

.card {  
 background: rgba(30, 27, 75, 0.6);  
 backdrop-filter: blur(12px);  
 border: 1px solid rgba(255, 255, 255, 0.1);  
 box-shadow: 0 8px 32px rgba(0, 0, 0, 0.4);  
}

### Typography

**Font Stack:**

body {  
 font-family: 'Inter', -apple-system, BlinkMacSystemFont, 'Segoe UI', sans-serif;  
 font-size: 16px;  
 line-height: 1.6;  
 font-weight: 400;  
}  
  
h1, h2, h3 {  
 font-family: 'Clash Display', 'SF Pro Rounded', sans-serif;  
 font-weight: 600;  
}

**Scale:** - **Body:** 16px (mobile), 18px (desktop) - **Small:** 14px (labels, metadata) - **H3:** 20px (card titles) - **H2:** 28px (page headers) - **H1:** 36px (hero text)

**Multilingual Support:** - **Arabic:** Line-height 1.8 (taller for diacritics) - **CJK:** Use Noto Sans CJK (Chinese/Japanese/Korean) - **RTL languages:** Auto-flip layout with dir="rtl"

### Layout System

**Grid:**

.container {  
 max-width: 480px; /\* Mobile-first \*/  
 margin: 0 auto;  
 padding: 1.5rem;  
}  
  
@media (min-width: 768px) {  
 .container {  
 max-width: 720px; /\* Tablet \*/  
 }  
}  
  
@media (min-width: 1200px) {  
 .container {  
 max-width: 1080px; /\* Desktop: Side-by-side modules \*/  
 }  
}

**Card Anatomy:**

.card {  
 border-radius: 20px;  
 padding: 1.5rem;  
 margin-bottom: 1.5rem;  
 transition: transform 0.2s ease;  
}  
  
.card:hover {  
 transform: translateY(-4px);  
 box-shadow: 0 12px 48px rgba(0, 0, 0, 0.6);  
}

**Spacing Scale:**

0.25rem → 4px (tight elements)  
0.5rem → 8px (form fields)  
1rem → 16px (related items)  
1.5rem → 24px (cards, sections)  
3rem → 48px (major sections)

### UI Components

#### 1. Flashcard (Vocabulary Module)

<div className="flashcard">  
 <div className="flashcard-front">  
 <h2>La manzana</h2>  
 <button className="audio-btn">🔊</button>  
 </div>  
   
 <div className="flashcard-back">  
 <p className="definition">The apple</p>  
 <p className="context">"Comí una manzana ayer."</p>  
   
 <div className="rating-buttons">  
 <button className="rating rating-again">Again</button>  
 <button className="rating rating-hard">Hard</button>  
 <button className="rating rating-good">Good</button>  
 <button className="rating rating-easy">Easy</button>  
 </div>  
 </div>  
</div>

**Visual:**

┌─────────────────────────────────┐  
│ │  
│ La manzana 🔊 │  
│ │  
└─────────────────────────────────┘  
 ⬇️ (flip animation)  
┌─────────────────────────────────┐  
│ The apple │  
│ "Comí una manzana ayer." │  
│ │  
│ [Again] [Hard] [Good] [Easy] │  
└─────────────────────────────────┘

#### 2. Progress Vine (Persistent UI Element)

**Concept:** A growing vine (SVG) on the left sidebar that visualizes long-term progress.

<svg id="progress-vine" width="60" height="100%">  
 <path   
 d="M30,0 Q40,100 30,200 Q20,300 30,400"  
 stroke="#67e8f9"  
 stroke-width="3"  
 fill="none"  
 stroke-dasharray="1000"  
 stroke-dashoffset="800"  
 <!-- Animates as user progresses -->  
 />  
   
 <!-- Leaves = milestones (10 cards, 50 cards, 100 cards) -->  
 <circle cx="30" cy="100" r="8" fill="#10b981" />  
 <circle cx="30" cy="200" r="8" fill="#fbbf24" />  
</svg>

**Growth Logic:** - Vine height = Total XP / 100 - Leaf appears every 1000 XP - Vine color shifts: Cyan (beginner) → Emerald (intermediate) → Gold (advanced)

#### 3. AI Avatar (Bottom-Right Corner)

**Purpose:** Subtle companion that reacts to user actions.

**Appearance:** - 2.5D stylized face (SVG-based) - Minimal features (eyes, smile) - Soft glow around avatar

**Reactions:** | Event | Avatar Response | |——-|—————-| | Correct answer | Eyes close briefly (contentment), smile widens | | Wrong answer | Head tilts (empathy), no judgment | | Streak milestone | Subtle sparkle animation | | Session complete | Gentle nod, eyes glow cyan |

**Implementation:**

<div className="ai-avatar">  
 <svg viewBox="0 0 100 100">  
 <!-- Eyes (animate based on state) -->  
 <circle cx="35" cy="40" r="8" fill="#67e8f9" className="eye-left" />  
 <circle cx="65" cy="40" r="8" fill="#67e8f9" className="eye-right" />  
   
 <!-- Smile (path morphs) -->  
 <path   
 d="M30,60 Q50,70 70,60"   
 stroke="#f8fafc"   
 stroke-width="3"  
 fill="none"  
 className="smile"  
 />  
 </svg>  
</div>

#### 4. Daily Goal Widget

┌─────────────────────────────────────┐  
│ Today's Goal: 20 cards │  
│ │  
│ ████████████░░░░░░ 60% (12/20) │  
│ │  
│ 🔥 3-day streak │  
└─────────────────────────────────────┘

### Micro-Interactions

**1. Card Flip Animation:**

.flashcard {  
 transition: transform 0.6s;  
 transform-style: preserve-3d;  
}  
  
.flashcard.flipped {  
 transform: rotateY(180deg);  
}

**2. Correct Answer Pulse:**

@keyframes success-pulse {  
 0% { transform: scale(1); }  
 50% { transform: scale(1.05); box-shadow: 0 0 20px #67e8f9; }  
 100% { transform: scale(1); }  
}  
  
.card.correct {  
 animation: success-pulse 0.3s ease;  
}

**3. Haptic Feedback (Mobile):**

// On correct answer  
navigator.vibrate(30); // Short tick  
  
// On wrong answer  
navigator.vibrate([50, 100, 50]); // Double tap  
  
// On milestone  
navigator.vibrate([100, 50, 100, 50, 200]); // Celebration pattern

**4. Spatial Audio:**

const audio = {  
 correct: new Audio('/sounds/chime-soft.mp3'), // 440Hz, 0.2s  
 incorrect: new Audio('/sounds/thud-soft.mp3'), // 220Hz, 0.3s  
 milestone: new Audio('/sounds/bell-warm.mp3'), // Harmonious chord  
};  
  
audio.correct.volume = 0.3; // Subtle, not jarring

### Accessibility

**WCAG AAA Compliance:** - **Color contrast:** 4.5:1 minimum (body text) - **Focus indicators:** 3px cyan outline on interactive elements - **Keyboard navigation:** Tab through all actions - **Screen reader:** ARIA labels on all icons/buttons

**Reduce Motion:**

@media (prefers-reduced-motion: reduce) {  
 \* {  
 animation-duration: 0.01ms !important;  
 transition-duration: 0.01ms !important;  
 }  
}

**Font Scaling:** - Respect user’s OS font size setting - Allow in-app text size adjustment (Settings)

### Performance Targets

| Metric | Target | Why |
| --- | --- | --- |
| **First Contentful Paint** | < 1.2s | User sees content fast |
| **Largest Contentful Paint** | < 2.5s | Main content loaded |
| **Time to Interactive** | < 3.0s | User can act quickly |
| **JavaScript Bundle** | < 150KB | Fast on 3G networks |
| **Image Optimization** | WebP, lazy load | Reduce bandwidth |

**Optimization Strategies:** - Code splitting per module (load Vocabulary separate from Speaking) - Service worker for offline caching - CDN for audio/image assets - Database query caching (Redis)

## Gamification Strategy

### Philosophy

**“Gamification should reward learning, not just logging in.”**

**What We Avoid:** - ❌ Daily login bonuses (encourages empty sessions) - ❌ Pay-to-skip mechanics (undermines learning) - ❌ Public shaming (leaderboards showing “worst” performers)

**What We Embrace:** - ✅ Mastery-based XP (more XP for difficult cards) - ✅ Intrinsic rewards (seeing your vine grow) - ✅ Collaborative goals (study with friends)

### XP System

**XP Sources:**

| Action | XP Earned | Rationale |
| --- | --- | --- |
| Review card (Good) | 10 XP | Base reward |
| Review card (Hard) | 15 XP | More effort = more reward |
| Review card (Easy) | 5 XP | Too easy = less learning |
| Complete 20-card session | 50 XP | Consistency bonus |
| 7-day streak maintained | 200 XP | Building habit |
| Shadowing exercise (>80% score) | 30 XP | Output practice |
| Write 100-word composition | 40 XP | Deep engagement |
| Read article (5+ min) | 25 XP | Input practice |
| Create public deck (>10 subscribers) | 500 XP | Community contribution |

**XP Decay Prevention:** - No XP loss for missing days (no punishment) - Bonus XP for returning after 3+ day break (encouragement)

**Level System:**

Level 1: 0 - 500 XP (Seedling 🌱)  
Level 2: 500 - 1,500 XP (Sprout 🌿)  
Level 5: 5,000 - 10,000 XP (Tree 🌳)  
Level 10: 25,000 - 50,000 XP (Forest 🌲)

### Streaks

**Definition:** Consecutive days with at least 1 completed study session.

**Visualization:**

🔥 14-day streak  
  
Week 1: ✅✅✅✅✅✅✅  
Week 2: ✅✅✅✅✅✅✅  
Today: ← 2 hours left to maintain streak!

**Streak Freezes:** - Earn 1 freeze per 7-day streak - Use freeze to skip 1 day without breaking streak - Max 2 freezes stored

**Milestones:** - 7 days: +200 XP, “Week Warrior” badge - 30 days: +1000 XP, “Monthly Maestro” badge - 100 days: +5000 XP, “Centurion” badge, custom avatar frame

### Badges

**Categories:**

**1. Consistency Badges:** - 🌟 **First Steps:** Complete 1st study session - 🔥 **Week Warrior:** 7-day streak - 📅 **Monthly Maestro:** 30-day streak - 💎 **Century Club:** 100-day streak

**2. Mastery Badges:** - 📚 **Vocab Novice:** Review 100 cards - 📖 **Vocab Scholar:** Review 1,000 cards - 🎓 **Vocab Master:** Review 10,000 cards - 🗣️ **Pronunciation Pro:** 50 shadowing exercises (>80% score) - ✍️ **Writer’s Guild:** Write 10,000 words total

**3. Social Badges:** - 👥 **Deck Creator:** Publish 1st public deck - ⭐ **Community Star:** Your deck reaches 100 subscribers - 🤝 **Study Buddy:** Complete 10 co-study sessions with friends

**4. Special Badges:** - 🌙 **Night Owl:** Study session at 2-4am - 🌍 **Polyglot Path:** Study 3+ languages in platform - 🏆 **Leaderboard Legend:** Top 10 in monthly XP

**Display:** - Profile page: Showcase up to 6 favorite badges - Badge cabinet: View all earned badges (grayed out = locked)

### Leaderboards

**Types:**

**1. Global Leaderboard (Monthly):**

Rank User XP This Month  
─────────────────────────────────  
 1 🥇 Sarah 15,240 XP  
 2 🥈 Miguel 14,890 XP  
 3 🥉 Yuki 13,750 XP  
...  
 42 You 8,120 XP

**2. Friends Leaderboard:**

Among your 12 friends:  
  
 1 Alex 3,450 XP  
 2 You 3,210 XP  
 3 Jamie 2,980 XP

**3. Language-Specific:**

Top Spanish Learners (This Week):  
  
 1 Carlos 2,100 XP  
 2 You 1,850 XP

**Privacy:** - Opt-out option (hide from global leaderboard) - Only show first name + last initial (e.g., “Sarah M.”) - Friends leaderboard requires mutual follow

### Progress Visualization

**1. Module Progress Rings:**

Dashboard shows 5 rings (one per module):  
  
 Vocabulary Speaking Writing Reading Listening  
 88% 45% 23% 67% 34%

**2. Language Proficiency Estimate:**

Spanish Proficiency: B1 (Intermediate)  
  
📊 Breakdown:  
- Vocabulary: 1,842 words known (B1: 1,500-2,500)  
- Grammar: 78% accuracy on B1 structures  
- Listening: 85% comprehension on B1 audio  
- Speaking: Estimated B1 (based on AI conversations)  
  
🎯 Next milestone: B2 (need 658 more words)

**3. Time Investment Graph:**

Study Time This Month: 14h 32m  
  
 Hours  
 8 ┤ ╭───●  
 6 ┤ ╭─╯  
 4 ┤ ╭─╯  
 2 ┤─╯  
 0 └──────────────  
 Week 1 2 3 4

## AI & Personalization

### Learning Profile

**System tracks:** - **Vocabulary size** (per language) - **Grammar competency** (which structures mastered) - **Preferred content** (topics: sports, tech, food, etc.) - **Optimal study time** (morning person vs. night owl) - **Review patterns** (FSRS difficulty parameters)

**Adaptive Content Recommendations:**

"Based on your progress, we recommend:  
- 📖 Reading: 'El Alchemista' (90% known vocabulary)  
- 🎧 Podcast: 'Coffee Break Spanish' Episode 42  
- 📝 Writing: Practice present subjunctive (your weak area)

### AI Features

**1. Smart Review Ordering:** - Mix old + new cards (not all hard cards at end) - Interleave topics (vocabulary + grammar, not blocks) - Priority to cards near “forgetting threshold”

**2. Difficulty Auto-Adjustment:** - Text too easy (>98% comprehension) → suggest harder texts - Speaking exercises too fast → auto-slow to 0.8x

**3. Personalized Study Plans:**

Your goal: B2 Spanish in 6 months  
  
Weekly plan:  
- Monday/Wed/Fri: 30 min vocabulary review  
- Tuesday/Thursday: 20 min speaking practice  
- Weekends: 40 min reading + listening

**4. AI Tutor (Future Feature):** - Ask questions: “When do I use ‘ser’ vs. ‘estar’?” - Get explanations in your native language - Request custom exercises for weak areas

## Roadmap

### Phase 1: MVP (Q4 2025) ✅ In Progress

**Core Features:** - ✅ User authentication (register, login, JWT) - ✅ Vocabulary module (FSRS flashcards) - ✅ Deck management (create, fork, commit) - ✅ Basic gamification (XP, streaks, levels) - 🚧 Speaking module (shadowing only) - 🚧 Reading module (graded texts library)

**Tech Debt:** - Finalize gRPC communication (Python ↔ ASP.NET) - Docker compose for local dev environment - CI/CD pipeline (GitHub Actions)

### Phase 2: Enhanced Modules (Q1 2026)

**New Features:** - Listening module (podcast library, dictation) - Writing module (sentence builder, composition studio) - Speaking: Conversation simulator (AI partner) - Social features (friends, leaderboards, profile pages)

**Design:** - Full “Quiet Immersion” UI implementation - AI avatar reactions - Progress vine animation - Mobile PWA (offline mode)

### Phase 3: Community & Content (Q2 2026)

**Marketplace:** - Public deck discovery (search, filters, ratings) - Deck versioning UI (commit history, diffs, merge) - Creator analytics (subscriber count, review stats)

**User-Generated Content:** - Import tool (Anki, CSV, Quizlet) - Bulk sentence mining (paste article → auto-generate cards) - Image/audio uploads for custom cards

**Monetization (Optional):** - Premium tier ($5/mo): - Unlimited decks (free: 5 decks max) - Advanced stats (granular progress graphs) - Priority AI features (faster pronunciation scoring) - Keep core learning free forever

### Phase 4: Advanced AI (Q3 2026)

**AI Tutor:** - Chat with AI in target language (Socratic method) - Grammar explanations on-demand - Personalized study plan generator

**Content Intelligence:** - Auto-generate decks from YouTube videos (extract subtitles) - Podcast transcription + vocabulary extraction - Adaptive text difficulty (AI rewrites texts to your level)

**Speech Tech:** - Real-time pronunciation feedback during shadowing - Accent training (British vs. American English) - Emotion detection (are you confident or hesitant?)

### Phase 5: Mobile Apps (Q4 2026)

**Native iOS/Android:** - Offline study mode (sync when online) - Widgets (daily goal progress, streak counter) - Push notifications (gentle reminders, not spam) - Voice-first interface (study while commuting)

**Wearables:** - Apple Watch: Quick reviews during breaks - Smart speakers: “Alexa, quiz me on Spanish vocab”

## Success Metrics

### Learning Outcomes (Primary)

| Metric | Target | Measurement |
| --- | --- | --- |
| **Vocabulary retention** | 85%+ after 30 days | FSRS data (cards due vs. cards remembered) |
| **User-reported fluency gain** | +1 CEFR level per 6 months | Self-assessment survey |
| **Active study rate** | 60% of users study 3+ days/week | Session logs |

### Engagement (Secondary)

| Metric | Target | Measurement |
| --- | --- | --- |
| **7-day retention** | 50% | Users who return after 1 week |
| **30-day retention** | 30% | Users still active after 1 month |
| **Average session length** | 15-20 minutes | Time from start to end of study session |
| **Daily active users (DAU)** | Grow 10% month-over-month | Login events per day |

### Community (Tertiary)

| Metric | Target | Measurement |
| --- | --- | --- |
| **Public decks created** | 1,000+ in Year 1 | Deck publish events |
| **Deck forks** | 20% of public decks forked | Fork action count |
| **Average deck rating** | 4.2+ / 5 stars | User ratings (after studying deck) |

### Technical (Infrastructure)

| Metric | Target | Current |
| --- | --- | --- |
| **API response time** | < 200ms (p95) | Monitor with Datadog/Grafana |
| **Uptime** | 99.5% | Exclude planned maintenance |
| **Mobile load time** | < 2s (LCP) | Lighthouse CI scores |

## Conclusion

**LineByLine** is not just another language app—it’s a **scientifically-grounded learning ecosystem** that respects users’ time, intelligence, and goals.

### What Makes Us Different

1. **Science over engagement hacks** — FSRS, comprehensible input, output practice
2. **Modular mastery** — Focus on one skill deeply, not shallow “gamified” lessons
3. **Community-driven content** — Git-like deck versioning, public marketplace
4. **Privacy-first design** — No data selling, no manipulative streaks
5. **Beautiful, calming UI** — “Quiet Immersion” design for distraction-free learning

### Our Promise

**“We succeed when you become fluent, not when you open the app 100 days in a row.”**

## Appendices

### A. Glossary of Language Learning Terms

| Term | Definition |
| --- | --- |
| **CEFR** | Common European Framework of Reference (A1 → C2) |
| **Comprehensible Input** | Language slightly above current level (i+1) |
| **Comprehensible Output** | Producing language to test hypotheses |
| **FSRS** | Free Spaced Repetition Scheduler (ML-based algorithm) |
| **Shadowing** | Repeating audio simultaneously to improve pronunciation |
| **SRS** | Spaced Repetition System (generic term) |
| **i+1** | Input at “current level + 1 difficulty” |

### B. Recommended Reading

* **“The Natural Approach”** by Stephen Krashen
* **“How Languages Are Learned”** by Patsy Lightbown
* **“Make It Stick”** by Peter Brown (learning science)
* **“Fluent Forever”** by Gabriel Wyner (practical methods)

### C. Technical Documentation Links

* **FSRS Algorithm:** [open-spaced-repetition/fsrs4anki](https://github.com/open-spaced-repetition/fsrs4anki)
* **gRPC Protocol:** proto/fsrs\_service.proto (internal repo)
* **API Endpoints:** docs/api-reference.md (internal repo)
* **Design System:** docs/design-system.md (internal repo)

**Last Updated:** October 31, 2025  
**Document Owner:** LineByLine Product Team  
**Contact:** [project repository]

*This is a living document. As we learn from users and iterate on features, we’ll update this vision accordingly.*