

Base Library Litepaper

Base Library Labs, 2025

The first open decentralized EdTech platform for creating and sharing educational content with flexible and modular AI generation

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Abstract

Base Library is an open educational platform that combines artificial intelligence and blockchain technologies to create a decentralized knowledge ecosystem. The first EdTech platform on Base, a universal intelligent system for creating educational materials, built on LangGraph and leveraging advanced natural language processing and computer vision technologies. The system automatically generates comprehensive learning materials for any subject area and educational level, conducts analysis of students' knowledge retention, and creates assessment questions with detailed answers.

The platform is designed for teachers, students, and researchers who can freely use it to generate new materials or explore already created content. Base Library makes quality education accessible to everyone through AI-powered content generation and decentralized storage.

Covered Disciplines

- **Professional Fields:** Business, Engineering, Medicine, Law, Blockchain
- **Social Sciences:** Political Science, Economics, Psychology
- **Humanities:** Languages, Philosophy, History, Literature, LLM
- **Sciences & Technology:** Computer Science, Biology, Chemistry, Physics, Mathematics

Key Features

1. **Generation of educational materials:** Creates comprehensive educational content in any discipline based on educational questions and assignments.
2. **Handwritten note recognition:** Processing students' handwritten notes using text recognition with smooth integration into materials.
3. **Knowledge Gap Analysis:** Automatically identifies knowledge gaps and generates targeted additional questions.
4. **Detailed answers:** Provides detailed answers with mathematical conclusions and practical examples.
5. **Refinement mode:** Allows interactive interaction with users to refine and improve the created content.
6. **Interactive editing:** An editing agent with fuzzy matching for precise modification of synthesized materials.
7. **Security system:** Universal protection against attacks with rapid implementation and gradual degradation.
8. **Content Reviewer:** Study materials created by other users in the community.

1 Introduction

The modern educational ecosystem faces fundamental challenges: limited access to quality educational content, difficulty in creating personalized learning materials, centralized platforms restricting creative freedom, and lack of tools for effective knowledge

sharing [1]. Students and teachers need tools that enable them to quickly create high-quality educational materials adapted to individual needs.

Base Library addresses these challenges through an open decentralized platform that makes education accessible to everyone. The platform combines AI technologies with Base blockchain infrastructure to create an ecosystem where anyone can generate, share, and study educational materials [2].

Primary Mission: Democratizing education through AI-powered content generation and open access to knowledge.

Target Audience:

- **Teachers:** Create personalized materials for their students
- **Students:** Generate study guides and explore existing educational content
- **Researchers:** Develop and share educational resources in their fields
- **Self-learners:** Access quality materials on any subject

In this document, we will explore the technological architecture, platform capabilities, user interaction mechanisms, and development roadmap.

2 The Case for AI-Powered Open Education

2.1 Technology Justification

Creating an open platform for AI-generated educational content addresses key challenges in modern education:

- **Universal Access:** Free material generation for anyone with internet access, regardless of location or financial capabilities.
- **Personalized Learning:** AI generation allows creating materials tailored to individual learner needs and knowledge levels.
- **Community Knowledge Base:** Users can browse materials created by others, fostering collaborative learning and knowledge sharing.
- **Authorship Verification:** SHA-256 content hashing and blockchain recording provide verifiable proof of authorship and content integrity [3].
- **Decentralized Storage:** IPFS integration ensures censorship resistance and long-term content preservation.

2.2 Potential Applications

- **Micro-Credentialing:** Creating verifiable certificates for specific skills
- **Peer-to-Peer Learning:** Sharing educational resources within the community
- **Corporate Training:** Corporate training programs with achievement verification
- **Research Collaboration:** Collaborative research projects and knowledge sharing
- **Language Learning:** Interactive language courses adapted to learner level
- **Skill Development:** Professional skill development with structured materials
- **Academic Resources:** Open educational resources for students and researchers
- **Study Groups:** Creating and sharing materials within study communities

2.3 Challenges and Solutions

- **Scalability:** Solved through sharding and off-chain computations for AI generation
- **User Adoption:** Intuitive interface and Web3 wallet integration with familiar UX
- **Content Quality:** Multi-level validation system and community-driven feedback
- **Accessibility:** Optimized through Base Layer 2 solutions for minimal transaction costs

3 Overview of the Platform

3.1 Core Platform Architecture

Base Library is built on a multi-layered architecture combining AI generation, blockchain technologies, and decentralized storage:

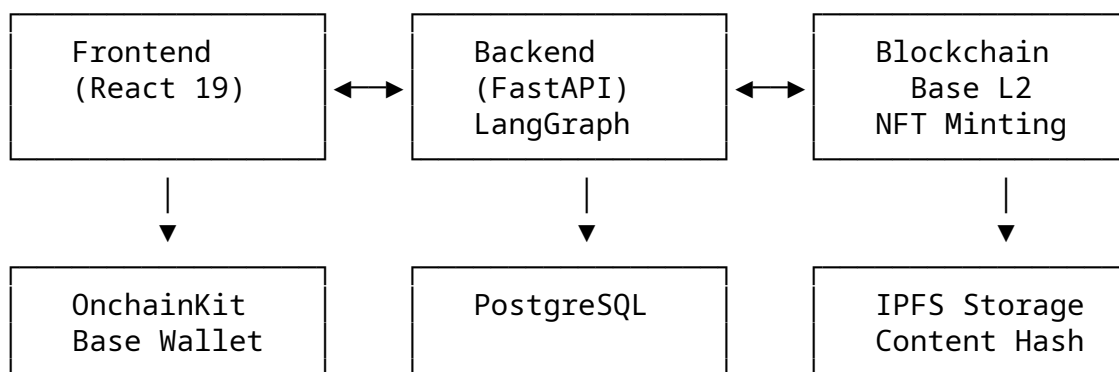


Figure 1: Platform Architecture

3.2 Protocol Layer

- **REST API Communication:** FastAPI provides high-performance communication between frontend and backend with automatic documentation through Swagger UI.
- **Web3 Integration:** OnchainKit and Wagmi v2 ensure seamless integration with crypto wallets for authentication and content verification.
- **AI Workflow Engine:** LangGraph manages multi-stage content generation with Refinement Mode interaction support.

3.3 Learning Materials as Digital Assets

Each educational material is automatically classified by AI and can be tokenized as an NFT for authorship verification and content integrity:

AI Classification Pipeline:

1. Content Analysis: LLM analyzes material content
2. Subject Detection: Automatic determination of subject area (Web3, Mathematics, Physics, etc.)

3. Grade Assessment: Classification by difficulty level (Beginner, Intermediate, Advanced)
4. Topic Extraction: Key topic identification for indexing

Material Metadata Structure:

```
1 {  
2   "name": "Web3 Fundamentals Course",  
3   "description": "Comprehensive guide to blockchain technology",  
4   "subject": "Web3",  
5   "grade": "Beginner",  
6   "topic": "Blockchain Fundamentals",  
7   "content_hash": "8f3d9e2a...",  
8   "ipfs_cid": "QmXxXxXx...",  
9   "author": "0x123...",  
10  "word_count": 2500,  
11  "created_at": "2025-01-15",  
12  "public": true  
13 }
```

3.4 Compute Layer

LangGraph Workflow Nodes:

- input_processing: User request analysis
- generating_content: Educational material creation
- recognition_handwritten: Image OCR processing
- synthesis_material: Combining various sources
- edit_material: Interactive editing
- generating_questions: Creating knowledge check questions
- answer_question: Generating detailed answers

Smart Contracts: Base L2 smart contracts manage NFT minting for authorship verification and content integrity.

3.5 Available Operations

1. Material Generation: AI generation of personalized educational materials
2. Material Browsing: Explore materials created by other users
3. Content Classification: Automatic categorization using AI
4. NFT Minting: Creating NFTs for authorship verification (optional)
5. IPFS Upload: Decentralized content storage (planned)
6. Web3 Authentication: Login through crypto wallets without passwords
7. Refinement Mode Interaction: Human-machine interaction for quality improvement
8. Export Functions: Export to PDF/Markdown formats
9. Duplicate Prevention: Content duplication prevention through hashing

3.6 Decentralized Storage

- **IPFS Integration (Pinata):** Material content will be uploaded to IPFS for decentralized storage and long-term preservation.
- **Content Hashing:** SHA-256 hashing ensures data integrity and prevents duplication.
- **Local Backup:** Content storage on platform servers for immediate availability.

3.7 Scalability

- **Microservices Architecture:** Separation into independent services (core, article-service, prompt-studio-service) ensures horizontal scaling.
- **Database Sharding:** PostgreSQL with user and subject area sharding capability.
- **CDN Integration:** Ready for CDN integration for fast content delivery worldwide.

3.8 Performance

Response Times:

- Material generation: 30-60 seconds
- NFT minting: 1-5 seconds
- Web3 authentication: 2-5 seconds
- Content classification: 5-10 seconds
- Material browsing: < 1 second

Throughput: Up to 1000 concurrent users on current infrastructure.

3.9 Security

- **Web3 Authentication:** Cryptographic message signing instead of passwords
- **JWT Tokens:** Secure session management with automatic renewal
- **Input Validation:** SecurityGuard system protects against prompt injection attacks
- **Content Verification:** SHA-256 hashing for data integrity verification

4 Platform Infrastructure

4.1 Types of Nodes

- **Full Nodes:** Store entire material history and metadata, ensuring platform decentralization.
- **Light Nodes:** Lightweight nodes for mobile devices, synchronizing with full nodes.
- **Validator Nodes:** Nodes participating in content verification and integrity validation.
- **AI Processing Nodes:** Specialized nodes for executing LangGraph workflows and AI generation.

4.2 Scalability

- **Horizontal Scaling:** Adding new AI processing nodes to increase content generation capacity.
- **Off-chain Computation:** AI generation is performed off-chain to reduce blockchain load.
- **Caching Layer:** Redis caching for frequently requested materials and metadata.

4.3 Key Management

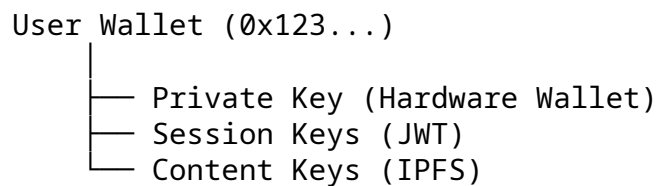


Figure 2: Authentication Flow

- **Hardware Wallet Integration:** Ledger, Trezor support for maximum security.
- **Multi-signature Support:** Multi-signature capability for institutional accounts.

4.4 Security

- **Encrypted Storage (Planned):** Content encryption before IPFS upload for private materials.
- **Audit Trail:** Complete logging of all operations for transparency and security.

4.5 Content Validation

- **AI Quality Assessment:** Automated content quality evaluation using GPT-4o-mini.
- **Community Feedback:** User rating system for material quality and usefulness.
- **Duplicate Detection:** SHA-256 hashing prevents identical content duplication.

4.6 Content Verification Mechanism

Proof of Educational Value (PoEV): Content verification mechanism based on educational value.

PoEV Algorithm:

1. Content Generation: User generates educational material
2. AI Validation: GPT-4o-mini evaluates quality and educational value
3. Community Review: Users rate material usefulness
4. Content Verification: Material is verified and stored in the network
5. NFT Creation (Optional): Author can mint NFT for authorship proof

Quality Score Calculation Formula:

$$\text{Quality_Score} = (\text{AI_Assessment} \times 0.5) + (\text{Community_Rating} \times 0.5)$$

Generation → AI Validation → Community Review → Storage → Optional NFT

Figure 3: Content Flow

5 Platform Ecosystem

5.1 Material Explorer

Base Library Explorer: Web interface for browsing all materials, viewing statistics, and exploring content by subject and difficulty.

Features:

- Material search by subjects, difficulty level, topics
- Content preview and full material viewing
- User statistics and popular content tracking
- Filtering by date, popularity, and rating
- BaseScan integration for blockchain verification

5.2 Material Library

Open Access Library: Browse and study educational materials created by the community.

Features:

- Categorized content by subject areas
- Difficulty level filtering
- Content rating and reviews
- Bookmark and favorites system
- Reading progress tracking

5.3 Smart Contracts

- **MaterialNFT Contract:** ERC-721 compatible contract for optional educational NFT minting.
- **Content Verification Contract:** Automated content integrity and authorship verification.

5.4 Types of Contracts

- **Educational Contracts:** Specialized contracts for different types of educational content (materials, certificates, research).
- **Access Contracts:** Content visibility and sharing rights management.

6 Use Cases

6.1 Student Self-Study

Students can generate personalized study materials on any topic, adapted to their knowledge level. The platform analyzes handwritten notes and creates comprehensive study guides with questions for knowledge verification.

6.2 Teacher Resources

Teachers can quickly create educational materials for their students, adapting content to class needs and individual student levels. Materials can be shared with students or kept private.

6.3 Research Collaboration

Researchers can create educational materials in their fields, share knowledge with students, and collaborate on educational content development.

6.4 Language Learning

Interactive language learning with AI-generated materials adapted to learner level. Materials include vocabulary, grammar exercises, and comprehension questions.

6.5 Skill Development

Professional skill development through structured materials and practical examples. Users can track their progress and verify knowledge with AI-generated questions.

6.6 Study Groups

Students can create and share materials within study groups, collaborate on content creation, and learn from each other's materials.

6.7 Open Educational Resources

Creating open educational resources accessible to everyone. Teachers and experts can contribute to the global knowledge base.

6.8 Personalized Learning Paths

AI-generated individual learning trajectories based on student progress and knowledge gaps. System creates targeted materials for optimal learning.

6.9 Cross-Platform Integration

Integration with existing educational platforms. Universities and schools can use Base Library as supplementary tool for content creation and knowledge verification.

6.10 Material Discovery

Explore materials created by other users, discover new topics, and learn from community-generated content. Rating system helps identify high-quality resources.

7 Future Work

• Q4 2025: Course Builder

- Multi-lesson course creation: Users can combine materials into structured courses
- Learning path design: Create sequential learning experiences
- Progress tracking: Monitor student advancement through courses
- Completion certificates: Optional NFT certificates for course completion

• Q4 2025: Community Features

- Donation system: Support content creators through voluntary donations
- Tipping mechanism: Appreciate quality materials with crypto tips
- Creator profiles: Showcase author contributions and popular materials
- Social features: Comments, discussions, and material recommendations

• Q4 2025: Content Monetization

- NFT-Based Licensing: Create and sell NFTs for exclusive access to premium educational materials
- Subscription Models: Offer tiered access to specialized courses and content libraries via recurring payments
- Microtransactions: Enable pay-per-use options for individual lessons, quizzes, or downloadable resources
- Revenue Sharing: Implement a decentralized profit-sharing system for content creators based on usage and engagement metrics

• Q1 2026: Enhanced ML Capabilities

- Improved Content Generation: Advanced machine learning algorithms with planning and decomposition for higher-quality, contextually relevant educational materials
- External Source Integration: Incorporation of verified external data sources to enrich content accuracy and depth
- Automated Content Optimization: Dynamic refinement of generated materials through iterative ML-driven analysis and feedback loops
- Personalized Learning Enhancements: Tailored content adjustments based on user performance and knowledge gap analysis

• Q1 2026: External Data Enrichment

- API Integrations: Seamless connection to external educational databases, research repositories, and open-access platforms for enriched content
- Real-Time Data Fetching: Incorporation of up-to-date information from trusted sources to keep materials current
- Cross-Platform Compatibility: Support for importing and adapting content from external learning management systems (LMS)
- Metadata Enrichment: Enhanced tagging and categorization of materials using external ontologies and knowledge graphs for better discoverability

- **Q1 2026: Mobile Application**

- Farcaster Mini App
- Native mobile apps (iOS/Android)
- Offline mode for material access
- Push notifications for new content

8 Conclusion

Base Library is an open EdTech platform that combines the best achievements in AI and blockchain technologies to democratize education. Our vision is to create a global knowledge ecosystem where everyone can freely create, share, and access quality educational materials.

Core Values:

- **Open Access:** Free platform for generating and browsing educational content
- **AI-Powered:** Advanced material generation adapted to user needs
- **Web3 Authentication:** Secure access through crypto wallets
- **Community-Driven:** Browse and learn from materials created by others
- **Quality Education:** Comprehensive materials with questions and detailed answers
- **Decentralized:** Prepared for IPFS integration and decentralized storage

Future Vision:

- **Course Creation:** Build complete educational courses from individual materials
- **Community Support:** Donation and tipping systems for content appreciation
- **Global Knowledge Base:** Accessible educational content for learners worldwide

Get Started: Join the community building open decentralized education. Connect your wallet, create your first educational material, and explore knowledge created by others.

9 Disclaimer

9.1 Platform Info

Base Library is an open educational platform. Materials can optionally be tokenized as NFTs for authorship verification and content integrity. NFTs are not investment instruments and serve purely educational and verification purposes.

9.2 Legal Considerations

- **Educational Purpose:** Platform designed exclusively for educational content creation and sharing
- **Regulatory Compliance:** Platform complies with applicable data protection and intellectual property laws
- **User Responsibility:** Users are responsible for complying with local legislation

- **Content Liability:** Authors are responsible for created content quality and accuracy
- **Technical Risks:** Blockchain technology use involves technical risks
- **No Financial Advice:** Platform does not provide financial or investment advice

10 References

References

- [1] Tapscott, D. (2018). *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World*.
- [2] Swan, M. (2015). *Blockchain: Blueprint for a New Economy*.
- [3] Buterin, V. (2014). *A Next-Generation Smart Contract and Decentralized Application Platform*.

11 How to Engage

Join the Base Library community:

- **Discord:** Discussions, support, development news
- **GitHub:** Source code, bug reports, feature requests
- **Twitter:** Updates, announcements, educational content
- **Documentation:** Complete technical documentation and API reference

Start learning and creating:

1. Connect your Web3 wallet
2. Generate your first educational material
3. Browse materials created by the community
4. Share knowledge with learners worldwide
5. Optional: Mint NFT for authorship verification

Base Library - where knowledge meets Web3

