

Product Requirements Document (PRD)

StudyHub: Collaborative AI-Enhanced Learning Platform

1. App Overview and Objectives

1.1 Product Vision

StudyHub is a web-based learning platform that enables users to create, manage, and share study materials with AI assistance and real-time collaboration. The platform aims to enhance learning efficiency by providing intelligent tools for creating flashcards, study guides, and practice tests, combined with an AI tutor feature and seamless collaboration capabilities.

1.2 Core Objectives

- Create a centralized platform for various study materials and learning tools
- Leverage AI to assist in content creation and personalized learning
- Enable real-time collaboration between users
- Provide an intuitive, tab-based organization system for study materials
- Ensure secure access and sharing controls for user content
- Scale effectively from thousands to potentially millions of users

1.3 Success Metrics

- User acquisition and retention rates
- Study material creation frequency
- Collaboration engagement metrics
- AI tool usage statistics
- User satisfaction and feedback scores
- Learning outcome improvements (future metric)

2. Target Audience

2.1 Primary Users

- High school students
- College/university students
- Lifelong learners

- Professional development learners

2.2 User Personas

Persona 1: College Student (Alex)

- Needs to manage materials across multiple courses
- Collaborates with study groups regularly
- Seeks efficiency in creating comprehensive study materials
- Limited time to create materials from scratch

Persona 2: High School Student (Jamie)

- Preparing for standardized tests and regular exams
- Benefits from guided study approaches
- Shares materials with classmates
- May need assistance structuring information effectively

Persona 3: Professional Learner (Morgan)

- Learning new skills for career advancement
- Studies intermittently based on work schedule
- Requires organized, accessible materials
- Values efficiency and targeted learning approaches

3. Core Features and Functionality

3.1 User Account Management

- Social login integration (Google, Apple, etc.)
- User profile management
- Account settings and preferences
- Default AI model selection

3.2 Content Organization

- Tab-based organization system for study materials
- Custom naming and descriptions for tabs
- Search and filter capabilities
- Recent activity tracking

3.3 Study Material Creation

3.3.1 Flashcards

- Manual creation with text and image support
- AI-assisted content generation
- Import/export capabilities
- Spaced repetition study mode

3.3.2 Study Guides

- Rich text editor for manual creation
- AI-generated study guide templates
- Multimedia embedding capabilities
- Version history

3.3.3 Practice Tests

- Manual question creation
- AI-generated questions based on study materials
- Multiple question types (multiple choice, short answer, etc.)
- Performance analytics

3.4 AI Tutor

- Conversational interface
- Context-aware responses based on user's study materials
- Visual explanation capabilities
- Persistent chat history within tabs

3.5 Collaboration Features

- Sharing of tabs with customizable permissions (view/edit)
- Real-time collaborative editing
- Comment and feedback functionality
- Activity tracking for collaborative tabs

3.6 Settings and Preferences

- AI model selection and configuration
- Notification preferences
- Display and theme options
- Privacy and sharing defaults

4. Technical Stack Recommendations

4.1 Frontend

- Next.js (existing framework)
- React for component structure
- Tailwind CSS for styling
- Socket.IO client for real-time features

4.2 Backend

- Node.js with Express for API endpoints
- Socket.IO for real-time collaboration
- AWS Lambda for serverless functions (optional)

4.3 Database and Storage

- MongoDB for user data and metadata (flexible schema benefits)
- AWS S3 for content storage (as specified)
- Redis for caching and real-time feature support

4.4 Authentication

- NextAuth.js for social authentication integration
- JWT for session management
- AWS Cognito (optional for additional security)

4.5 AI Integration

- OpenAI API for GPT-4o integration
- Anthropic API for Claude models
- Google API for Gemini
- Custom middleware for Ollama integration
- Model switching and fallback system

4.6 Real-time Collaboration

- Socket.IO for real-time updates
- Operational Transformation or CRDT for conflict resolution
- Presence indicators and activity tracking

4.7 DevOps and Infrastructure

- AWS for hosting (EC2, ECS, or EKS)
- CI/CD pipeline with GitHub Actions
- Infrastructure as Code with Terraform or AWS CDK
- Monitoring with CloudWatch and Datadog

5. Conceptual Data Model

5.1 Core Entities

5.1.1 User

- id: String (unique)
- email: String
- name: String
- profileImage: String (URL)
- preferences: Object
 - defaultAIModel: String
 - theme: String
 - notificationSettings: Object
- createdAt: DateTime
- updatedAt: DateTime

5.1.2 Tab

- id: String (unique)
- title: String
- description: String (optional)
- owner: UserId
- collaborators: Array<{userId: String, permission: String}>

- materials: Array<{materialId: String, type: String}>
- createdAt: DateTime
- updatedAt: DateTime
- lastAccessedAt: DateTime

5.1.3 Flashcard

- id: String (unique)
- tabId: String
- front: Object (supports text, images)
- back: Object (supports text, images)
- tags: Array<String>
- createdBy: UserId
- aiGenerated: Boolean
- promptUsed: String (if AI-generated)
- createdAt: DateTime
- updatedAt: DateTime

5.1.4 StudyGuide

- id: String (unique)
- tabId: String
- title: String
- content: RichTextContent
- tags: Array<String>
- createdBy: UserId
- aiGenerated: Boolean
- promptUsed: String (if AI-generated)
- versionHistory: Array<{version: Number, content: RichTextContent, timestamp: DateTime}>
- createdAt: DateTime
- updatedAt: DateTime

5.1.5 PracticeTest

- id: String (unique)

- tabId: String
- title: String
- description: String
- questions: Array<Question>
- tags: Array<String>
- createdBy: UserId
- aiGenerated: Boolean
- promptUsed: String (if AI-generated)
- createdAt: DateTime
- updatedAt: DateTime

5.1.6 Question

- id: String (unique)
- type: String (multipleChoice, shortAnswer, etc.)
- prompt: RichTextContent
- options: Array<{id: String, text: String}> (for multiple choice)
- correctAnswer: String or Array<String>
- explanation: RichTextContent
- difficulty: Number (1-5)
- tags: Array<String>
- aiGenerated: Boolean

5.1.7 AIChat

- id: String (unique)
- tabId: String
- messages: Array<{role: String, content: String, timestamp: DateTime}>
- model: String
- createdBy: UserId
- createdAt: DateTime
- updatedAt: DateTime

5.2 Relationships

- User owns multiple Tabs
- Tab contains multiple study materials (Flashcards, StudyGuides, PracticeTests)
- Tab has one AIChat thread
- User can collaborate on Tabs owned by other users
- Study materials track creating user for audit purposes

6. UI Design Principles

6.1 Key UI Components

- Tab navigation and management interface
- Study material creation and editing interfaces
- AI chat interface
- Sharing and collaboration controls
- Settings and preferences panel

6.2 Design Guidelines

- Clean, distraction-free interface for focused learning
- Responsive design for desktop and mobile browsers
- Consistent color scheme and typography
- Clear visual hierarchy and intuitive navigation
- Accessibility compliance (WCAG 2.1 AA standards)

6.3 User Flows

6.3.1 Creating a New Tab

1. User clicks "New Tab" button
2. User enters tab title and optional description
3. System creates tab and redirects to empty tab view
4. User is presented with options to add study materials

6.3.2 Creating AI-Generated Flashcards

1. User selects "Flashcards" within a tab
2. User clicks "Create with AI" button
3. User enters topic and specific instructions

4. System generates flashcard set preview
5. User reviews, edits, and saves the flashcards

6.3.3 Sharing a Tab

1. User selects "Share" on the desired tab
2. User enters collaborator email or username
3. User sets permission level (view/edit)
4. System sends notification to collaborator
5. Collaborator accepts and gains access to tab

7. Security Considerations

7.1 Authentication and Authorization

- Secure OAuth 2.0 implementation for social logins
- JWT with appropriate expiration and refresh token strategy
- RBAC (Role-Based Access Control) for content access
- Regular security audits and penetration testing

7.2 Data Protection

- All data encrypted at rest (AES-256)
- All data encrypted in transit (TLS 1.3)
- Personally identifiable information (PII) protected with additional encryption
- Compliance with relevant data protection regulations (GDPR, CCPA, etc.)

7.3 Content Security

- XSS protection for user-generated content
- CSRF protection for all forms and state-changing requests
- Content validation and sanitization
- Rate limiting to prevent abuse

7.4 API Security

- API key management for third-party services
- Secure storage of API keys and secrets (AWS Secrets Manager)
- Request verification and validation

- Rate limiting and abuse prevention

8. Development Phases and Milestones

8.1 Phase 1: MVP Release (2-3 months)

- User authentication with social login
- Basic tab creation and management
- Manual flashcard and study guide creation
- Basic AI assistance for content generation
- Simple sharing functionality (view-only)

8.1.1 Milestones

- Authentication system implementation
- Tab management UI and backend
- Basic study material creation tools
- Initial AI integration (single model)
- Basic sharing system

8.2 Phase 2: Collaboration Features (1-2 months)

- Real-time collaboration on study materials
- Comment and feedback functionality
- Enhanced permissions system
- Activity tracking for collaborative tabs

8.2.1 Milestones

- Real-time editing infrastructure
- Permissions and access control system
- Collaboration UI components
- Activity and presence indicators

8.3 Phase 3: Enhanced AI Features (2-3 months)

- Multi-model AI support
- AI tutor with visual explanation capabilities
- Enhanced practice test generation

- Personalized learning recommendations

8.3.1 Milestones

- Multi-model switching infrastructure
- AI tutor conversation system
- Visual explanation integration
- Learning analytics foundation

8.4 Phase 4: Scaling and Optimization (1-2 months)

- Performance optimization for large user base
- Enhanced analytics and telemetry
- Improved search and discovery
- Advanced export and sharing options

8.4.1 Milestones

- Database indexing and query optimization
- Caching implementation
- Advanced search functionality
- Export and integration features

9. Potential Challenges and Solutions

9.1 Technical Challenges

9.1.1 Real-time Collaboration Scaling

- **Challenge:** Maintaining performance with many concurrent users
- **Solution:** Implement sharding for Socket.IO, use Redis for pub/sub patterns, and implement efficient client-side debouncing

9.1.2 AI Cost Management

- **Challenge:** Managing API costs as user base grows
- **Solution:** Implement tiered usage limits, caching of common AI responses, and intelligent request batching

9.1.3 Data Storage Scaling

- **Challenge:** Efficient management of growing study material content
- **Solution:** Implement S3 lifecycle policies, content compression, and CDN integration for frequently accessed content

9.2 User Experience Challenges

9.2.1 Complexity vs. Simplicity

- **Challenge:** Balancing feature richness with intuitive interface
- **Solution:** Progressive disclosure of advanced features, contextual help, and user onboarding flows

9.2.2 AI Quality Variability

- **Challenge:** Ensuring consistent quality of AI-generated content
- **Solution:** Implement quality scoring, allow user feedback, and continuous prompt engineering improvement

9.2.3 Collaborative Conflicts

- **Challenge:** Managing conflicting changes in collaborative editing
- **Solution:** Implement robust conflict resolution with OT or CRDT algorithms and clear indication of changes to users

10. Future Expansion Possibilities

10.1 Learning Analytics

- Personalized learning pathways based on performance
- Spaced repetition optimization
- Comprehension level assessment
- Study habit analytics and recommendations

10.2 Mobile Application

- Native mobile apps for iOS and Android
- Offline study capabilities
- Push notifications for collaboration activities
- Mobile-specific features (camera for content capture, etc.)

10.3 Integration Ecosystem

- LMS integrations (Canvas, Blackboard, etc.)

- Calendar and scheduling integration
- Citation and reference management
- Academic integrity tools

10.4 Advanced Collaboration

- Study group formation and management
- Real-time audio/video study sessions
- Collaborative note-taking during lectures
- Peer review and assessment functionality

10.5 Monetization Options

- Freemium model with advanced features
- Institutional licensing for schools and organizations
- API access for third-party developers
- Premium AI models and capabilities

11. Technical Considerations

11.1 Scalability Architecture

- Microservices approach for key components
- Horizontal scaling with containerization
- Database sharding strategy for large user bases
- Edge caching for global user distribution

11.2 Performance Optimization

- Client-side rendering with selective SSR for SEO
- Asset optimization and lazy loading
- Efficient real-time update batching
- Intelligent caching strategies

11.3 Monitoring and Maintenance

- Comprehensive logging and monitoring
- Automated testing and CI/CD pipeline
- Feature flagging for controlled rollouts

- A/B testing infrastructure for optimization

11.4 Backup and Disaster Recovery

- Regular automated backups
- Cross-region replication
- Disaster recovery procedures
- Business continuity planning

12. Conclusion

This PRD outlines the vision and technical requirements for the StudyHub platform, a collaborative AI-enhanced learning tool that combines powerful study material creation, AI assistance, and real-time collaboration. By implementing this product in phases, we can deliver value quickly while building toward a comprehensive learning ecosystem that scales effectively from thousands to potentially millions of users.

The platform's focus on both AI assistance and human collaboration creates a unique value proposition in the educational technology space, empowering users to learn more effectively through intelligent tools and social learning approaches.