Faculty of Computers and Information

Minia University

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DUOCODO

Gamified, Arabic-Centered Programming Learning Platform and Application

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Chapter 1: Project Overview

1.1 Main Idea

We aim to create a Duolingo-inspired programming education platform that transforms how beginners learn to code by eliminating overwhelm through structured, gamified micro-lessons. Unlike fragmented resources, this platform provides a clear, progressive learning path—from core programming fundamentals to advanced topics like OOP, algorithms, and web development—all delivered via multi-format explanations (articles, videos, and guided walkthroughs).

At its core, the platform seamlessly integrates:

1. Interactive Practice & Feedback:

   - An in-browser code editor (supporting Python and JavaScript) with real-time execution, syntax highlighting, and instant error diagnostics.
   - Hands-on exercises featuring model solutions and optional complexity analysis to deepen understanding of code efficiency.

2. Motivational Gamification:

   - XP systems, unlockable levels, daily streaks, and skill badges to reward consistency.
   - Global leaderboards competitions to fuel engagement.

3. Personalized Progress Tracking:

   - Visual roadmaps highlighting completed, active, and upcoming modules.
   - Mastery dashboards quantifying skill growth and retention.

By combining structured curriculum, instant feedback, and social accountability, the platform turns programming education into an addictive, confidence-building journey—making learning feel like play while ensuring tangible skill development.

1.2 Project Scope

1. Comprehensive Curriculum & Content

- Structured Learning Path:
  - Tiered modules from absolute fundamentals (variables, loops) to advanced domains (OOP, algorithms, web frameworks, databases).
  - Specialized tracks for Python, JavaScript, and full-stack development.
- Multi-Format Delivery:
  - Concept primers: Short videos + annotated articles.
  - Interactive Chat Learning: AI mascot chatbot for conversational explanations.

2. Intelligent Code Editor

- Multi-Language Support:
  - Browser-based execution for Python, JavaScript, HTML/CSS, and more.
- Enhanced Developer Experience:
  - Real-time syntax + error highlighting, auto-completion, and debugging hints.
- Accessibility:
  - Dark/light mode, keyboard shortcuts.

3. Dynamic Interactive Exercises

- Adaptive Challenges:
  - Exercises auto-adjust difficulty based on user performance.
  - "Fix-the-Bug" tasks: Debug pre-written flawed code.
- Deep-Dive Analysis:
  - Runtime complexity breakdowns (Big O notation).
  - Memory/performance metrics for optimization practice.
- Solution Libraries:
  - Model answers + multiple approach comparisons (e.g., iterative vs. recursive).

4. Advanced Gamification System

- Engagement Mechanics:
  - Daily streaks, skill-specific badges (e.g., "Algorithm Ace"), and XP bonuses for consistency.
  - Unlockable content: Secret lessons or tools for high achievers.
- Competitive Elements:
  - Global/weekly leaderboards (XP-based).

5. Personalized Progress Ecosystem

- Learning Analytics:
  - Mastery dashboards showing skill proficiency (e.g., "Data Structures: 85%").
  - Time-tracking: Session duration, concepts revisited.

6. Accessibility & Scalability

- Mobile-responsive design: Seamless tablet/phone access.
- Offline mode: Download lessons/exercises for practice without internet.

1.3 Problem Statement

Learning programming remains a daunting barrier for beginners, exacerbated by *four core gaps* in existing solutions:

1. Structural Deficiency:
    - Resources are fragmented (video tutorials, disjointed exercises) with no coherent progression, leaving learners adrift.
    - *Advanced topics* (OOP, algorithms) feel inaccessible without scaffolded skill-building.
2. Practice-Explanation Misalignment:
    - Passive video/article consumption fails to translate to coding competence.
    - Feedback is delayed or absent, leading to reinforcement of errors and frustration.
3. Motivation Erosion:
    - Isolated learning lacks psychological hooks (rewards, social accountability) to sustain consistency.
    - *80% of beginners quit within 3 months* due to diminishing confidence.

1.4 Solution Approach

To bridge these gaps, the platform leverages Duolingo’s engagement model fused with developer-centric depth:

A. Structured Yet Adaptive Onboarding

- Skill Tree Curriculum:
    - *Tiered modules* map concepts from syntax basics → real-world stacks (e.g., Flask/React).
    - Diagnostic quizzes auto-route learners to optimal starting points.
- Bite-Sized, Multi-Modal Lessons:
    - Concepts taught via < 5-min videos, annotated snippets, and interactive sandboxes—all in one flow.

B. Contextual Practice Engine

- AI-Assisted Feedback:
    - Real-time error explanations + debugging hints (e.g., "Your loop exits early: check conditionals!").
- Exercise Evolution:
    - Adaptive difficulty: Problems scale complexity based on user mastery.
    - Project Sprints: Build *portfolio-ready micro-apps* (e.g., API-driven weather dashboard).

C. Gamification × Depth

- Progressive Unlock System:
    - Earn XP/badges for *accuracy*, *efficiency* (e.g., “O(1) Solver”), and *streaks*.
- Competitive Depth:
    - Leaderboards rank speed (solved in 30s) vs. elegance (least code lines).
- Complexity Playgrounds:
    - Visualize Big O trade-offs via interactive graph comparisons (e.g., $O(n^2)$ vs. $O(n \log n)$).

D. Personalized Reinforcement

- Predictive Roadmaps:
    - Weakness-targeted challenges (e.g., “Struggling with callbacks? Try these 3 exercises!”).
- Mastery Analytics:
    - Heatmaps track concept retention + time-to-proficiency across skills.

1.5 Project Objectives

1. Deliver a Progressive, Mastery-Based Curriculum

- Modular Skill Tiers: Implement 10+ competency levels (Novice → Architect) with checkpoint assessments for each tier.
- Cross-Language Tracks: Offer specialized paths for Python (Data Science/Backend), JavaScript (Frontend/Full-Stack), and Algorithms.
- Real-World Alignment: Integrate industry frameworks (e.g., React, Flask) and tools (Git, APIs) into advanced modules.

2. Build an Intelligent, Adaptive Practice Ecosystem

- AI-Driven Exercise Engine:
  - Generate personalized problem sets targeting weak areas (e.g., "80% accuracy on recursion? Try these 5 challenges!").
  - Auto-graded projects with rubrics for code quality, efficiency, and creativity.
- Multi-Layer Feedback:
  - Provide instant syntax corrections, runtime error diagnostics, and performance benchmarks (CPU/memory usage).

3. Gamify Learning with Depth & Nuance

- Tiered Reward System:
  - Award skill-specific badges (e.g., "Memory Optimizer") + rarity tiers (Bronze → Platinum).
  - "Double-or-Quit" streaks: Bonus XP for consecutive days, reset on skip.
- Competitive Arenas:
  - Host weekly efficiency leagues (lowest Big O wins) and speed sprints (fastest debugger).

4. Enable Hyper-Personalized Tracking

- Predictive Analytics Dashboard:
  - Visualize skill decay (e.g., "Arrays mastery ↓15% in 2 weeks") and recommend refreshers.
  - Track efficiency gains (e.g., "Reduced solution time by 40% this month").
- Custom Roadmapping:
  - Let users build goal-oriented playlists ("Prep for FAANG Interviews" → auto-adds relevant exercises).

5. Ensure Accessibility & Scalability

- Inclusive Design:
  - Support screen readers, keyboard navigation, and color-blind modes.
  - Offer text-to-speech explanations for complex concepts.
- Infrastructure Goals:
  - Offline-first capability: Download modules + editor for remote learning.
  - API extensibility: Integrate with GitHub/LMS platforms for portfolio syncing.

By achieving these objectives, the platform will not only demystify programming for beginners but also cultivate a motivated, skilled community ready to tackle real-world coding challenges.

Chapter

Chapter 2: Project Background

2.1 Project Background

Figma is a versatile, cloud-based design platform widely used for crafting user interfaces, wireframes, and interactive prototypes. It enables designers and stakeholders to collaborate in real time, streamlining the design process from ideation to final output. Figma’s rich feature set — including vector editing, component-based design, version history, and a robust plugin ecosystem — makes it central to modern UI/UX workflows. As a browser-based tool, it removes installation barriers and ensures cross-device accessibility.

For more detailed imformation. you can refer to Figma.

Nuxt.js is a high-level framework built on Vue.js, optimized for developing server-rendered applications and static websites. It offers features like automatic routing, server-side rendering (SSR), static site generation, and a modular architecture. With built-in support for SEO, performance optimizations, and a rich community-driven ecosystem, Nuxt simplifies the development of scalable, high-performance web apps.

For more detailed imformation. you can refer to Nuxt.js.

.NET is a powerful, open-source development platform created by Microsoft for building modern, scalable, and high-performance applications. It supports multiple languages such as C#, F#, and VB.NET, and enables developers to create applications across web, desktop, mobile, cloud, and IoT environments. Known for its strong type system, robust security features, and extensive class libraries, .NET streamlines development while ensuring reliability and maintainability. With the introduction of .NET Core and now .NET 8, it offers cross-platform support and exceptional performance.

For more detailed information, you can refer to .NET.

Microsoft SQL Server is a robust, enterprise-grade relational database management system (RDBMS) developed by Microsoft. It is designed to store, manage, and retrieve data efficiently while ensuring high performance, security, and reliability. SQL Server supports both structured query language (SQL) for relational data and JSON for semi-structured data, making it suitable for diverse modern applications. It offers advanced features such as ACID compliance, indexing, views, triggers, stored procedures, and built-in analytics through SQL Server Analysis Services (SSAS). With strong support for scalability, data integrity, and transaction management, SQL Server is widely used in enterprise environments for web applications, business intelligence, and large-scale data solutions.

For more detailed information, you can refer to Microsoft SQL Server.

OpenRouter is an open-source API platform that offers a unified interface to multiple large language models (LLMs). It enables developers to seamlessly integrate AI features—such as natural language processing, chat interfaces, and content generation—while managing authentication, fallback strategies, and cost efficiency. OpenRouter simplifies switching between or combining models from different providers.

For more detailed imformation. you can refer to OpenRouter.

Gemini API is a developer-friendly interface provided by Google to access the capabilities of its Gemini family of large language models (LLMs). It allows developers to integrate advanced AI features into their applications, including natural language understanding, code generation, content summarization, and multi-modal reasoning (text, image, and more). The Gemini API is accessible through Google AI Studio and is designed to support rapid prototyping and scalable deployment of generative AI solutions. With robust security, comprehensive documentation, and seamless integration with Google Cloud, the Gemini API enables powerful, flexible AI experiences across a wide range of use cases.

For more detailed imformation. you can refer to Gemini API documentation.

Monaco Editor is the highly customizable, in-browser code editor that powers Visual Studio Code. It supports syntax highlighting, IntelliSense, code folding, and more. Lightweight yet powerful, Monaco is perfect for embedding code editing experiences within web applications such as educational platforms, developer tools, or live coding playgrounds.

For more detailed imformation. you can refer to Monaco Editor.

Cloudflare is a leading web performance and security platform that provides a wide range of services to protect and accelerate websites, APIs, and applications. It acts as a reverse proxy between users and web servers, offering features such as DDoS protection, content delivery network (CDN), SSL/TLS encryption, firewall rules, and performance optimization. By caching content at global edge locations and filtering malicious traffic, Cloudflare helps improve loading speeds, reduce server load, and enhance overall security. It also offers developer tools like Cloudflare Pages and Workers for deploying scalable, serverless applications.

For more detailed imformation. you can refer to: CloudFlare.

2.2 Related Work

Elzero Web School

Description	Techniques Used	Advantages	Disadvantages
Elzero Web School is an excellent free resource for Arabic-speaking beginners and intermediate learners who want to build strong web development skills through structured, practical learning.	- External resources and useful tool recommendations included - A Q&A section to ask questions and receive community support	- Step-by-step structured study plans for better learning flow - Dedicated learning paths for Frontend, Backend, and Full Stack	- No built-in progress tracking to monitor course completion - Users cannot rate or review courses or lessons

Reference: https://elzero.org

Codeforces

Description	Techniques Used	Advantages	Disadvantages
A well-known platform that hosts regular contests like Div 1 and Div 2. It includes a robust rating system and editorial support to develop algorithmic thinking.	- Mathematical algorithms - Rating system - Editorial learning	- Regular contests with large community participation - Detailed editorial explanations - Transparent and active rating system	- Interface can be intimidating for beginners - Problems often require deep mathematical insight

Reference: https://codeforces.com

CodeChef

Description	Techniques Used	Advantages	Disadvantages
An Indian educational platform hosting contests like Long Challenge and Lunchtime, with a vast problem archive and community engagement.	- Long format contests (Long Challenge) - Short contests (Lunchtime) - Tutorial-based learning	- Great for long-term learning with multiple contest formats - Offers tutorials and mentorship programs	- Sometimes suffers from server lags during contests - Problems can be less curated compared to Codeforces or LeetCode

Reference: https://www.codechef.com

HackerRank

Description	Techniques Used	Advantages	Disadvantages
Focuses on algorithms, SQL, and data structures with a live coding environment, widely used for tech interviews.	- Structured learning paths - Auto-grading system - Skill-specific tracks (SQL, AI, etc.) - Live coding interface	- Beginner-friendly interface and structured learning paths - Great for practicing specific skills (e.g. SQL, AI) - Instant feedback and auto-grading	- Contest competitiveness is relatively low - Less challenging for advanced users

Reference: https://www.hackerrank.com

LeetCode

Description	Techniques Used	Advantages	Disadvantages
A premier platform for coding interview prep with 2,500+ problems and company-specific questions.	- Interview prep questions - Company-tagged problems - Weekly contests - Solution discussions	- Focused on technical interview preparation - Community solutions and tutorials - Weekly contests to benchmark skills	- Some premium features are behind a paywall - Less emphasis on advanced algorithms

Reference: https://leetcode.com

TopCoder

Description	Techniques Used	Advantages	Disadvantages
One of the oldest platforms, known for SRM (Single Round Matches) and Marathon Matches focusing on complex, long-term problems.	- SRM (Single Round Match) - Marathon Match - High-difficulty algorithm challenges - Real-world modeling problems	- Highly competitive and professional-grade problems - Real-world challenges and big prizes - Community of expert coders	- Interface feels outdated - Steeper learning curve for newcomers

Reference: https://www.topcoder.com

AtCoder

Description	Techniques Used	Advantages	Disadvantages
A Japanese platform offering well-structured contests (ABC, ARC, AGC) with a focus on clean problem statements and difficulty progression.	- ABC, ARC, AGC contests - Clean and structured problems - Difficulty progression - On-time weekly contests	- High-quality problems and fair difficulty curve - Regular, punctual contests - Structured for serious learners	- Japanese-first interface; some translations may be rough - Smaller international community than others

Reference: https://atcoder.jp

CodinGame

Description	Techniques Used	Advantages	Disadvantages
Gamifies coding challenges with multiplayer and story-based games like Clash of Code and Code vs Zombies.	- Game-based problem solving - Real-time multiplayer coding - Visual programming challenges - Language flexibility (25+)	- Fun and visual way to learn coding - Supports 25+ programming languages - Great for casual or team play	- Not focused on algorithm depth - Less suitable for serious competitive programming

Reference: https://www.codingame.com

CodeCombat

Description	Techniques Used	Advantages	Disadvantages
An RPG-style platform that teaches Python, JavaScript, and HTML through story-driven games and challenges.	- RPG-style game interface - Code-to-play mechanics - Curriculum-based learning - Beginner visual feedback	- Ideal for children and beginners - Game-based engagement with rewards - Offers structured curriculum	- Too basic for experienced developers - Some content requires a subscription

Reference: https://codecombat.com

Codewars

Description	Techniques Used	Advantages	Disadvantages
Uses "Kata" - short coding exercises - to improve coding progressively with ranking and community feedback.	- Community challenge creation - Rank-based progression - Peer-reviewed solutions	- Unique ranking and progression system - Community-driven challenges and solutions - Good for practicing idiomatic code	- Lacks formal contest system - Quality of community challenges can vary

Reference: https://www.codewars.com

CheckiO

Description	Techniques Used	Advantages	Disadvantages
Offers gamified learning of Python and JavaScript through short, interactive problem-solving challenges.	- Gamified challenges - Code review mechanism - Puzzle solving - Interactive feedback	- Fun and visual interface - Encourages reviewing others' code - Python-focused challenges are especially polished	- Less suitable for advanced algorithm training - Limited language support

Reference: https://checkio.org

2.3 Summary

In this chapter, the tools that will be used in implementation like (Node.js, Nuxt.js, Figma, Gemini API, OpenRouter, Monaco Editor, and CloudFlare). were described. Then the related work was described, (Which is listed in the previous table), and the advantages, disadvantages, and benefits of each one, then compared with the project.

Chapter

Chapter 3: Feasibility and Project Planning

3.1 Feasibility Study

3.1.1 Technical Feasibility

- **Familiarity with Applications:**
  - The target learners and educators in our region are already familiar with mobile educational apps and interactive tutorials (e.g. Duolingo, Code.org) in Arabic. Using a gamified, Arabic-language interface makes the platform intuitive; users require no extra training to log in, practice coding, or track progress.
  - Core team members have experience building web/mobile learning tools, so we understand typical user workflows (account setup, interactive lessons).
  - Because the UI and content are in Arabic, language barriers are eliminated, further smoothing the learning curve for beginners.
- **Familiarity with Technology:**
  - Our team has strong expertise in the chosen tech stack: we have built Vue/Nuxt.js and .NET applications before and are proficient with SQL Server databases. This means we can efficiently develop the front-end UI and the back-end server.
  - We have experience with embedding real-time code editors (the platform will use Microsoft's Monaco Editor, the same engine as VS Code) and handling Python and JavaScript code execution on the server.
  - We are comfortable working with AI APIs; in past projects we have integrated services (e.g. OpenAI APIs) and we can similarly use OpenRouter to connect to the Gemini API for intelligent hints. Overall, **our familiarity is high** and we have confidence that we have the coding, design, and integration skills needed to implement all planned features.
- **Project Size:**

- The core team will include about 6 members (detailed below), which is appropriate for a mid-size project.
- The platform’s scope involves a moderate variety of features: a real-time code editor (supporting Python and JS), gamification mechanics (XP, badges, streaks, daily goals), AI-driven hints. This is a mid-level complexity for an experienced team.
- The development timeline is relatively tight: with a target launch by May 2026 (about 6 months from planning start), the schedule is ambitious. However, by assigning parallel sprints for front-end, back-end, and content creation, and by leveraging reusable components (Nuxt/Vue libraries, Monaco Editor, etc.), we believe the team can meet this deadline.

3.1.2 Organizational Feasibility

- **Project Advisor:** Dr. Rehab Emad El-Dein
- **Champion:** The development team and supervisors provide time and effort for the system.
- **System Users:**
  - 1. **Learners:** Arabic-speaking students and self-learners who use the platform to learn programming through structured courses, interactive exercises, and real-time code challenges. They earn XP, badges, and streaks as they progress.
  - 2. **Mentors/Instructors:** More experienced developers or educators who contribute by answering questions, reviewing user code, curating content, and moderating the community. Mentors help ensure quality and provide additional support (similar to Duolingo "language mentors").
  - 3. **Administrators/Content Creators:** A small team of admins who upload new course material, monitor the system, and handle technical support.
- **Development Team Breakdown:** The team is organized into specialized roles with overlapping collaboration to ensure flexibility:

- **Back-end Developers (2):**
  Build and maintain the server-side logic in .NET, manage the SQL Server database, and implement APIs. One of the back-end developers will also take on DevOps responsibilities, handling cloud infrastructure, CI/CD pipelines, and security. Together, they will also implement real-time code execution and integration with AI APIs.

- **Front-end Developers (2):**
  Develop the user interface using Nuxt.js, ensuring a responsive and intuitive design across desktop and mobile browsers. They will integrate the Monaco editor, implement gamification features (XP, badges, leaderboards), and collaborate closely with the mobile developer to keep design consistent.

- **Mobile Developer (1):**
  Focuses on building and optimizing the mobile application version of the platform, ensuring a smooth experience on iOS and Android. Works with front-end and back-end teams for synchronization and performance.

- **AI Engineer (1):**
  Specializes in integrating AI features, including intelligent hints and personalized feedback, through APIs like OpenRouter/Gemini. This role also explores adaptive learning models to tailor exercises to each learner's progress.

- **Content & Instructional Design (shared responsibility):**
  Instead of dedicated content creators, **all team members will collaborate** on producing and localizing course material in Arabic. This includes designing structured lessons, writing exercises, and embedding gamification mechanics. Team members' technical expertise ensures content is accurate, while shared responsibility distributes workload evenly.

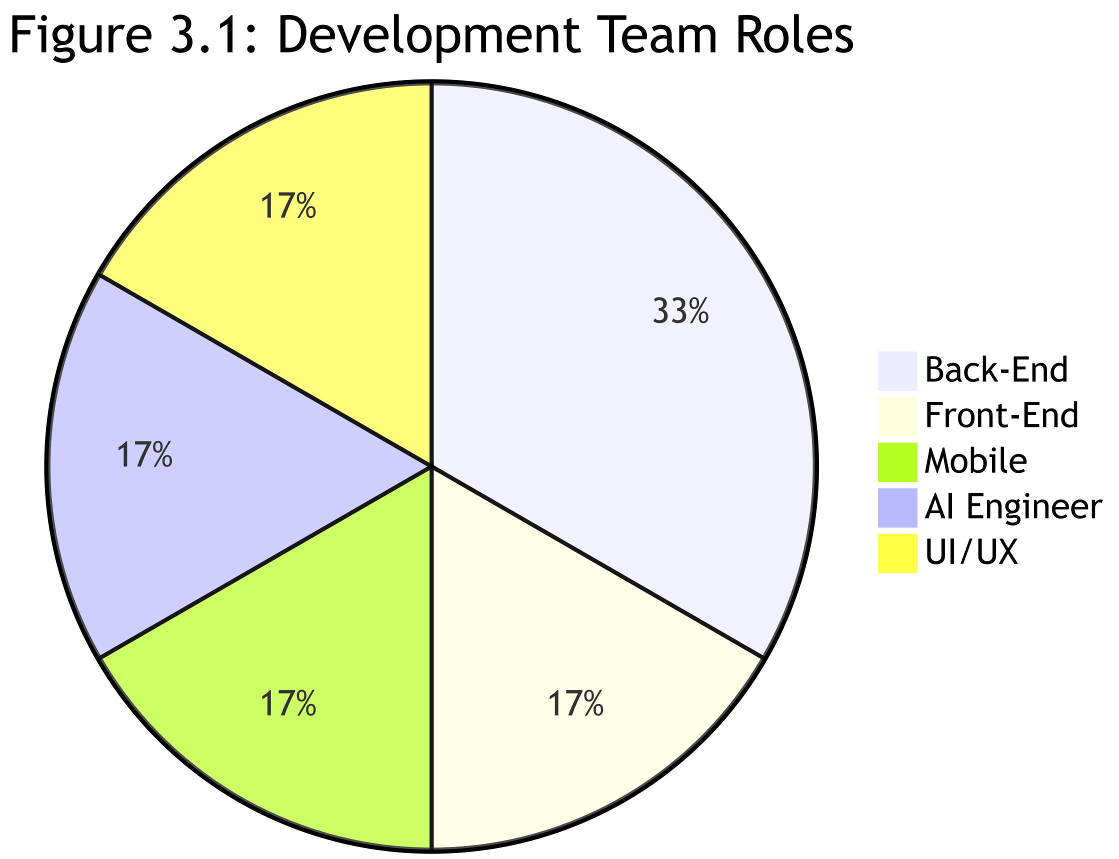

Figure 3.1: Development Team Roles

3.1.3 Economic Feasibility

- **Tangible Benefits:**
  - **Course Revenue:** With a pay-per-course model at an average price of $30 per course, enrolling 5,000 users in Year 1 (our target) would generate roughly $150,000 in Year-1 sales. As user growth continues, Year 2 and 3 revenues could be, for example, $225,000 and $300,000 (assuming 50% year-over-year user growth).
  - **Additional Revenue Streams:** We can develop premium content or certification services in later years (e.g. advanced courses, official completion certificates) to create new revenue. Partnerships or bulk licenses with schools or companies could also add income.
  - **Economies of Scale:** Because hosting and maintenance costs (see below) are largely fixed per year, each additional user above Year 1 yields mostly profit. For instance, once we cover the $20,000/year hosting expense and $50,000/year marketing, further enrollments significantly improve margins.
- **Intangible Benefits:**
  - **Learner Engagement:** The gamified, Duolingo-style approach will keep students motivated. Studies show gamification (points, streaks, badges) significantly boosts user engagement and retention. By making coding fun and rewarding, we help learners persist.
  - **Education Impact:** Providing coding education in Arabic removes language barriers and makes computer science more accessible. This can broaden participation in tech education and help develop local talent in programming.
  - **Brand and Market Position:** Successfully launching this platform will position our team as innovators in Arabic EdTech. Positive reputation and user testimonials will attract future investments, partnerships, and possibly expansion into new topics or markets.

Development and Operational Costs (Years 0–3):

Item	Year 0	Year 1	Year 2	Year 3	Total
Development (one-time)	$280,000	$0	$0	$0	$280,000
Dev team salaries	$180,000	–	–	–	$180,000
Content creation	$100,000	–	–	–	$100,000
Hosting/AI/maint.	$0	$20,000	$20,000	$20,000	$60,000
Marketing	$0	$50,000	$50,000	$50,000	$150,000
Total Cost	**$280,000**	**$70,000**	**$70,000**	**$70,000**	**$490,000**

ROI and Cumulative Net:

Metric	Year 0	Year 1	Year 2	Year 3	Total
Revenue	$0	$150,000	$225,000	$300,000	$675,000
Total Cost	$280,000	$70,000	$70,000	$70,000	$490,000
Net Profit	-$280,000	$80,000	$155,000	$230,000	$185,000
Cumulative Net	-$280,000	-$200,000	-$45,000	$185,000	—

3-Year ROI: $185,000 ÷ $490,000 ≈ **37.8%**

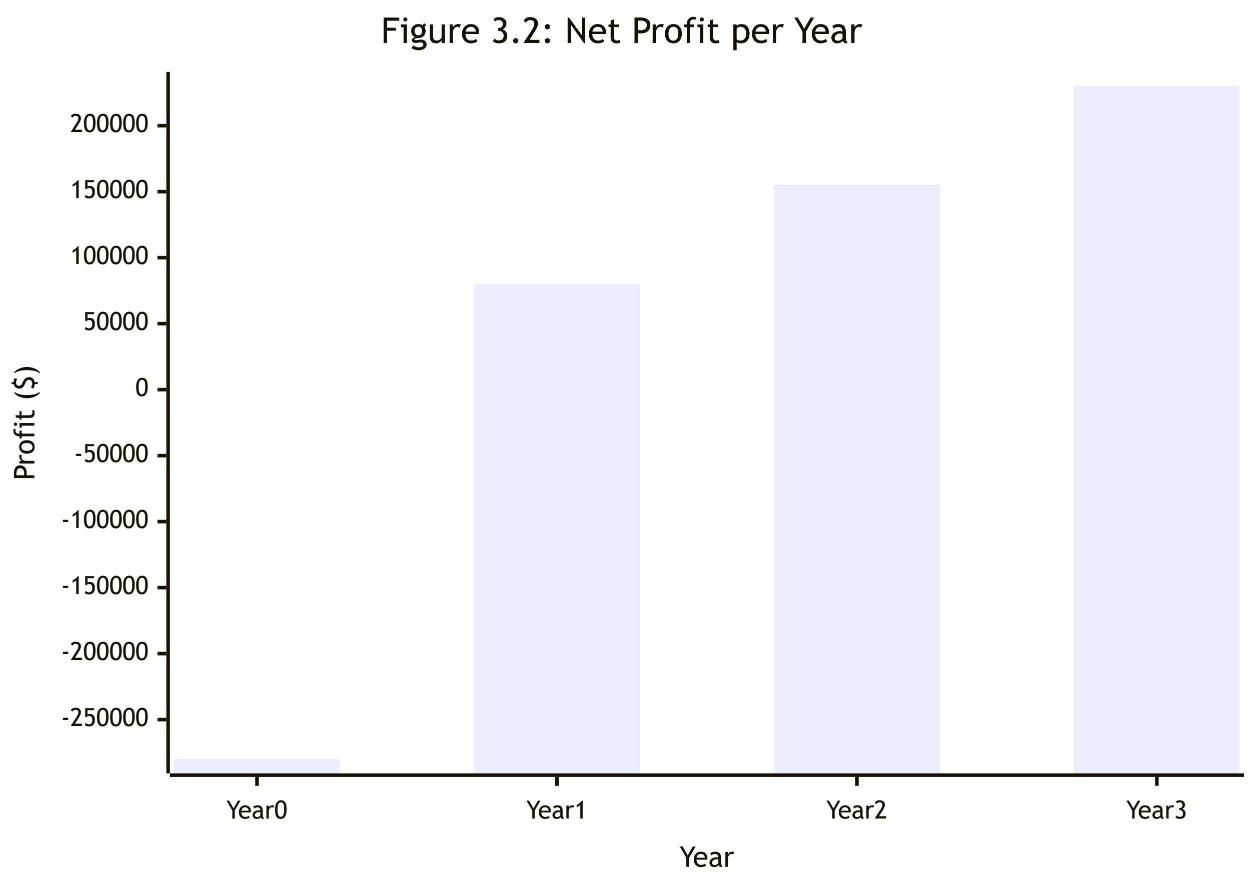

Figure 3.2: Net Profit per Year

Break-even Analysis

The **break-even point** occurs when cumulative revenue surpasses cumulative costs:

- **Year 1:** Cumulative revenue = $150,000, cumulative cost = $350,000 → still negative (-$200,000).
- **Year 2:** Cumulative revenue = $375,000, cumulative cost = $420,000 → still negative (-$45,000).
- **Year 3:** Cumulative revenue = $675,000, cumulative cost = $490,000 → **positive cumulative net ($185,000)** .

Therefore, the project is expected to **break even during Year 3** , after which all additional revenue contributes to profit.

To illustrate:

- **Break-even revenue threshold:** $490,000 (total 3-year cost).
- Achieved at ~ **16,333 paid enrollments** (490,000 ÷ $30).
- Based on projected growth, this milestone will be reached in the **third year of operation** .

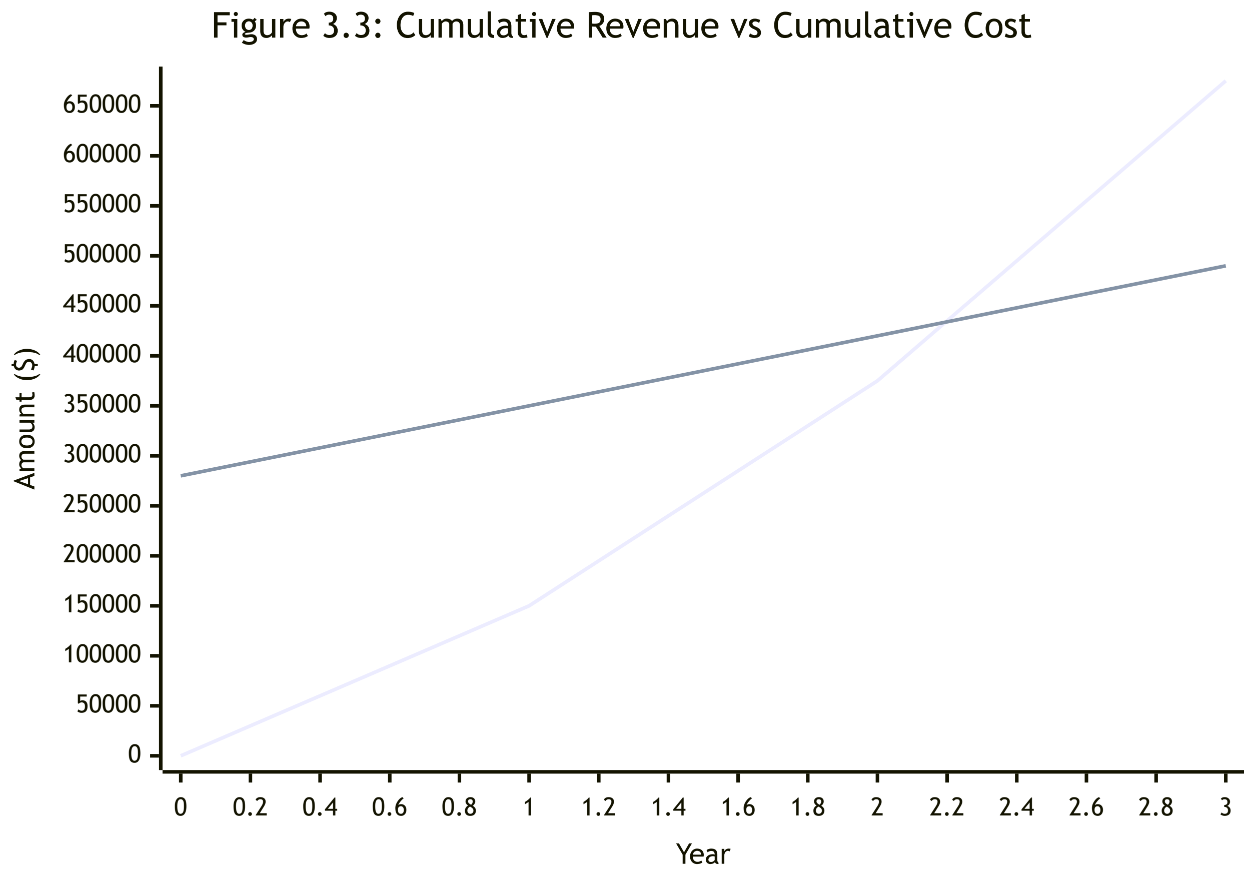

Figure 3.3: Cumulative Revenue vs Cumulative Cost

3.2 Risk Management

This section identifies key risks for the coding education platform across technical, operational, and legal domains. Each risk is assessed with a likelihood (Low/Medium/High), impact (Low/Medium/High), and mitigation strategies. Where appropriate, a qualitative risk matrix is used to emphasize prioritization.

3.2.1 Technical Risks

Risk	Description	Likelihood	Impact	Mitigation
Scalability & Uptime	High traffic or data growth could overwhelm the platform. Without modular architecture and robust testing, performance bottlenecks and downtime can occur.	High	High	Design a scalable, microservices-based architecture; use horizontal scaling (load balancing, CDN, caching); implement automated testing and monitoring to detect and prevent bottlenecks.
External API Integration	Reliance on third-party APIs (e.g. Gemini, OpenRouter) can introduce outages or unpredictable behavior. Third-party services may have downtime or breaking changes.	Medium	High	Vet and monitor external APIs closely (uptime/SLA checks); implement timeouts and retries; use circuit breakers to protect against surges; prepare fallback or degraded modes if an API fails.
Real-time Code Execution	Running user-submitted code in real time is error-prone. Sandbox failures, resource exhaustion, or vulnerabilities could crash the executor, harming reliability.	Medium	High	Isolate execution in secure sandboxes or containers; enforce resource limits (memory/time); continuously test with diverse workloads; scale the execution engine separately; monitor and auto-recover.

3.2.2 Operational Risks

Risk	Description	Likelihood	Impact	Mitigation
Timeline Delays	Requirement changes, scope creep, or underestimation can derail schedules. Over-optimistic estimates may lead to extended deadlines.	High	High	Use thorough upfront planning and clear requirements; apply realistic time estimates with contingency; use agile sprints for incremental delivery and reviews.
Resource Constraints	Limited team size or skill shortages create bottlenecks.	Medium	High	Cross-train staff and onboard talent early; use contingent resources; maintain a pipeline of developers; forecast and reallocate workloads proactively.
Content Development Bottlenecks	Creating high-quality, engaging coding lessons and exercises is time-consuming, which can delay releases or reduce quality.	Medium	Medium	Develop content iteratively with SMEs; reuse or adapt existing materials; employ instructional designers; prioritize high-impact modules first.

3.2.3 Legal & Compliance Risks

Risk	Description	Likelihood	Impact	Mitigation
Data Privacy (Minors)	Collecting data on children raises strict legal requirements (e.g., COPPA, GDPR). Failure to comply can cause severe penalties.	Medium	High	Apply "privacy by design": minimize data collection, encrypt sensitive data, obtain parental consent, maintain clear privacy policies, and conduct regular audits.
Copyright & Licensing	Using third-party or community code/assets risks license infringement. Even one noncompliant license could result in legal or financial penalties.	Low	Medium	Enforce strict review of all content/code; use license scanners; prefer permissive or original content; educate users on plagiarism; remediate infringing material.
Terms-of-Service Violations	Users may post disallowed content (hate speech, copyrighted code, malicious submissions) or cheat, violating the platform's ToS.	Medium	Medium	Publish comprehensive ToS; implement moderation and reporting tools; enforce rules via filters and manual review; respond promptly and revise policies regularly.

3.3 Project plan

TO DO

3.4 Gantt Chart

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Chapter Chapter 4: System Analysis

4.1 Function Requireements

4.1.1 User Management System

User Registration and Authentication

- **FR-1.1:** System shall allow users to create accounts using email, username, and password.
- **FR-1.2:** System shall support social login (Google, GitHub) for quick registration.
- **FR-1.3:** System shall implement email verification for new accounts.
- **FR-1.4:** System shall provide secure password reset functionality via email.
- **FR-1.5:** System shall enforce strong password policies (minimum 8 characters, special characters).
- **FR-1.6:** System shall implement two-factor authentication (2FA) as an additional security feature.

Optional Feature: Two-factor authentication (2FA).

User Profiles and Settings

- **FR-1.7:** System shall allow users to create and edit personal profiles with avatar, bio, and learning goals.
- **FR-1.8:** System shall allow users to select preferred programming languages (Python, JavaScript, etc.).
- **FR-1.9:** System shall support multiple language interface options (Arabic, English).

Optional Feature: Language interface options.

User Roles and Permissions

- **FR-1.10:** System shall support multiple user roles: Learner, Administrator, Content Creator.
- **FR-1.11:** System shall implement role-based access control for different platform features.

4.1.2 Learning Management System

Course Structure and Navigation

- **FR-2.1:** System shall organize content into structured learning paths from fundamentals to advanced topics.
- **FR-2.2:** System shall implement prerequisite-based lesson unlocking mechanisms.
- **FR-2.3:** System shall provide a visual learning roadmap showing completed, current, and locked modules.
- **FR-2.4:** System shall support multiple learning tracks (Python, JavaScript, Web Development, OOP, Algorithms).

> **Optional Feature:** Lesson bookmarking.

Lesson Content Delivery

- **FR-2.5:** System shall support multi-format lesson content (text, videos, interactive demos).
- **FR-2.6:** System shall provide step-by-step coding walkthroughs with highlighted code segments.
- **FR-2.7:** System shall include conceptual explanations before practical exercises.
- **FR-2.8:** System shall support rich text formatting, code syntax highlighting, and embedded media.

> **Optional Feature:** Estimated completion time per lesson.

Adaptive Learning Features

- **FR-2.9:** System shall track user performance and recommend personalized learning paths.
- **FR-2.10:** System shall adjust exercise difficulty based on user success rates.
- **FR-2.11:** System shall provide spaced repetition reminders for previously learned concepts.

4.1.3 Code Editor and Execution Environment

In-Browser Code Editor

- **FR-3.1:** System shall embed Monaco Editor for in-browser code editing.
- **FR-3.2:** System shall support syntax highlighting for Python, JavaScript, etc.
- **FR-3.3:** System shall provide auto-completion and IntelliSense features.
- **FR-3.4:** System shall include line numbering, code folding, and bracket matching.
- **FR-3.5:** System shall support multiple editor themes (dark/light mode).
- **FR-3.6:** System shall provide keyboard shortcuts for common coding operations.

Code Execution and Testing

- **FR-3.7:** System shall execute user code securely using APIs.
- **FR-3.8:** System shall display real-time output and error messages.

> **Optional Feature:** Test case validation, execution performance metrics.

Code Analysis and Feedback

- **FR-3.9:** System shall provide instant syntax error detection and suggestions.
- **FR-3.10:** System shall offer code optimization suggestions and best practices.
- **FR-3.11:** System shall compare user solutions with model answers.
- **FR-3.12:** System shall highlight potential bugs or logical errors using LLM.

> **Optional Feature:** Code complexity analysis with Big O insights.

Blockly Integration

- **FR-3.13:** System shall provide a block-based workspace with customizable categories (Logic, Math, Control, Events, etc.).
- **FR-3.14:** System shall allow users to generate source code (JavaScript/Python) from block structures.
- **FR-3.15:** System shall enable code execution within the application environment.
- **FR-3.16:** System shall support saving and loading block configurations in XML/JSON format.

Optional Feature: Custom block expansion.

4.1.4 Interactive Exercise System

Exercise Types and Structure

- **FR-4.1:** System shall support coding challenges, bug fixing, code completion, and multiple-choice exercises.
- **FR-4.2:** System shall provide clear problem statements with input/output examples.
- **FR-4.3:** System shall include starter code templates when appropriate.
- **FR-4.4:** System shall support progressive difficulty within exercise sets.
- **FR-4.5:** System shall offer optional hints and explanations.

Validation and Grading

- **FR-4.6:** System shall automatically validate solutions against test cases.
- **FR-4.7:** System shall track solution attempts and provide retry mechanisms.

Optional Feature: Immediate feedback, partial credit.

Solution Management

- **FR-4.8:** System shall provide "section of solutions" after successful completion.
- **FR-4.9:** System shall allow users to submit multiple approaches to the same problem.

Optional Feature: Save and version solutions.

4.1.5 Gamification System

Points and Experience (XP)

- **FR-5.1:** System shall award XP for completed lessons, exercises, and achievements.
- **FR-5.2:** System shall implement progressive XP requirements for level advancement.
- **FR-5.3:** System shall provide XP bonuses for consecutive learning streaks.
- **FR-5.4:** System shall award bonus points for first attempts.
- **FR-5.5:** System shall display XP progress bars and level indicators.

Achievement System

- **FR-5.6:** System shall implement badge categories (completion, mastery, collaboration).
- **FR-5.7:** System shall provide rare and legendary badges for exceptional achievements.
- **FR-5.8:** System shall display badge galleries on user profiles.
- **FR-5.9:** System shall notify users upon earning new achievements.

> **Optional Feature:** Skill-specific badges.

Leaderboards and Competition

- **FR-5.10:** System shall maintain global and weekly leaderboards.
- **FR-5.11:** System shall support friend-based leaderboards and challenges.
- **FR-5.12:** System shall provide leaderboard filtering by time, skill level, or language.

Streaks and Daily Goals

- **FR-5.13:** System shall track daily learning streaks with visual indicators.
- **FR-5.14:** System shall send streak reminder notifications.
- **FR-5.15:** System shall provide streak recovery options.

> **Optional Feature:** Personalized daily goals.

Certification Management

- **FR-5.16:** System shall display all available certifications with details.
- **FR-5.17:** System shall allow eligible users to enroll in certification tracks.
- **FR-5.18:** System shall create a certification dashboard showing progress and deadlines.

4.1.6 Progress Tracking and Analytics

Individual Progress Monitoring

- **FR-6.1:** System shall maintain comprehensive learning history per user.
- **FR-6.2:** System shall calculate and display skill mastery percentages.
- **FR-6.3:** System shall track time spent on topics and exercises.
- **FR-6.4:** System shall identify strengths and weaknesses.

Performance Analytics

- **FR-6.5:** System shall track accuracy rates and improvement trends.
- **FR-6.6:** System shall monitor learning velocity.
- **FR-6.7:** System shall calculate estimated completion time for coursework.

Visual Progress Representation

- **FR-6.8:** System shall provide interactive progress roadmaps.
- **FR-6.9:** System shall display skill trees showing mastered and locked concepts.

Optional Feature: Charts and graphs for analytics.

4.1.7 AI-Powered Features

Intelligent Hints and Assistance

- **FR-7.1:** System shall integrate AI APIs (Gemini via OpenRouter) for contextual hints.
- **FR-7.2:** System shall provide progressive hint levels.
- **FR-7.3:** System shall analyze user code and suggest improvements.
- **FR-7.4:** System shall generate explanations for complex programming concepts.
- **FR-7.5:** System shall adapt hint complexity based on user skill.

Personalized Learning Recommendations

- **FR-7.6:** System shall suggest relevant exercises when users struggle.

Optional Feature: Learning schedules, AI practice problems.

Automated Content Generation

- **FR-7.7:** System shall generate variations of exercises for extra practice.
- **FR-7.8:** System shall generate code examples for abstract concepts.

4.1.8 Content Management System

Course and Lesson Administration

- **FR-8.1:** System shall provide a content creation interface for authorized users.

Optional Feature: Content scheduling, review workflows.

Exercise and Assessment Management

- **FR-8.2:** System shall allow creation of coding exercises with test cases.
- **FR-8.3:** System shall support exercise difficulty categorization.
- **FR-8.4:** System shall validate exercises before publication.

Optional Feature: Exercise cloning and templates.

Multimedia Content Support

- **FR-8.5:** System shall support video upload or embedding.
- **FR-8.6:** System shall support content localization for multiple languages.

Optional Feature: Image embedding and interactive content creation.

4.1.9 System Administration

User Management

- **FR-9.1:** System shall provide an administrative dashboard for managing user accounts.
- **FR-9.2:** System shall support user role assignment and permission management.

Platform Monitoring and Analytics

- **FR-9.3:** System shall maintain system logs and audit trails.
- **FR-9.4:** System shall provide usage statistics and dashboards.

Content Moderation

- **FR-9.5:** System shall support manual content review and moderation workflows.
- **FR-9.6:** System shall maintain content removal and user warning systems.

4.1.10 Integration and API Features

Third-Party Integrations

- **FR-10.1:** System shall integrate with external authentication providers (OAuth or BetterAuth).
- **FR-10.2:** System shall connect with AI services (OpenRouter, Gemini API).

Platform APIs

- **FR-10.3:** System shall provide RESTful APIs for web and mobile apps.
- **FR-10.4:** System shall support webhook integrations.

Mobile and Cross-Platform Support

- **FR-10.5:** System shall deliver a responsive web interface optimized for mobile.
- **FR-10.6:** System shall provide mobile-specific features (push notifications).
- **FR-10.7:** System shall ensure cross-browser compatibility.

> **Optional Feature:** Offline content caching.

4.1.11 Security and Privacy

Data Protection

- **FR-11.1:** System shall encrypt sensitive user data at rest and in transit.
- **FR-11.2:** System shall implement secure session management and timeouts.
- **FR-11.3:** System shall provide privacy controls and data deletion options.
- **FR-11.4:** System shall comply with GDPR and COPPA standards.

Platform Security

- **FR-11.5:** System shall implement input validation and sanitization.
- **FR-11.6:** System shall protect against XSS, CSRF, and SQL injection.
- **FR-11.7:** System shall secure API endpoints with authentication and authorization.
- **FR-11.8:** System shall implement rate limiting and DDoS protection.

4.2 Non-Function Requirements

4.2.1 Performance

NFR-1.1: Response Time

- Landing page load: **2 seconds** (3G or better)
- Monaco editor initialization: **3 seconds**
- Code execution results: **5 seconds** (standard exercises)
- API responses: **1 second** (login, save, submit)
- Search/filtering: **2 seconds**

NFR-1.2: Throughput

- Concurrent users: **1,000+** without degradation
- Simultaneous code executions: **500+**
- Peak submissions: **10,000/hour**

NFR-1.3: Resource Utilization

- Client memory: ≤ **500MB**
- Monaco editor: ≤ **200MB**
- Database queries: **100ms** (95% of operations)
- CDN cache hit rate: **90%+**

NFR-1.4: Rendering Performance

- Interactive elements response: **100ms**
- Animation frame rate: **60 FPS**
- Roadmap rendering (100 nodes): **1.5 seconds**

4.2.2 Availability

NFR-2.1: System Uptime

- Annual uptime: **99.5%** (~43.8 hours downtime)
- Maintenance windows: ≤ **4 hours/month** (low-usage periods)

NFR-2.2: Service Availability

- Core features: **24/7** availability
- AI hints: **95%** uptime
- Leaderboards: **98%** uptime

NFR-2.3: Geographic Availability

- Global accessibility with focus on Arabic-speaking regions

NFR-2.4: Graceful Degradation

- AI unavailable → pre-generated hints available
- Execution service down → lessons & content accessible

4.2.3 Scalability

NFR-3.1: Horizontal Scalability

- Stateless architecture for seamless load balancing
- Connection pooling for efficient resource management

NFR-3.2: User Growth

- Year 1: **50,000** users
- Year 3: **200,000** users (without major changes)

NFR-3.3: Content Scalability

- Launch: **500 lessons** , **5,000 exercises**
- Future: **2,000 lessons** , **20,000 exercises**
- Support new languages without refactoring

NFR-3.4: Database Scalability

- PostgreSQL with read replicas
- Quarterly query plan reviews

4.2.4 Reliability

NFR-4.1: Error Rate

- System error rate: **&lt0.5%**
- Code execution failures: **&lt1%** (system errors only)

NFR-4.2: Data Integrity

- ACID compliance for progress data (Atomicity, Consistency, Isolation, Durability)
- Daily backups with 30-day point-in-time recovery

NFR-4.3: Fault Tolerance

- No single point of failure
- Database failover: **60 seconds** automatic

NFR-4.4: Data Consistency

- Leaderboards: eventual consistency within **5 minutes**
- User profiles: immediate consistency
- Cache invalidation: **30 seconds**

4.2.5 Interoperability

NFR-5.1: API Standards

- RESTful design with standard HTTP methods
- JSON responses with consistent structure
- OpenAPI/Swagger documentation

NFR-5.2: Third-Party Integration

- OAuth 2.0 (Google, GitHub)
- Webhook support with JSON payloads

NFR-5.3: Data Exchange

- Export formats: JSON, CSV
- Version-control compatible storage

NFR-5.4: Browser Compatibility

- Chrome, Firefox, Safari, Edge (latest versions)
- Browsers released within **2 years**

NFR-5.5: Mobile Compatibility

- Responsive: **320px–2560px**
- Native notifications (FCM/APNs)

4.2.6 Usability

NFR-6.1: Learnability

- Account setup → first lesson: **5 minutes**
- Interactive tutorial: **&lt10 minutes**

NFR-6.2: UI Design

- Material Design principles
- Arabic (RTL) and English (LTR) support
- 3 font size options

NFR-6.3: Accessibility

- Keyboard navigation (tab, arrows, enter)
- ARIA labels and semantic HTML
- Color-blind modes with alternative indicators

NFR-6.4: Error Handling

- User-friendly messages (Arabic/English)
- Contextual help tooltips
- Searchable help center accessible from all pages

NFR-6.5: Localization

- Full Arabic/English localization
- Language switching without progress loss
- Regional date, time, and number formatting

NFR-6.6: Responsiveness

- Immediate visual feedback
- Progress indicators for operations > **1 second**

4.2.7 Maintainability

NFR-7.1: Code Quality

- Test coverage: ≥ **80%** (critical components)
- Peer review required before merge

NFR-7.2: Documentation

- API docs with examples and schemas
- Architecture diagrams (system, database, data flow)
- Code comments for complex logic

NFR-7.3: Modularity

- Reusable, independently testable components
- Versioned migration scripts

NFR-7.4: Logging & Monitoring

- Centralized logs with **90-day** retention
- Automated alerts for critical errors

NFR-7.5: Deployment

- Automated CI/CD pipelines
- Rollback capability: **10 minutes**

4.2.8 Recovery

NFR-8.1: Backup & Restore

- Daily full + 6-hour incremental backups
- 30-day point-in-time recovery
- Weekly integrity verification

NFR-8.2: Disaster Recovery

- Semi-annual testing
- **RTO** : 4 hours
- **RPO** : ≤ 1 hour data loss

NFR-8.3: Failure Detection

- Alert within **2 minutes** of critical failure

NFR-8.4: Data Recovery

- Individual account restoration
- Checksum validation with automatic rollback

NFR-8.5: Service Recovery

- Resume after maintenance: **5 minutes**
- Automatic session restoration
- Clear incident messaging

NFR-8.6: Transaction Recovery

- Automatic completion or manual review
- Transaction log maintenance

4.3 Functional Decomposition

Decomposition Diagram - Part 1

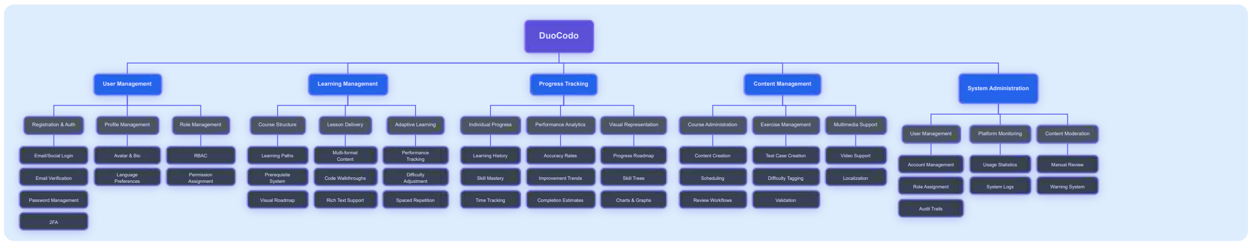


Figure 4.1: Decomposition Diagram Part 1

Decomposition Diagram - Part 2

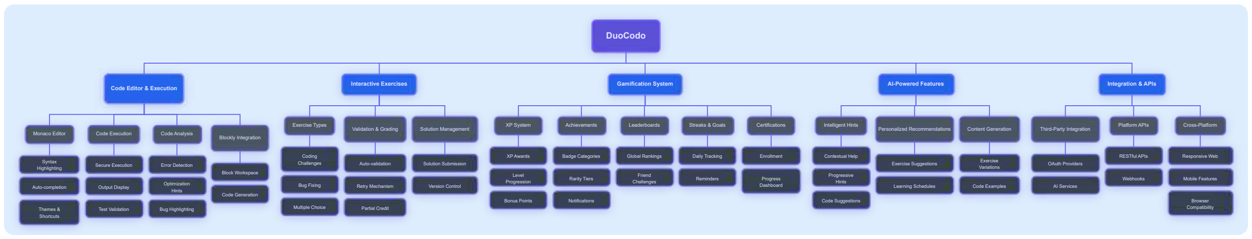


Figure 4.2: Decomposition Diagram Part 2

Chapter

Chapter 5: System Architecture

5.1 Actor-goal List

Actor	Goals
Learner	1. Register, log in, and manage their own profiles. 2. Choose preferred programming languages and interface languages. 3. Follow structured learning paths and unlock lessons progressively. 4. Learn via text, videos, and interactive demos. 5. Practice coding using Monaco Editor with syntax highlighting, auto-completion, and real-time feedback. 6. Receive AI-powered hints, explanations, and recommendations. 7. Complete exercises, earn XP, badges, and certifications. 8. Track progress, mastery, and performance analytics. 9. Participate in leaderboards, streaks, and challenges.
Content Creator / Instructor	1. Create and manage courses, lessons, and coding exercises. 2. Categorize exercises by difficulty and validate before publishing. 3. Add multimedia (videos, images) and localized content. 4. Review and update educational materials. 5. Generate content in different formats (text, code, interactive demos).
Administrator	1. Manage user accounts and assign roles/permissions. 2. Monitor platform analytics and logs. 3. Moderate content and enforce warnings or removals. 4. Oversee data security, backups, and system performance. **"-"** 5. Configure integrations and APIs for external services. **"-"**
AI System (Gemini / OpenRouter)	1. Provide contextual hints and adaptive learning recommendations. 2. Analyze learner code to detect errors and suggest improvements. 3. Generate additional exercises and code examples. **"-"** 4. Adjust hint complexity based on user skill level. **"-"**

5.2 Use Cases Diagram

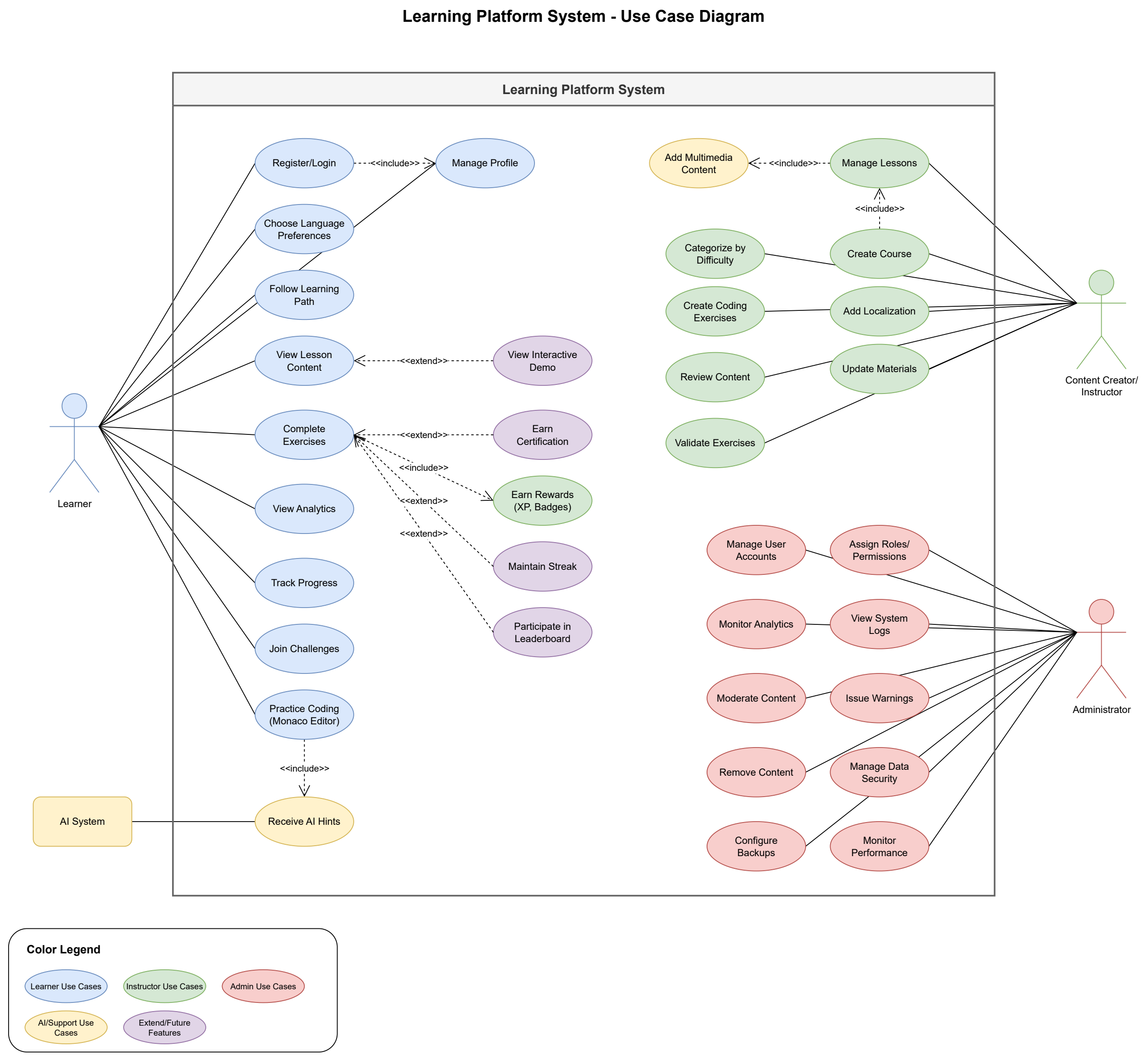


Figure 5.1: Use Cases Diagram

5.3 Use Cases Format

This section presents use cases for the DuoCodo platform organized by user role. The cases progress from administrative functions through content creation to learner interactions, using three format levels: Brief (one-line), Casual (structured scenarios), and Fully Dressed (comprehensive specifications).

5.3.1 Administrator Use Cases

Brief Format Use Cases

UC 1. View System Logs

The administrator views system activity logs, error reports, and security events to monitor platform health.

UC 2. Check Platform Statistics

The administrator views key metrics including total users, active learners, course enrollments, and system performance indicators.

UC 3. View User List

The administrator displays a searchable list of all registered users with basic information and account status.

Casual Format Use Cases

UC 4. Manage User Accounts

▸ **Actor**	Administrator

Main Success Scenario

1. The administrator logs into the admin dashboard.
2. The administrator navigates to the "User Management" section.
3. The system displays a searchable, filterable user list with columns:
    - Username
    - Email
    - Role (Learner/Content Creator/Admin)
    - Account status (Active/Suspended/Deactivated)
    - Registration date
    - Last login

- Total XP/Activity level

4. The administrator can search by username, email, or user ID.
5. The administrator can filter by:
    - Role type
    - Account status
    - Registration date range
    - Activity level (active/inactive)
6. The administrator selects a specific user to view details.
7. The system displays comprehensive user profile:
    - Personal information
    - Enrolled courses
    - Progress statistics
    - Activity history
    - Violation reports (if any)
8. The administrator can perform actions:
    - Edit user information
    - Reset password
    - Change account status
    - Adjust user role
    - View security logs
9. The administrator makes necessary changes and clicks "Save."
10. The system updates user information and logs the administrative action.
11. The affected user receives notification of account changes (if applicable).

Alternative Scenarios

A1. User Not Found

At Step 4, if search returns no results:

> 💬 *"No users found matching '[search term]'. Try different keywords or check spelling."*

A2. Concurrent Admin Actions

At Step 9, if another admin is editing the same user:

> 💬 *"Administrator [Name] is currently editing this account. Changes may conflict."*

System prevents conflicting simultaneous edits.

A3. Cannot Modify Super Admin

At Step 8, if attempting to change super admin permissions:

> 💬 *"Super Administrator accounts cannot be modified. Contact platform owner for changes."*

A4. Bulk Action Requested

At Step 8, if admin selects multiple users:

The system offers bulk actions: suspend, send message, export data

Admin confirms bulk action

System processes with progress indicator

UC 5. Assign User Roles

▸ **Actor**	Administrator

Main Success Scenario

1. The administrator navigates to "Role Management" in the admin panel.
2. The system displays available roles:
    - Learner (default)
    - Content Creator
    - Mentor/Reviewer
    - Administrator
    - Super Administrator
3. The administrator searches for a specific user.
4. The administrator selects the user and clicks "Change Role."
5. The system displays current role and available role options.
6. The administrator selects the new role from the dropdown.
7. If promoting to Content Creator or higher, the system prompts:

    > *"This role grants elevated permissions. Confirm you want to proceed?"*

8. The administrator confirms the role change.
9. The system updates the user's role and permissions.

10. The system sends notification to the user:

> *"Your account role has been updated to [New Role]. You now have access to [features]."*

11. The system logs the role change with timestamp and admin identifier.
12. The user's interface updates to reflect new capabilities on next login.

Alternative Scenarios

A1. Insufficient Permissions

At Step 6, if the admin lacks authority to assign certain roles:

> *"You cannot assign [Role Name]. Only Super Administrators can grant this role."*

A2. User Already Has Role

At Step 6, if attempting to assign current role:

> *"This user already has the [Role Name] role."*

A3. Content Creator Requirements Not Met

At Step 8, if promoting to Content Creator but user hasn't met criteria:

> *"This user hasn't completed Content Creator training. Assign role anyway?"*

Admin can proceed with override or require training first.

A4. Demoting Active Content Creator

At Step 8, if demoting a creator with published content:

> 💬 *"This user has [X] published courses. Demoting will affect content management. Reassign content?"*

Admin must decide how to handle existing content.

UC 6. Monitor Platform Analytics

▸ **Actor**	Administrator

Main Success Scenario

1. The administrator logs into the admin dashboard.
2. The administrator navigates to "Platform Analytics."
3. The system displays a comprehensive analytics dashboard with widgets:
    - User Metrics: Total users, new registrations, active users (daily/weekly/monthly)
    - Engagement Metrics: Average session duration, lessons completed, exercises submitted
    - Content Metrics: Total courses, lessons, exercises; most popular content
    - Performance Metrics: System uptime, response times, error rates
    - Revenue Metrics: Enrollments, certification purchases, subscription status

- Geographic Distribution: User locations, regional activity

4. The administrator can customize the date range (last 7 days, 30 days, 90 days, custom).
5. The administrator can filter by:
    - User segment (learners, content creators)
    - Course categories
    - Learning paths
    - Device types (desktop, mobile)
6. The administrator views detailed charts and graphs:
    - User growth trends (line graph)
    - Enrollment distribution (pie chart)
    - Peak usage times (heatmap)
    - Course completion rates (bar chart)
7. The administrator can drill down into specific metrics:
    - Clicks on "Course Completion Rate"
    - System shows breakdown by course, difficulty level, and time period
8. The administrator identifies trends:
    - Notice a drop in engagement on weekends
    - See spike in mobile usage
    - Identify popular learning paths
9. The administrator can export reports in multiple formats:
    - PDF (executive summary)
    - Excel (detailed data)
    - CSV (raw data)
10. The administrator schedules automated reports:
    - Weekly summary email

- Monthly executive dashboard
- Quarterly performance review

11. The system saves admin's preferred dashboard configuration.

Alternative Scenarios

A1. Insufficient Data

At Step 3, if platform is newly launched with minimal data:

> 💬 *"Limited data available. Analytics become more meaningful after 30+ days of activity."*

A2. Data Loading Delays

At Step 3, if analytics take time to compile:

> 💬 *"Loading analytics... This may take a minute for large datasets."*

A3. Export Limit Exceeded

At Step 9, if requesting very large data export:

> 💬 *"This export contains 100,000+ records. It will be processed in the background and emailed when ready."*

A4. Real-Time Data Unavailable

At Step 3, if requesting real-time metrics during system maintenance:

> 💬 *"Real-time data temporarily unavailable. Showing last cached data from [timestamp]."*

UC 7. Review and Filter System Logs

▸ **Actor**	Administrator

Main Success Scenario

1. The administrator navigates to "System Logs" in the admin panel.
2. The system displays log categories:
   - Security logs (authentication, failed logins, permission changes)
   - Error logs (application errors, API failures)
   - User activity logs (major actions, submissions)
   - Content logs (course creation, updates, deletions)
   - System performance logs (response times, resource usage)
3. The administrator selects "Security Logs."
4. The system displays recent security events with details:
   - Timestamp
   - Event type

- User involved
- IP address
- Action taken
- Outcome (success/failure)

5. The administrator can filter logs by:
    - Date/time range
    - Event severity (info, warning, error, critical)
    - User or IP address
    - Event type
6. The administrator searches for specific events (e.g., "failed login attempts from IP X").
7. The system highlights matching log entries.
8. The administrator can expand log entries for detailed information:
    - Full error stack trace
    - Request parameters
    - System state at time of event
9. The administrator can export filtered logs for analysis.
10. The system allows the administrator to flag logs for follow-up investigation.
11. The administrator can set up alerts for specific log patterns:
    - Multiple failed logins from same IP → possible attack
    - Spike in errors → system issue requiring attention

Alternative Scenarios

A1. Excessive Log Volume

At Step 4, if millions of log entries exist:

> 💬 *"Showing most recent 10,000 entries. Narrow your search or time range for specific logs."*

A2. Sensitive Information in Logs

At Step 8, if logs contain sensitive data:

The system masks passwords, tokens, personal data

Only super admins can view unmasked logs with additional authentication

A3. Log Storage Full

At Step 2, if log storage approaching limit:

> 💬 *"Warning: Log storage at 85% capacity. Archive or delete old logs to prevent data loss."*

UC 8. Remove Inappropriate Content

▸ **Actor**	Administrator

Main Success Scenario

1. The administrator receives a content flagging notification or browses flagged content.
2. The administrator navigates to "Content Moderation" section.
3. The system displays pending moderation queue:
    - Flagged courses
    - Flagged exercises
    - Flagged forum posts
    - Flagged solutions
    - Reported user profiles
4. Each item shows:
    - Content preview
    - Reporter information
    - Reason for flag
    - Timestamp
    - Content creator
5. The administrator selects a flagged item to review.
6. The system displays the full content with context.
7. The administrator evaluates against platform guidelines:
    - Offensive language
    - Plagiarized content
    - Inappropriate images
    - Misleading information
    - Spam or advertising
    - Copyright violations

8. If content violates guidelines, the administrator chooses action:
    - Remove content immediately
    - Require revision by creator
    - Issue warning to creator
    - Suspend creator account
9. The administrator selects "Remove Content."
10. The system prompts for removal reason (required for transparency).
11. The administrator enters: "Contains plagiarized code from [source]. Violates copyright policy."
12. The system removes the content from public view.
13. The system notifies the content creator:

> *"Your content '[Title]' has been removed for: [Reason]. You may appeal this decision or create compliant content."*

14. If repeat violation, the system automatically escalates to account suspension.
15. The system logs all moderation actions for audit trail.
16. The reporter receives notification that their flag was reviewed and action taken.

Alternative Scenarios

A1. Content Doesn't Violate Guidelines

At Step 8, if content is acceptable:

Administrator selects "Dismiss Flag"

Enters reason: "Content reviewed - no violation found. Appropriate educational material."

Reporter notified that content was reviewed but approved

Flag dismissed from queue

A2. Borderline Content

At Step 8, if content is questionable but not clearly violating:

Administrator selects "Request Revision"

Specifies improvements needed

Creator has 7 days to revise

If not revised, content is removed

A3. False/Malicious Reporting

At Step 7, if multiple flags from same user are consistently dismissed:

> *"User [X] has filed 5+ false reports. Possible abuse of flagging system."*

Administrator can warn or restrict user's flagging ability

A4. Emergency Content Removal

At Step 1, for severe violations (illegal content, safety concerns):

Administrator uses "Emergency Remove" option

Content immediately removed without notification delay

Account automatically suspended pending investigation

Legal team notified if necessary

UC 9. Issue User Warnings

▸ **Actor**	Administrator

Main Success Scenario

1. The administrator identifies a policy violation (minor infraction).
2. The administrator navigates to the user's account.
3. The administrator clicks "Issue Warning."
4. The system displays warning form with fields:
    - Violation type (dropdown: spam, inappropriate language, plagiarism, etc.)
    - Severity (Minor, Moderate, Severe)
    - Description of violation
    - Evidence (attach screenshots, links)
    - Suggested corrective action
5. The administrator fills in the form:
    - Violation: "Inappropriate forum language"
    - Severity: Minor
    - Description: "Used profanity in discussion thread on [date]"
    - Action: "Please review community guidelines and maintain respectful communication"
6. The administrator selects "Send Warning."
7. The system records the warning on user's account.
8. The system sends notification to the user:

- Email and in-platform notification
- Clear explanation of violation
- Link to relevant policy
- Consequences of repeated violations

9. The warning appears on user's account record (visible to admins only).
10. The system tracks warning count:
    - 1st warning: Notice only
    - 2nd warning: 24-hour activity restriction
    - 3rd warning: 7-day suspension
    - 4th warning: Permanent ban
11. User can acknowledge warning or submit an appeal.
12. The system logs the warning issuance.

Alternative Scenarios

A1. User Appeals Warning

After Step 11, if user submits appeal:

Administrator reviews appeal and additional context

Can uphold, modify, or rescind warning

User notified of appeal decision with explanation

Decision is final unless escalated to senior admin

A2. Warning Escalation Required

At Step 5, if violation is more serious than initially assessed:

Administrator changes severity to "Severe"

> *"This user has [X] prior warnings. Escalated action may be warranted."*

Administrator can proceed with suspension instead

A3. Pattern of Violations

At Step 3, if user has prior warnings:

> *"This user has [X] prior warnings. Escalated action may be warranted."*

Suggests automatic penalties based on policy

A4. Warning Expiration

Warnings expire after 90 days of good behavior

System automatically archives expired warnings

User's slate cleaned if no violations in 90 days

Fully Dressed Format Use Cases

UC 10. Design Learning Path

Primary Actor	Administrator

Administrator: Wants to design a coherent, strategic curriculum that aligns with platform goals.

Content Creators: Need clear assignments and guidance on what content to create.

Learners: Need a clear, logical progression that builds on previous knowledge.

Platform: Needs well-structured paths that improve learning outcomes and retention.

▸ **Preconditions**	Administrator must be logged in with appropriate privileges. Multiple courses and lessons should exist in the system (or be planned). Administrator should have curriculum design knowledge.

▸ **Postconditions**	A complete learning path structure is created. Content creators are assigned to specific modules/tiers. Path is organized into skill tiers with clear progression. Path is ready for content creation phase. Path can be published when all content is completed.

Main Success Scenario

1. The administrator navigates to "Learning Path Management" in the admin panel.
2. The administrator clicks "Create New Learning Path."
3. The system displays the path creation wizard with fields:
    - Path name (e.g., "Python Full-Stack Developer")
    - Path description and learning objectives
    - Target audience (beginners, intermediate, advanced)
    - Estimated total duration (e.g., 6 months, 200 hours)
    - Career outcomes or certifications earned
    - Prerequisites (if any)
4. The administrator enters the basic path information.
5. Step 1: Define Skill Tiers Structure

- The system displays a visual canvas for organizing content
- The administrator creates skill tiers (levels):

> *Tier 1: Foundation (variables, data types, basic syntax)*

> *Tier 2: Core Concepts (loops, functions, data structures)*

> *Tier 3: Intermediate (OOP, file handling, APIs)*

> *Tier 4: Advanced (frameworks, databases, deployment)*

> *Tier 5: Mastery (architecture, optimization, real projects)*

6. For each tier, the administrator defines:

- Tier name and description
- Learning objectives
- Expected number of courses/lessons
- Estimated time to complete tier
- Tier completion criteria

7. Step 2: Assign Content Requirements

- For each tier, the administrator specifies required content types:

> *Number of video lessons needed*

> *Number of coding exercises needed*

> *Number of quizzes/assessments needed*

8. Step 3: Set Prerequisites and Dependencies

- The administrator defines relationships between tiers:

> *Tier 2 requires 100% completion of Tier 1*

> *Tier 3 requires 80% mastery of Tier 2 skills*

> *Optional branches for advanced learners*

9. The system visualizes dependencies as a flowchart.
10. Step 4: Assign Content Creators to Tiers
    - For each tier/module, the administrator clicks "Assign Creator."
    - The system displays a list of available content creators with:

> *Expertise areas*

> *Current workload*

> *Previous content quality ratings*

> *Availability status*

11. The administrator selects one or multiple creators for each tier:
    - Primary creator (responsible for main content)
    - Contributing creators (assist with specific topics)
    - Reviewer (quality checks)
12. The system displays assignment summary showing which creators are assigned where.
13. Step 5: Create Content Creation Timeline
    - The administrator sets deadlines for each tier:

> *Tier 1 content: Due in 4 weeks*

> *Tier 2 content: Due in 8 weeks*

> *And so on...*

- The administrator can set milestones (e.g., "50% of Tier 1 lessons by week 2")

14. Step 6: Configure Assessment Checkpoints

    - The administrator adds evaluation points between tiers:

      > *End-of-tier quizzes (specify passing score: 70%)*

      > *Portfolio projects (define requirements)*

      > *Skill validation exercises*

15. The administrator defines checkpoint passing criteria.

16. Step 7: Set Adaptive Learning Rules (Optional)

    - The administrator configures adaptive progression rules:

      > *If learner struggles with topic X → recommend supplementary exercises*

      > *If learner excels → offer accelerated track options*

      > *If learner abandons for 7+ days → send encouragement notification*

17. Step 8: Define Milestones and Rewards

    - The administrator creates milestone achievements:

      > *25% completion → "Python Beginner" badge + 500 XP*

      > *50% completion → "Python Intermediate" badge + 1000 XP*

      > *75% completion → "Python Advanced" badge + 1500 XP*

      > *100% completion → Certificate + "Python Master" badge + 3000 XP*

18. Step 9: Configure Enrollment Options

    - The administrator sets:

      > *Enrollment type: Free / Paid / Premium*

> *Entry requirements: Diagnostic quiz score / Prior experience*

> *Maximum concurrent enrollments (if limited)*

> *Certification fee (if applicable)*

19. The administrator writes a compelling path overview for learners:
    - What you'll learn (detailed breakdown)
    - Career opportunities (job roles, salary ranges)
    - Success stories from graduates (if available)
20. The administrator adds preview content (free introductory lessons).
21. The administrator reviews the complete path structure.
22. The administrator clicks "Validate Learning Path."
23. System Validation Process:
    - Checks for circular dependencies (A requires B, B requires A)
    - Verifies all tiers have assigned creators
    - Ensures prerequisite logic is sound
    - Validates that content requirements are reasonable
    - Estimates total time commitment is realistic
24. The system reports validation results.
25. If validation passes, the administrator sees: "✓ Learning path structure validated successfully."
26. The administrator sets the path status:
    - Draft (visible only to admin and assigned creators)
    - In Development (creators can start working)
    - Beta (open to limited testers once content is ready)
    - Published (publicly available after all content is completed)
27. The administrator selects "In Development" to activate content creation.

28. Step 10: Notify Assigned Content Creators

- The system sends notifications to all assigned creators:

> *"You've been assigned to create content for '[Path Name]' - [Tier/Module Name]."*

- Notification includes:

> *Content requirements*

> *Deadlines*

> *Guidelines and templates*

> *Contact info for coordination*

29. Assigned creators receive task assignments in their dashboards.

30. The system creates a project management view showing:

- Content creation progress for each tier
- Creator task statuses
- Upcoming deadlines
- Bottlenecks or delays

31. The administrator can monitor progress and send reminders.

32. The system displays: "Learning path '[Path Name]' created successfully! Content creators have been notified."

Alternative Scenarios

A1. Circular Dependency Detected

At Step 23, if prerequisites create a loop:

> 💬 *"✗ Circular dependency detected: Tier A → Tier B → Tier C → Tier A"*

Shows visual diagram of the problematic chain

Validation fails; administrator must restructure

Suggests which prerequisite to remove to break cycle

A2. No Content Creators Available

At Step 10-11, if no creators match the required expertise:

> 💬 *"⚠ No content creators with '[Skill]' expertise are currently available."*

Administrator options:

Recruit new creators

Assign less experienced creator with mentor support

Delay tier creation until suitable creator is available

A3. Content Creator Declines Assignment

After Step 28, if a creator declines:

Creator provides reason (workload, expertise mismatch, timeline)

System notifies administrator

Administrator must reassign to another creator

Timeline may need adjustment

A4. Unrealistic Time Commitment

At Step 23, if total estimated time is excessive:

> 💬 *"⚠ This path requires ~500 hours. Average learner completion for similar paths is 6-12 months. Consider breaking into multiple paths or reducing content."*

Shows completion rate data for paths of similar length

Administrator can proceed or revise

A5. Content Requirements Exceed Creator Capacity

At Step 13, if deadlines are too aggressive:

> 💬 *"⚠ Current assignments require 200 hours of content creation in 4 weeks. Assigned creators have capacity for 120 hours. Adjust timeline or add creators."*

Administrator must revise timeline or add more creators

A6. Tier Without Learning Objectives

At Step 6, if a tier lacks clear objectives:

> 💬 *"⚠ Tier [X] has no defined learning objectives. Creators need clear goals."*

Administrator must add objectives before proceeding

A7. Missing Assessment Checkpoints

At Step 14-15, if few or no checkpoints exist:

> 💬 *"⚠ This path lacks assessment checkpoints. Learners may progress without adequate skill validation."*

Recommends adding checkpoints every 20-30 hours of content

Administrator can add checkpoints or acknowledge and proceed

A8. Duplicate or Overlapping Path

At Step 22, if a very similar path exists:

> 💬 *"⚠️ A similar learning path exists: '[Path Name]'. Overlap: 60% of content. This may confuse learners or dilute enrollments."*

Shows comparison of content overlap

Administrator options:

Differentiate the new path clearly

Merge with existing path

Archive old path if replacing it

Proceed with justification

A9. Creator Workload Imbalance

At Step 11-12, if one creator is overloaded:

> 💬 *"⚠️ [Creator Name] is assigned to 3 tiers with deadlines in the same month. Consider redistributing workload."*

Suggests alternative creators

Administrator can adjust assignments

A10. Budget Constraints for Paid Creators

At Step 11, if assigning paid creators:

> 💬 *"⚠️ Current assignments will cost $[X], exceeding the $[Y] budget. Adjust assignments or increase budget."*

Administrator must optimize assignments

Extensions

E1. Path Branching

Administrator can design choice points in the path:

After Core Python, learner chooses:

Branch A: Data Science specialization

Branch B: Web Development specialization

Branch C: Automation/DevOps specialization

Each branch has unique content, assigned to specialized creators

E2. Collaborative Path Design

Multiple administrators can co-design a path:

Each contributes expertise in specific areas

System tracks changes and responsibilities

Approval workflow for major structural changes

E3. Path Templates

Administrator can use templates for common path types:

"Beginner to Professional" template

"Specialization Track" template

"Certification Prep" template

Templates include suggested tier structures and checkpoints

E4. Content Reuse from Existing Paths

Administrator can import tiers/modules from other successful paths:

Select existing content to include

System links to original content (doesn't duplicate)

Credits original creators

Useful for building hybrid or cross-domain paths

E5. Dynamic Path Updates

After publication, administrator can update path without disrupting active learners:

Add new optional modules

Deprecate outdated content (remains accessible to enrolled learners)

Update prerequisites if needed

System notifies active learners of updates with opt-in

E6. Path Analytics Dashboard (Post-Publication)

After content is created and path is published, administrator accesses analytics:

Enrollment trends over time

Completion rates per tier

Common drop-off points

Average time per module

Learner satisfaction ratings

Employment outcomes (if tracked)

Creator performance metrics

Data informs path improvements

E7. Certification Integration

Administrator can configure official certification:

Final comprehensive exam specifications

Portfolio review criteria

Interview simulation requirements

Digital credential design

Verification method (blockchain, QR code)

E8. Corporate/Academic Partnerships

Paths designed for institutions:

Align with specific curriculum standards

Include institutional branding

Provide instructor dashboard for monitoring groups

Export transcripts and grades
Bulk enrollment management

Special Requirements

- The visual path designer must support drag-and-drop for organizing tiers.
- The system must prevent circular dependencies through real-time validation.
- Administrator must be able to visualize the entire path structure at a glance.
- All creator assignments must be logged with timestamps.
- System must send automated reminders to creators as deadlines approach.
- Content creation progress must be trackable in real-time.
- Administrators must be able to export path structure as PDF for documentation.
- The system must support versioning for path updates.
- All prerequisite logic must be clearly documented and testable.
- System must handle paths with 50+ courses without performance degradation.
- Path analytics must aggregate data without exposing individual learner privacy.
- Paths must support localization for international audiences.

Frequency of Use

Moderate frequency by administrators. Typically 1-2 new major paths per quarter. High usage during platform expansion or curriculum revisions. Ongoing monitoring and updates for existing paths.

Open Issues

Should administrators require approval from senior management for new paths? How do we handle creator disputes over assignments or deadlines? Should there be financial incentives for creators who meet quality/timeline goals? Can AI assist in recommending optimal path structures based on learning science? How do we measure ROI for paths (enrollments vs. development cost)? Should learning paths have expiration dates or version numbers?

5.3.2 Content Creator Use Cases

Brief Format Use Cases

UC 1. View Created Content

The content creator views a list of all courses, lessons, and exercises they have authored.

UC 2. Preview Lesson

The content creator previews how learners will see and interact with a lesson before publishing.

UC 3. Duplicate Exercise

The content creator clones an existing exercise as a template for creating similar challenges.

UC 4. Delete Draft

The content creator removes unpublished course materials or exercises from their drafts.

Casual Format Use Cases

UC 5. Register Account

▸ **Actor**	Content Creator

Main Success Scenario

1. The Content Creator navigates to the "Sign Up" page of the platform.
2. The Content Creator selects the "Content Creator" role from account type options.
3. The Content Creator provides required details:
    - Full name
    - Email address
    - Password (with confirmation)
    - Username

    - Resume/CV upload

4. The Content Creator agrees to Terms and Conditions and submits the form.
5. The system validates input (email format, password strength, username uniqueness, resume/CV format).
6. The system sends a verification email to the provided address.
7. The Content Creator clicks the OTP in the email.
8. Admin activates the account after reviewing the resume/CV.
9. The system redirects to the login page.
10. The Content Creator logs in successfully and sees a welcome message.

Alternative Scenarios

A1. Email Already Exists

At Step 5, if the email is already registered, the system displays:

> *"An account with this email already exists. Please log in or use a different email."*

A2. Weak Password

At Step 5, if the password doesn't meet security criteria (minimum 8 characters with uppercase, lowercase, numbers, special characters), the system displays:

> *"Your password must be at least 8 characters long and include uppercase, lowercase, numbers, and symbols."*

A3. Username Taken

At Step 5, if the username is already in use, the system displays:

> *"This username is already taken. Please choose a different one."*

A4. Admin Reject Resume/CV

At Step 8, if the admin rejects the uploaded resume/CV after review, the system displays:

> *"Your resume/CV did not meet our criteria. Please update and resubmit."*

UC 6. Login to System

▸ **Actor**	Content Creator

Main Success Scenario

1. The content creator navigates to the login page.
2. The content creator enters their email and password.
3. The content creator clicks "Login."
4. The system validates credentials.
5. The system authenticates the content creator and redirects to the dashboard.
6. The content creator sees their personalized dashboard with progress and recommendations.

Alternative Scenarios

A1. Incorrect Credentials

At Step 4, if credentials are invalid, the system displays:

> 💬 *"Incorrect email or password. Please try again."*

A2. Account Not Verified

At Step 4, if the email is not verified, the system displays:

> 💬 *"Please verify your email address before logging in. Check your inbox for the OTP."*

A3. Account Suspended

At Step 4, if the account is suspended, the system displays:

> 💬 *"Your account has been suspended. Please contact support for assistance."*

UC 7. Create Course

▸ **Actor**	Content Creator

Main Success Scenario

1. The content creator logs into the platform.
2. The content creator navigates to "Content Management" section.
3. The content creator clicks "Create New Course."
4. The system displays a course creation form with fields:
   - Course title
   - Course description
   - Programming language (Python/JavaScript/Multi-language)
   - Difficulty level (Beginner/Intermediate/Advanced)
   - Estimated duration
   - Prerequisites
   - Course thumbnail image
5. The content creator fills in all required information.
6. The content creator organizes the course into modules:
   - Adds module titles
   - Orders modules sequentially
   - Assigns estimated time per module
7. The content creator clicks "Create Course."

8. The system validates all inputs and generates a unique course ID.

9. The system creates the course structure and saves it as a draft.

10. The system displays:

    > *"Course created successfully! Now you can add lessons and exercises."*

11. The content creator is redirected to the course dashboard to begin adding content.

Alternative Scenarios

A1. Missing Required Fields

At Step 7, if required fields are empty:

> *"Please complete all required fields: [Field Names]."*

Incomplete fields are highlighted in red.

A2. Duplicate Course Title

At Step 8, if a course with the same title exists:

> *"A course with this title already exists. Please choose a different title or modify the existing course."*

A3. Invalid Image Format

At Step 5, if the thumbnail isn't in an accepted format:

"Please upload an image in JPG, PNG, or WebP format."

A4. Course Creation Limit Reached

At Step 3, if the creator has reached their course limit:

"You've reached the maximum number of draft courses (5). Please publish or delete existing drafts."

UC 8. Create Lesson

▸ **Actor**	Content Creator

Main Success Scenario

1. The content creator selects an existing course from their dashboard.
2. The content creator selects a module within the course.
3. The content creator clicks "Add New Lesson."
4. The system displays the lesson creation interface with sections:
   - Lesson title
   - Lesson objectives
   - Content type selection (Text/Video)

    - Estimated completion time

5. The content creator enters the lesson title and objectives.
6. The content creator creates multi-format content:
    - Writes explanatory text with rich formatting
    - Uploads or embeds video tutorial
7. The content creator adds code snippets with syntax highlighting.
8. The content creator sets lesson order within the module.
9. The content creator can mark the lesson as:
    - Draft (not visible to learners)
    - Published (immediately available)
    - Scheduled (available on specific date)
10. The content creator clicks "Save Lesson."
11. The system validates content and saves the lesson.
12. The system displays:

    > 💬 *"Lesson saved successfully!"*

Alternative Scenarios

A1. Video Upload Fails

At Step 6, if video upload encounters an error:

> 💬 *"Video upload failed. Please ensure the file is under 500MB and in MP4 format."*

Text content is saved as draft automatically.

A2. Content Too Short

At Step 11, if the lesson content is minimal:

> 💬 *"This lesson appears brief. Consider adding more detail to help learners understand the concept."*

The creator can proceed or add more content.

UC 9. Add Multimedia Content

▸ **Actor**	Content Creator

Main Success Scenario

1. The content creator is editing a lesson.
2. The content creator clicks "Add Media" in the content editor.
3. The system displays media upload options:
   - Upload video file
   - Embed YouTube/Vimeo link
   - Upload images/diagrams
   - Add audio explanations
4. The content creator selects "Upload Video."
5. The content creator selects a video file from their device.

6. The system validates file size (max 500MB) and format (MP4, WebM).
7. The system displays upload progress bar.
8. The video uploads successfully to cloud storage.
9. The system generates a video player preview.
10. The content creator positions the video within the lesson content.
11. The content creator adds captions or transcripts (optional).
12. The content creator saves the lesson with embedded media.
13. The system confirms:

> *"Media added successfully!"*

Alternative Scenarios

A1. File Size Exceeds Limit

At Step 6, if the video is larger than 500MB:

> *"Video file is too large. Please compress to under 500MB or use an external hosting link."*

A2. Unsupported Format

At Step 6, if the file format isn't supported:

> *"This format is not supported. Please upload MP4 or WebM files."*

A3. Upload Interrupted

At Step 7, if internet connection drops:

The system attempts to resume upload.

If unsuccessful after 3 attempts:

> *"Upload interrupted. Please try again."*

A4. Embed Link Invalid

At Step 4, if an external video link doesn't work:

> *"Unable to embed this link. Please verify the URL and privacy settings."*

UC 10. Localize Content

Actor	Content Creator

Main Success Scenario

1. The content creator selects a published course or lesson.
2. The content creator clicks "Add Translation."
3. The system displays available languages (Arabic, English).
4. The content creator selects the target language (e.g., Arabic).

5. The system creates a duplicate content template with original text.
6. The content creator translates:
   - Lesson titles and descriptions
   - Content paragraphs
   - Code comments
   - Exercise instructions
7. The content creator adjusts formatting for RTL (right-to-left) if translating to Arabic.
8. The content creator can use AI-assisted translation for initial draft.
9. The content creator reviews and refines the AI-generated translation.
10. The content creator saves the localized version.
11. The system marks the content as available in multiple languages.
12. Learners can now switch between languages when viewing the content.

Alternative Scenarios

A1. AI Translation Unavailable

At Step 8, if AI service is down:

> *"AI translation is temporarily unavailable. Please translate manually."*

A2. Incomplete Translation

At Step 10, if some sections remain untranslated:

> *"Some content is still in [Original Language]. Do you want to save anyway?"*

The creator can save as draft or complete translation.

UC 11. Categorize Exercise Difficulty

▸ **Actor**	Content Creator

Main Success Scenario

1. The content creator is creating or editing an exercise.
2. The system displays difficulty level options:
    - Beginner (Basic syntax and concepts)
    - Intermediate (Multiple concepts, logic building)
    - Advanced (Complex algorithms, optimization)
    - Expert (Real-world problems, system design)
3. The content creator selects the appropriate difficulty.
4. The system displays difficulty criteria to guide selection.
5. The content creator assigns skill tags (e.g., "loops", "arrays", "recursion").
6. The system estimates average completion time based on difficulty.
7. The content creator can test the exercise themselves to verify difficulty.
8. The content creator saves the categorization.
9. The system uses this information for:

- Adaptive learning path recommendations
- Filtering in course catalog
- XP reward calculation

Alternative Scenarios

A1. Difficulty Mismatch Detected

At Step 8, if the system's AI analysis suggests different difficulty:

> 💬 *"Our analysis suggests this exercise may be [Suggested Level]. Would you like to review?"*

The creator can keep their choice or adjust.

UC 12. Update Course Materials

Actor	Content Creator

Main Success Scenario

1. The content creator navigates to "My Courses."
2. The content creator selects a published course.

3. The content creator identifies content to update (lesson, exercise, video).
4. The content creator clicks "Edit."
5. The system loads the content in edit mode.
6. The content creator makes changes:
    - Updates outdated information
    - Fixes errors or typos
    - Improves explanations
    - Adds new examples
7. The content creator saves changes.
8. The system creates a new version and maintains version history.
9. If the course has active learners, the system displays:

    > *"[X] students are enrolled. Notify them of updates?"*

10. The content creator chooses to send update notification.
11. Enrolled learners receive:

    > *"[Course Name] has been updated with new content!"*

12. The system logs all changes for audit trail.

Alternative Scenarios

A1. Breaking Changes

At Step 6, if changes affect exercise solutions or grading:

> *"This change may affect existing student submissions. Consider creating a new exercise instead."*

A2. Multiple Editors Conflict

At Step 5, if another creator is editing simultaneously:

> *"[Creator Name] is currently editing this content. Changes may conflict."*

The system locks editing or enables collaborative editing mode.

UC 13. Review Student Submissions

Actor	Content Creator

Main Success Scenario

1. The content creator navigates to "Course Management" dashboard.
2. The content creator selects a lesson in specific course to review submissions.
3. The system displays recent submissions for the creator's lesson.
4. The content creator filters by:
    - Execution metrics (time/memory)
    - Test case pass rate

    - Submission date

5. The content creator selects a student submission to review.
6. The system displays:
    - Student information (anonymous option available)
    - Problem statement
    - Student's code solution
    - Test case results
    - Execution metrics
7. The content creator reviews the code for:
    - Correctness
    - Code quality and style
    - Efficiency
    - Best practices
8. The content creator provides written feedback.
9. The content creator clicks "Submit Review."
10. The system saves the review and updates the student's grade.
11. The student receives notification with feedback.

Alternative Scenarios

A1. Auto-Graded Exercise

At Step 4, if the exercise is automatically graded:

> 💬 *"This exercise was automatically graded. Manual review is optional."*

The creator can still provide additional feedback.

A2. Plagiarism Suspected

At Step 6, if the system detects potential plagiarism:

The system flags the submission with similarity score.

The creator investigates and can report if confirmed.

UC 14. Manage Course Structure

▸ **Actor**	Content Creator

Main Success Scenario

1. The content creator selects a course from their dashboard.
2. The content creator clicks "Edit Course Structure."
3. The system displays the course outline with all modules and lessons.
4. The content creator can:
    - Drag and drop to reorder modules
    - Drag and drop to reorder lessons within modules
    - Add new modules
    - Rename modules

5. The content creator sets prerequisites:
    - Marks lessons that must be completed before others unlock
    - Creates skill dependencies
6. The content creator saves the new structure.
7. The system validates that prerequisites don't create circular dependencies.
8. The system updates the course structure.
9. If students are enrolled, the system adjusts their progress tracking.
10. The system displays:

> 💬 *"Course structure updated successfully!"*

Alternative Scenarios

A1. Circular Dependency Detected

At Step 7, if prerequisites create a loop:

> 💬 *"Error: This creates a circular dependency. Lesson A cannot require Lesson B if Lesson B requires Lesson A."*

Changes are not saved until resolved.

A2. Active Students Affected

At Step 6, if reordering affects students mid-course:

> 💬 *"[X] students are currently progressing through this course. Major restructuring may confuse them."*

The creator can proceed with caution or schedule changes.

Fully Dressed Format Use Cases

UC 15. Create Coding Exercise

Primary Actor	Content Creator

Content Creator: Wants to design effective, fair exercises that test specific skills.

Learners: Need clear instructions, fair test cases, and appropriate difficulty.

Platform: Needs quality-controlled exercises that can be auto-graded reliably.

Preconditions	Content creator must be logged in and authorized. Content creator must have at least one course created. Content creator must have completed platform training on exercise creation.

Postconditions	Exercise is created with complete problem statement, test cases, and model solution. Exercise is saved as draft and ready for validation. Exercise metadata is stored in the database.

Main Success Scenario

1. The content creator navigates to a course lesson.
2. The content creator clicks "Add Exercise."
3. The system displays the exercise creation wizard with tabs:
    - Problem Details
    - Test Cases
    - Model Solution
    - Hints
    - Metadata
4. **Problem Details Tab:** The content creator enters:
    - Exercise title (clear, concise)
    - Problem statement with context
    - Input format explanation
    - Output format explanation
    - Example inputs and outputs (2-3 examples)
    - Constraints (time limits, input ranges)
5. The content creator writes starter code template (optional).
6. **Test Cases Tab:** The content creator creates test cases:
    - At least 5 test cases (minimum requirement)
    - Mix of edge cases, typical cases, and boundary cases
    - For each test case: input data, expected output, visibility (public/hidden)
    - Test case descriptions explaining what is being tested
7. The content creator marks 2-3 test cases as public (visible to learners).
8. The content creator marks remaining cases as hidden (for final validation).
9. **Model Solution Tab:** The content creator writes a reference solution:

    - Correct, efficient code in the target language
    - Well-commented for educational value
    - Multiple approaches (optimal, brute-force, alternative methods)

10. The content creator runs the model solution against all test cases.
11. The system validates that the model solution passes all test cases.
12. **Hints Tab:** The content creator creates progressive hints:
    - Level 1: Conceptual hint (approach suggestion)
    - Level 2: Algorithmic hint (specific strategy)
    - Level 3: Implementation hint (code structure)
13. **Metadata Tab:** The content creator sets:
    - Difficulty level (Beginner/Intermediate/Advanced)
    - Estimated time to complete
    - Skill tags (e.g., "arrays", "sorting", "dynamic-programming")
    - XP reward value
14. The content creator clicks "Save as Draft."
15. The system saves the exercise in draft status.
16. The system displays:

    > *"Exercise saved successfully! Proceed to validation when ready."*

17. The content creator can:
    - Continue editing
    - Submit for validation (goes to Use Case 16)
    - Delete draft
18. The content creator clicks "Submit for Validation."
19. The system transitions to Use Case 16 (Validate Exercise Before Publishing).

Alternative Scenarios

A1. Insufficient Test Cases

At Step 14, if fewer than 5 test cases exist:

> *"Add at least 5 test cases before saving."*

Save is blocked until minimum requirement is met.

A2. Model Solution Fails Test Cases

At Step 11, if the model solution doesn't pass all tests:

> *"Your model solution failed test case [X]. Expected: [Y], Got: [Z]."*

The creator must fix either the solution or the test case before saving.

A3. Missing Required Fields

At Step 14, if mandatory fields are empty:

> *"Complete all required fields: [List]"*

Incomplete sections are highlighted in red.

A4. Auto-Save During Creation

Throughout the process, the system auto-saves progress every 2 minutes.

If creator closes browser, they can resume from last saved state.

A5. Multiple Programming Languages

At Step 9, if the exercise supports multiple languages:

Creator must provide model solutions in each language.

Each solution is validated independently before saving.

Language-specific hints may be needed.

Extensions

E1. Complexity Analysis Addition

Creator adds Big O notation explanations:

Time complexity of optimal solution

Space complexity analysis

Comparison with alternative approaches

This enhances educational value.

E2. Interactive Test Case Builder

System provides GUI to build test cases:

Generate random inputs within constraints

Automatically compute expected outputs using model solution

Visualize test coverage

E3. Import from External Sources

Creator can import exercise templates from:

Other platforms (with proper attribution)

Previous exercises (as starting point)

Community-contributed templates

Special Requirements

- All data must be auto-saved every 2 minutes to prevent loss.
- Draft exercises are only visible to the creator.
- Model solutions must be encrypted in database.
- System must support Python, JavaScript, and eventually Java/C++.
- Problem statements must pass basic grammar check before saving.
- Exercise creation interface must be accessible via keyboard navigation.

Frequency of Use

High frequency during initial course development. Moderate ongoing use as creators add content. Estimated 10-20 exercises created per active content creator per month.

Open Issues

Should we allow saving incomplete exercises with warnings?
How long should drafts be retained before auto-deletion?
Should creators earn points for creating quality exercises?

UC 16. Validate Exercise Before Publishing

Primary Actor	Content Creator

Content Creator: Wants assurance that the exercise functions correctly before peer review.

Learners: Need exercises that work properly without technical issues or unfair test cases.

Platform Quality Team: Wants to maintain high content standards.

Peer Reviewers: Need well-validated exercises to review efficiently.

▸ **Preconditions**	Exercise must be created and saved as draft (Use Case 15 completed). Content creator must be logged in. Validation API and code execution environment must be operational. Exercise must have minimum required components (problem, test cases, solution).

▸ **Postconditions**	Exercise is thoroughly tested and validated. Validation report is generated and stored. If validation passes, exercise is ready for peer review assignment. If validation fails, creator receives detailed feedback for improvements.

Main Success Scenario

1. The content creator has completed exercise creation (from Use Case 15).
2. The content creator clicks "Submit for Validation."
3. The system displays:

   > *"Beginning comprehensive validation... This may take 30-60 seconds."*

4. **Step 1: Model Solution Validation**
   - System executes model solution against all test cases
   - Measures execution time and memory usage
   - Checks for runtime errors or infinite loops
   - Validates against time and memory constraints
5. The system confirms:

> *"✓ Model solution passes all [X] test cases."*

6. **Step 2: Test Case Quality Check**
    - System analyzes test case diversity
    - Checks for edge cases: empty inputs, maximum values, negative numbers, boundary conditions
    - Verifies hidden tests differ meaningfully from public tests
    - Ensures test cases cover multiple solution approaches
    - Validates test case descriptions are clear
7. The system reports:

> *"✓ Test cases provide adequate coverage."*

8. **Step 3: Problem Statement Analysis**
    - AI reviews problem statement for clarity and completeness
    - Checks grammar and spelling
    - Identifies ambiguous phrasing
    - Verifies examples match expected input/output format
    - Ensures constraints are clearly defined
9. The system reports:

> *"✓ Problem statement is clear and complete."*

10. **Step 4: Difficulty Calibration**
    - System estimates difficulty based on:
    - Solution complexity (cyclomatic complexity, lines of code)
    - Required concepts (data structures, algorithms)
    - Test case difficulty
    - Compares with creator's assigned difficulty
11. The system reports:

> *"✓ Estimated difficulty matches assigned level (Intermediate)."*

12. **Step 5: Hint Quality Assessment**
    - Validates that hints don't reveal complete solution
    - Checks hint progression (conceptual → specific → implementation)
    - Ensures hints are appropriate for difficulty level
13. The system reports:

> *"✓ Hints provide appropriate guidance without spoiling solution."*

14. **Step 6: Security and Fairness Check**
    - Ensures no hardcoded test cases in problem description
    - Validates that public test cases don't make hidden cases obvious
    - Checks for potential exploitation methods
15. The system reports:

> *"✓ Exercise meets security and fairness standards."*

16. The system compiles a comprehensive validation report showing all checks.
17. The system displays final status:

> *"✓ Validation Complete: PASSED"*

18. The content creator reviews the full validation report.
19. The system offers options:
    - **Assign for Peer Review** (proceed to step 20)
    - **Make Revisions** (return to editing)
    - **Save for Later** (keep in validated draft status)
20. The content creator clicks "Assign for Peer Review."
21. The system displays peer reviewer selection interface.
22. The system recommends 1-3 qualified reviewers based on:

- Expertise in relevant programming language
- Experience with similar difficulty levels
- Current review workload
- Reviewer ratings and reliability

23. The content creator selects reviewers (1-3 reviewers).
24. The system sends notifications to selected reviewers:

> 💬 *"You've been assigned to review exercise '[Title]'. Please complete within 3-5 business days."*

25. The exercise is added to each reviewer's review queue.
26. The system sets review deadline (5 business days from assignment).
27. The system displays to creator:

> 💬 *"Exercise assigned for peer review. You'll be notified when reviews are complete."*

28. The exercise status changes to "Under Peer Review."
29. The creator receives a confirmation summary:
    - Validation results
    - Assigned reviewers
    - Expected review completion date
30. The system transitions to peer review workflow (not detailed in this use case).

Alternative Scenarios

A1. Model Solution Fails Test Cases

At Step 4-5, if model solution fails any test:

> 💬 *"✗ Model solution failed test case #[X]"*

Shows: Input provided, Expected output, Actual output, Error message

Validation status: **FAILED**

Creator options:

Fix model solution
Modify test case
Add explanation if intentional

Cannot proceed to peer review until resolved

A2. Missing Edge Cases

At Step 6-7, if edge case coverage is insufficient:

> 💬 *"⚠ Test cases may not cover edge scenarios: [empty input, single element, maximum constraints]"*

Validation status: **PASSED WITH WARNINGS**

Creator can:

Add recommended edge cases
Proceed to peer review with warning documented

Peer reviewers will see this warning

A3. Problem Statement Unclear

At Step 8-9, if AI detects ambiguity:

> 💬 *"⚠ Problem statement may be unclear: '[specific phrase]' could be interpreted multiple ways."*

Provides revision suggestions with examples

Validation status: **PASSED WITH WARNINGS**

Creator should clarify but can proceed

Peer reviewers will be asked to verify clarity

A4. Difficulty Mismatch

At Step 10-11, if estimated difficulty differs significantly:

> 💬 *"⚠️ This exercise appears to be [Advanced] but is marked [Intermediate]. Consider adjusting."*

Shows difficulty scoring breakdown

Validation status: **PASSED WITH WARNINGS**

Creator can:

Adjust difficulty level
Provide justification for current level
Proceed with warning (reviewers will validate)

A5. Execution Timeout

At Step 4, if model solution exceeds time limit:

> 💬 *"✗ Model solution exceeded [N]-second time limit. Execution time: [X]s"*

Validation status: **FAILED**

Creator must:

Optimize solution
Adjust time constraints
Reconsider problem complexity

Cannot proceed until resolved

A6. Test Cases Too Similar

At Step 6, if hidden tests are predictable:

> 💬 *"⚠️ Hidden test cases appear similar to public tests. Add more diverse scenarios."*

Suggests specific missing scenarios

Validation status: **PASSED WITH WARNINGS**

Creator should improve diversity

Reviewers will test with their own approaches

A7. No Available Reviewers

At Step 22-23, if no suitable reviewers available:

> *"No reviewers currently available with matching expertise. Options:"*

Wait for reviewers to become available (estimated: X days)
Expand reviewer criteria
Request admin to assign reviewers

Exercise remains in validated draft status

A8. Creator Cancels Review Assignment

At Step 23, if creator changes mind:

Creator clicks "Cancel Assignment"

Exercise returns to validated draft status

Can be edited or assigned later

A9. Grammatical Errors

At Step 8-9, if grammar issues detected:

System highlights errors with suggestions

Auto-correct offered for minor issues

Validation status: **PASSED WITH WARNINGS**

Creator should review and fix

Reviewers will verify corrections

A10. Validation Service Unavailable

At Step 3, if validation API fails:

> 💬 *"Validation service temporarily unavailable. Options:"*

Retry now

Save and retry later

Contact support if issue persists

Exercise saved but not validated

Creator notified when service resumes

A11. Multiple Languages, Different Results

At Step 4-5, if exercise supports Python and JavaScript:

If Python solution passes but JavaScript fails:

System reports issues separately by language

Validation status: **PARTIALLY FAILED**

Creator must fix failing language implementation

All language versions must pass before proceeding

A12. Hints Reveal Too Much

At Step 12-13, if hints are too specific:

> 💬 *"⚠️ Hint level [X] may reveal too much of the solution. Consider making it more conceptual."*

Validation status: **PASSED WITH WARNINGS**

Shows which hints are problematic

Reviewers will test hint effectiveness

Extensions

E1. Automated Test Generation Suggestions

After validation, system offers to generate additional test cases:

Creates random inputs within constraints

Uses model solution to compute expected outputs

Creator reviews and approves generated tests

Re-validates with new tests

E2. Validation Report Export

Creator can download detailed validation report as PDF

Includes:

All validation checks and scores

Recommendations for improvement

Comparison with similar exercises

Quality metrics

Useful for documentation or training

E3. Incremental Validation

For large exercises with many test cases:

System validates in stages, showing progress

Creator can cancel if early stages reveal issues

Partial results saved for faster re-validation

E4. A/B Testing Suggestion

If exercise is similar to existing ones:

System suggests A/B testing with learners

Tracks which version performs better

Informs future exercise design

E5. Reviewer Self-Selection

Instead of creator assigning reviewers:

Creator can post exercise to "Review Marketplace"

Qualified reviewers volunteer to review

Creator selects from volunteers

Faster assignment in active communities

Special Requirements

- Validation must complete within 60 seconds for standard exercises.
- All validation checks must be logged for quality assurance auditing.
- Validation must detect common anti-patterns (hardcoded solutions, trivial test cases).
- System should cache validation results; re-validation only needed if exercise changes.
- Validation API must handle concurrent requests from multiple creators.
- Failed validations must provide actionable guidance, not just error messages.
- Warnings must be clearly documented for peer reviewers.
- Reviewer recommendations must consider expertise, workload, and reliability.
- System must prevent assigning reviewers who have conflicts of interest.

Frequency of Use

Every exercise must be validated before peer review (100% usage). Re-validation after any exercise modification. Estimated 50-100 validations per active content creator over platform lifetime.

Open Issues

Should we implement tiered validation (basic, standard, rigorous) based on difficulty?

How do we handle edge cases where automated validation gives false positives?

Should validation scores affect creator reputation?

Can we use machine learning to improve validation accuracy over time?
Should we allow creators to skip certain validation checks with justification?
How do we balance validation thoroughness with creator experience?

UC 17. Contribute to Learning Path

▸ **Primary Actor**	Content Creator

Content Creator: Wants clear requirements and reasonable deadlines for content creation.

Administrator: Needs quality content delivered on time to complete the learning path.

Learners: Will benefit from well-crafted, cohesive content within the path.

▸ **Preconditions**	Content creator must be logged in and authorized. Administrator must have created a learning path and assigned the creator to a specific tier/module. Content creator must have received assignment notification.

▸ **Postconditions**	Required content (lessons, exercises) is created within the assigned tier. Content meets quality standards and aligns with path objectives. Administrator can review and approve the content. Tier is marked as complete and ready for integration.

Main Success Scenario

1. The content creator receives a notification:

   > *"You've been assigned to create content for '[Path Name]' - [Tier/Module Name]."*

2. The content creator navigates to "My Assignments" in their dashboard.
3. The system displays the learning path assignment with details:
   - Path name and overall objectives
   - Assigned tier/module name
   - Content requirements:
   - Number of lessons to create (e.g., 5 video lessons)
   - Number of exercises to create (e.g., 10 coding challenges)
   - Learning objectives for this tier
   - Target audience and skill level
   - Deadline for completion
   - Guidelines and templates provided by administrator
   - Contact information for coordination
4. The content creator reviews the requirements and clicks "Accept Assignment."
5. The system creates a task board for the creator showing:
   - Checklist of required content items
   - Progress tracker (0% complete)
   - Deadline countdown
6. **Step 1: Plan Content Structure**
   - The creator outlines topics to cover in each lesson
   - Maps exercises to specific learning objectives
   - Designs project requirements

7. The creator can request clarification from the administrator if objectives are unclear.

8. **Step 2: Create Lessons**

   - The creator follows Use Case 8 (Create Lesson) for each required lesson
   - Ensures lessons align with tier objectives
   - Covers prerequisite knowledge appropriately
   - Follows platform style guidelines

9. The system tracks completed lessons and updates progress (e.g., 30% complete).

10. **Step 3: Create Exercises**

    - The creator follows Use Case 15-16 (Create and Validate Coding Exercise) for each exercise
    - Ensures difficulty aligns with tier level
    - Ties exercises to specific lesson concepts
    - Creates diverse problem types

11. The system tracks completed exercises and updates progress (e.g., 60% complete).

12. **Step 5: Review Content Cohesion**

    - The creator reviews all created content for the tier
    - Ensures logical flow between lessons
    - Verifies exercises progressively build skills
    - Checks that project appropriately challenges learners

13. The creator can preview the entire tier as a learner would experience it.

14. **Step 6: Internal Quality Check**

    - The creator runs through their own content:
    - Tests all code examples
    - Verifies exercise solutions
    - Checks for typos or errors
    - Ensures multimedia loads correctly

15. The creator makes any necessary revisions.

16. **Step 7: Mark as Ready for Review**

    - The creator clicks "Submit for Administrator Review."
    - The system prompts:

      > *"Are you sure all content is complete and meets quality standards?"*

17. The creator confirms submission.

18. The system notifies the administrator:

    > *"[Creator Name] has submitted content for '[Tier Name]' in '[Path Name]'. Ready for review."*

19. The system changes the tier status to "Under Administrator Review."

20. The creator's task board shows "Awaiting Review" status.

21. **Administrator Review Phase:**

    - Administrator reviews all content (separate use case)
    - Administrator can approve, request revisions, or reject

22. If approved:

    - Creator receives notification:

      > *"Your content for '[Tier Name]' has been approved! Great work."*

    - Creator earns XP/badges for completing assignment
    - Content is integrated into the learning path

23. If revisions requested:

    - Creator receives detailed feedback with specific issues
    - Creator makes requested changes
    - Creator resubmits (returns to Step 17)

24. The system tracks the creator's contribution for analytics and reputation.

Alternative Scenarios

A1. Creator Declines Assignment

At Step 4, if the creator cannot accept:

Creator clicks "Decline Assignment"

System prompts for reason (workload, expertise mismatch, timeline)

System notifies administrator to reassign

Creator is removed from assignment

A2. Deadline Extension Needed

Before deadline, if creator needs more time:

Creator clicks "Request Extension"

Provides justification and proposed new deadline

Administrator reviews and approves/denies

If approved, deadline is updated

If denied, creator must meet original deadline or decline

A3. Clarification Required

At Step 7, if objectives are unclear:

Creator clicks "Request Clarification"

Sends specific questions to administrator

Administrator responds with guidance

Creator proceeds with clarified understanding

A4. Content Requirements Change

During content creation, if administrator updates requirements:

Creator receives notification of changes

System highlights what changed

Creator acknowledges changes

Deadline may be adjusted if significant changes

A5. Missed Deadline

If creator doesn't submit by deadline:

System sends urgent reminder 3 days before deadline

If still missed:

Administrator is notified
Administrator can extend deadline or reassign
Creator's reputation may be affected

A6. Revisions Requested Multiple Times

At Step 24, if content is rejected twice:

Administrator and creator have a coordination meeting

Discuss issues and expectations

If third submission also fails:

Assignment may be reassigned
Creator's compensation/reputation affected

A7. Technical Issues During Creation

If system errors prevent content creation:

Creator reports issue to support

System logs the issue

Deadline may be extended if issue is system-wide

Creator can save drafts to prevent data loss

A8. Collaborating with Other Creators

If multiple creators are assigned to the same tier:

System provides shared workspace

Creators can see each other's progress

Chat/comment feature for coordination

One creator designated as "lead" to avoid conflicts

Extensions

E1. Early Completion Bonus

If creator completes high-quality content ahead of schedule:

Creator earns "Early Bird" badge

May receive bonus XP or recognition

Reputation score increases

E2. Feedback and Iteration

After path is published and learners use the content:

Creator receives analytics on their tier:

Completion rates

Average time spent

Learner satisfaction ratings

Common misconceptions

Creator can update content based on feedback

E3. Content Reuse Permission

Creator can request to reuse tier content in personal courses:
Submits request to administrator
If approved, content can be adapted for other uses
Original path retains rights to the content

E4. Compensation Tracking

For paid creators:
System tracks time spent on assignment
Milestones trigger partial payments
Final approval triggers full payment
Invoicing generated automatically

Special Requirements

- The task board must clearly show progress and remaining work.
- Creators must be able to save work-in-progress at any time (auto-save every 2 minutes).
- System must support version history for all created content.
- Communication between creator and administrator must be logged.
- Deadline reminders must be sent at 7 days, 3 days, and 1 day before due date.
- Content submission must include a checklist confirmation (all requirements met).
- Administrator feedback must be clear, actionable, and specific.

Frequency of Use

Moderate to high frequency depending on path creation activity. Each creator may have 2-5 active assignments at any time. Typically takes 2-6 weeks per tier assignment depending on complexity.

Open Issues

Should creators be able to collaborate in real-time on the same content?

How do we handle disputes between creator and administrator on content direction?
Should there be peer review before administrator review?
Can AI assist in identifying content gaps or quality issues?

5.3.3 Learner Use Cases

Brief Format Use Cases

1. View Profile

The learner views their profile information including avatar, bio, learning goals, and XP progress.

2. Change Theme

The learner switches between dark and light mode in the editor settings (or using switch sun/moon icon).

3. View Badges

The learner views their earned badges and achievements in their profile gallery.

4. Check Streak

The learner checks their current daily learning streak and streak milestones.

5. View Leaderboard

The learner views global, weekly, or friend-based leaderboards showing XP rankings.

6. Update Avatar

The learner uploads or changes their profile picture.

Casual Format Use Cases

UC 7. Register Account

▸ **Actor**	Learner

Main Success Scenario

1. The learner navigates to the "Sign Up" page of the platform or app.
2. The learner selects the "Learner" role from account type options.
3. The learner provides required details:
    - Full name

    - Email address
    - Password (with confirmation)
    - Username
4. The learner can register using social media accounts (Google, Github, LinkedIn) as an alternative.
5. The learner agrees to Terms and Conditions and submits the form.
6. The system validates input (email format, password strength, username uniqueness).
7. The system sends a verification email to the provided address.
8. The learner clicks the OTP in the email.
9. The system activates the account and redirects to the login page.
10. The learner logs in successfully and sees a welcome message.

Alternative Scenarios

A1. Email Already Exists

At Step 5, if the email is already registered, the system displays:

> *"An account with this email already exists. Please log in or use a different email."*

A2. Weak Password

At Step 5, if the password doesn't meet security criteria (minimum 8 characters with uppercase, lowercase, numbers, special characters), the system displays:

> *"Your password must be at least 8 characters long and include uppercase, lowercase, numbers, and symbols."*

A3. Username Taken

At Step 5, if the username is already in use, the system displays:

> *"This username is already taken. Please choose a different one."*

UC 8. Login to System

▸ **Actor**	Learner

Main Success Scenario

1. The learner navigates to the login page in the platform or app.
2. The learner enters their email and password.
3. The learner can choose to log in using social media accounts (Google, Github, LinkedIn) as an alternative.
4. The learner clicks "Login."
5. The system validates credentials.
6. The system authenticates the learner and redirects to the dashboard.
7. The learner sees their personalized dashboard with progress and recommendations.

Alternative Scenarios

A1. Incorrect Credentials

At Step 4, if credentials are invalid, the system displays:

> 💬 *"Incorrect email or password. Please try again."*

A2. Account Not Verified

At Step 4, if the email is not verified, the system displays:

> 💬 *"Please verify your email address before logging in. Check your inbox for the OTP."*

A3. Account Suspended

At Step 4, if the account is suspended, the system displays:

> 💬 *"Your account has been suspended. Please contact support for assistance."*

UC 9. Recover Password

▸ **Actor**	Learner

Main Success Scenario

1. The learner clicks "Forgot Password" on the login page.
2. The learner enters their registered email address.
3. The system validates the email.
4. The system sends a password OTP to the email.
5. The learner enters the OTP received.
6. The learner enters and confirms a new password.
7. The system updates the password.
8. The learner sees confirmation:

> *"Password reset successfully. You can now log in."*

Alternative Scenarios

A1. Email Not Found

At Step 3, if the email isn't registered, the system displays:

> *"No account found with this email address."*

A2. Link Expired

At Step 5, if the OTP expired, the system displays:

"This link has expired. Please request a new password reset."

UC 10. Choose Learning Path

Actor	Learner

Main Success Scenario

1. The learner logs into the platform or app.
2. The learner navigates to the "Learning Paths" section.
3. The system displays available tracks (Fundamentals, Machine Learning, Cybersecurity, Full-Stack Development).
4. The learner selects their preferred learning path.
5. The system shows a detailed overview including modules, estimated time, and prerequisites.
6. The learner confirms their selection by clicking "Start Path."
7. The system updates the learner's dashboard with the selected path.
8. The learner receives a confirmation message:

   "You've successfully enrolled in the [Path Name] learning path! Let's start coding."

Alternative Scenarios

A1. Prerequisite Not Met

At Step 6, if the learner lacks prerequisite skills, the system displays:

> *"This path requires basic programming knowledge. We recommend starting with [Beginner Path]."*

The system offers to take a diagnostic quiz to determine the appropriate starting point.

A2. Already Enrolled in Path

At Step 6, if the learner is already enrolled, the system displays:

> *"You're already enrolled in this path. Continue learning from your dashboard."*

UC 11. View Lesson Content

▸ **Actor**	Learner

Main Success Scenario

1. The learner navigates to their enrolled course from the dashboard.
2. The learner selects a module and clicks on a specific lesson.

3. The system displays the lesson content including:
    - Text explanation
    - Video tutorial
4. The learner reads/watches the content at their own pace.
5. The learner can pause, rewind, or fast-forward video content.
6. The system tracks time spent on the lesson.
7. The lesson is marked as complete when finished.
8. The system updates progress and unlocks the next lesson.

Alternative Scenarios

A1. Lesson Locked

At Step 2, if prerequisites aren't completed, the system displays:

> *"Complete the previous lessons to unlock this content."*

A2. Content Loading Error

At Step 3, if content fails to load, the system displays:

> *"We're having trouble loading this lesson. Please refresh or try again later."*

UC 12. Complete Exercise

▸ **Actor** Learner

Main Success Scenario

1. The learner navigates to the exercises section of a lesson.
2. The learner selects an available coding challenge.
3. The system displays the problem statement, input/output examples, and starter code.
4. The learner writes code in the Code Editor in platform.
5. The learner drag/drop blocks of code in the blockly Editor in app.
6. The learner clicks "Run Tests" to validate their solution.
7. The system executes the code against test cases.
8. The system displays results showing passed/failed test cases.
9. If all tests pass, the learner clicks "Submit Solution."
10. The system awards XP and updates skill mastery.
11. The learner receives a success message with earned points.

Alternative Scenarios

A1. Tests Failed

At Step 7, if some tests fail, the system displays:

> *"Some test cases failed. Review the expected vs. actual output and try again."*

The learner can request hints or revise their code.

A2. Syntax Error

At Step 6, if the code has syntax errors, the system displays:

> *"Syntax Error: [Error Description]. Check line [X]."*

A3. Runtime Error

At Step 6, if the code causes a runtime error, the system displays:

> *"Runtime Error: [Error Description]. Your code crashed during execution."*

UC 13. Track Progress and View Learning Analytics

▸ **Actor**	Learner

Main Success Scenario

1. The learner navigates to the "Progress & Analytics" section from the dashboard.
2. The system displays a comprehensive dashboard with two main views:
   - **Progress Overview**
   - **Detailed Analytics**
3. **Progress Overview Section** displays:
   - Completed modules and lessons
   - Current XP and level
   - Skill mastery percentages
   - Time spent learning
   - Streak information
4. **Detailed Analytics Section** displays:
   - Accuracy rates per skill
   - Time-to-completion trends
   - Learning velocity
   - Performance metrics with charts and graphs
5. The system highlights weak areas and recommends improvement exercises based on analytics.
6. The learner can view predictions and insights:
   - Estimated time to complete current path
   - Suggested focus areas
7. The system provides actionable recommendations based on combined progress and analytics data.

Alternative Scenarios

A1. No Progress Data

At Step 2, if the learner hasn't completed any content:
The system displays:

> 💬 *"Start your learning journey! Complete lessons to see your progress and analytics here."*

Shows sample analytics dashboard with demo data

A2. Insufficient Data for Detailed Analytics

At Step 4, if there's not enough activity for meaningful analytics:
The system displays:

> 💬 *"Complete more lessons (at least 10) to unlock detailed analytics and insights."*

Shows basic progress metrics only
Detailed analytics sections are grayed out with unlock requirements

A3. Data Loading Delays

At Step 2, if analytics take time to compile:
The system displays progress indicator:

> 💬 *"Loading your analytics... This may take a moment."*

Shows cached data with timestamp while fresh data loads

UC 14. Earn XP and Level Up

▸ **Actor**	Learner

Main Success Scenario

1. The learner completes a lesson, exercise, or challenge.
2. The system calculates earned XP based on:
   - Task difficulty
   - Completion time
   - Accuracy
   - Streak bonuses
3. The system adds XP to the learner's total.
4. If the learner reaches a level threshold, the system triggers level-up animation.
5. The learner sees a congratulatory message with new level badge.
6. The system unlocks new content or features appropriate to the new level.

Alternative Scenarios

A1. Bonus XP Earned

At Step 2, if the learner completes on the first attempt or maintains a streak, the system displays:

"Bonus XP! You earned +[X] extra points for [reason]."

UC 15. Set Language Preferences

Actor	Learner

Main Success Scenario

1. The learner navigates to Settings.
2. The learner selects "Language Preferences."
3. The system displays options for:
   - Interface language (Arabic/English)
   - Primary programming language (Python/JavaScript) in platform.
4. The learner makes selections and clicks "Save."
5. The system updates preferences and refreshes the interface.
6. The learner sees confirmation:

   "Preferences updated successfully."

Alternative Scenarios

A1. Save Error

At Step 5, if saving fails, the system displays:

> 💬 *"Unable to save preferences. Please try again."*

UC 16. Bookmark Lesson

▸ **Actor**	Learner

Main Success Scenario

1. The learner is viewing a lesson.
2. The learner clicks the "Bookmark" icon.
3. The system adds the lesson to the learner's bookmarks.
4. The learner sees confirmation:

   > 💬 *"Lesson bookmarked!"*

5. The learner can access bookmarks from their profile.

Alternative Scenarios

A1. Already Bookmarked

At Step 3, if the lesson is already bookmarked, the system removes it and displays:

> 💬 *"Bookmark removed."*

UC 17. Share Solution

▸ **Actor**	Learner

Main Success Scenario

1. The learner completes an exercise successfully.
2. The learner navigates to the "Solution Gallery" section.
3. The learner clicks "Share My Solution."
4. The learner adds optional comments or explanations.
5. The learner submits the solution for community viewing.
6. The system publishes the solution with the learner's profile.

7. Other learners can view, upvote, and comment.

Alternative Scenarios

A1. Solution Not Approved

At Step 6, if the solution violates guidelines, moderators reject it with feedback.

Fully Dressed Format Use Cases

UC 18. Enable Two-Factor Authentication

▸ **Primary Actor**	Learner

Learner: Wants enhanced account security to protect personal data and progress.

Platform: Needs to reduce account compromise and unauthorized access.

Security Team: Wants to enforce best practices for account protection.

▸ **Preconditions**	Learner must be logged in. Learner must have a verified email address. Learner must have access to a mobile device or authenticator app.

▸ **Postconditions**	2FA is enabled on the learner's account. Future logins require both password and verification code. Backup codes are generated and stored securely.

Main Success Scenario

1. The learner navigates to Account Settings.
2. The learner selects "Security" tab.
3. The learner clicks "Enable Two-Factor Authentication."
4. The system displays 2FA setup options:
   - Authenticator app (recommended)
   - Email verification code
5. The learner selects "Authenticator App."
6. The system generates a QR code and secret key.
7. The system displays instructions:
   - "Scan this QR code with your authenticator app (Google Authenticator, Authy, etc.)"
8. The learner opens their authenticator app and scans the QR code.
9. The authenticator app adds the DuoCodo account and begins generating codes.
10. The system prompts: "Enter the 6-digit code from your authenticator app to confirm setup."
11. The learner enters the current code from their app.
12. The system validates the code.
13. The system generates 10 backup recovery codes.
14. The system displays the recovery codes with instructions:
    - "Save these codes securely. Each can be used once if you lose access to your authenticator."

15. The learner downloads or copies the recovery codes.

16. The learner confirms they've saved the codes by checking a box.

17. The system enables 2FA on the account.

18. The learner sees confirmation:

    > *"Two-Factor Authentication is now active. Your account is more secure!"*

19. The system logs out all other sessions for security.

20. Future logins now require:
    - Email/username + password
    - 6-digit code from authenticator app

Alternative Scenarios

A1. Invalid Verification Code

At Step 12, if the code is incorrect:

> *"Invalid code. Please ensure you're entering the current 6-digit code from your authenticator app."*

The learner can try again (up to 5 attempts).
After 5 failed attempts, setup is cancelled and must restart.

A2. Backup Codes Not Saved

At Step 16, if the learner tries to continue without confirming:

"Please confirm you've saved your backup codes. You won't be able to view them again."

The "Continue" button remains disabled until confirmed.

A3. Learner Chooses Email Method

At Step 5, if the learner selects email verification:

The system uses the registered email address.

The system sends a test verification code via email.

The learner enters the code to confirm.

Setup completes with email as the 2FA method.

A4. QR Code Won't Scan

At Step 8, if the learner can't scan the QR code:

The learner clicks "Can't scan? Enter code manually."

The system displays the secret key as text.

The learner manually enters the key into their authenticator app.

Setup continues from Step 10.

A5. Lost Authenticator Device

After 2FA is enabled, if the learner loses access:

During login, the learner clicks "Use backup code instead."

The learner enters one of their saved recovery codes.

The system validates the code and grants access.

The system prompts the learner to reconfigure 2FA.

The used recovery code is marked as consumed.

A6. All Backup Codes Used

If all 10 backup codes are exhausted:

The learner must contact support with identity verification.
Support verifies identity through:
Email verification
Security questions
Recent activity verification
Support can temporarily disable 2FA or reset it.

A7. Technical Error During Setup

At any step, if a system error occurs:

> *"We encountered an error during 2FA setup. Please try again or contact support."*

The setup is rolled back; 2FA is not enabled.
The learner can retry after a few minutes.

Extensions

E1. Disable 2FA

The learner navigates to Security settings.
The learner clicks "Disable Two-Factor Authentication."
The system requires current password + 2FA code for confirmation.
The system warns about reduced security.
If confirmed, 2FA is disabled and all backup codes are invalidated.

E2. Regenerate Backup Codes

If the learner loses their backup codes:
The learner navigates to Security settings.
The learner authenticates with password + 2FA code.
The learner clicks "Generate New Backup Codes."

The system creates 10 new codes and invalidates old ones.
The learner saves the new codes securely.

E3. Change 2FA Method

The learner can switch from SMS to authenticator app (or vice versa):
The learner navigates to Security settings.
The learner selects "Change 2FA Method."
The system requires current 2FA verification.
Setup for new method proceeds as in main scenario.

E4. Trusted Devices

After successful 2FA login:
The system offers: "Trust this device for 30 days?"
If accepted, 2FA is not required on this device for 30 days.
Trusted devices can be managed in Security settings.

Special Requirements

- 2FA codes must expire after 30 seconds (standard TOTP protocol).
- Backup codes must be cryptographically secure random strings.
- The system must support time-based one-time passwords (TOTP) standard.
- SMS delivery must occur within 60 seconds.
- Recovery codes must be hashed in the database, not stored in plain text.
- The system must rate-limit 2FA verification attempts (max 5 per 15 minutes).
- All 2FA setup and verification events must be logged for security auditing.

Frequency of Use

One-time setup for security-conscious learners.

Estimated adoption rate: 25-40% of active users.
Daily use during login for enrolled users.

Open Issues

Should 2FA be mandatory for learners with certification credentials?
Should we support hardware security keys (FIDO2/U2F)?
How do we handle learners in regions with poor SMS delivery?

UC 19. Practice Coding with Code Editor (Platform)

▸ **Primary Actor**	Learner

Learner: Wants to write, execute, and debug code efficiently in a professional environment on web platform.

Platform: Needs to provide secure, real-time code execution with helpful feedback.

▸ **Preconditions**	Learner must be logged in to the web platform. Learner must have access to a lesson or exercise with a coding component. Code Editor and execution APIs must be operational. Learner must be using desktop or laptop computer with modern web browser.

▸ **Postconditions**	Code is written, executed, and results are displayed. Progress is tracked and saved. Learner receives feedback on their solution.

Main Success Scenario

1. The learner navigates to a coding exercise or lesson on the web platform.
2. The system loads the Code Editor with syntax highlighting for the selected language (Python/JavaScript).
3. The system displays:
   - Problem statement on the left panel
   - Code Editor in the center
   - Output console at the bottom
   - Starter code (if any) pre-loaded in the editor
4. The learner writes their code in the Code Editor.
5. The editor provides professional IDE features:
   - **IntelliSense** auto-completion
   - **Syntax highlighting** with color-coded keywords
   - **Real-time error detection** with red underlines
   - **Code folding** for functions and blocks
   - **Multiple cursor editing**
   - **Find and replace functionality**
   - **Code formatting** (Ctrl+Shift+F)
   - **Bracket matching**
6. The learner can customize editor settings:
   - Font size adjustment
   - Theme selection (dark/light mode)
   - Tab size configuration
   - Line numbers toggle
7. The learner clicks "Run Code" to test their solution.
8. The system sends the code to the secure execution API via HTTPS.

9. The execution API runs the code in an isolated Docker sandbox environment.
10. The system returns execution results:
    - Standard output (console.log, print statements)
    - Execution time (in milliseconds)
    - Memory usage (in MB)
    - Error messages with line numbers (if any)
    - Return values
11. The results are displayed in the output console below the editor with syntax highlighting.
12. The learner can view detailed execution metrics in an expandable panel.
13. If the output matches expected results, the learner clicks "Submit Solution."
14. The system validates the solution against all test cases (visible and hidden).
15. The system displays test results:
    - Passed test cases (✓ in green)
    - Failed test cases (✗ in red) with input/output comparison
    - Edge cases handled correctly
16. If all tests pass:
    - The system awards XP based on:
        - First attempt bonus (+50 XP)
        - Code efficiency score
        - Time taken to solve
    - Updates skill mastery metrics
    - Saves the code to learner's solution history
17. The learner sees a success message with:
    - Earned XP and badges
    - Performance comparison with other learners
    - Suggestions for optimization (if applicable)

Alternative Scenarios

A1. Syntax Error Detected

At Step 5, if the learner's code contains syntax errors:
Code Editor underlines the error in red with wavy line
Hovering shows tooltip:

> 💬 *"Syntax Error: [Description] at line [X], column [Y]"*

Error panel shows detailed message with suggested fixes
The learner corrects the error and continues

A2. Runtime Error During Execution

At Step 10, if the code crashes during execution:

> 💬 *✗ Runtime Error: IndexError Your code encountered an issue at line 15 Stack Trace: File "main.py", line 15, in <module> print(arr[10]) IndexError: list index out of range*

The learner can view full stack trace
System suggests debugging tips based on error type

A3. Execution Timeout

At Step 9, if code execution exceeds 5 seconds:

> 💬 *Execution Timeout Your code took longer than 5 seconds to run. Possible issues: - Infinite loop detected - Inefficient algorithm (O(n^2) or worse) Suggestion: Consider optimizing your approach*

The learner can review algorithm complexity

A4. Memory Limit Exceeded

At Step 10, if memory usage exceeds 512MB:

> 💬 *Memory Limit Exceeded Your code used more than 512MB of memory. Consider: - Reducing data structure sizes - Using generators instead of lists - Implementing streaming solutions*

A5. Test Cases Failed

At Step 14-15, if some test cases fail:

> 💬 *Test Case 3: ✗ Failed Input: [1, 2, 3, 4, 5] Expected Output: 15 Your Output: 14 Difference: Off by 1 (check array indexing)*

The learner can revise and resubmit

Hint button becomes available after 2 failed attempts

A6. Code Execution Service Unavailable

At Step 8, if the execution API is down:

> 💬 *Execution Service Temporarily Unavailable The code execution service is currently down. Your code has been saved as a draft. Please try again in a few minutes.*

Code is auto-saved every 30 seconds

Learner can continue working offline

A7. Browser Crash or Tab Closed

If browser crashes or tab is accidentally closed:

On return, system displays:

Restored from Auto-Save Last saved: 30 seconds ago Would you like to continue where you left off? [Restore Code] [Start Fresh]

Extensions

E1. Code Snapshotting

The learner can save multiple versions of their solution
Click "Save Snapshot" button (Ctrl+S)
System stores code with timestamp: "Version 1 - 14:30:25"
Learner can compare versions side-by-side
Restore any previous version with one click

E2. Code Sharing

After successful submission, learner can share solution
Click "Share Code" generates unique URL
Other learners can view (not edit) the code
Solution appears in "Community Solutions" gallery

E3. Accessing Model Solutions

After successful submission, "View Solutions" button appears
System displays 3-5 model solutions:
Optimal Solution (best time/space complexity)
Beginner-Friendly (easiest to understand)
Alternative Approaches (different algorithms)
Each includes:
Big O complexity analysis
Line-by-line explanations

When to use this approach

E4. Code Execution History

Learner can view all previous runs:

Timestamp of execution

Output results

Performance metrics

Can re-run any previous version

E5. Split Screen View

Learner can enable split-screen mode:

Problem description on left

Code editor on right

Resizable panels

Useful for referencing requirements while coding

E6. Keyboard Shortcuts

Code Editor supports VS Code shortcuts:

`Ctrl+/` - Toggle line comment

`Ctrl+D` - Select next occurrence

`Alt+Up/Down` - Move line up/down

`Ctrl+Shift+K` - Delete line

`F12` - Go to definition

Full shortcut reference available in help menu

E7. Code Formatting

Learner clicks "Format Code" or presses `Ctrl+Shift+F`

System auto-formats code following PEP 8 (Python) or StandardJS style

Fixes indentation and spacing

Improves code readability

E8. Collaborative Coding (Future)

Multiple learners can work on same exercise together
Real-time cursor positions visible
Chat panel for discussion
Useful for pair programming exercises

Special Requirements

- Code Editor must load within 2 seconds
- Editor must support Python 3.10+ and ES6+ JavaScript
- Code execution must complete within 5 seconds for standard exercises
- The sandbox environment must prevent:
  - File system access
  - Network requests
  - System command execution
  - Resource exhaustion attacks
- All code submissions must be encrypted during transmission (TLS 1.3)
- The editor must be fully keyboard-accessible (WCAG 2.1 AA compliant)
- Dark and light themes must both have sufficient contrast ratios
- Editor must work on screens as small as 1024x768
- Auto-save must occur every 30 seconds
- Maximum code file size: 10,000 lines
- Support for multiple programming languages must be extensible

Frequency of Use

This is the most frequently used feature on web platform
Average: 15-20 code executions per active session

Daily active users spend 60% of their time in Code Editor

Open Issues

Should we support additional languages (Java, C++, Ruby) in future releases?
How do we handle collaborative coding exercises without real-time sync?
Should we implement code review features for peer learning?
What's the optimal balance between sandbox security and execution speed?

UC Practice Coding with Blockly Editor (Mobile App)

Primary Actor	Learner

Learner: Wants an intuitive, visual way to learn programming concepts on mobile devices without typing code.

Platform: Needs to make coding accessible to beginners and younger learners through mobile-friendly interface.

Educators: Want a tool that teaches computational thinking before syntax complexity.

Preconditions

- Learner must be logged in to the mobile app (iOS/Android).
- Learner must have access to a lesson or exercise supporting block-based coding.
- Blockly library and execution engine must be operational.
- Device must have touchscreen capability.

▸ **Postconditions**	▸ Visual block program is created and executed. ▸ Generated code (Python/JavaScript) is executed successfully. ▸ Progress is tracked and saved. ▸ Learner understands the underlying code structure.

Main Success Scenario

1. The learner navigates to a coding exercise on the mobile app.
2. The system detects the device type and loads the Blockly visual editor.
3. The system displays:
    - Problem statement at the top (collapsible)
    - **Blockly workspace** in the center (main area)
    - **Block toolbox** on the left side (categorized blocks)
    - **Output console** at the bottom (expandable)
    - **Block bin/trash** for removing blocks
4. The problem requires building a simple program (e.g., "Calculate sum of numbers in a list").
5. The learner taps the toolbox to browse available block categories:
    - **Logic blocks** (if/else, comparison, boolean)
    - **Loop blocks** (for, while, repeat)
    - **Math blocks** (arithmetic, random, functions)
    - **Text blocks** (string operations, concatenation)
    - **List blocks** (create, add, get, length)
    - **Variable blocks** (create, set, get)
    - **Function blocks** (define, call, return)

6. The learner selects a "create variable" block and names it `sum`.

7. The learner drags a "set variable to" block to the workspace.

8. The learner adds a "for each item in list" loop block.

9. Inside the loop, learner adds a "set sum to sum + item" block.

10. Blocks automatically snap together when compatible (visual feedback):

    ◦ **Green outline** when blocks can connect

    ◦ **Red outline** when blocks are incompatible

    ◦ **Magnetic snap** when released near compatible blocks

11. The learner can:

    ◦ **Drag blocks** with finger/stylus

    ◦ **Pinch to zoom** for better view

    ◦ **Pan** the workspace by dragging background

    ◦ **Duplicate blocks** by long-press

    ◦ **Delete blocks** by dragging to trash icon

12. The system shows real-time validation:

    ◦ Incomplete blocks highlighted in yellow

    ◦ Required connections shown with puzzle piece icons

    ◦ Error indicators if logic is invalid

13. The learner taps "Run Code" button.

14. The system converts blocks to executable code (Python or JavaScript):

    ◦ ```python sum = 0 list = [1, 2, 3, 4, 5] for item in list: sum = sum + item print(sum) ```

15. The generated code is displayed in a collapsible "View Code" panel.

16. The learner can switch between:

    ◦ **Block View** (visual programming)

    ◦ **Code View** (text-based equivalent)

    ◦ **Split View** (both simultaneously)

17. The system sends the generated code to the execution API.
18. The execution API runs the code in a secure sandbox.
19. The output console displays results:
    - Console output: `15`
    - Execution time: `0.02s`
    - Memory used: `12MB`
20. If output is correct, the learner taps "Submit Solution."
21. The system validates against test cases:
    - **Test 1:** Input `[1, 2, 3]` → Expected `6` ✓
    - **Test 2:** Input `[10, 20, 30]` → Expected `60` ✓
    - **Test 3:** Input `[]` → Expected `0` ✓
22. If all tests pass:
    - Confetti animation plays on mobile screen
    - Success sound effect (optional, can be muted)
    - XP points awarded with animation
    - Badge earned (e.g., "Loop Master" for completing loop exercises)
23. The learner sees a summary screen:

    > *Exercise Completed!*

    - XP earned: +30 XP
    - Total XP: 450 XP
    - Next exercise unlocked
24. The block program is saved to the learner's solution history.
25. The learner can share their block solution as an image on social media.

Alternative Scenarios

A1. Blocks Won't Connect (Type Mismatch)

At Step 10, if learner tries to connect incompatible blocks:

- Blocks shake and show red outline
- Tooltip displays: *"❌ Cannot connect: Expected NUMBER, got TEXT"*
- Blocks bounce back to original position
- Learner must use correct block type

A2. Missing Required Blocks

At Step 13, if program is incomplete:

> 💬 ⚠️ *Your program is incomplete. Missing: output block*

- Incomplete blocks flash yellow
- "Run Code" button is disabled until complete
- Hint suggests which category has needed blocks

A3. Infinite Loop Detected

At Step 18, if blocks create infinite loop:

- Execution is terminated after 3 seconds
- System displays:

> 💬 *Infinite Loop Detected*
> *Your loop ran more than 1000 times.*
> *Check your loop condition to ensure it can exit.*

- Problematic loop block is highlighted in red
- Learner can review loop logic

A4. Runtime Error in Generated Code

At Step 18, if execution fails:

- System displays error in simple terms:

> 💬 *Error: Division by Zero*
> *Your program tried to divide by 0 at this block:*
> *[Highlights the specific block causing error]*
> *Tip: Check if denominator can be zero*

- Problematic block glows red
- Learner can tap block for more details

A5. Test Cases Failed

At Step 21, if some tests fail:

- System shows which tests failed:

```
💬 Test 2: ❌ Failed
Input: [10, 20, 30]
Expected: 60
Your Output: 50
Issue: Check your addition logic
```

- Learner can revise blocks and retry

A6. Accidental Block Deletion

At Step 11, if learner accidentally deletes important blocks:

- "Undo" button appears for 5 seconds
- Tapping "Undo" restores deleted blocks
- After 5 seconds, deletion is permanent
- Learner can recreate blocks from toolbox

A7. Device Orientation Change

If device is rotated during exercise:

- System saves current block positions
- Re-layouts workspace for new orientation
- **Portrait mode:** Toolbox becomes bottom drawer
- **Landscape mode:** Toolbox on left sidebar
- All blocks remain in same relative positions

A8. App Crashes or Closed

If app crashes or is closed:

- On relaunch, system displays:

> 💬 *Restore Previous Session?*
> *You were working on: "Sum Calculator"*
> *Last saved: 2 minutes ago*
> *[Restore] [Start New]*

- Auto-save occurs every 20 seconds

A9. Network Unavailable

At Step 17, if no internet connection:

> 💬 📡 *No Internet - Code saved locally*

- Execution is queued
- When connection restores, code executes automatically
- Learner receives notification when results are ready

Extensions

E1. Block Customization

Learner can customize block colors:

- Tap block settings icon
- Choose from color palette
- Useful for organizing complex programs
- Custom colors saved per learner

E2. Voice Input for Block Names

Learner can name variables using voice:

- Tap microphone icon
- Say variable name: "total score"
- System creates variable with that name
- Useful for accessibility

E3. Block Animation

During execution, blocks light up sequentially:

- Shows program flow in real-time
- Helps learners understand execution order
- Speed can be adjusted (slow/normal/fast)
- Can be paused at any block

E4. Tutorial Hints with Arrows

For first-time users:

- Animated arrows point to next action
- Speech bubbles explain each step
- "Try dragging this block here 👉"
- Tutorial can be skipped or replayed

E5. Block Library Favorites

Learner can mark frequently-used blocks as favorites:

- Star icon on blocks
- Favorites appear in "My Blocks" category
- Speeds up program building

E6. Convert to Text Code

After mastering blocks, learner can transition:

- Tap "Convert to Code" button
- System generates Python/JavaScript
- Opens in Code Editor (if on tablet/larger screen)
- Learner can edit and learn text-based syntax

E7. Collaborative Block Coding

Learner can invite friend to code together:

- Share session code
- Both see blocks in real-time
- Each user's cursor shown with name
- Chat feature for discussion
- Useful for pair programming

E8. Block Challenges with Timers

Timed challenges for competitive learning:

- Build program in 3 minutes
- Leaderboard for fastest correct solutions
- Bonus XP for speed
- Encourages efficiency

E9. Parent/Teacher Monitoring

Parents or teachers can view learner's block programs:

- Dashboard shows completed exercises
- Can view block solutions
- Progress reports
- Useful for tracking learning at home/school

E10. Block Export as Image

Learner can export block program as PNG:

- Tap "Share" button
- System generates image of blocks
- Can post to social media
- Useful for showcasing progress

E11. Adaptive Block Difficulty

System adjusts available blocks based on skill level:

- **Beginner:** Basic blocks only (print, variables, simple loops)
- **Intermediate:** Add functions, lists, conditions
- **Advanced:** Classes, recursion, advanced data structures
- Prevents overwhelming beginners with too many options

Special Requirements

- Blockly editor must load within 1.5 seconds on mobile devices
- Touch targets must be at least 44x44 pixels (Apple HIG standard)
- Blocks must have high contrast for visibility in sunlight
- Pinch-to-zoom must support 50% to 200% zoom range
- Drag operations must have 150ms delay to prevent accidental moves
- Block snapping must have haptic feedback (vibration) on compatible devices
- Workspace must support up to 100 blocks without performance degradation
- App must work offline with local execution for basic exercises
- All block actions must have undo/redo support (up to 50 steps)
- Block colors must be colorblind-friendly (use patterns/icons in addition to colors)
- Text on blocks must be readable at minimum 16px font size
- Auto-save must occur every 20 seconds
- Generated code must be syntactically correct and executable
- Block toolbox must be searchable for finding specific blocks quickly

Frequency of Use

- Very high frequency among mobile learners (ages 8-16 primary users)
- Average: 10-15 block exercises per active mobile session
- 70% of mobile app users prefer Blockly over text-based coding initially
- Gateway to text-based programming (users transition after 3-6 months)

Open Issues

- Should we support custom block creation for advanced users?
- How do we handle very complex programs (100+ blocks) on small screens?
- Should we implement AR (Augmented Reality) mode for 3D block visualization?
- Can we integrate voice coding ("add a loop block") for hands-free operation?
- Should there be a "block marketplace" where users share custom block libraries?
- How do we transition users from Blockly to Code smoothly?
- Should we support multiple languages (Spanish, Arabic) for block text?

UC Receive AI-Powered Hints

Primary Actor	Learner

Learner: Wants contextual, progressive hints that guide without giving away the complete solution.

Platform: Needs to provide intelligent assistance that enhances learning without creating dependency.

AI System (Gemini/OpenRouter/Custom model): Provides adaptive hints based on code analysis.

Preconditions	- Learner must be working on an exercise. - Learner must be logged in. - AI API services (OpenRouter/Gemini/Custom model) must be operational. - Learner must have made at least one attempt at the exercise.

▸ **Postconditions**	▸ Appropriate hint is provided based on learner's current code and skill level. ▸ Hint usage is tracked for analytics. ▸ Learner can progress with better understanding.

Main Success Scenario

1. The learner is working on a coding exercise and encounters difficulty.
2. The learner clicks the "Get Hint" button.
3. The system analyzes the learner's current code and attempt history.
4. The system determines the learner's skill level and hint count for this exercise.
5. The system sends a request to the AI API with:
    - Problem statement
    - Learner's current code
    - Skill level
    - Previous hint history
    - Requested hint level
6. The AI API processes the request and generates an appropriate hint.
7. The AI returns a hint that:
    - Doesn't reveal the complete solution
    - Addresses the learner's specific issue
    - Matches the learner's comprehension level
8. The system displays the hint in a panel below the editor.
9. The hint includes:

    - Conceptual guidance
    - Suggested approach
    - Relevant examples (if needed)

10. The learner reads the hint and applies the guidance.
11. The system tracks the hint usage and adjusts XP rewards accordingly.
12. If the learner needs additional help, they can request more specific hints (progressive levels).

Alternative Scenarios

A1. No Attempt Made Yet

At Step 2, if the learner hasn't written any code:

> 💬 *Try writing some code first! Hints are most helpful after you've made an attempt.*

- The "Get Hint" button remains disabled until code is written.

A2. Maximum Hints Reached

At Step 4, if the learner has used all available hints for this exercise:

> 💬 *You've used all available hints. Try applying what you've learned or view the model solution.*

- The learner is offered the option to view the complete solution (with loss XP reward).

A3. AI Service Unavailable

At Step 6, if the AI API is down or unresponsive:

> *AI hints are temporarily unavailable. Here's a pre-generated hint for this problem.*

- The system provides a fallback hint from the database.

A4. Request Timeout

At Step 6, if the AI API doesn't respond within 10 seconds:

> *The hint service is taking longer than usual. Please try again.*

- The request is logged for admin review.

A5. Inappropriate Code Detected

At Step 5, if the learner's code contains inappropriate content:

> *Please ensure your code is appropriate before requesting hints.*

- The system doesn't send to AI and displays the message.

A6. Hint Too Advanced

At Step 7, if the AI generates a hint beyond the learner's level:

- The system uses natural language processing to simplify the hint.
- If simplification fails, a pre-generated hint is used instead.

Extensions

E1. Progressive Hint Levels

- First hint: Conceptual guidance only
- Second hint: Specific approach suggestion
- Third hint: Pseudocode or example structure
- Fourth hint: Partial code implementation
- Fifth hint: Complete solution with explanation

E2. Code Analysis Insights

The AI identifies specific issues in the learner's code:

- Logic errors
- Incorrect algorithm choice
- Edge case handling
- The hint addresses these specific issues.

E3. Hint History

- The learner can view all previously received hints.
- The learner clicks "Previous Hints" to review earlier guidance.
- This helps reinforce learning without requesting duplicate hints.

E4. Contextual Examples

- If the hint references a concept, the system includes a link to relevant lesson content.
- The learner can click to review the concept before continuing.

Special Requirements

- AI hints must not reveal complete solutions directly.
- Hint generation must complete within 10 seconds.
- The system must track hint usage for XP calculation (fewer hints = more XP).
- Hints must be appropriate for the learner's skill level.
- The AI API must be rate-limited to prevent abuse.
- All API communications must be encrypted.
- Fallback hints must be available for all exercises.

Frequency of Use

- Moderate to high frequency, especially among beginner learners.
- Expected usage: 30-40% of learners per exercise.

Open Issues

- Should we implement a "hint cost" using virtual currency?
- How do we balance hint availability with learning independence?
- Should hints be personalized based on learning style preferences?

UC Complete Certification Track

Primary Actor	Learner

Learner: Wants to earn a credential that validates completion of their learning path and acquired programming skills.

Platform: Needs to ensure certification standards are maintained and verifiable.

Potential Employers/Institutions: Want assurance that certifications represent genuine path completion and competency.

Content Creators: Want their learning paths to offer valuable credentials that motivate completion.

Preconditions

- Learner must be logged in.
- Learner must be enrolled in a learning path (from Use Case 10: Choose Learning Path).
- Learner must have completed at least 95% of the learning path requirements.
- The final challenge of the learning path must be unlocked.

Postconditions

- Learning path is marked as 100% complete.
- Learner receives a digital certificate for the completed path.
- Certificate is added to learner's profile and portfolio.
- Certification data is recorded in the system with timestamp.
- Certificate can be verified and shared publicly.

Main Success Scenario

1. The learner is enrolled in a learning path (e.g., "Python Full-Stack Developer" from Use Case 10).
2. The learner progresses through the path by completing courses, lessons, and exercises across all tiers:
    - Tier 1: Foundation modules completed
    - Tier 2: Core concepts mastered
    - Tier 3: Intermediate skills acquired
    - Tier 4: Advanced topics finished
3. The system tracks progress in the learner's dashboard:
    - Progress bar shows: 95% complete
    - Status: "Final Challenge Unlocked"
4. The learner navigates to the learning path dashboard.
5. The system displays:

    > 💬 🎉 *You're almost there! Complete the final challenge to earn your certification.*

6. The learner clicks "Start Final Challenge."
7. The system displays the final challenge details:
    - Challenge title: "Build a Full-Stack Task Management Application"
    - Requirements:
        - Implement frontend interface
        - Create backend API
        - Database integration
        - User authentication
        - Deployment instructions
    - Time limit: 3-7 days (self-paced)
    - Submission format: GitHub repository link + deployed app URL

8. The learner works on the final challenge project using skills learned throughout the path.

9. The learner tests their application thoroughly.

10. The learner clicks "Submit Final Challenge."

11. The system prompts for submission details:
    - GitHub repository URL
    - Live deployment URL
    - Project description (optional)
    - Technologies used

12. The learner provides all required information and clicks "Confirm Submission."

13. The system validates submission:
    - Checks if URLs are accessible
    - Verifies repository contains code
    - Scans for plagiarism using code similarity detection

14. **Automated Evaluation Process:**
    - The system runs automated tests on the submitted project:
        - Code quality analysis (linting, formatting)
        - Functionality tests (API endpoints work correctly)
        - Security checks (no obvious vulnerabilities)
        - Performance benchmarks (response times acceptable)

15. **Scoring System:**
    - The system calculates a score based on:
        - Functionality: 40 points (all features work correctly)
        - Code quality: 30 points (clean, well-documented code)
        - Creativity: 15 points (innovative features, UI/UX)
        - Best practices: 15 points (security, performance, structure)
    - Minimum passing score: 70/100

16. If the learner achieves 70+ points:

> 💬 ✅ *Congratulations! Your project meets certification standards.*

17. **Certificate Generation:**
    - The system generates a digital certificate including:
        - Learner's full name
        - Learning path title: "Python Full-Stack Developer"
        - Completion date
        - Unique certificate ID (e.g., DCD-PY-2025-12345)
        - Platform logo and signature
        - QR code for verification
        - Path details (total hours, skills acquired)
18. The system displays certificate preview with animation:
    - Confetti effect
    - Achievement sound
    - Certificate appears with fade-in animation
19. The system updates learner's profile:
    - Badge: "Python Full-Stack Developer Certified"
    - Total XP bonus: +5000 XP
    - New level unlocked (if applicable)
    - Certificate added to "My Certificates" section
20. The system sends congratulatory email with:
    - Certificate PDF attachment (high-resolution, printable)
    - Certificate verification link
    - Social sharing templates
    - LinkedIn credential integration link
21. The learner can now:

- Download certificate as PDF
- Share on social media (LinkedIn, Twitter, Facebook)
- Add to digital portfolio
- Print for display

22. **Certificate Verification:**
    - Each certificate has unique URL: `duocodo.com/verify/DCD-PY-2025-12345`
    - Anyone can verify authenticity by:
      - Scanning QR code on certificate
      - Entering certificate ID on verification page
    - Verification page displays:
      - Learner name
      - Path completed
      - Completion date
      - " This certificate is authentic and verified by DuoCodo"
23. The learning path is marked as "Completed" in learner's dashboard.
24. The system recommends next learning paths:
    - "Advanced Python Development"
    - "DevOps for Full-Stack Developers"
    - "React Native Mobile Development"
25. The learner's portfolio automatically showcases:
    - The certificate
    - Final challenge project
    - All portfolio projects from the path

Alternative Scenarios

A1. Final Challenge Score Below 70

At Step 16, if score is 60-69 points:

> 💬 *Your project scored [X]/100. You need 70+ to pass. Review the feedback and resubmit.*

The system provides detailed feedback:

> 💬 *Areas for improvement:*
> *- Functionality: Missing user logout feature (-5 points)*
> *- Code quality: Inconsistent naming conventions (-8 points)*
> *- Security: API endpoints not protected (-7 points)*
>
> *Recommendations:*
> *- Review authentication lessons in Tier 4*
> *- Study API security best practices*
> *- Fix identified issues and resubmit*

- The learner can revise and resubmit (up to 3 attempts total).
- Each attempt must wait 48 hours for review.

A2. Plagiarism Detected

At Step 13, if code similarity exceeds 80% with existing projects:

- The system flags submission for manual review.
- Admin investigates source of similarity.
- If confirmed plagiarism:
  - Submission is rejected.
  - The system displays: *"Your submission contains plagiarized content. Certification requires original work."*
  - Learner receives warning.
  - Must create new project from scratch.
  - Serious violations may result in temporary suspension.

A3. Submission URLs Invalid

At Step 13, if provided URLs are broken or inaccessible:

> *Unable to access your project. Please ensure URLs are correct and publicly accessible.*

- Learner must fix URLs and resubmit.
- Submission is not counted as an attempt if URLs are invalid.

A4. Technical Issues During Submission

At Step 12, if submission fails due to system error:

> *Submission failed due to technical issues. Your work has been saved as draft.*

- Learner can retry submission.
- Support team is notified automatically.
- Deadline is extended by 24 hours if system was at fault.

A5. Maximum Attempts Reached (3 Failed Submissions)

After 3rd failed submission:

> *You've reached the maximum submission attempts. To earn certification, you must:*

- Option 1: Retake specific path modules and retry after 30 days
- Option 2: Schedule mentorship session for guidance
- Option 3: Restart learning path from Tier 3
- The learner must choose an option to continue.

A6. Deadline Expired (If Path Has Time Limit)

If learner doesn't submit within path deadline (e.g., 6 months):

> *Your enrollment period has ended. To earn certification, re-enroll in the next cohort.*

- Progress is saved but path must be re-enrolled.
- Learner can view what they completed.

A7. Learning Path Not Fully Completed

At Step 6, if learner tries to start final challenge prematurely:

> *Complete all path requirements before attempting final challenge. Current progress: [X]%*

- Shows remaining incomplete modules/exercises.
- "Start Final Challenge" button remains disabled.

A8. Project Repository Private

At Step 13, if GitHub repository is set to private:

> 💬 *Repository must be public for evaluation. Please change repository visibility settings.*

- Provides instructions on making repository public.
- Submission is not processed until accessible.

Extensions

E1. Certificate Levels Based on Performance

Certificates are tiered by final challenge score:

- **Bronze Certificate:** 70-79 points (Pass)
- **Silver Certificate:** 80-89 points (Merit)
- **Gold Certificate:** 90-100 points (Distinction)
- Certificate design and badge reflect achievement level.
- Higher tiers may unlock additional benefits (e.g., featured portfolio, mentor access).

E2. LinkedIn Integration

After certificate issuance:

- Learner clicks "Add to LinkedIn" button.
- System auto-populates LinkedIn credential form:
  - Credential name: "Python Full-Stack Developer"
  - Issuing organization: DuoCodo
  - Issue date: [Completion date]
  - Credential ID: [Certificate ID]
  - Credential URL: [Verification link]
- Learner confirms and posts to LinkedIn profile.

E3. Portfolio Project Showcase

Final challenge project is featured prominently:

- Public portfolio page displays:
  - Project demo video/screenshots
  - Live project link
  - GitHub repository
  - Technologies used
  - Project description
- Other learners can view and learn from completed projects.
- Recruiters can discover learners through project showcase.

E4. Peer Recognition

Other learners can congratulate certificate earners:

- "Congratulate" button sends encouragement message.
- Achievement appears in community feed.
- Builds motivational community culture.

E5. Multiple Learning Paths

Learners can pursue multiple certifications:

- Each completed path earns separate certificate.
- Dashboard shows all earned certificates.
- "Collection" badges for completing related paths:
  - "Web Development Master" (3 web paths completed)
  - "Data Science Expert" (4 data science paths completed)

E6. Certificate Renewal/Updates

For technology-focused paths that evolve:

- Certificates remain valid but note version: "Python Full-Stack Developer (2025)"
- Learners notified when path is significantly updated.
- Optional: Complete update modules for refreshed certificate.
- Keeps certifications current with industry standards.

E7. Employer Verification Portal

Employers can verify certificates in bulk:

- Upload list of certificate IDs.
- System validates all certificates.
- Generates report of verified credentials.
- Useful for HR departments during hiring.

E8. Certificate Analytics

Learner can view certificate statistics:

- How many people completed this path
- Average completion time
- Most common career outcomes
- Salary ranges for certificate holders (if data available)

E9. Blockchain Verification (Advanced)

Certificate hash stored on blockchain:

- Immutable proof of achievement.
- Cannot be forged or tampered with.
- Blockchain explorer link included.
- Future-proof credential verification.

E10. Custom Certificate Frames

Learners can choose certificate design themes:

- Professional (formal design)
- Modern (colorful, vibrant)
- Minimalist (clean, simple)
- Personalization makes certificates more meaningful.

Special Requirements

- Certificate generation must complete within 10 seconds of passing final challenge.
- Certificates must be high-resolution (300 DPI) for printing.
- PDF certificates must be accessible (screen reader compatible).
- Certificate IDs must be cryptographically unique (collision-resistant).
- Verification URLs must remain valid indefinitely (no expiration).
- All certificate data must be backed up securely.
- The system must handle concurrent certificate generation (100+ simultaneous).
- Certificate templates must support multiple languages (English/Arabic).
- Plagiarism detection must have <5% false positive rate.
- Automated project evaluation must complete within 5 minutes.
- Manual review (if needed) must complete within 2 business days.

Frequency of Use

- Moderate frequency (20-30% of enrolled learners complete paths).
- Peak certification periods: End of quarter, year-end, academic semesters.
- Average time from path enrollment to certification: 3-6 months.
- Completion rate varies by path difficulty and learner commitment.

Open Issues

- Should certificates expire after a certain period (e.g., 3 years)?
- How do we handle certificate revocation if plagiarism is discovered later?
- Should we offer physical printed certificates for premium users?
- Can certificates be transferable or sold (NFT certificates)?
- How do we price premium certifications vs. free learning paths?
- Should we partner with universities for academic credit recognition?
- What level of manual review is needed vs. automated evaluation?
- How do we keep certification standards consistent as platform scales?

5.4 Sequence Diagram

Sequence diagrams were created only for casual and fully-dressed use cases, as these provide sufficient interaction detail to model system behavior. Brief use cases were excluded since they describe high-level functionality without internal system collaboration.

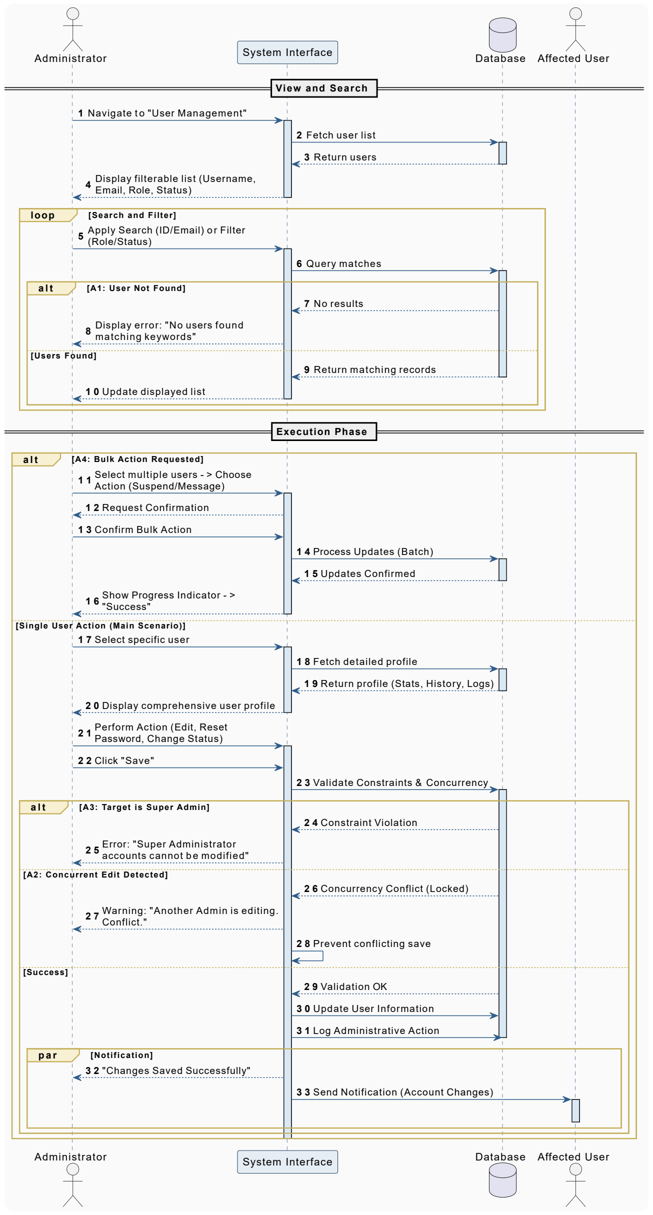
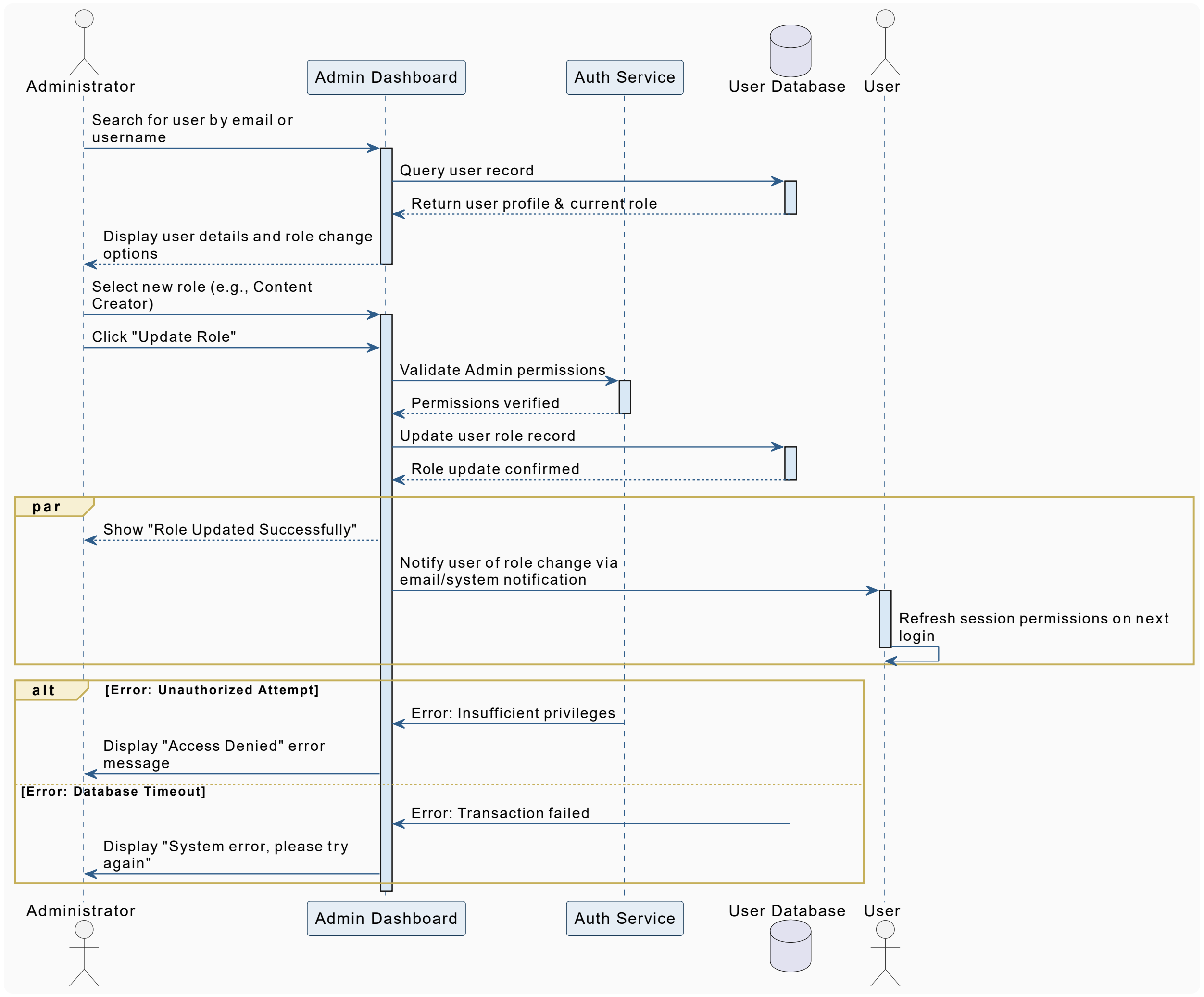

Administrator
System Interface
Database
Affected User
View and Search
1 Navigate to "User Management"
2 Fetch user list
3 Return users
4 Display filterable list (Username, Email, Role, Status)
loop [Search and Filter]
5 Apply Search (ID/Email) or Filter (Role/Status)
6 Query matches
alt [A1: User Not Found]
7 No results
8 Display error: "No users found matching keywords"
[Users Found]
9 Return matching records
10 Update displayed list
Execution Phase
alt [A4: Bulk Action Requested]
11 Select multiple users -> Choose Action (Suspend/Message)
12 Request Confirmation
13 Confirm Bulk Action
14 Process Updates (Batch)
15 Updates Confirmed
16 Show Progress Indicator -> "Success"
[Single User Action (Main Scenario)]
17 Select specific user
18 Fetch detailed profile
19 Return profile (Stats, History, Logs)
20 Display comprehensive user profile
21 Perform Action (Edit, Reset Password, Change Status)
22 Click "Save"
23 Validate Constraints & Concurrency
alt [A3: Target is Super Admin]
24 Constraint Violation
25 Error: "Super Administrator accounts cannot be modified"
[A2: Concurrent Edit Detected]
26 Concurrency Conflict (Locked)
27 Warning: "Another Admin is editing. Conflict."
28 Prevent conflicting save
[Success]
29 Validation OK
30 Update User Information
31 Log Administrative Action
par [Notification]
32 "Changes Saved Successfully"
33 Send Notification (Account Changes)
Administrator
System Interface
Database
Affected User

Figure 5.2: Manage User Accounts



Administrator
Admin Dashboard
Auth Service
User Database
User
Search for user by email or username
Query user record
Return user profile & current role
Display user details and role change options
Select new role (e.g., Content Creator)
Click "Update Role"
Validate Admin permissions
Permissions verified
Update user role record
Role update confirmed
par
Show "Role Updated Successfully"
Notify user of role change via email/system notification
Refresh session permissions on next login
alt
[Error: Unauthorized Attempt]
Error: Insufficient privileges
Display "Access Denied" error message
[Error: Database Timeout]
Error: Transaction failed
Display "System error, please try again"

Figure 5.3: Assign User Role

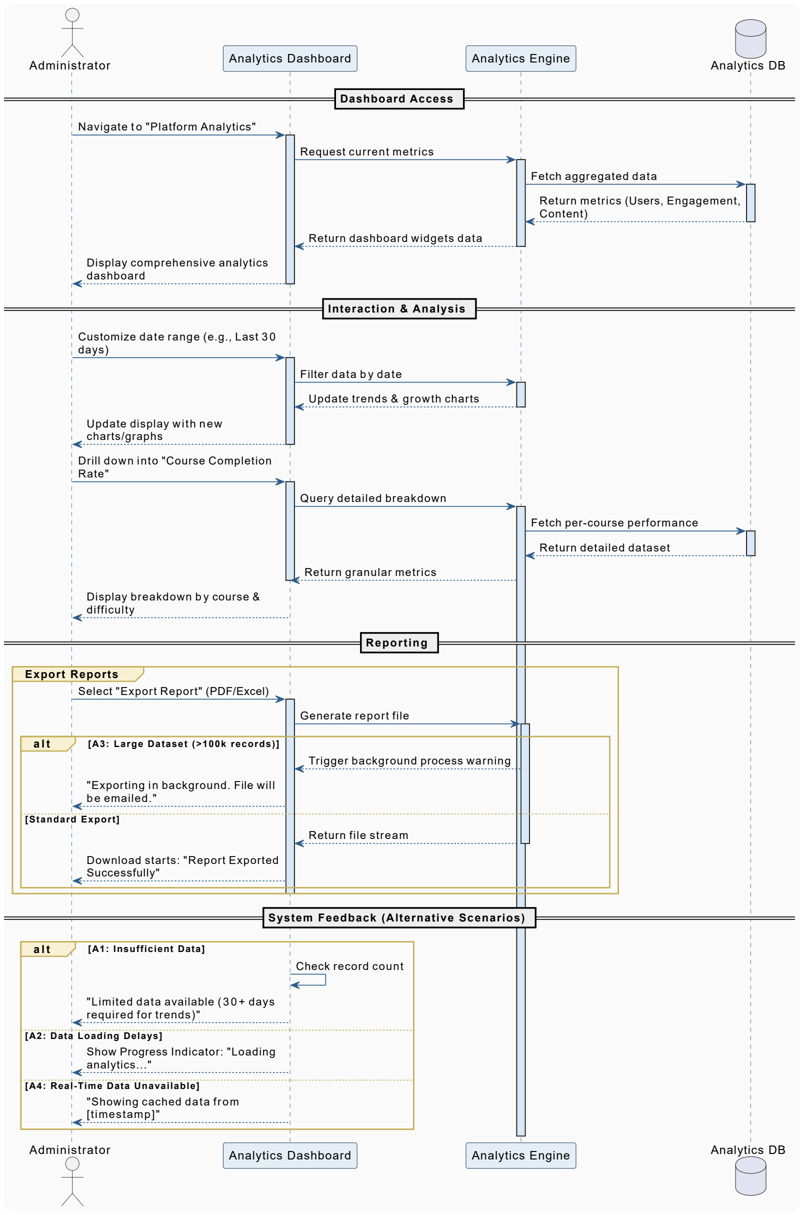

Administrator
Analytics Dashboard
Analytics Engine
Analytics DB
Dashboard Access
Navigate to "Platform Analytics"
Request current metrics
Fetch aggregated data
Return metrics (Users, Engagement, Content)
Return dashboard widgets data
Display comprehensive analytics dashboard
Interaction & Analysis
Customize date range (e.g., Last 30 days)
Filter data by date
Update trends & growth charts
Update display with new charts/graphs
Drill down into "Course Completion Rate"
Query detailed breakdown
Fetch per-course performance
Return detailed dataset
Return granular metrics
Display breakdown by course & difficulty
Reporting
Export Reports
Select "Export Report" (PDF/Excel)
Generate report file
alt
[A3: Large Dataset (>100k records)]
Trigger background process warning
"Exporting in background. File will be emailed."
[Standard Export]
Return file stream
Download starts: "Report Exported Successfully"
System Feedback (Alternative Scenarios)
alt
[A1: Insufficient Data]
Check record count
"Limited data available (30+ days required for trends)"
[A2: Data Loading Delays]
Show Progress Indicator: "Loading analytics..."
[A4: Real-Time Data Unavailable]
"Showing cached data from [timestamp]"
Administrator
Analytics Dashboard
Analytics Engine
Analytics DB

Figure 5.4: Monitor Platform Analytics

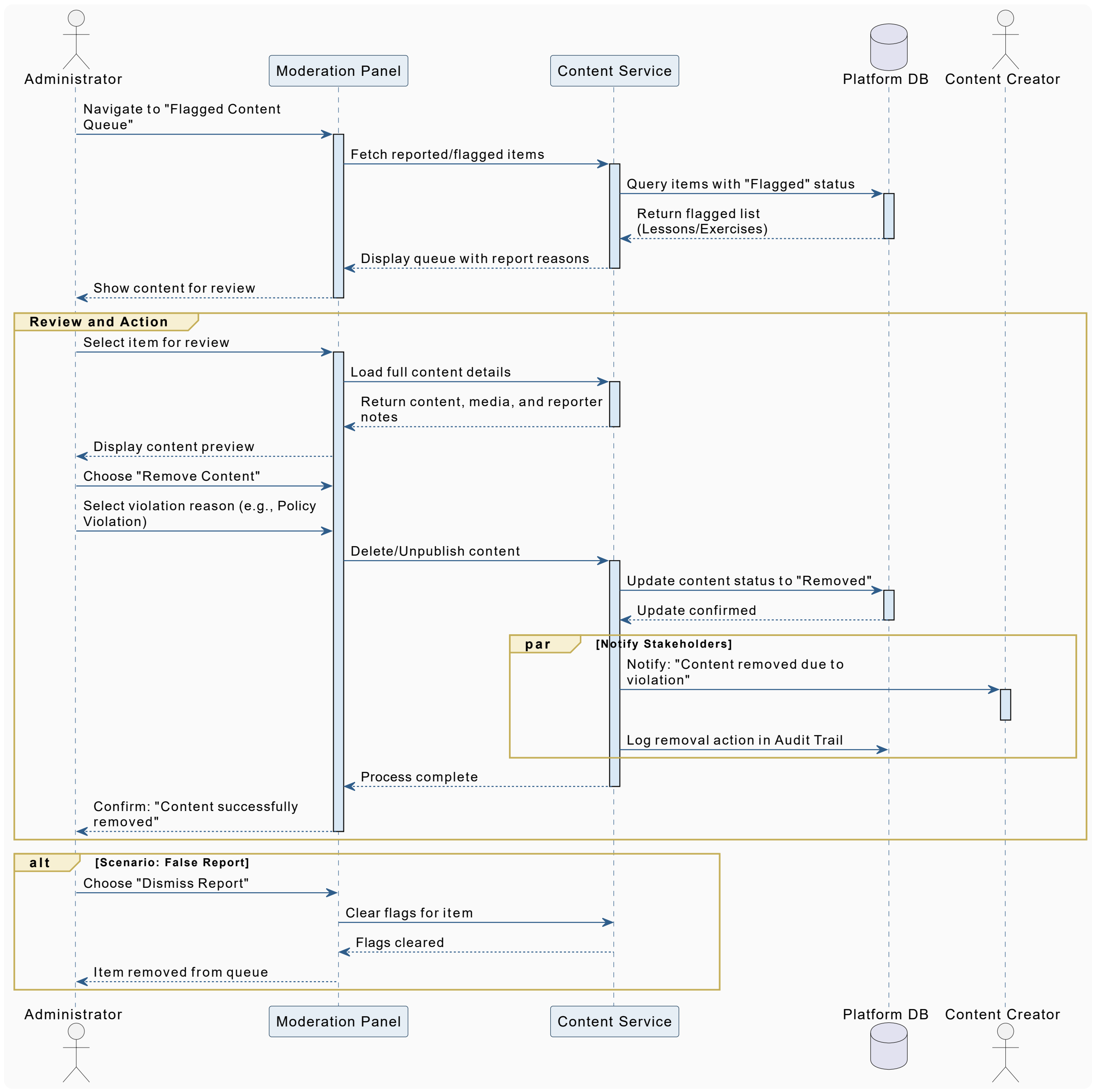

Administrator
Moderation Panel
Content Service
Platform DB
Content Creator
Navigate to "Flagged Content Queue"
Fetch reported/flagged items
Query items with "Flagged" status
Return flagged list (Lessons/Exercises)
Display queue with report reasons
Show content for review
Review and Action
Select item for review
Load full content details
Return content, media, and reporter notes
Display content preview
Choose "Remove Content"
Select violation reason (e.g., Policy Violation)
Delete/Unpublish content
Update content status to "Removed"
Update confirmed
par
[Notify Stakeholders]
Notify: "Content removed due to violation"
Log removal action in Audit Trail
Process complete
Confirm: "Content successfully removed"
alt
[Scenario: False Report]
Choose "Dismiss Report"
Clear flags for item
Flags cleared
Item removed from queue

Figure 5.5: Review And Filter System Logs

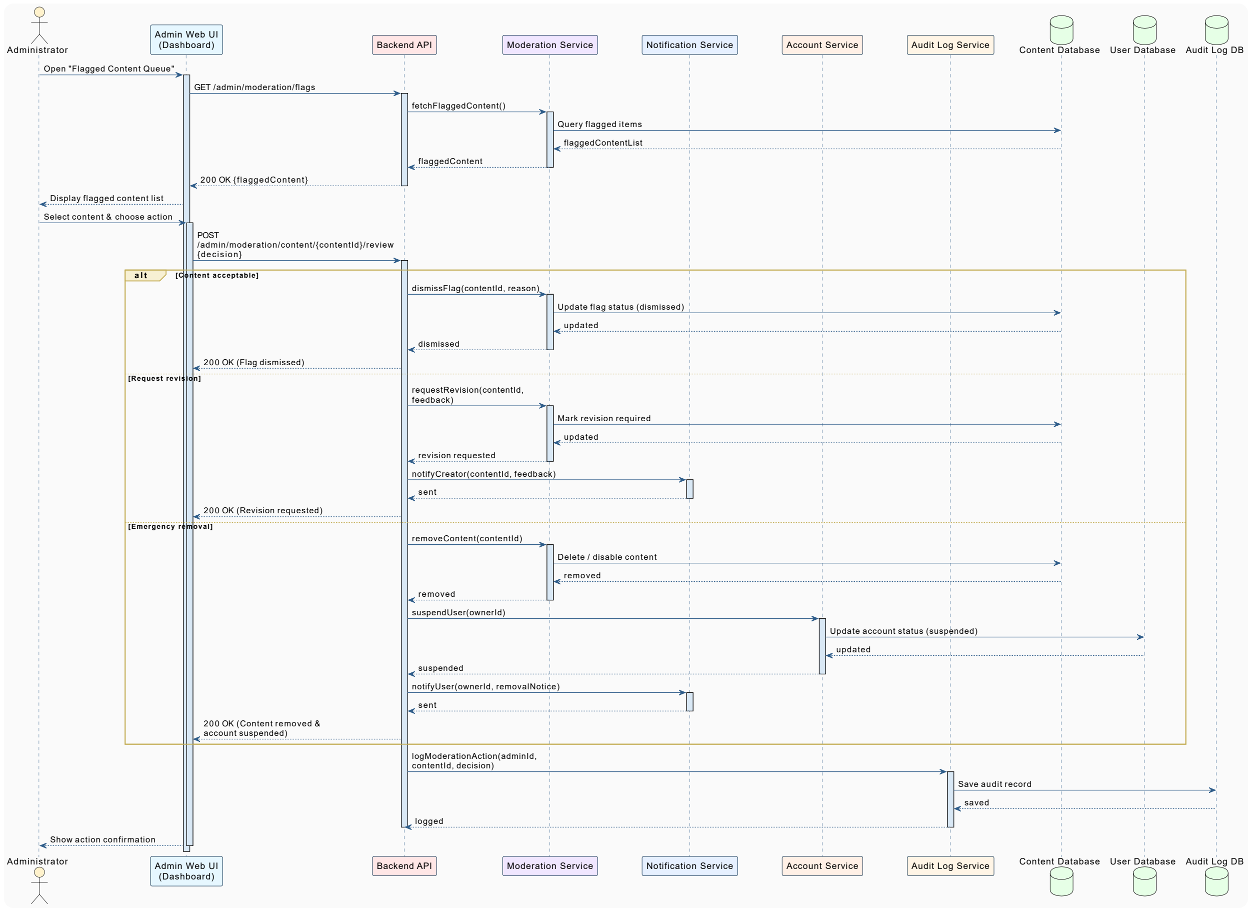
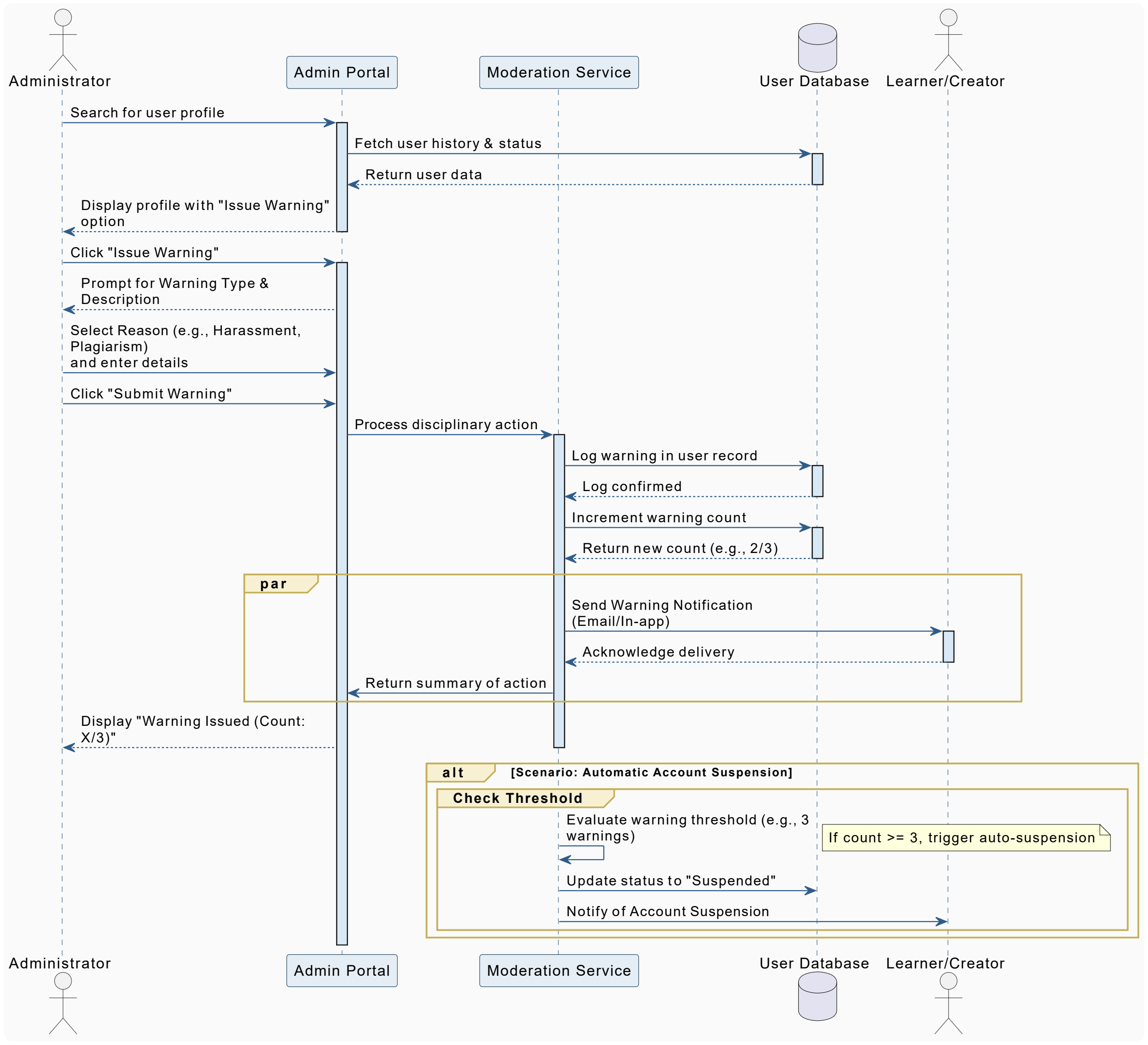


Figure 5.6: Remove Inappropriate Content



Administrator
Admin Portal
Moderation Service
User Database
Learner/Creator
Search for user profile
Fetch user history & status
Return user data
Display profile with "Issue Warning" option
Click "Issue Warning"
Prompt for Warning Type & Description
Select Reason (e.g., Harassment, Plagiarism) and enter details
Click "Submit Warning"
Process disciplinary action
Log warning in user record
Log confirmed
Increment warning count
Return new count (e.g., 2/3)
par
Send Warning Notification (Email/In-app)
Acknowledge delivery
Return summary of action
Display "Warning Issued (Count: X/3)"
alt
[Scenario: Automatic Account Suspension]
Check Threshold
Evaluate warning threshold (e.g., 3 warnings)
If count >= 3, trigger auto-suspension
Update status to "Suspended"
Notify of Account Suspension

Figure 5.7: Issue User Warning

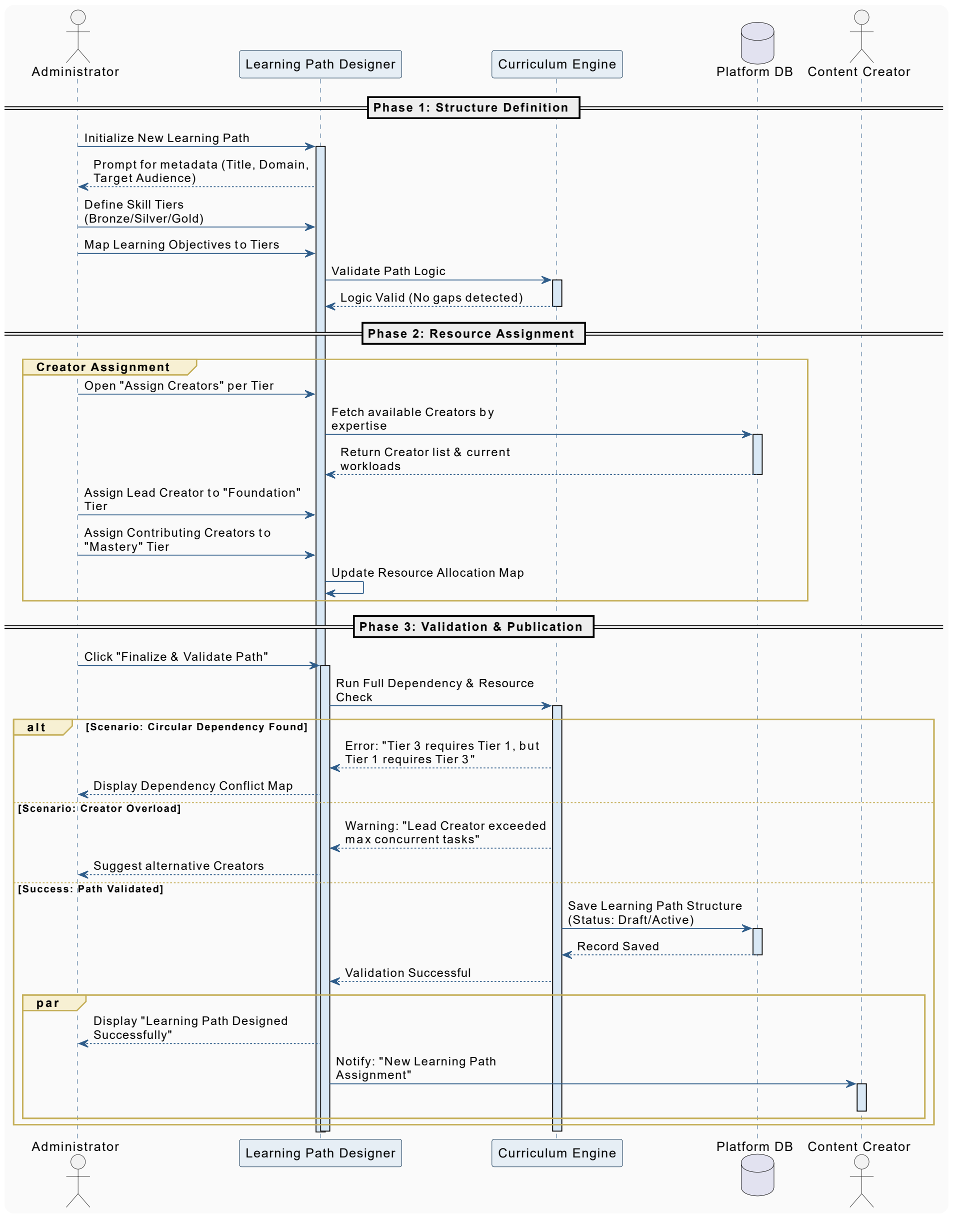

Administrator
Learning Path Designer
Curriculum Engine
Platform DB
Content Creator
Phase 1: Structure Definition
Initialize New Learning Path
Prompt for metadata (Title, Domain, Target Audience)
Define Skill Tiers (Bronze/Silver/Gold)
Map Learning Objectives to Tiers
Validate Path Logic
Logic Valid (No gaps detected)
Phase 2: Resource Assignment
Creator Assignment
Open "Assign Creators" per Tier
Fetch available Creators by expertise
Return Creator list & current workloads
Assign Lead Creator to "Foundation" Tier
Assign Contributing Creators to "Mastery" Tier
Update Resource Allocation Map
Phase 3: Validation & Publication
Click "Finalize & Validate Path"
Run Full Dependency & Resource Check
alt
[Scenario: Circular Dependency Found]
Error: "Tier 3 requires Tier 1, but Tier 1 requires Tier 3"
Display Dependency Conflict Map
[Scenario: Creator Overload]
Warning: "Lead Creator exceeded max concurrent tasks"
Suggest alternative Creators
[Success: Path Validated]
Save Learning Path Structure (Status: Draft/Active)
Record Saved
Validation Successful
par
Display "Learning Path Designed Successfully"
Notify: "New Learning Path Assignment"

Figure 5.8: Design Learning Path

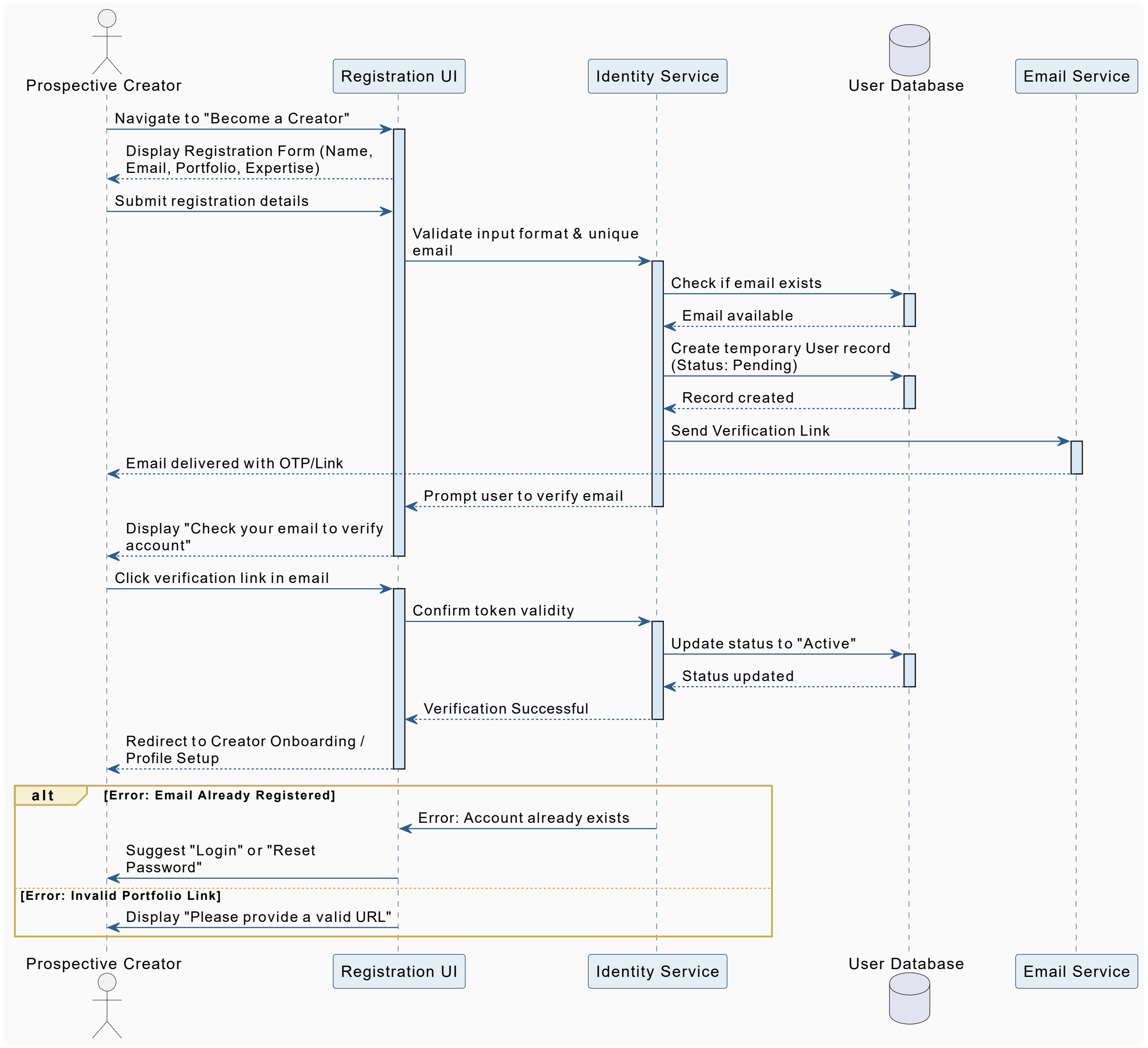

Prospective Creator
Registration UI
Identity Service
User Database
Email Service
Navigate to "Become a Creator"
Display Registration Form (Name, Email, Portfolio, Expertise)
Submit registration details
Validate input format & unique email
Check if email exists
Email available
Create temporary User record (Status: Pending)
Record created
Send Verification Link
Email delivered with OTP/Link
Prompt user to verify email
Display "Check your email to verify account"
Click verification link in email
Confirm token validity
Update status to "Active"
Status updated
Verification Successful
Redirect to Creator Onboarding / Profile Setup
alt
[Error: Email Already Registered]
Error: Account already exists
Suggest "Login" or "Reset Password"
[Error: Invalid Portfolio Link]
Display "Please provide a valid URL"

Figure 5.9: Register Account

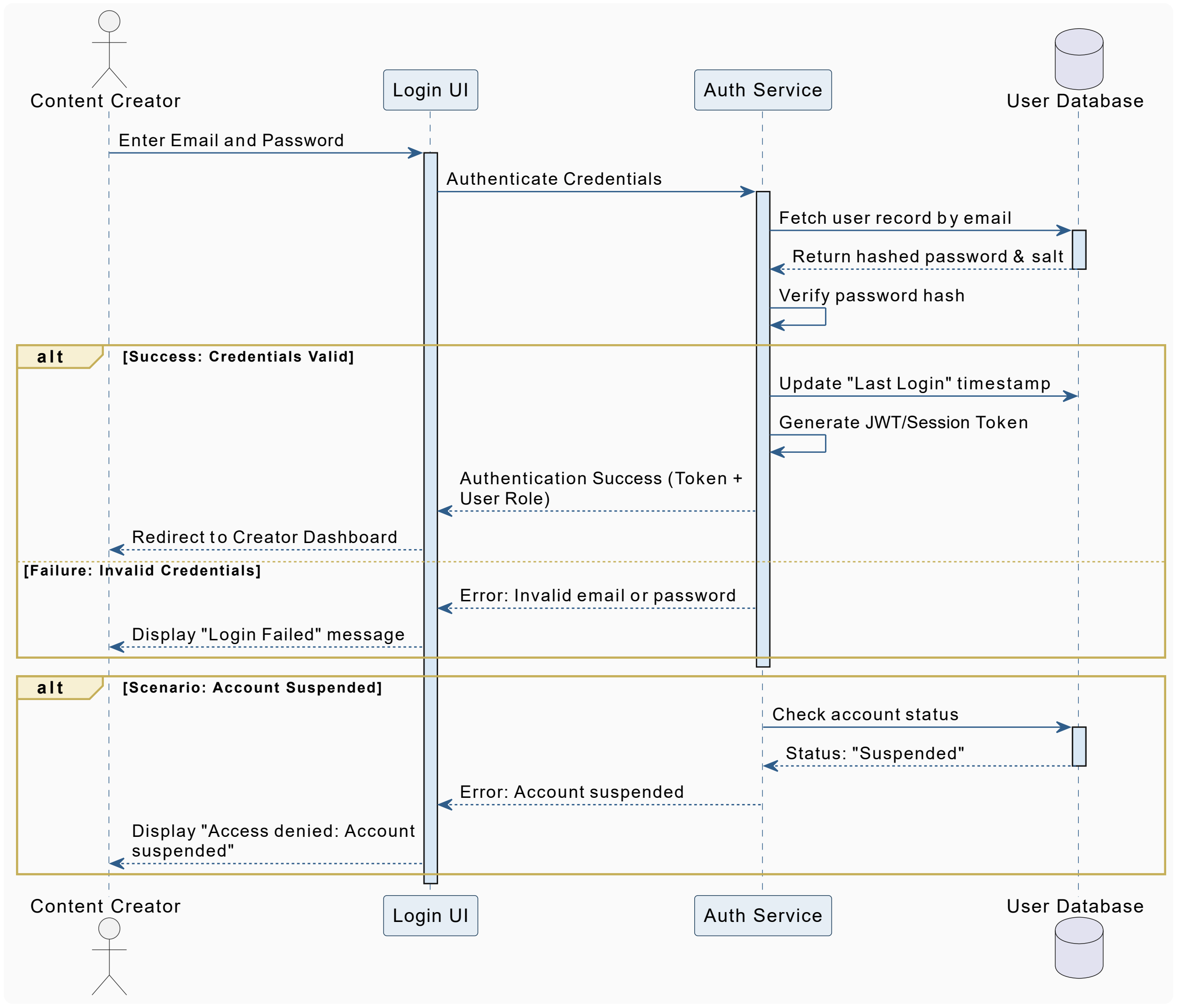

Content Creator
Login UI
Auth Service
User Database
Enter Email and Password
Authenticate Credentials
Fetch user record by email
Return hashed password & salt
Verify password hash
alt
[Success: Credentials Valid]
Update "Last Login" timestamp
Generate JWT/Session Token
Authentication Success (Token + User Role)
Redirect to Creator Dashboard
[Failure: Invalid Credentials]
Error: Invalid email or password
Display "Login Failed" message
alt
[Scenario: Account Suspended]
Check account status
Status: "Suspended"
Error: Account suspended
Display "Access denied: Account suspended"
Content Creator
Login UI
Auth Service
User Database

Figure 5.10: Login to System

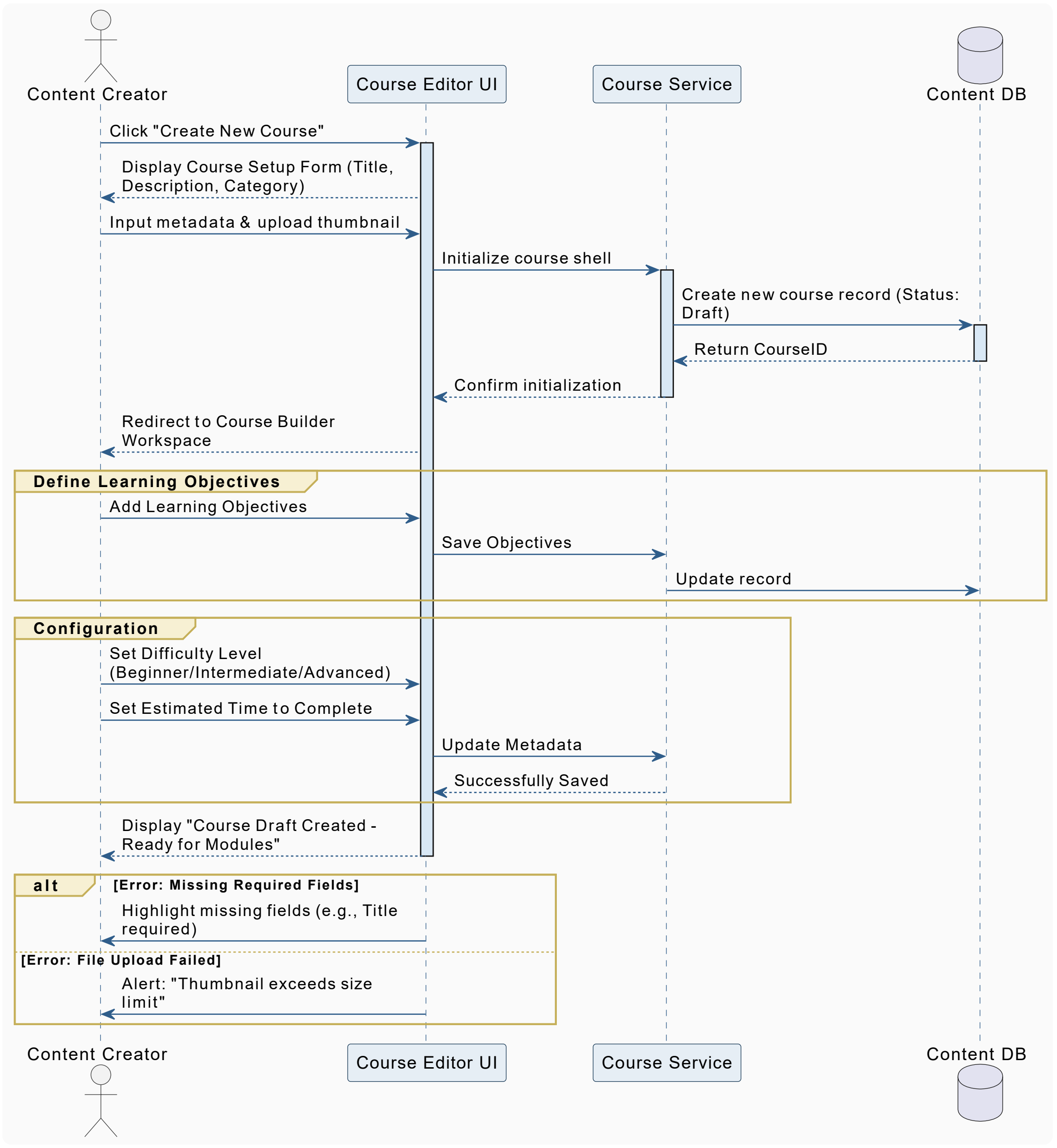

Content Creator
Course Editor UI
Course Service
Content DB
Click "Create New Course"
Display Course Setup Form (Title, Description, Category)
Input metadata & upload thumbnail
Initialize course shell
Create new course record (Status: Draft)
Return CourseID
Confirm initialization
Redirect to Course Builder Workspace
Define Learning Objectives
Add Learning Objectives
Save Objectives
Update record
Configuration
Set Difficulty Level (Beginner/Intermediate/Advanced)
Set Estimated Time to Complete
Update Metadata
Successfully Saved
Display "Course Draft Created - Ready for Modules"
alt
[Error: Missing Required Fields]
Highlight missing fields (e.g., Title required)
[Error: File Upload Failed]
Alert: "Thumbnail exceeds size limit"
Content Creator
Course Editor UI
Course Service
Content DB

Figure 5.11: Create Course

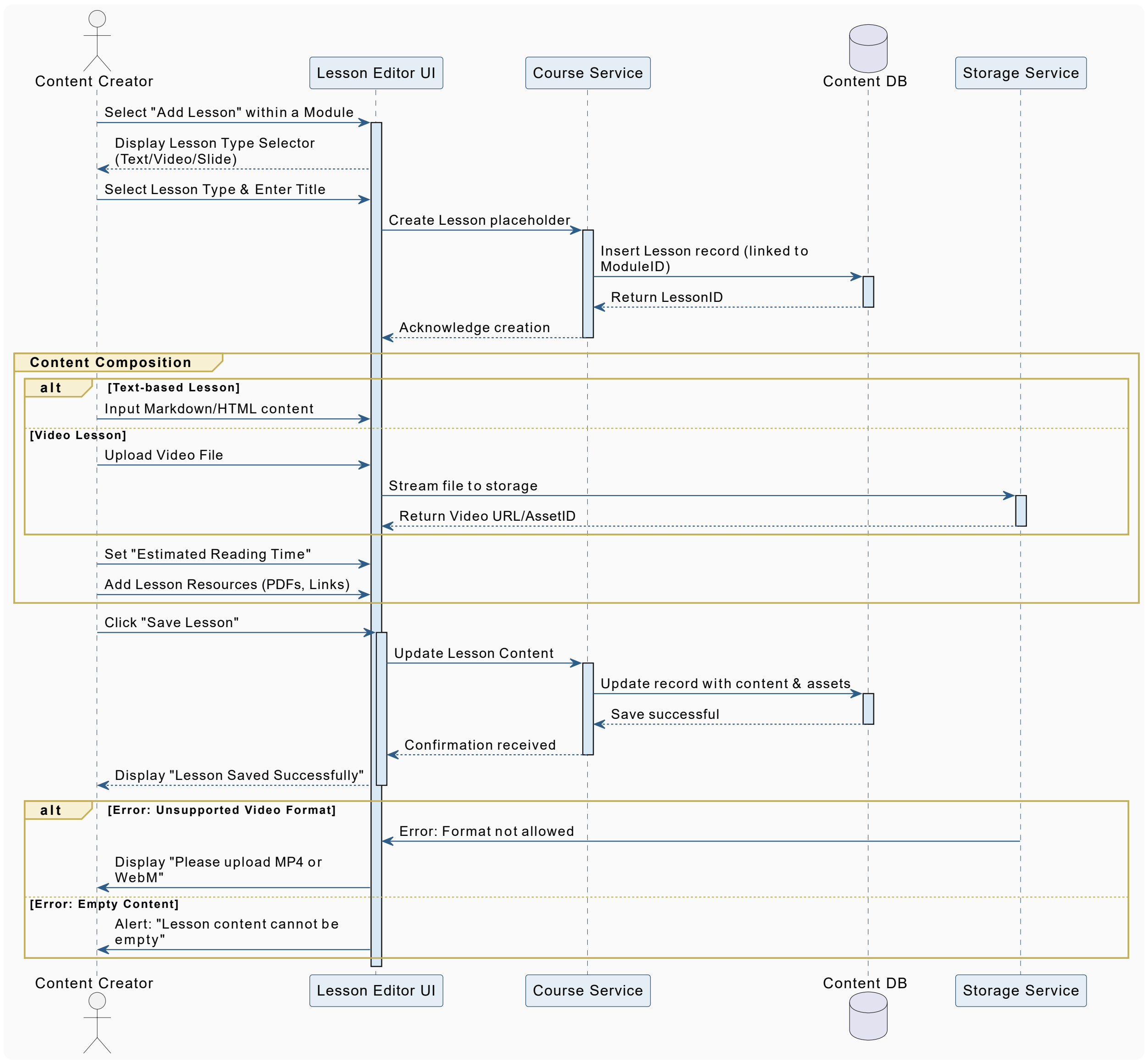
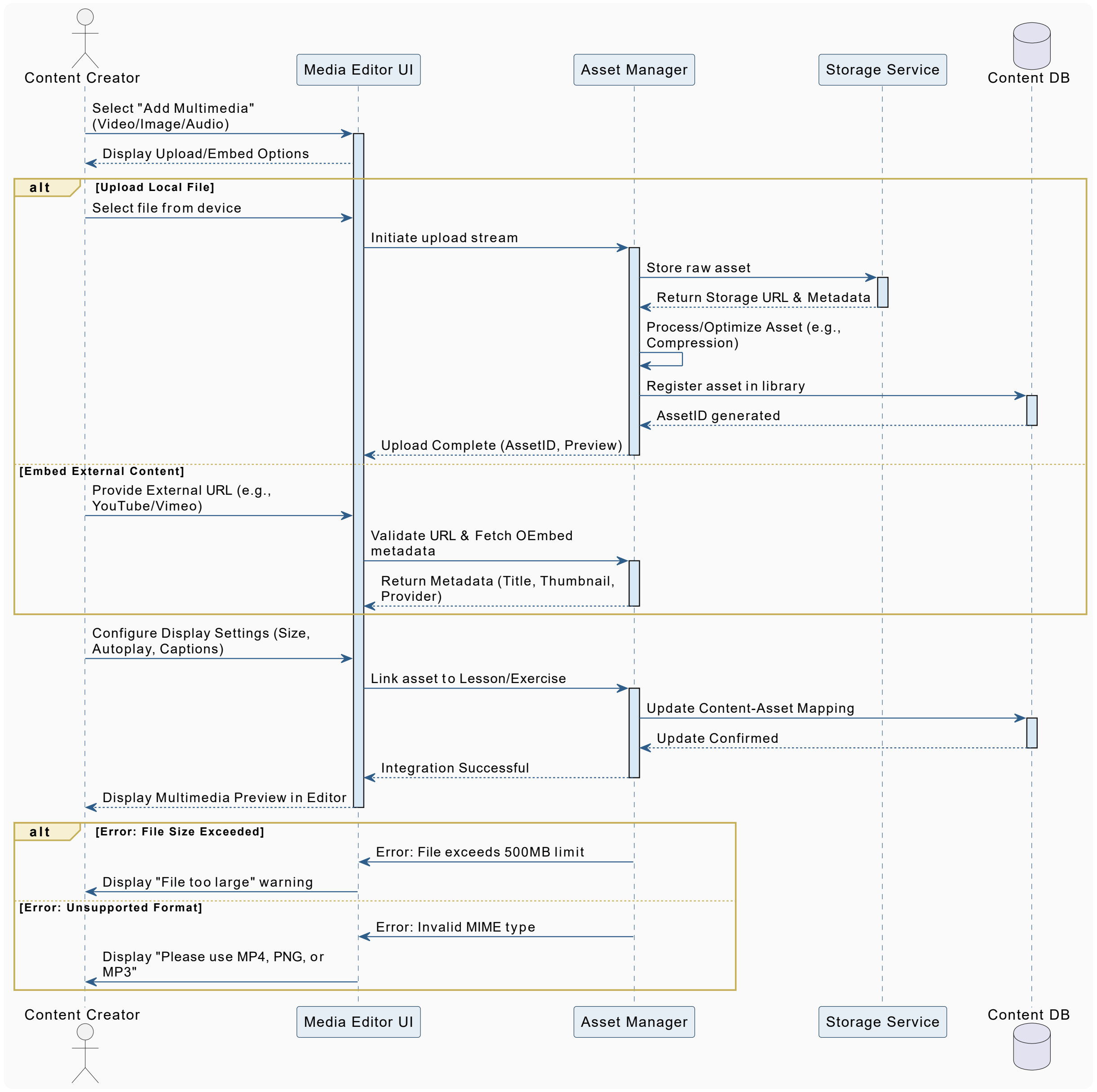

Content Creator
Lesson Editor UI
Course Service
Content DB
Storage Service
Select "Add Lesson" within a Module
Display Lesson Type Selector (Text/Video/Slide)
Select Lesson Type & Enter Title
Create Lesson placeholder
Insert Lesson record (linked to ModuleID)
Return LessonID
Acknowledge creation
Content Composition
alt
[Text-based Lesson]
Input Markdown/HTML content
[Video Lesson]
Upload Video File
Stream file to storage
Return Video URL/AssetID
Set "Estimated Reading Time"
Add Lesson Resources (PDFs, Links)
Click "Save Lesson"
Update Lesson Content
Update record with content & assets
Save successful
Confirmation received
Display "Lesson Saved Successfully"
alt
[Error: Unsupported Video Format]
Error: Format not allowed
Display "Please upload MP4 or WebM"
[Error: Empty Content]
Alert: "Lesson content cannot be empty"
Content Creator
Lesson Editor UI
Course Service
Content DB
Storage Service

Figure 5.12: Create Lesson



Content Creator
Media Editor UI
Asset Manager
Storage Service
Content DB
Select "Add Multimedia" (Video/Image/Audio)
Display Upload/Embed Options
alt [Upload Local File]
Select file from device
Initiate upload stream
Store raw asset
Return Storage URL & Metadata
Process/Optimize Asset (e.g., Compression)
Register asset in library
AssetID generated
Upload Complete (AssetID, Preview)
[Embed External Content]
Provide External URL (e.g., YouTube/Vimeo)
Validate URL & Fetch OEmbed metadata
Return Metadata (Title, Thumbnail, Provider)
Configure Display Settings (Size, Autoplay, Captions)
Link asset to Lesson/Exercise
Update Content-Asset Mapping
Update Confirmed
Integration Successful
Display Multimedia Preview in Editor
alt [Error: File Size Exceeded]
Error: File exceeds 500MB limit
Display "File too large" warning
[Error: Unsupported Format]
Error: Invalid MIME type
Display "Please use MP4, PNG, or MP3"

Figure 5.13: Add Multimedia Content

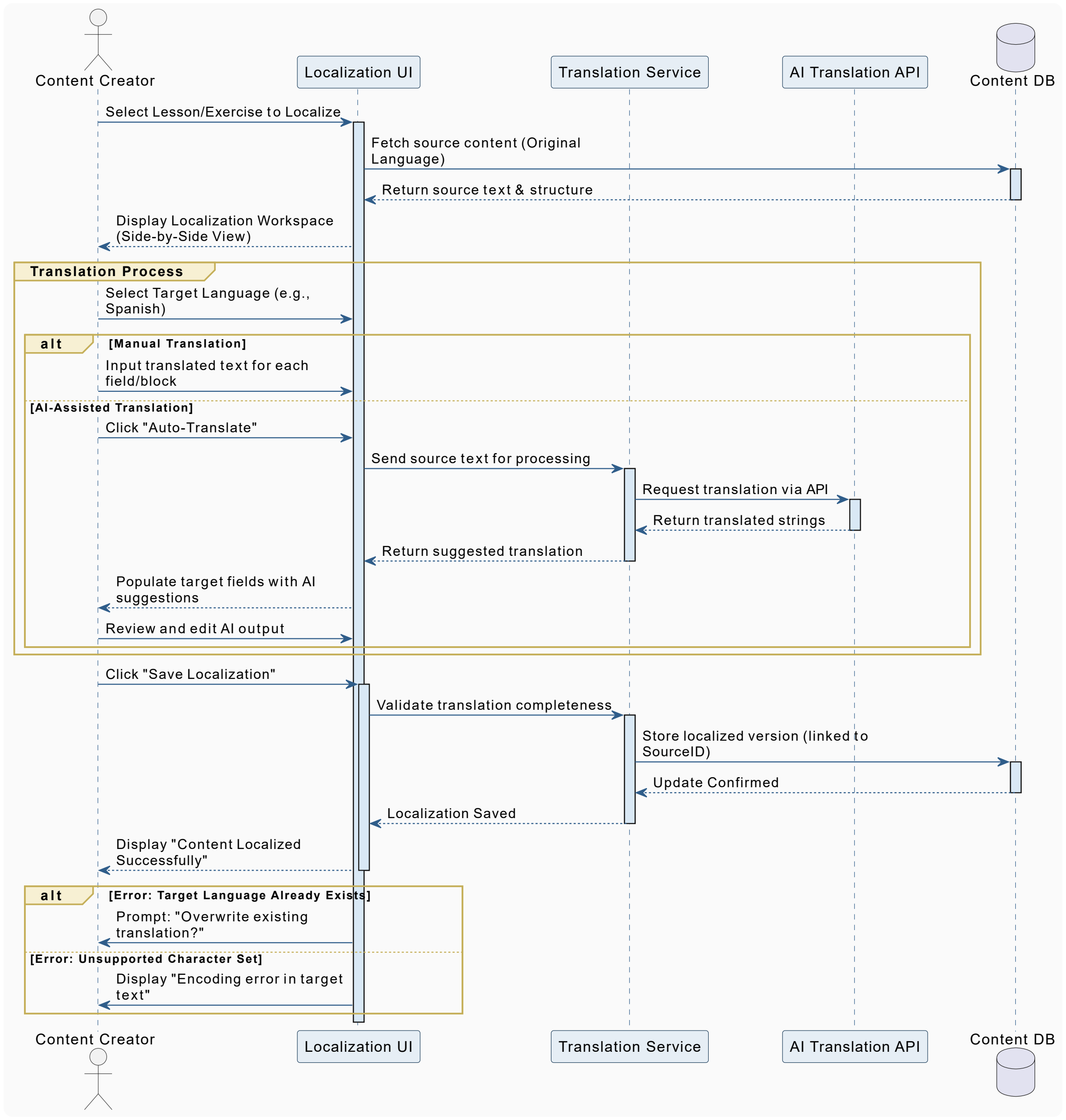
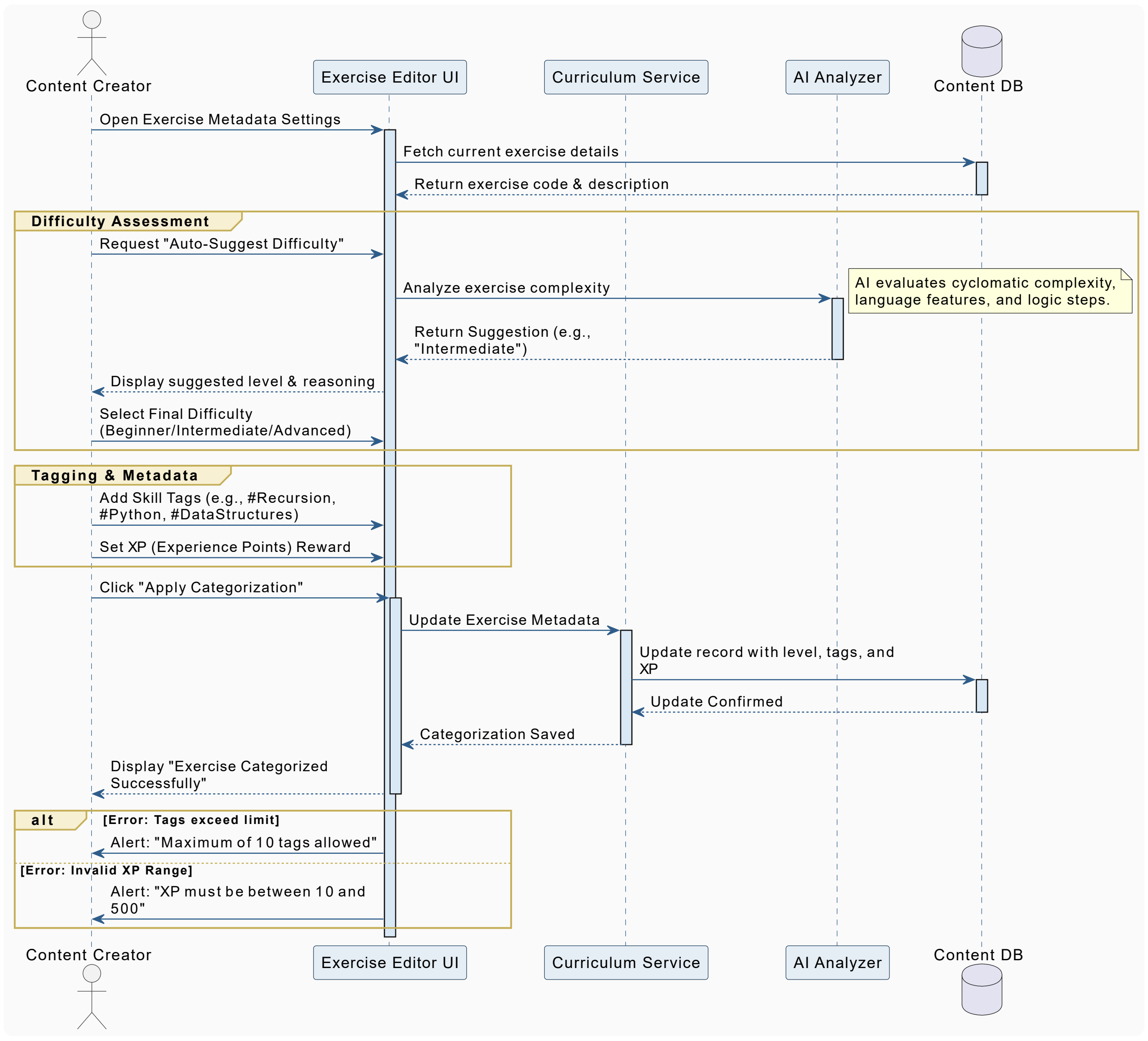

Content Creator
Localization UI
Translation Service
AI Translation API
Content DB
Select Lesson/Exercise to Localize
Fetch source content (Original Language)
Return source text & structure
Display Localization Workspace (Side-by-Side View)
Translation Process
Select Target Language (e.g., Spanish)
alt
[Manual Translation]
Input translated text for each field/block
[AI-Assisted Translation]
Click "Auto-Translate"
Send source text for processing
Request translation via API
Return translated strings
Return suggested translation
Populate target fields with AI suggestions
Review and edit AI output
Click "Save Localization"
Validate translation completeness
Store localized version (linked to SourceID)
Update Confirmed
Localization Saved
Display "Content Localized Successfully"
alt
[Error: Target Language Already Exists]
Prompt: "Overwrite existing translation?"
[Error: Unsupported Character Set]
Display "Encoding error in target text"
Content Creator
Localization UI
Translation Service
AI Translation API
Content DB

Figure 5.14: Localize Content



Content Creator
Exercise Editor UI
Curriculum Service
AI Analyzer
Content DB
Open Exercise Metadata Settings
Fetch current exercise details
Return exercise code & description
Difficulty Assessment
Request "Auto-Suggest Difficulty"
Analyze exercise complexity
AI evaluates cyclomatic complexity, language features, and logic steps.
Return Suggestion (e.g., "Intermediate")
Display suggested level & reasoning
Select Final Difficulty (Beginner/Intermediate/Advanced)
Tagging & Metadata
Add Skill Tags (e.g., #Recursion, #Python, #DataStructures)
Set XP (Experience Points) Reward
Click "Apply Categorization"
Update Exercise Metadata
Update record with level, tags, and XP
Update Confirmed
Categorization Saved
Display "Exercise Categorized Successfully"
alt
[Error: Tags exceed limit]
Alert: "Maximum of 10 tags allowed"
[Error: Invalid XP Range]
Alert: "XP must be between 10 and 500"

Figure 5.15: Categorize Exercise Difficulty

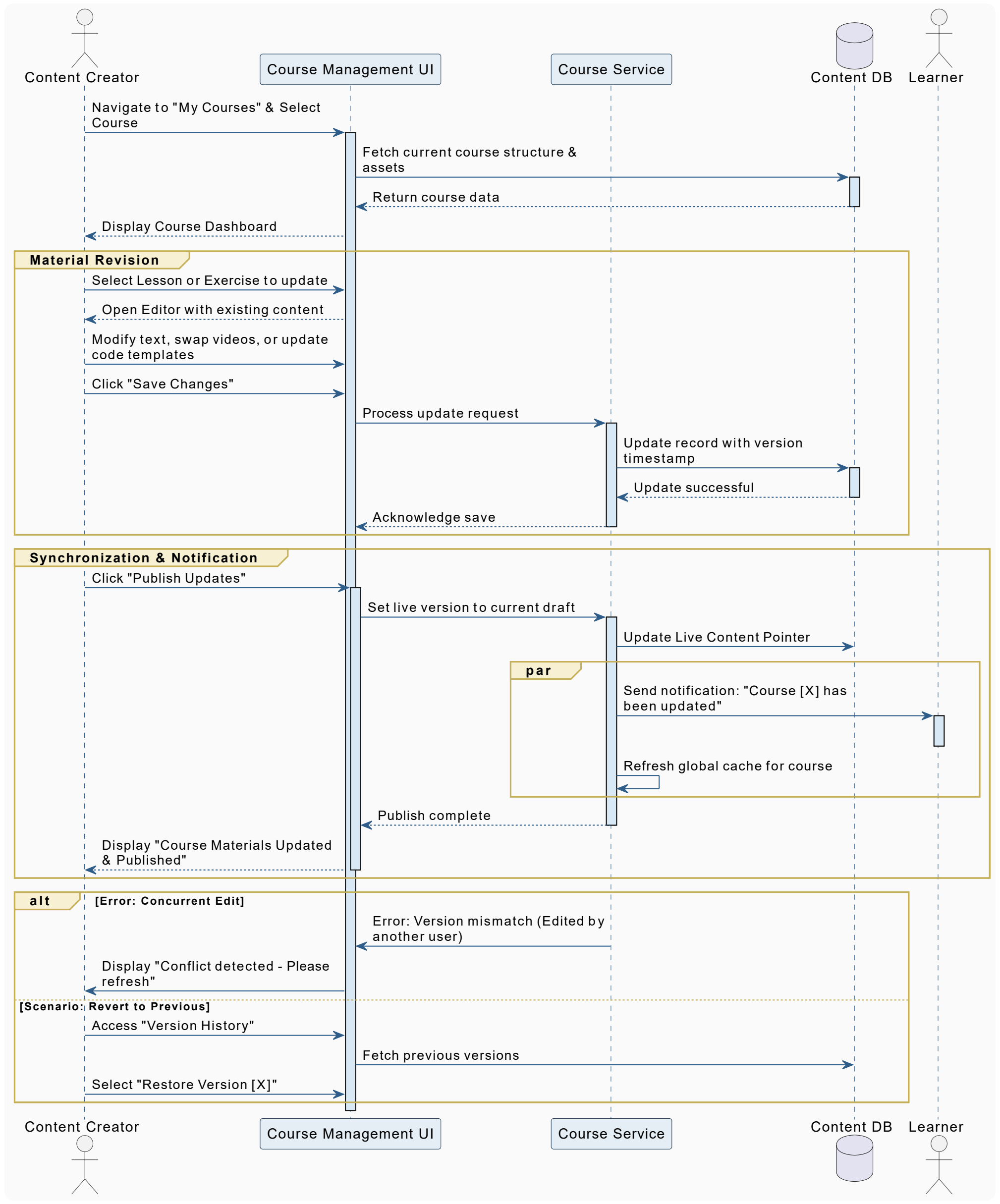
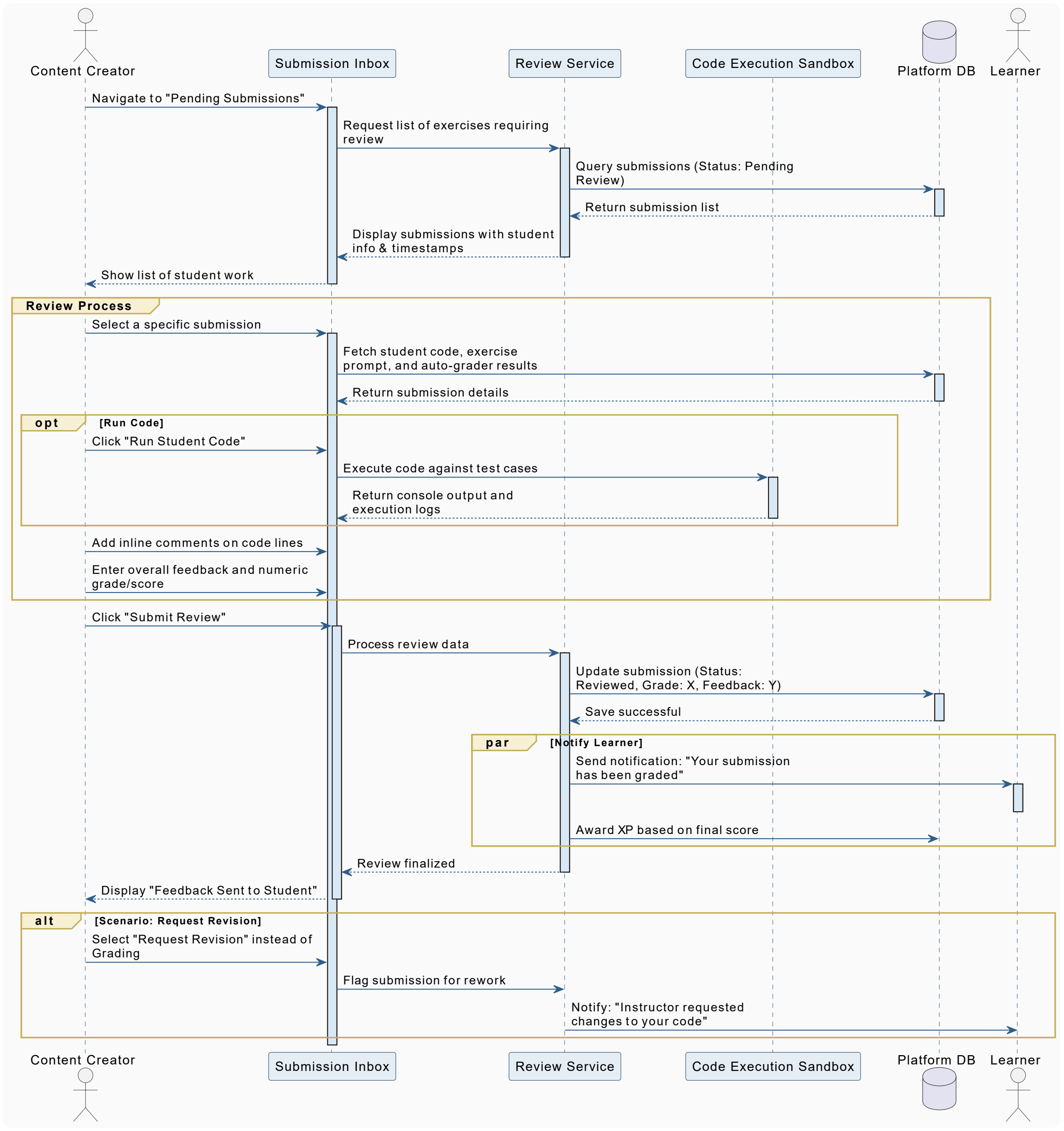

Content Creator
Course Management UI
Course Service
Content DB
Learner
Navigate to "My Courses" & Select Course
Fetch current course structure & assets
Return course data
Display Course Dashboard
Material Revision
Select Lesson or Exercise to update
Open Editor with existing content
Modify text, swap videos, or update code templates
Click "Save Changes"
Process update request
Update record with version timestamp
Update successful
Acknowledge save
Synchronization & Notification
Click "Publish Updates"
Set live version to current draft
Update Live Content Pointer
par
Send notification: "Course [X] has been updated"
Refresh global cache for course
Publish complete
Display "Course Materials Updated & Published"
alt
[Error: Concurrent Edit]
Error: Version mismatch (Edited by another user)
Display "Conflict detected - Please refresh"
[Scenario: Revert to Previous]
Access "Version History"
Fetch previous versions
Select "Restore Version [X]"
Content Creator
Course Management UI
Course Service
Content DB
Learner

Figure 5.16: Udate Course Materials



Content Creator
Submission Inbox
Review Service
Code Execution Sandbox
Platform DB
Learner
Navigate to "Pending Submissions"
Request list of exercises requiring review
Query submissions (Status: Pending Review)
Return submission list
Display submissions with student info & timestamps
Show list of student work
Review Process
Select a specific submission
Fetch student code, exercise prompt, and auto-grader results
Return submission details
opt [Run Code]
Click "Run Student Code"
Execute code against test cases
Return console output and execution logs
Add inline comments on code lines
Enter overall feedback and numeric grade/score
Click "Submit Review"
Process review data
Update submission (Status: Reviewed, Grade: X, Feedback: Y)
Save successful
par [Notify Learner]
Send notification: "Your submission has been graded"
Award XP based on final score
Review finalized
Display "Feedback Sent to Student"
alt [Scenario: Request Revision]
Select "Request Revision" instead of Grading
Flag submission for rework
Notify: "Instructor requested changes to your code"
Content Creator
Submission Inbox
Review Service
Code Execution Sandbox
Platform DB
Learner

Figure 5.17: Review Student Submissions

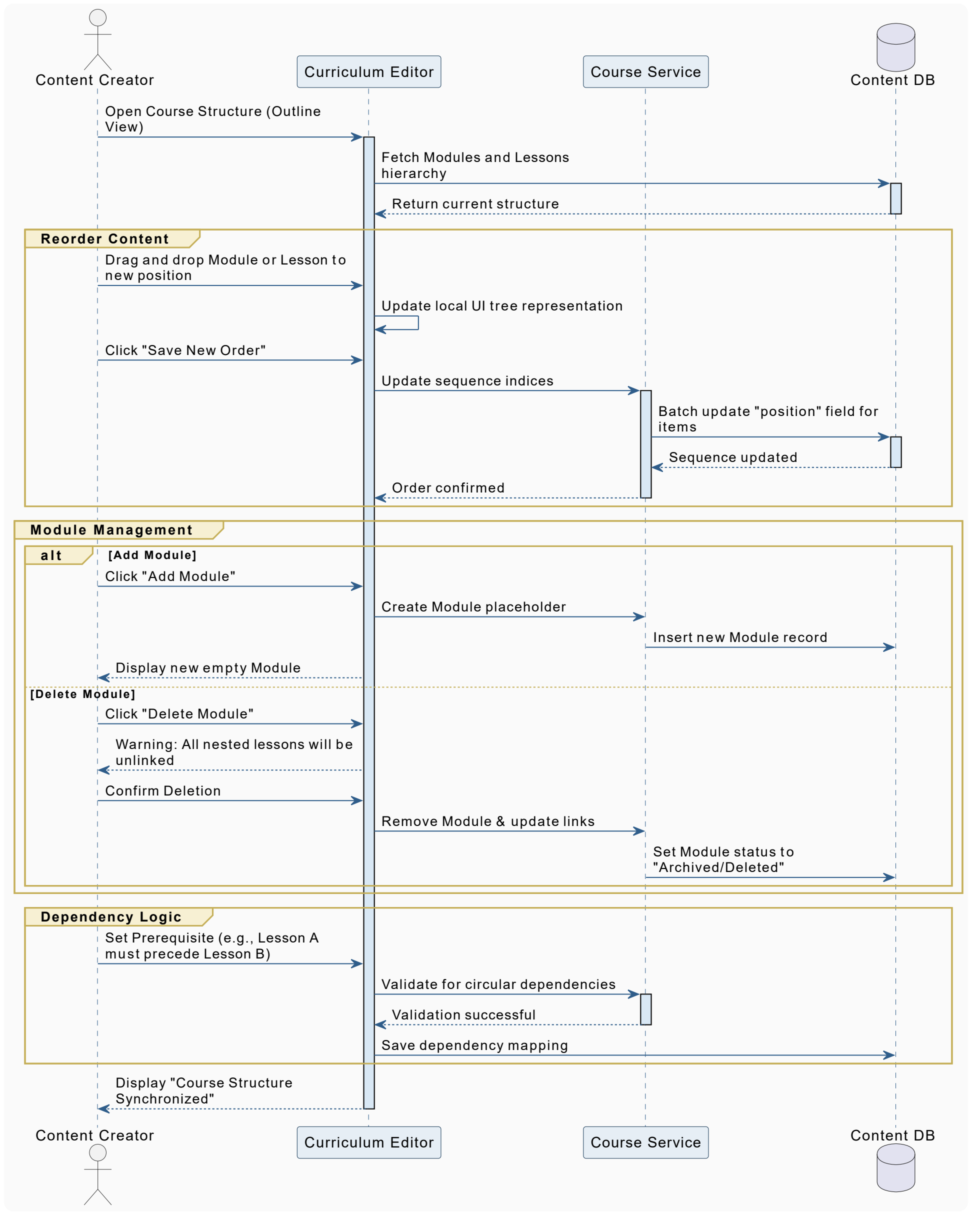

Content Creator
Curriculum Editor
Course Service
Content DB
Open Course Structure (Outline View)
Fetch Modules and Lessons hierarchy
Return current structure
Reorder Content
Drag and drop Module or Lesson to new position
Update local UI tree representation
Click "Save New Order"
Update sequence indices
Batch update "position" field for items
Sequence updated
Order confirmed
Module Management
alt
[Add Module]
Click "Add Module"
Create Module placeholder
Insert new Module record
Display new empty Module
[Delete Module]
Click "Delete Module"
Warning: All nested lessons will be unlinked
Confirm Deletion
Remove Module & update links
Set Module status to "Archived/Deleted"
Dependency Logic
Set Prerequisite (e.g., Lesson A must precede Lesson B)
Validate for circular dependencies
Validation successful
Save dependency mapping
Display "Course Structure Synchronized"
Content Creator
Curriculum Editor
Course Service
Content DB

Figure 5.18: Manage Course Structure

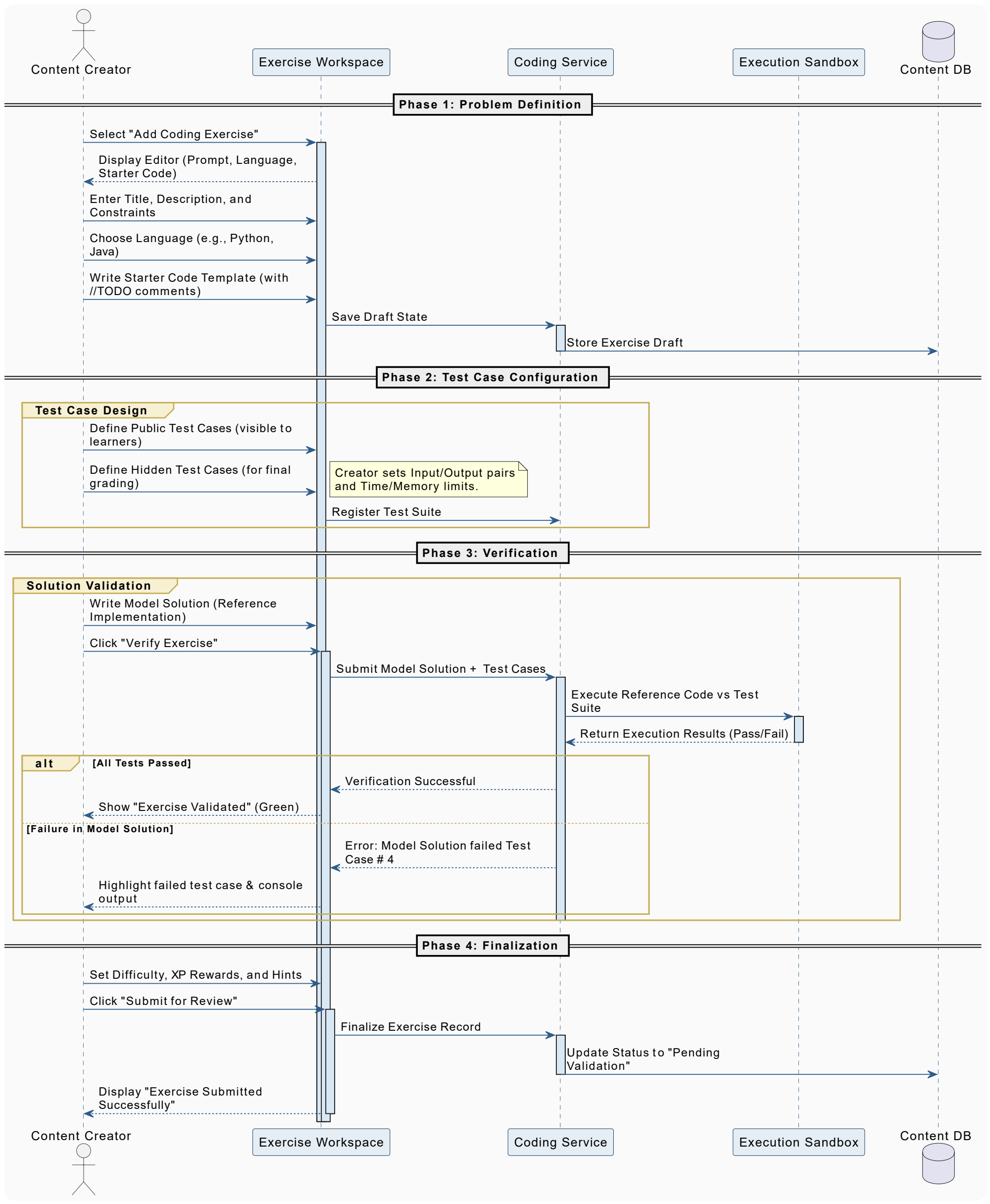

Content Creator
Exercise Workspace
Coding Service
Execution Sandbox
Content DB
Phase 1: Problem Definition
Select "Add Coding Exercise"
Display Editor (Prompt, Language, Starter Code)
Enter Title, Description, and Constraints
Choose Language (e.g., Python, Java)
Write Starter Code Template (with //TODO comments)
Save Draft State
Store Exercise Draft
Phase 2: Test Case Configuration
Test Case Design
Define Public Test Cases (visible to learners)
Define Hidden Test Cases (for final grading)
Creator sets Input/Output pairs and Time/Memory limits.
Register Test Suite
Phase 3: Verification
Solution Validation
Write Model Solution (Reference Implementation)
Click "Verify Exercise"
Submit Model Solution + Test Cases
Execute Reference Code vs Test Suite
Return Execution Results (Pass/Fail)
alt
[All Tests Passed]
Verification Successful
Show "Exercise Validated" (Green)
[Failure in Model Solution]
Error: Model Solution failed Test Case # 4
Highlight failed test case & console output
Phase 4: Finalization
Set Difficulty, XP Rewards, and Hints
Click "Submit for Review"
Finalize Exercise Record
Update Status to "Pending Validation"
Display "Exercise Submitted Successfully"
Content Creator
Exercise Workspace
Coding Service
Execution Sandbox
Content DB

Figure 5.19: Create Coding Exercise

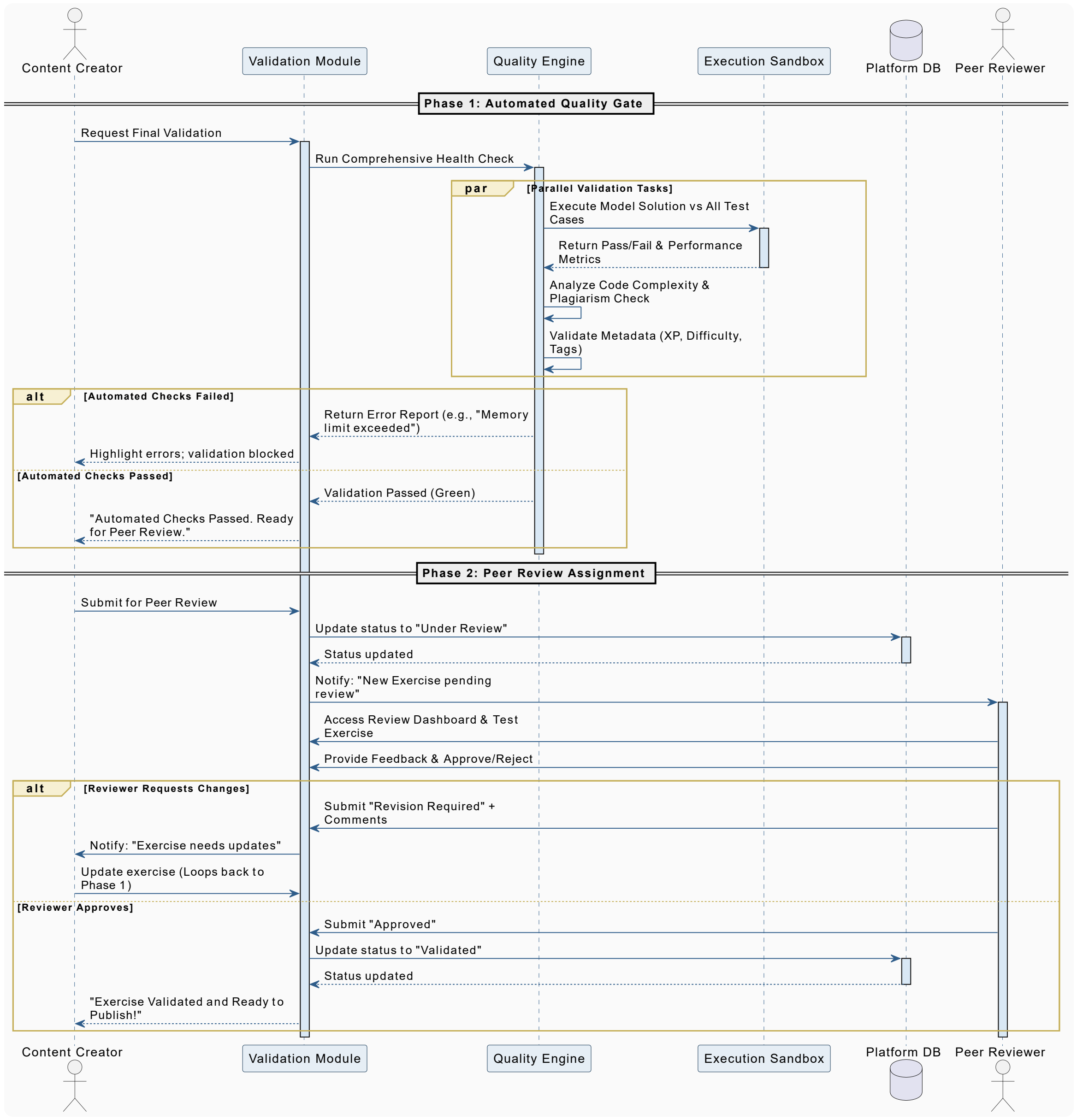

Content Creator
Validation Module
Quality Engine
Execution Sandbox
Platform DB
Peer Reviewer
Phase 1: Automated Quality Gate
Request Final Validation
Run Comprehensive Health Check
par [Parallel Validation Tasks]
Execute Model Solution vs All Test Cases
Return Pass/Fail & Performance Metrics
Analyze Code Complexity & Plagiarism Check
Validate Metadata (XP, Difficulty, Tags)
alt [Automated Checks Failed]
Return Error Report (e.g., "Memory limit exceeded")
Highlight errors; validation blocked
[Automated Checks Passed]
Validation Passed (Green)
"Automated Checks Passed. Ready for Peer Review."
Phase 2: Peer Review Assignment
Submit for Peer Review
Update status to "Under Review"
Status updated
Notify: "New Exercise pending review"
Access Review Dashboard & Test Exercise
Provide Feedback & Approve/Reject
alt [Reviewer Requests Changes]
Submit "Revision Required" + Comments
Notify: "Exercise needs updates"
Update exercise (Loops back to Phase 1)
[Reviewer Approves]
Submit "Approved"
Update status to "Validated"
Status updated
"Exercise Validated and Ready to Publish!"

Figure 5.20: Validate Exercise before Publishing

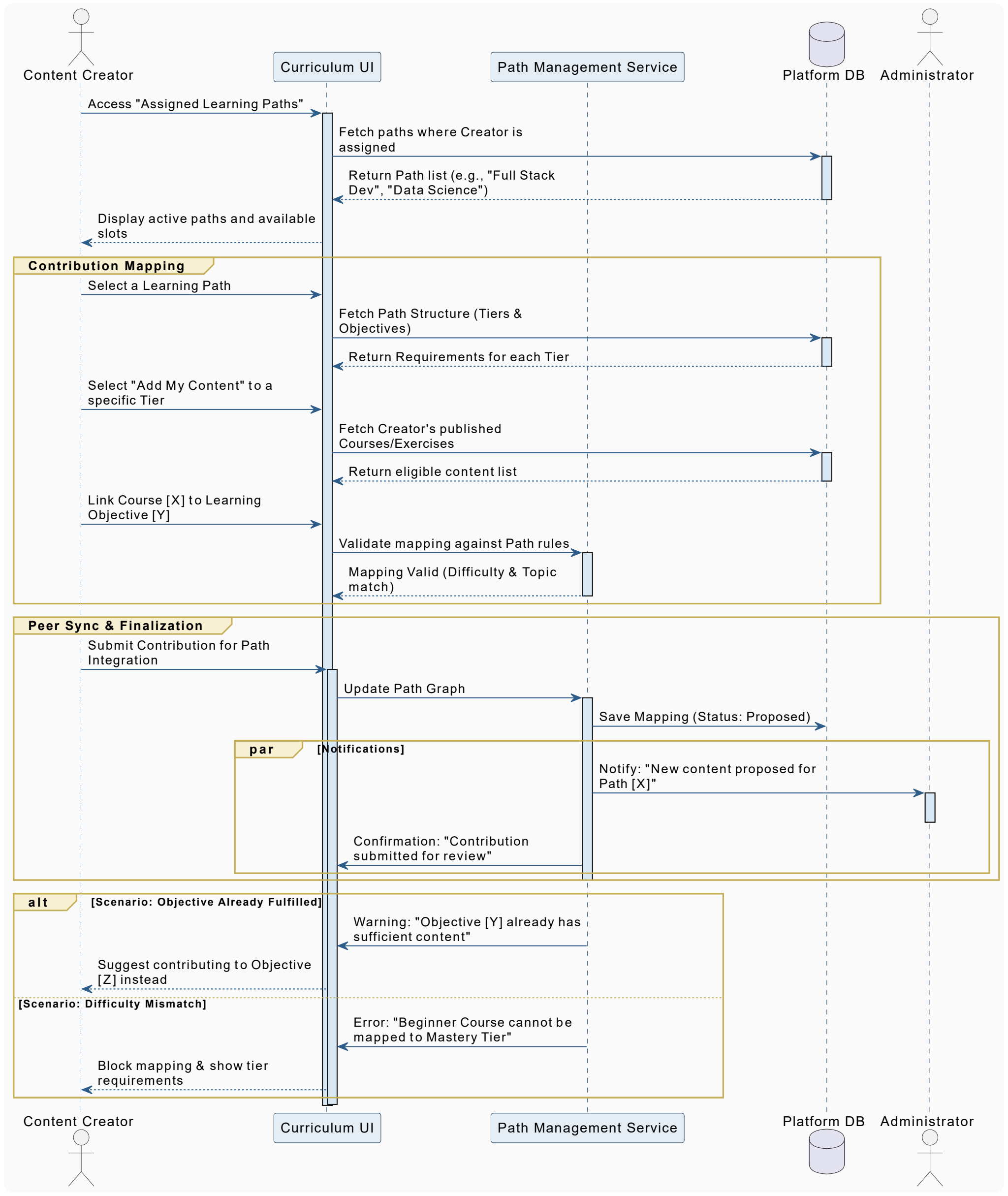

Content Creator
Curriculum UI
Path Management Service
Platform DB
Administrator
Access "Assigned Learning Paths"
Fetch paths where Creator is assigned
Return Path list (e.g., "Full Stack Dev", "Data Science")
Display active paths and available slots
Contribution Mapping
Select a Learning Path
Fetch Path Structure (Tiers & Objectives)
Return Requirements for each Tier
Select "Add My Content" to a specific Tier
Fetch Creator's published Courses/Exercises
Return eligible content list
Link Course [X] to Learning Objective [Y]
Validate mapping against Path rules
Mapping Valid (Difficulty & Topic match)
Peer Sync & Finalization
Submit Contribution for Path Integration
Update Path Graph
Save Mapping (Status: Proposed)
par [Notifications]
Notify: "New content proposed for Path [X]"
Confirmation: "Contribution submitted for review"
alt [Scenario: Objective Already Fulfilled]
Warning: "Objective [Y] already has sufficient content"
Suggest contributing to Objective [Z] instead
[Scenario: Difficulty Mismatch]
Error: "Beginner Course cannot be mapped to Mastery Tier"
Block mapping & show tier requirements

Figure 5.21: Contribute to Learning Path

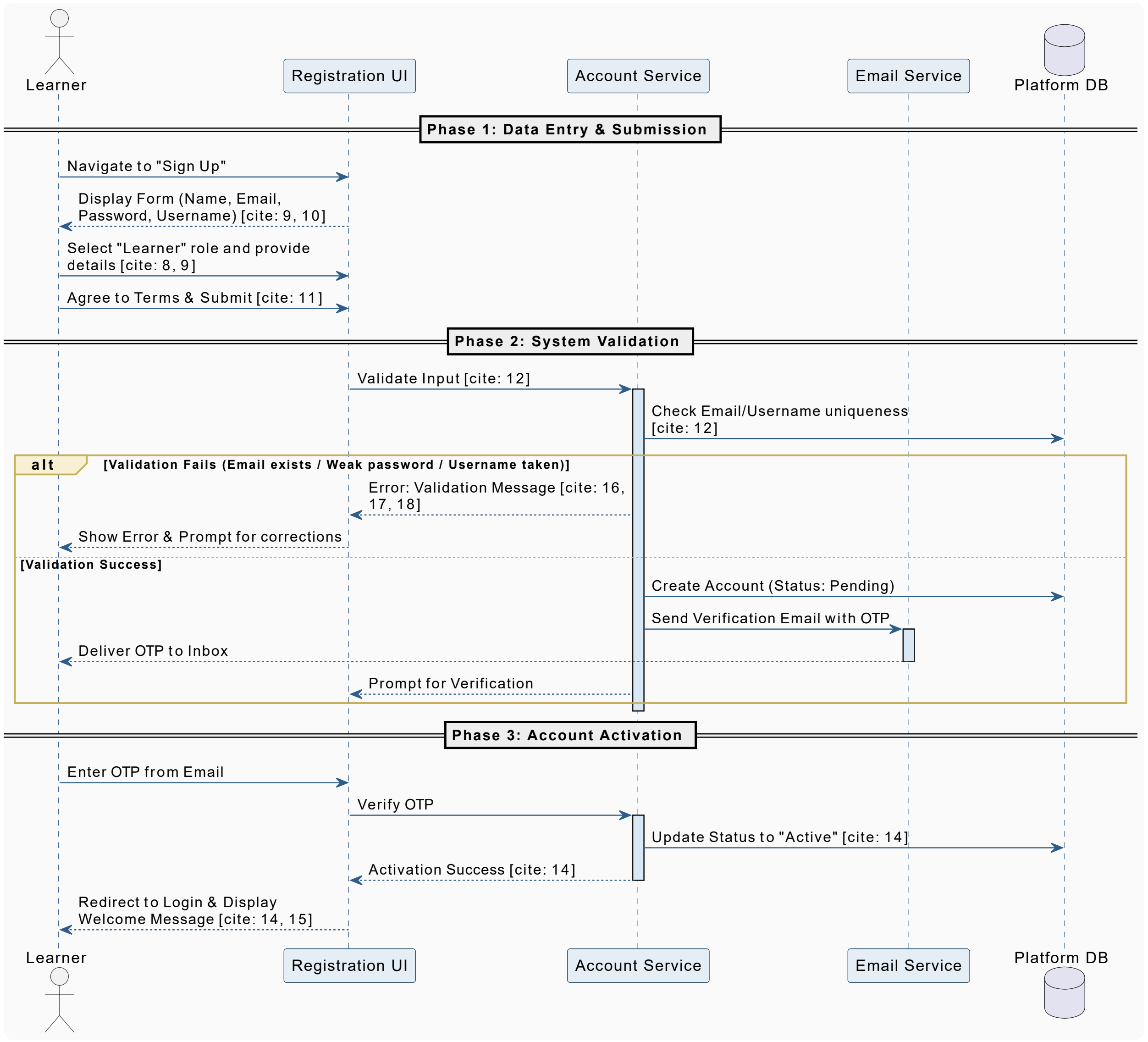
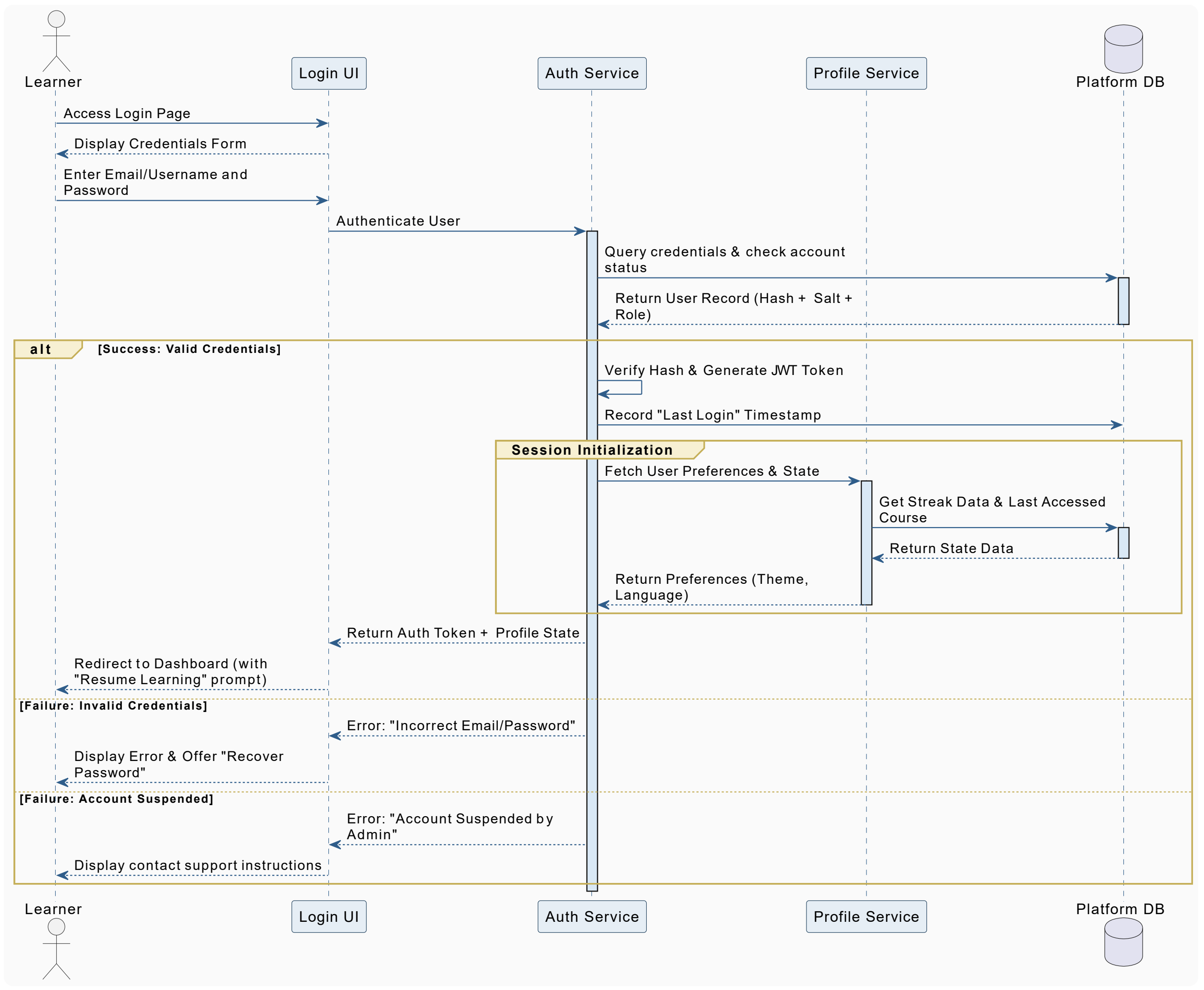

Learner
Registration UI
Account Service
Email Service
Platform DB
Phase 1: Data Entry & Submission
Navigate to "Sign Up"
Display Form (Name, Email, Password, Username) [cite: 9, 10]
Select "Learner" role and provide details [cite: 8, 9]
Agree to Terms & Submit [cite: 11]
Phase 2: System Validation
Validate Input [cite: 12]
Check Email/Username uniqueness [cite: 12]
alt
[Validation Fails (Email exists / Weak password / Username taken)]
Error: Validation Message [cite: 16, 17, 18]
Show Error & Prompt for corrections
[Validation Success]
Create Account (Status: Pending)
Send Verification Email with OTP
Deliver OTP to Inbox
Prompt for Verification
Phase 3: Account Activation
Enter OTP from Email
Verify OTP
Update Status to "Active" [cite: 14]
Activation Success [cite: 14]
Redirect to Login & Display Welcome Message [cite: 14, 15]
Learner
Registration UI
Account Service
Email Service
Platform DB

Figure 5.22: Register Account



Learner
Login UI
Auth Service
Profile Service
Platform DB
Access Login Page
Display Credentials Form
Enter Email/Username and Password
Authenticate User
Query credentials & check account status
Return User Record (Hash + Salt + Role)
alt
[Success: Valid Credentials]
Verify Hash & Generate JWT Token
Record "Last Login" Timestamp
Session Initialization
Fetch User Preferences & State
Get Streak Data & Last Accessed Course
Return State Data
Return Preferences (Theme, Language)
Return Auth Token + Profile State
Redirect to Dashboard (with "Resume Learning" prompt)
[Failure: Invalid Credentials]
Error: "Incorrect Email/Password"
Display Error & Offer "Recover Password"
[Failure: Account Suspended]
Error: "Account Suspended by Admin"
Display contact support instructions

Figure 5.23: Login to System

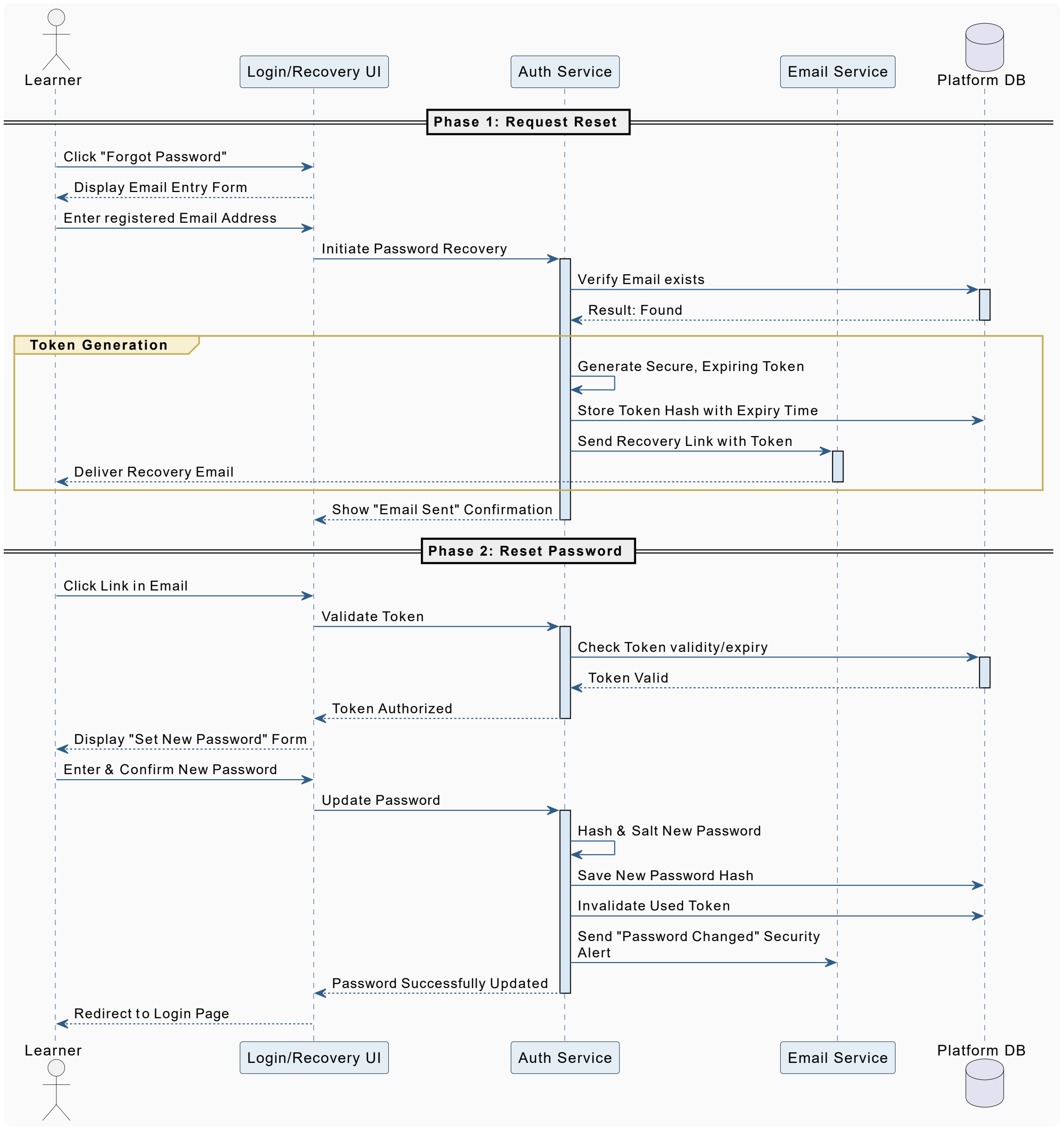


Figure 5.24: Recover password

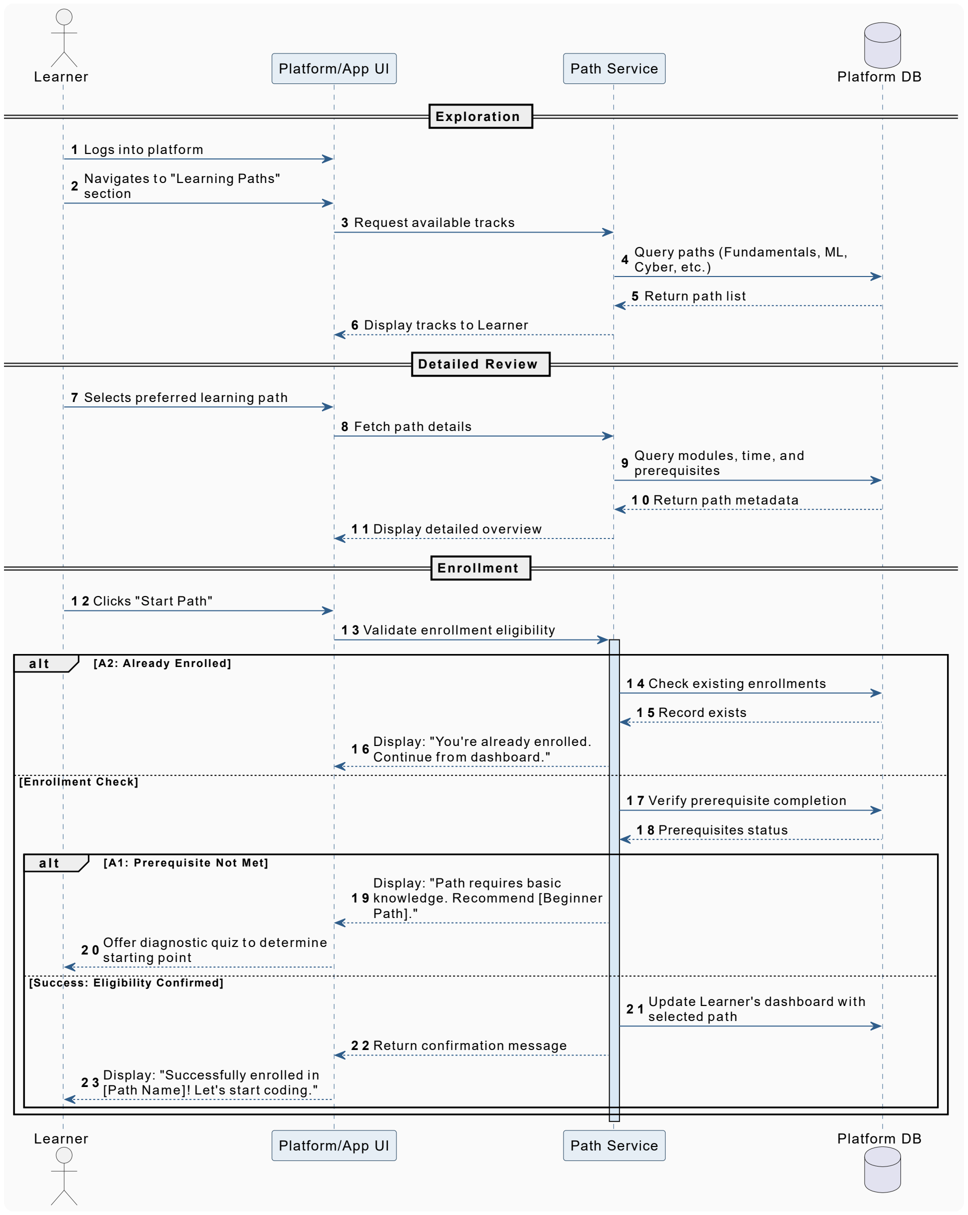
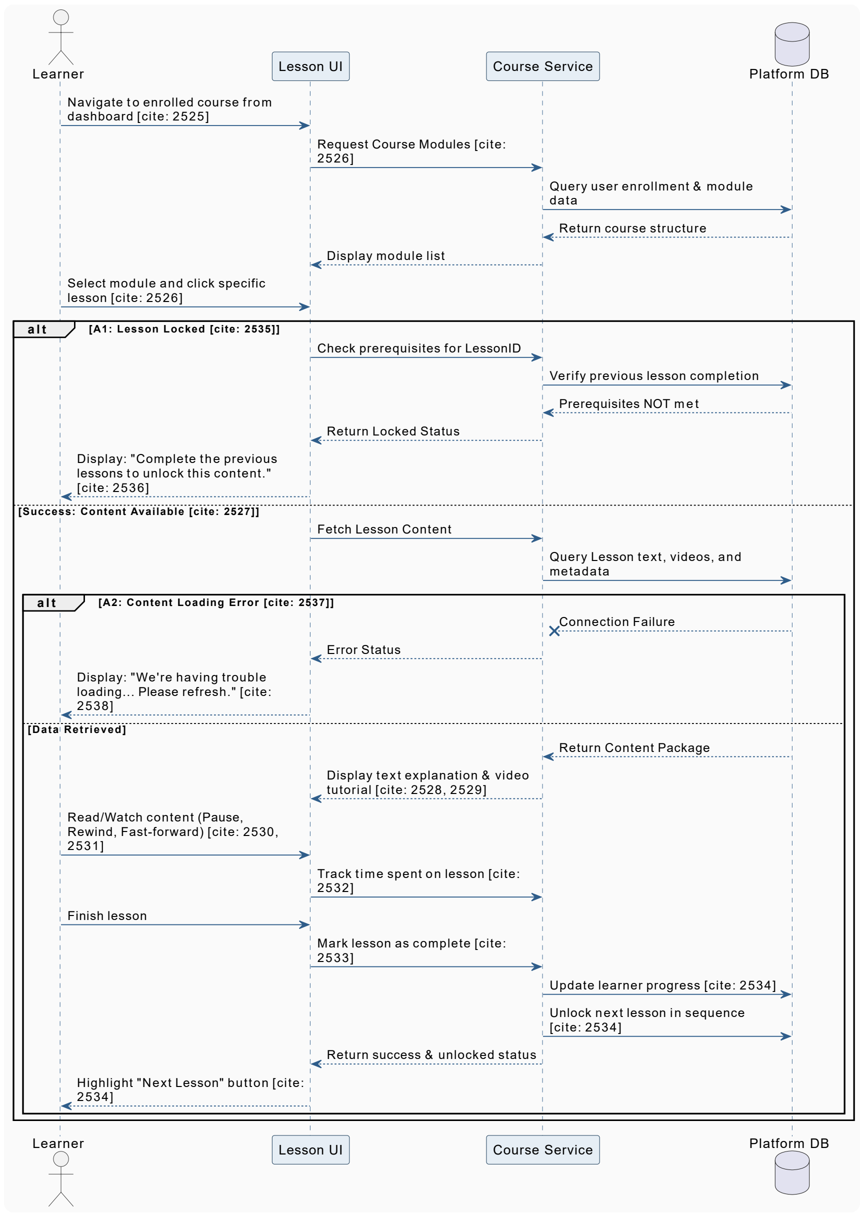

Learner
Platform/App UI
Path Service
Platform DB
Exploration
1 Logs into platform
2 Navigates to "Learning Paths" section
3 Request available tracks
4 Query paths (Fundamentals, ML, Cyber, etc.)
5 Return path list
6 Display tracks to Learner
Detailed Review
7 Selects preferred learning path
8 Fetch path details
9 Query modules, time, and prerequisites
10 Return path metadata
11 Display detailed overview
Enrollment
12 Clicks "Start Path"
13 Validate enrollment eligibility
alt [A2: Already Enrolled]
14 Check existing enrollments
15 Record exists
16 Display: "You're already enrolled. Continue from dashboard."
[Enrollment Check]
17 Verify prerequisite completion
18 Prerequisites status
alt [A1: Prerequisite Not Met]
19 Display: "Path requires basic knowledge. Recommend [Beginner Path]."
20 Offer diagnostic quiz to determine starting point
[Success: Eligibility Confirmed]
21 Update Learner's dashboard with selected path
22 Return confirmation message
23 Display: "Successfully enrolled in [Path Name]! Let's start coding."

Figure 5.25: Choose Learning Path



Learner
Lesson UI
Course Service
Platform DB
Navigate to enrolled course from dashboard [cite: 2525]
Request Course Modules [cite: 2526]
Query user enrollment & module data
Return course structure
Display module list
Select module and click specific lesson [cite: 2526]
alt [A1: Lesson Locked [cite: 2535]]
Check prerequisites for LessonID
Verify previous lesson completion
Prerequisites NOT met
Return Locked Status
Display: "Complete the previous lessons to unlock this content." [cite: 2536]
[Success: Content Available [cite: 2527]]
Fetch Lesson Content
Query Lesson text, videos, and metadata
alt [A2: Content Loading Error [cite: 2537]]
Connection Failure
Error Status
Display: "We're having trouble loading... Please refresh." [cite: 2538]
[Data Retrieved]
Return Content Package
Display text explanation & video tutorial [cite: 2528, 2529]
Read/Watch content (Pause, Rewind, Fast-forward) [cite: 2530, 2531]
Track time spent on lesson [cite: 2532]
Finish lesson
Mark lesson as complete [cite: 2533]
Update learner progress [cite: 2534]
Unlock next lesson in sequence [cite: 2534]
Return success & unlocked status
Highlight "Next Lesson" button [cite: 2534]

Figure 5.26: View Lesson Content

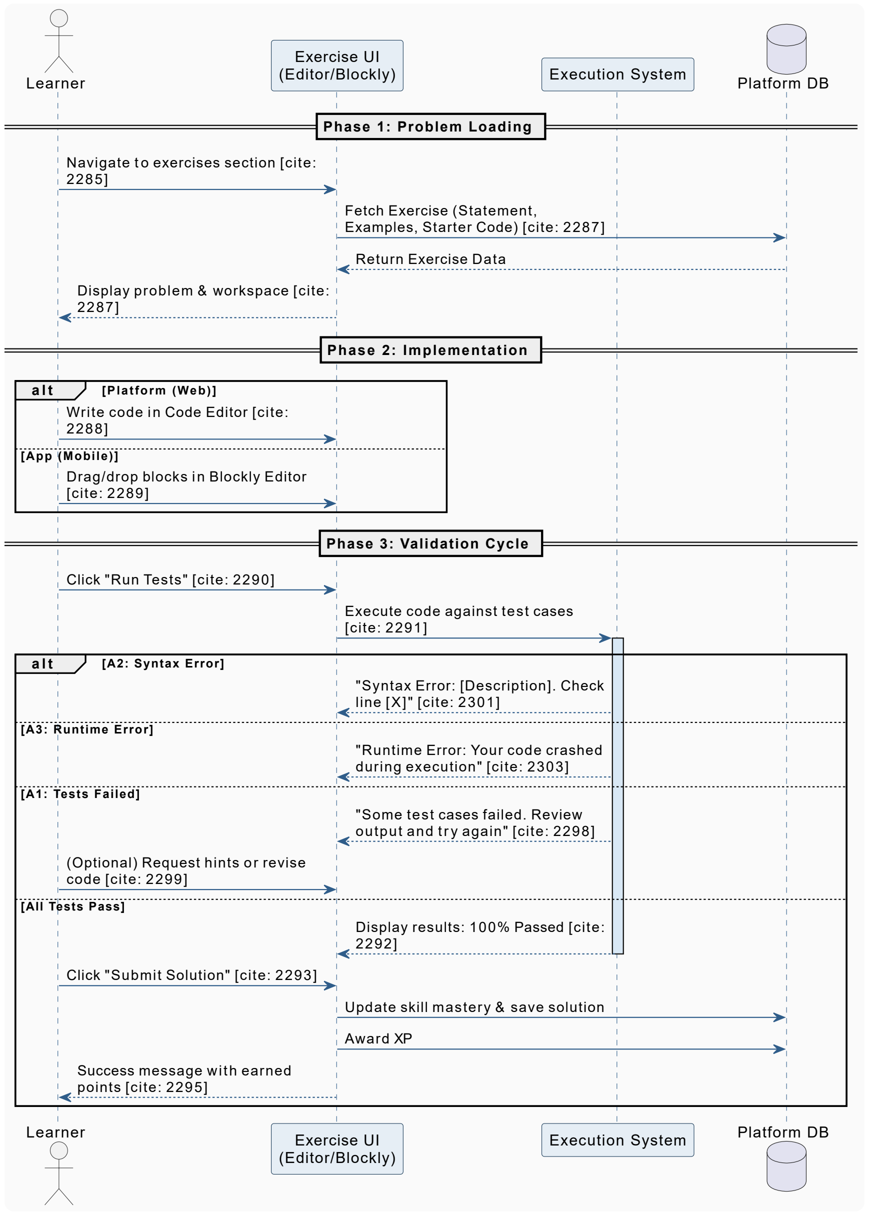

Learner
Exercise UI (Editor/Blockly)
Execution System
Platform DB
Phase 1: Problem Loading
Navigate to exercises section [cite: 2285]
Fetch Exercise (Statement, Examples, Starter Code) [cite: 2287]
Return Exercise Data
Display problem & workspace [cite: 2287]
Phase 2: Implementation
alt [Platform (Web)]
Write code in Code Editor [cite: 2288]
[App (Mobile)]
Drag/drop blocks in Blockly Editor [cite: 2289]
Phase 3: Validation Cycle
Click "Run Tests" [cite: 2290]
Execute code against test cases [cite: 2291]
alt [A2: Syntax Error]
"Syntax Error: [Description]. Check line [X]" [cite: 2301]
[A3: Runtime Error]
"Runtime Error: Your code crashed during execution" [cite: 2303]
[A1: Tests Failed]
"Some test cases failed. Review output and try again" [cite: 2298]
(Optional) Request hints or revise code [cite: 2299]
[All Tests Pass]
Display results: 100% Passed [cite: 2292]
Click "Submit Solution" [cite: 2293]
Update skill mastery & save solution
Award XP
Success message with earned points [cite: 2295]
Learner
Exercise UI (Editor/Blockly)
Execution System
Platform DB

Figure 5.27: Complete Exercise

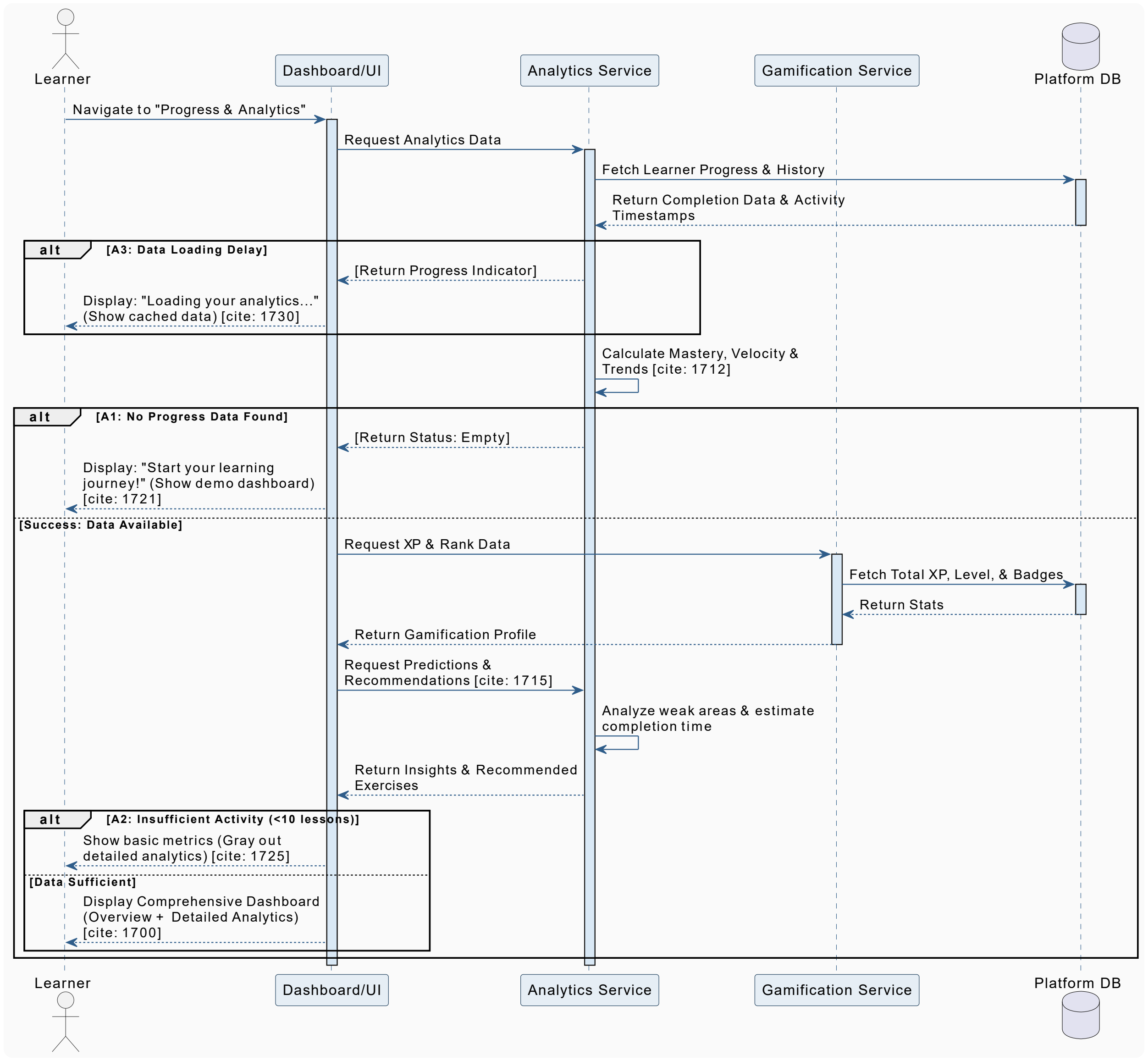
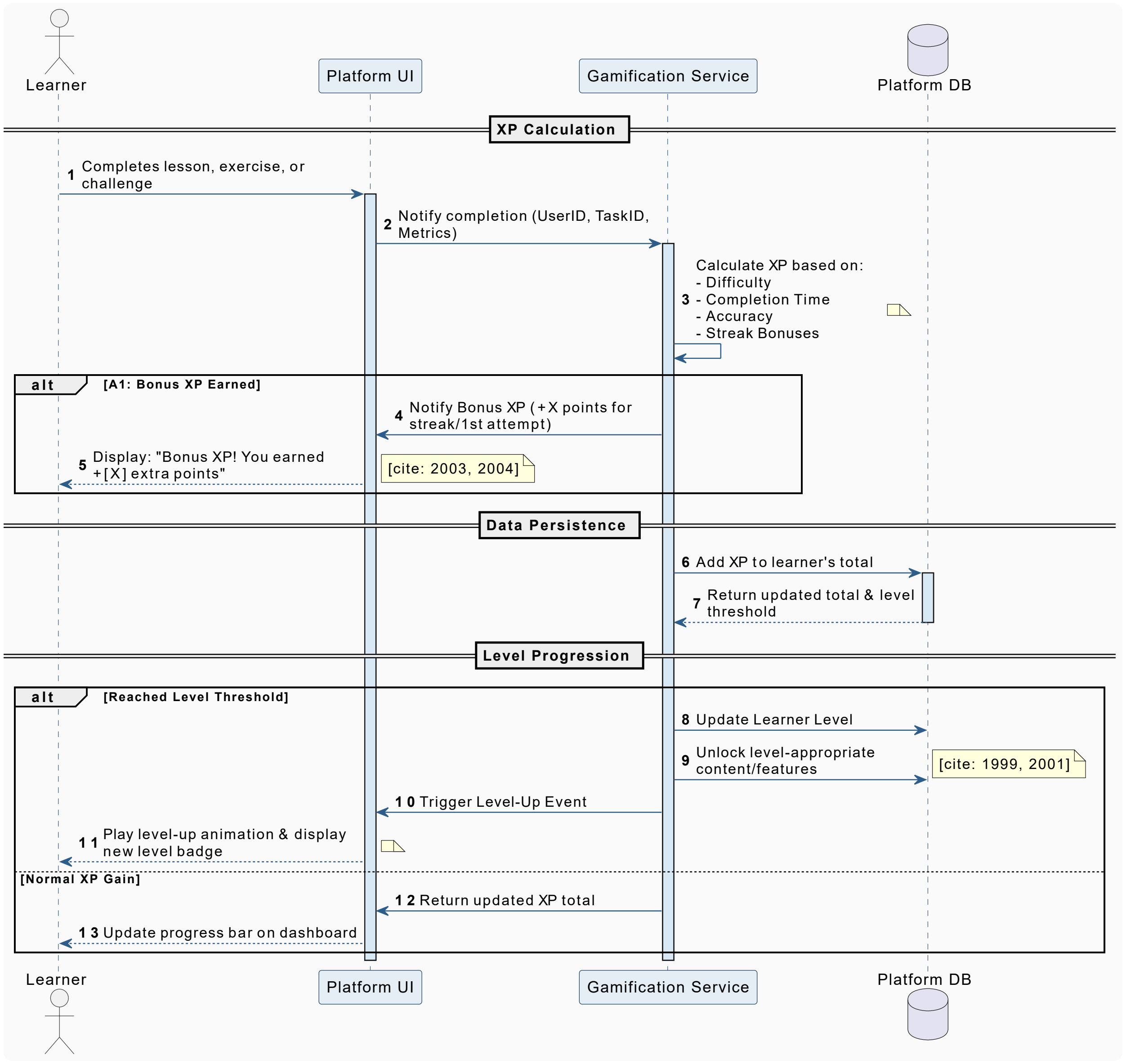
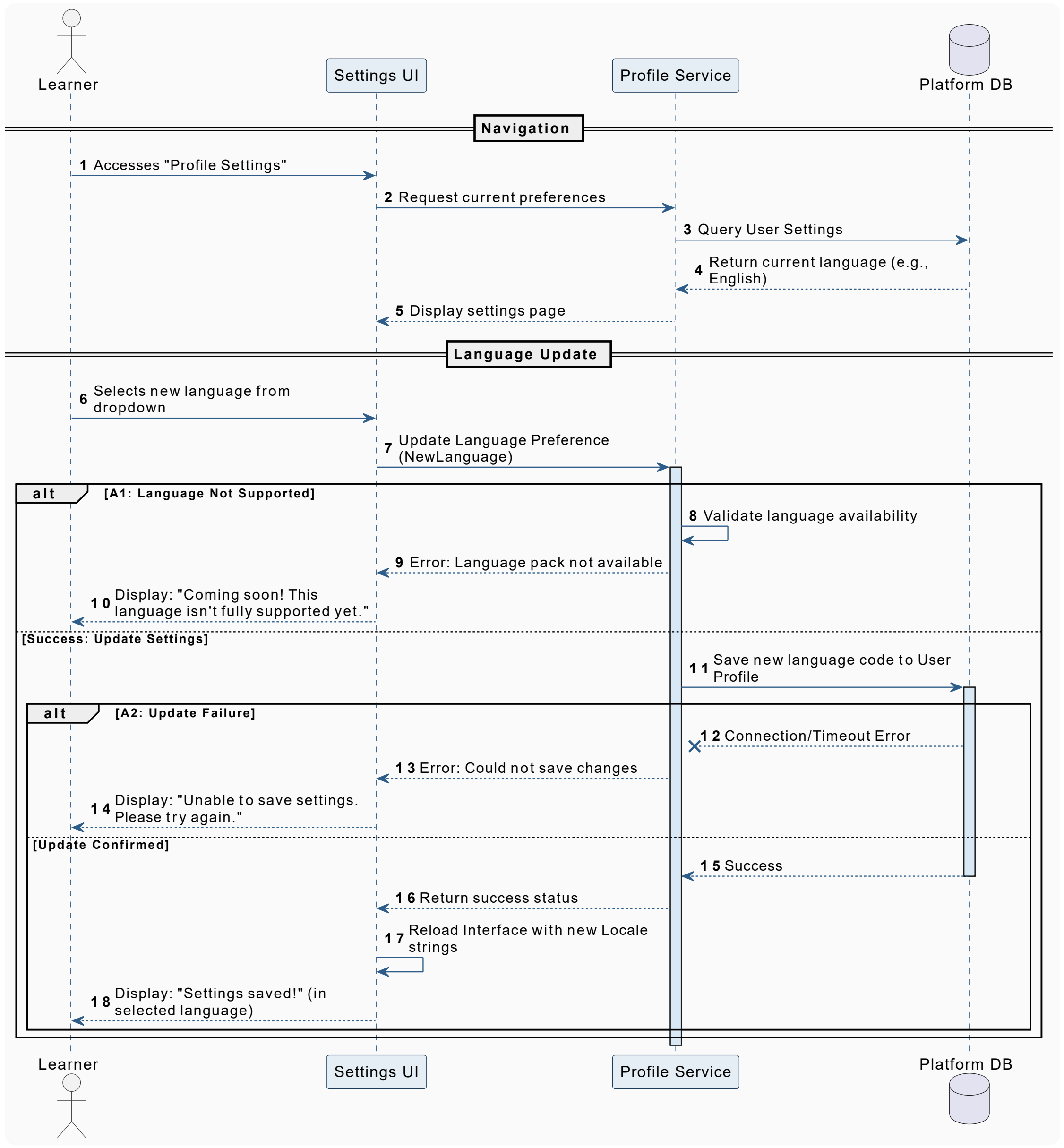

Learner
Dashboard/UI
Analytics Service
Gamification Service
Platform DB
Navigate to "Progress & Analytics"
Request Analytics Data
Fetch Learner Progress & History
Return Completion Data & Activity Timestamps
alt [A3: Data Loading Delay]
[Return Progress Indicator]
Display: "Loading your analytics..." (Show cached data) [cite: 1730]
Calculate Mastery, Velocity & Trends [cite: 1712]
alt [A1: No Progress Data Found]
[Return Status: Empty]
Display: "Start your learning journey!" (Show demo dashboard) [cite: 1721]
[Success: Data Available]
Request XP & Rank Data
Fetch Total XP, Level, & Badges
Return Stats
Return Gamification Profile
Request Predictions & Recommendations [cite: 1715]
Analyze weak areas & estimate completion time
Return Insights & Recommended Exercises
alt [A2: Insufficient Activity (<10 lessons)]
Show basic metrics (Gray out detailed analytics) [cite: 1725]
[Data Sufficient]
Display Comprehensive Dashboard (Overview + Detailed Analytics) [cite: 1700]

Figure 5.28: Track Progress



Learner
Platform UI
Gamification Service
Platform DB
XP Calculation
1 Completes lesson, exercise, or challenge
2 Notify completion (UserID, TaskID, Metrics)
3 Calculate XP based on: - Difficulty - Completion Time - Accuracy - Streak Bonuses
alt [A1: Bonus XP Earned]
4 Notify Bonus XP (+X points for streak/1st attempt)
5 Display: "Bonus XP! You earned +[X] extra points"
[cite: 2003, 2004]
Data Persistence
6 Add XP to learner's total
7 Return updated total & level threshold
Level Progression
alt [Reached Level Threshold]
8 Update Learner Level
9 Unlock level-appropriate content/features
[cite: 1999, 2001]
10 Trigger Level-Up Event
11 Play level-up animation & display new level badge
[Normal XP Gain]
12 Return updated XP total
13 Update progress bar on dashboard

Figure 5.29: Learn XP and Level Up



Learner
Settings UI
Profile Service
Platform DB
Navigation
1 Accesses "Profile Settings"
2 Request current preferences
3 Query User Settings
4 Return current language (e.g., English)
5 Display settings page
Language Update
6 Selects new language from dropdown
7 Update Language Preference (NewLanguage)
alt [A1: Language Not Supported]
8 Validate language availability
9 Error: Language pack not available
10 Display: "Coming soon! This language isn't fully supported yet."
[Success: Update Settings]
11 Save new language code to User Profile
alt [A2: Update Failure]
12 Connection/Timeout Error
13 Error: Could not save changes
14 Display: "Unable to save settings. Please try again."
[Update Confirmed]
15 Success
16 Return success status
17 Reload Interface with new Locale strings
18 Display: "Settings saved!" (in selected language)

Figure 5.30: Set Language Preferences

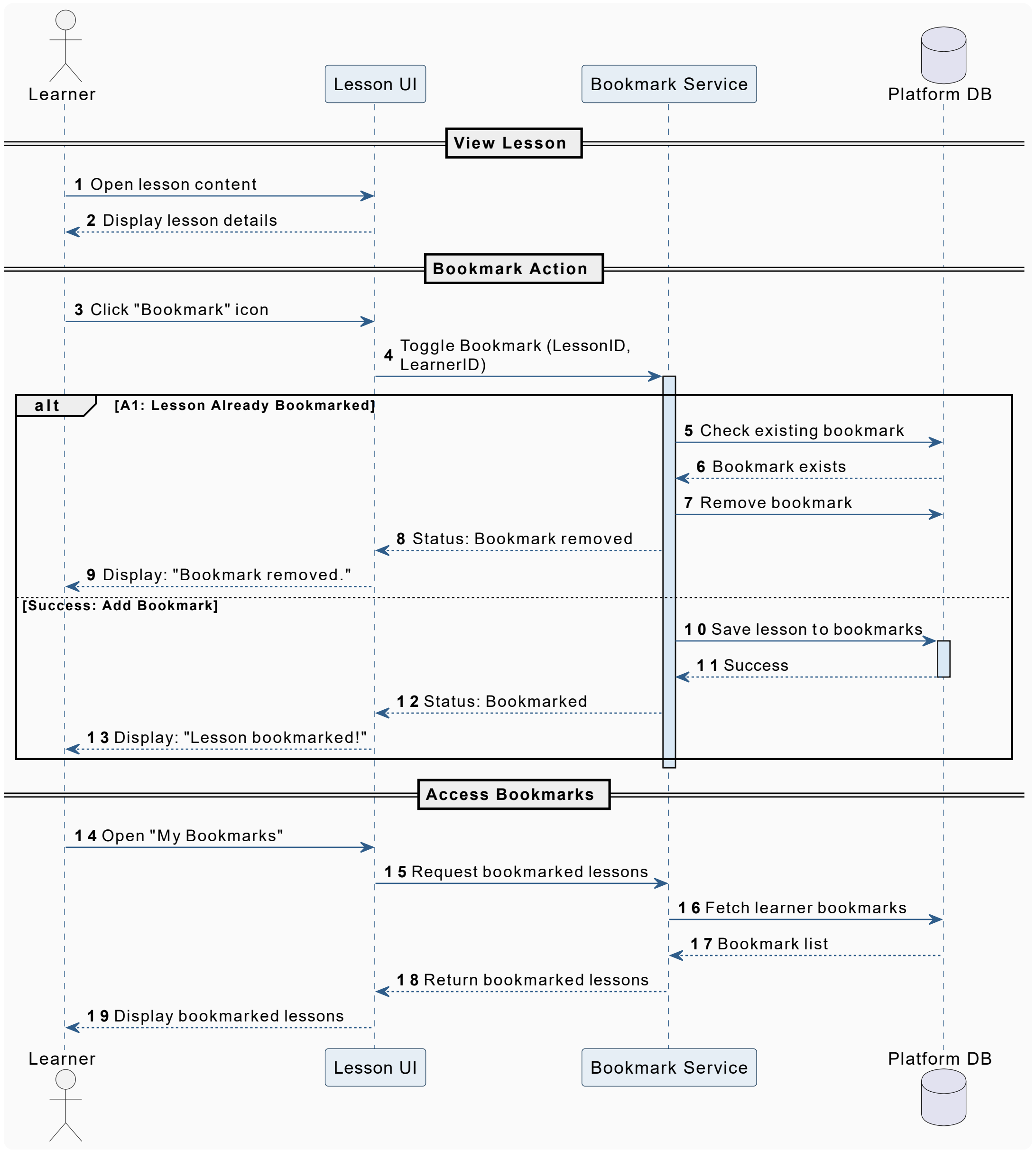
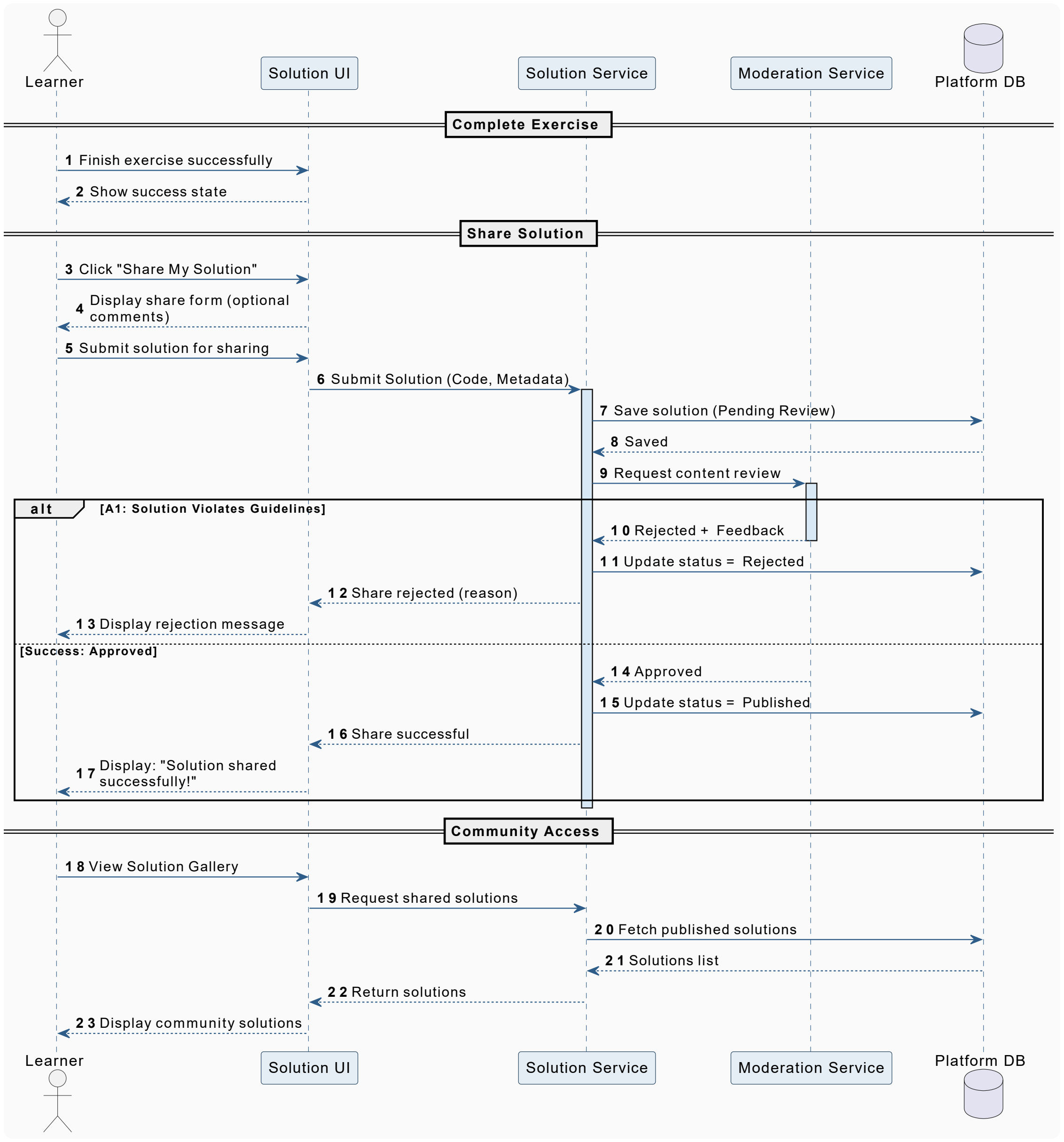
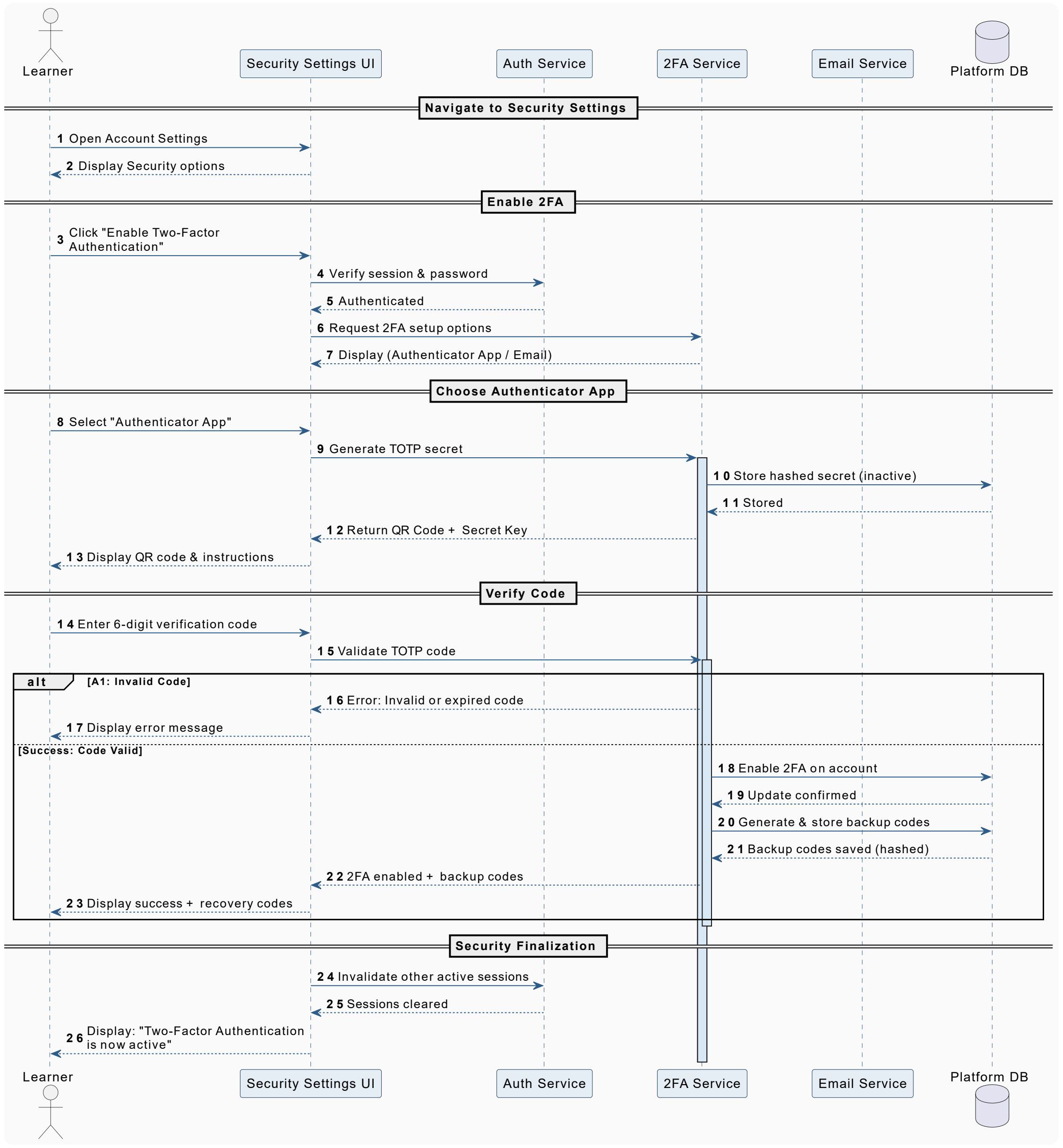


Figure 5.31: Bookmark Lesson



Learner
Solution UI
Solution Service
Moderation Service
Platform DB
Complete Exercise
1 Finish exercise successfully
2 Show success state
Share Solution
3 Click "Share My Solution"
4 Display share form (optional comments)
5 Submit solution for sharing
6 Submit Solution (Code, Metadata)
7 Save solution (Pending Review)
8 Saved
9 Request content review
alt
[A1: Solution Violates Guidelines]
10 Rejected + Feedback
11 Update status = Rejected
12 Share rejected (reason)
13 Display rejection message
[Success: Approved]
14 Approved
15 Update status = Published
16 Share successful
17 Display: "Solution shared successfully!"
Community Access
18 View Solution Gallery
19 Request shared solutions
20 Fetch published solutions
21 Solutions list
22 Return solutions
23 Display community solutions

Figure 5.32: Share Solution



Learner
Security Settings UI
Auth Service
2FA Service
Email Service
Platform DB
Navigate to Security Settings
1 Open Account Settings
2 Display Security options
Enable 2FA
3 Click "Enable Two-Factor Authentication"
4 Verify session & password
5 Authenticated
6 Request 2FA setup options
7 Display (Authenticator App / Email)
Choose Authenticator App
8 Select "Authenticator App"
9 Generate TOTP secret
10 Store hashed secret (inactive)
11 Stored
12 Return QR Code + Secret Key
13 Display QR code & instructions
Verify Code
14 Enter 6-digit verification code
15 Validate TOTP code
alt
[A1: Invalid Code]
16 Error: Invalid or expired code
17 Display error message
[Success: Code Valid]
18 Enable 2FA on account
19 Update confirmed
20 Generate & store backup codes
21 Backup codes saved (hashed)
22 2FA enabled + backup codes
23 Display success + recovery codes
Security Finalization
24 Invalidate other active sessions
25 Sessions cleared
26 Display: "Two-Factor Authentication is now active"

Figure 5.33: Enable Two-factor Authontecation

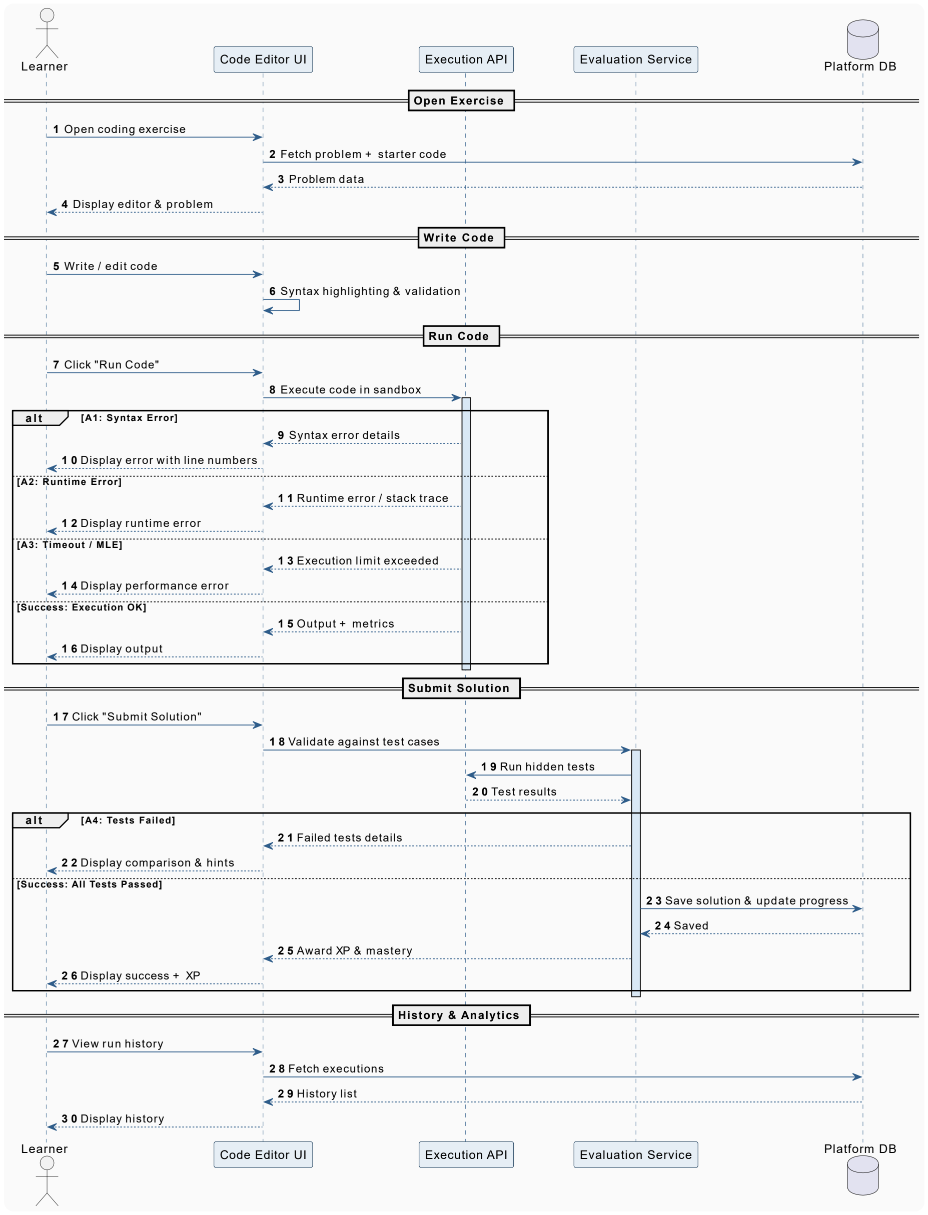


Figure 5.34: Practice Coding

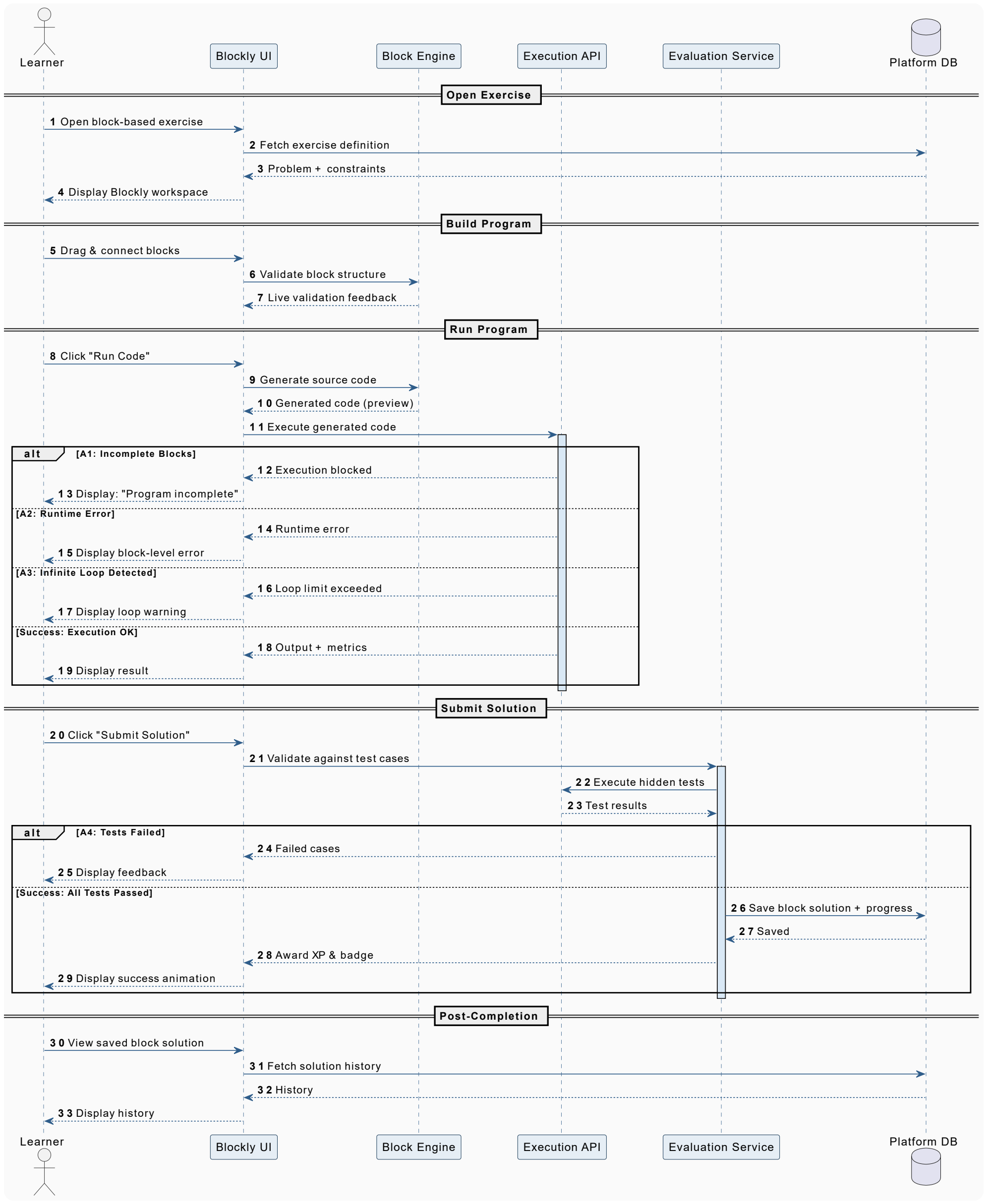


Figure 5.35: Practice Coding with Blockly Editor

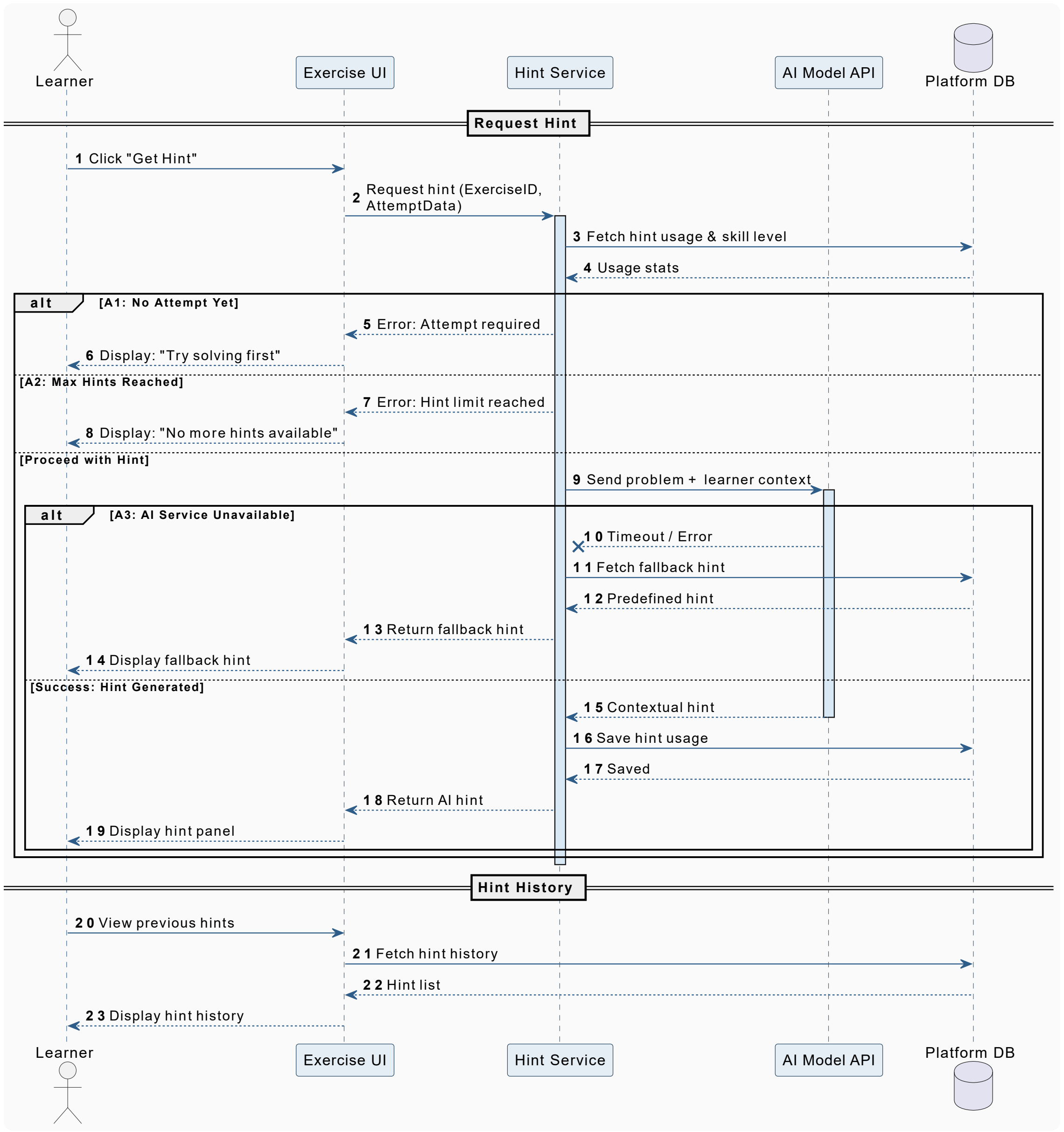


Figure 5.36: Receive AI-Powered Hints

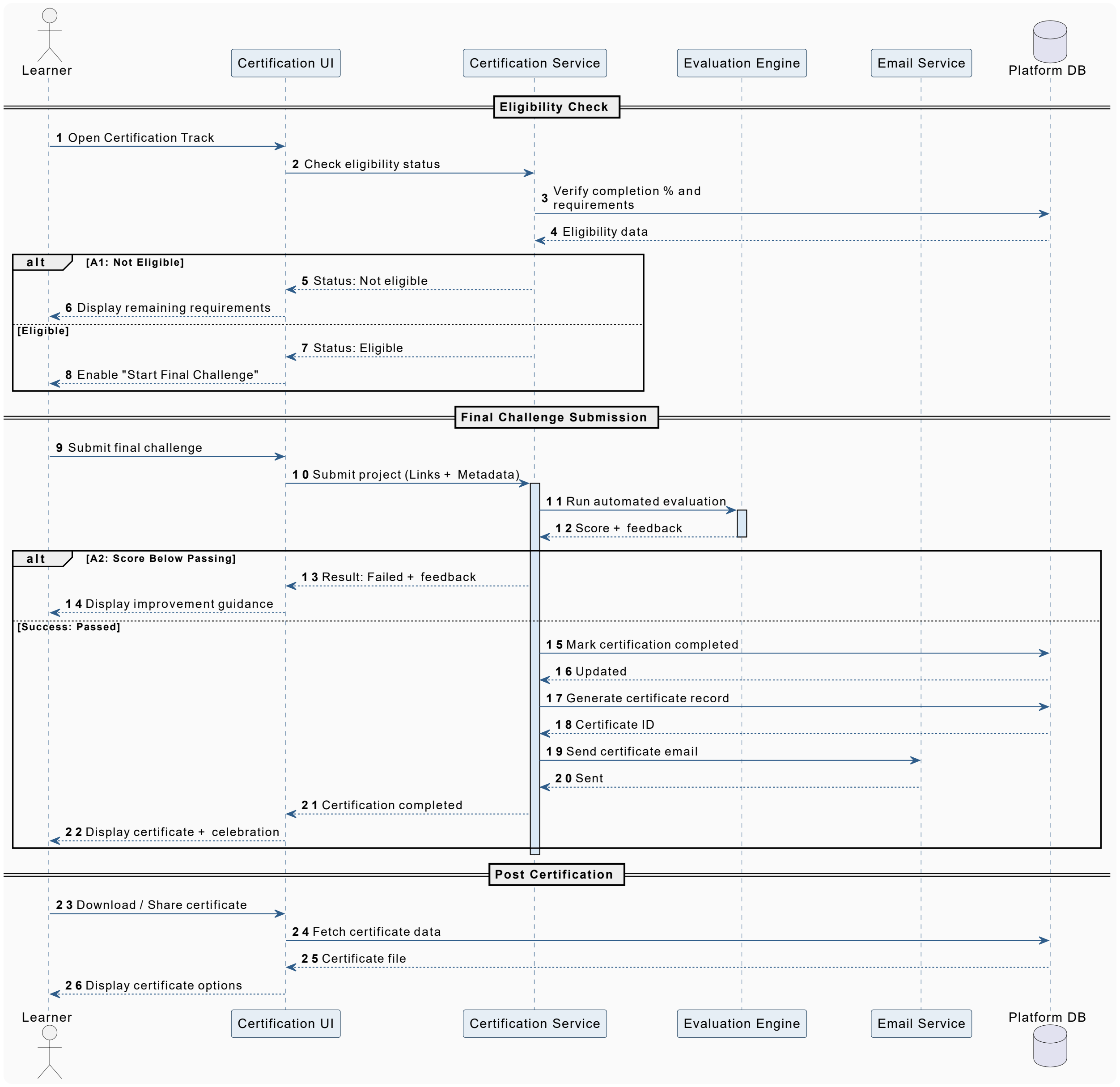

Learner
Certification UI
Certification Service
Evaluation Engine
Email Service
Platform DB
Eligibility Check
1 Open Certification Track
2 Check eligibility status
3 Verify completion % and requirements
4 Eligibility data
alt [A1: Not Eligible]
5 Status: Not eligible
6 Display remaining requirements
[Eligible]
7 Status: Eligible
8 Enable "Start Final Challenge"
Final Challenge Submission
9 Submit final challenge
10 Submit project (Links + Metadata)
11 Run automated evaluation
12 Score + feedback
alt [A2: Score Below Passing]
13 Result: Failed + feedback
14 Display improvement guidance
[Success: Passed]
15 Mark certification completed
16 Updated
17 Generate certificate record
18 Certificate ID
19 Send certificate email
20 Sent
21 Certification completed
22 Display certificate + celebration
Post Certification
23 Download / Share certificate
24 Fetch certificate data
25 Certificate file
26 Display certificate options

Figure 5.37: Complete Certification Track

5.5 Class Diagram

Class diagrams are structural diagrams that show the static structure of the system, including its classes, attributes, operations, and the relationships among objects. They provide a detailed view of the system's architecture and design.

Part 1: Core User and Authentication System

This section presents the foundational classes for user management, authentication, and authorization within the DuoCodo platform. It includes user roles, profile management, and security features.

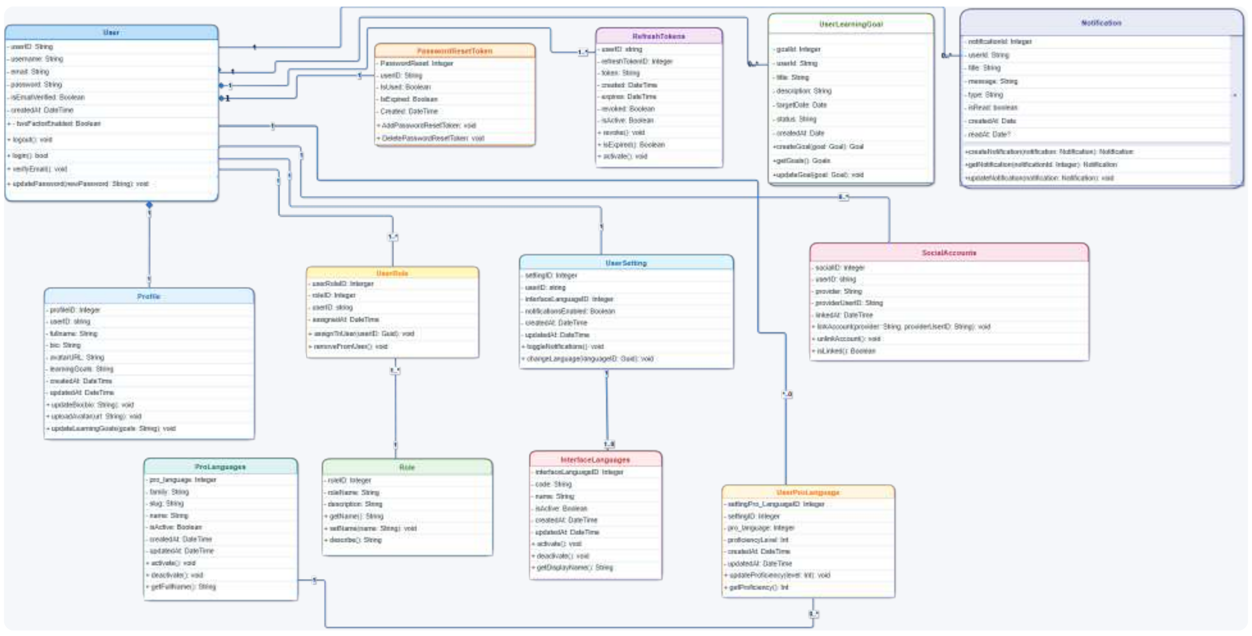


Figure 5.38: Class Diagram - Core User and Authentication System

Part 2: Learning Content Management

This section illustrates the classes responsible for managing educational content, including courses, lessons, exercises, and learning paths. It shows how content is structured and organized within the platform.

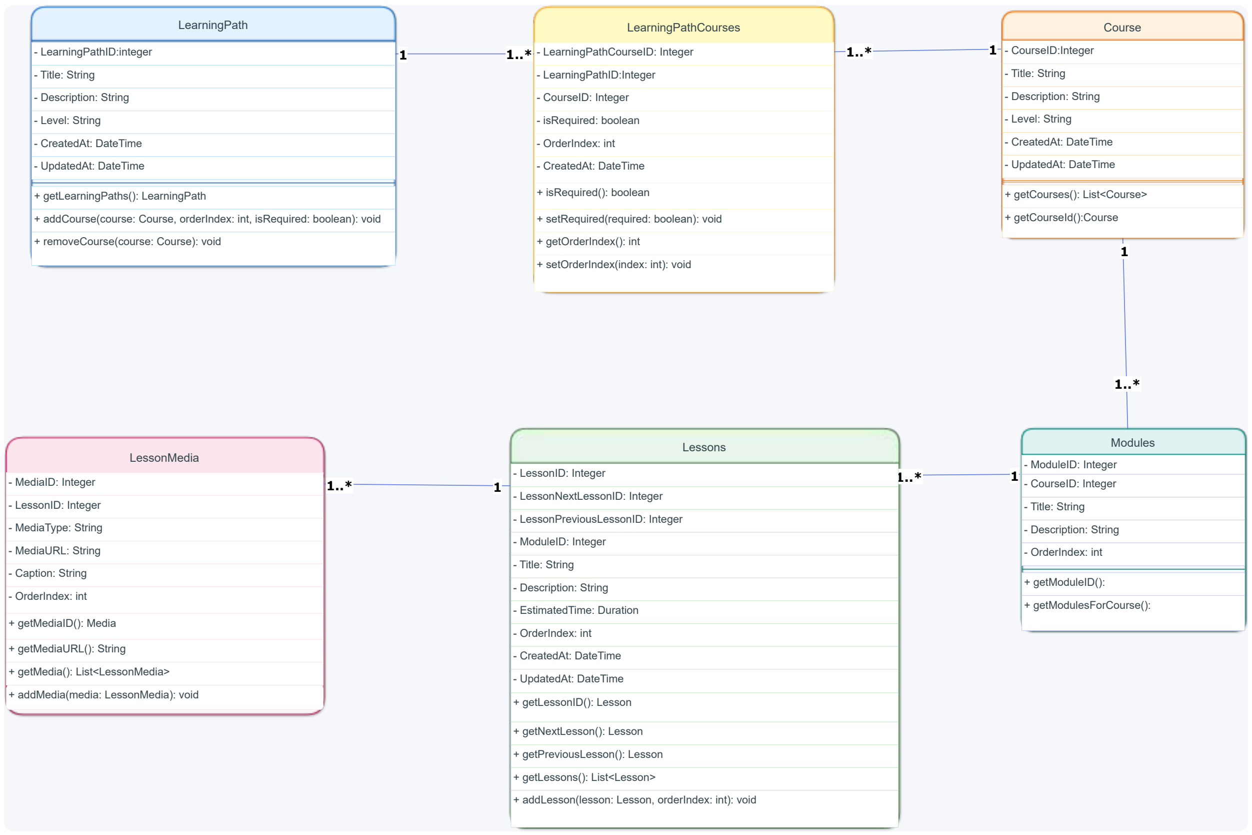


Figure 5.39: Class Diagram - Learning Content Management

Part 3: Submissions and Code Execution

This section demonstrates the classes that handle submission and code execution. It shows how the platform motivates and engages learners.

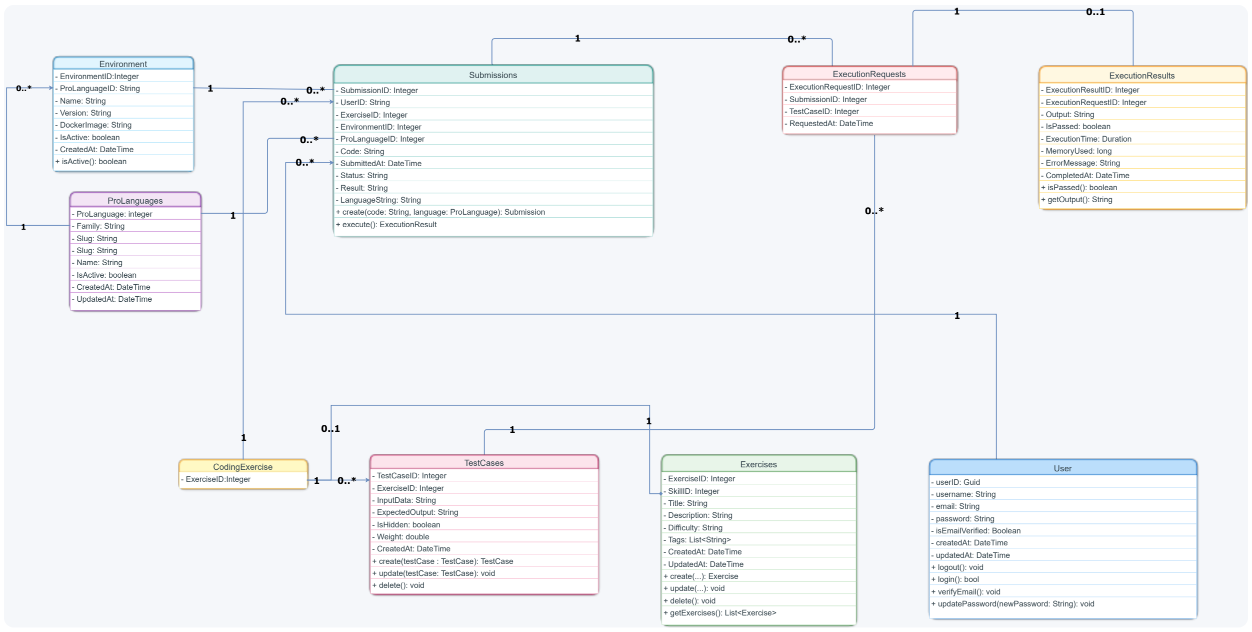


Figure 5.40: Class Diagram - Submissions and Code Execution

Part 4: Exercises, Attempts and Code Analysis

This section presents the classes that enable exercises, attempts and code analysis, including comments, discussions, friend connections, sharing capabilities, and community engagement features.

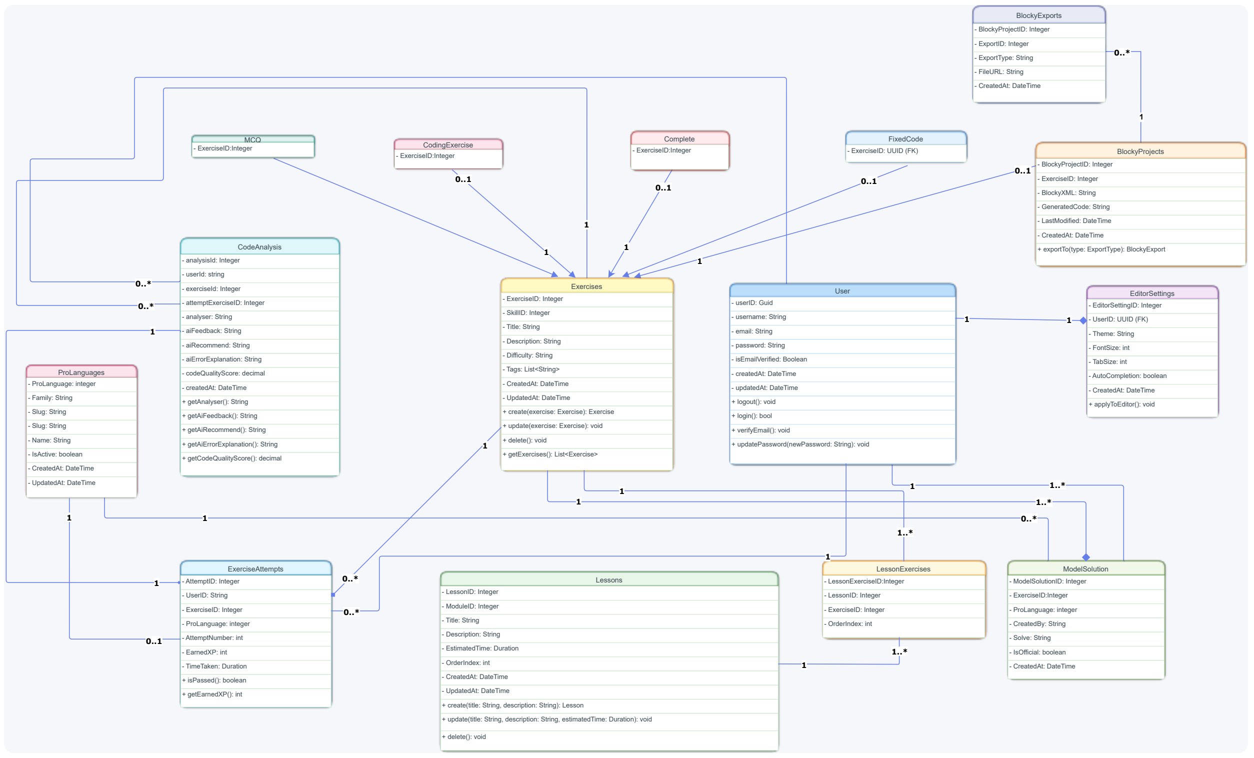


Figure 5.41: Class Diagram - Exercises, Attempts and Code Analysis

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Part 5: Certification and Gamification

This section shows the classes related to certification and gamification, and validation mechanisms. It demonstrates how the platform evaluates learner competency and awards credentials.

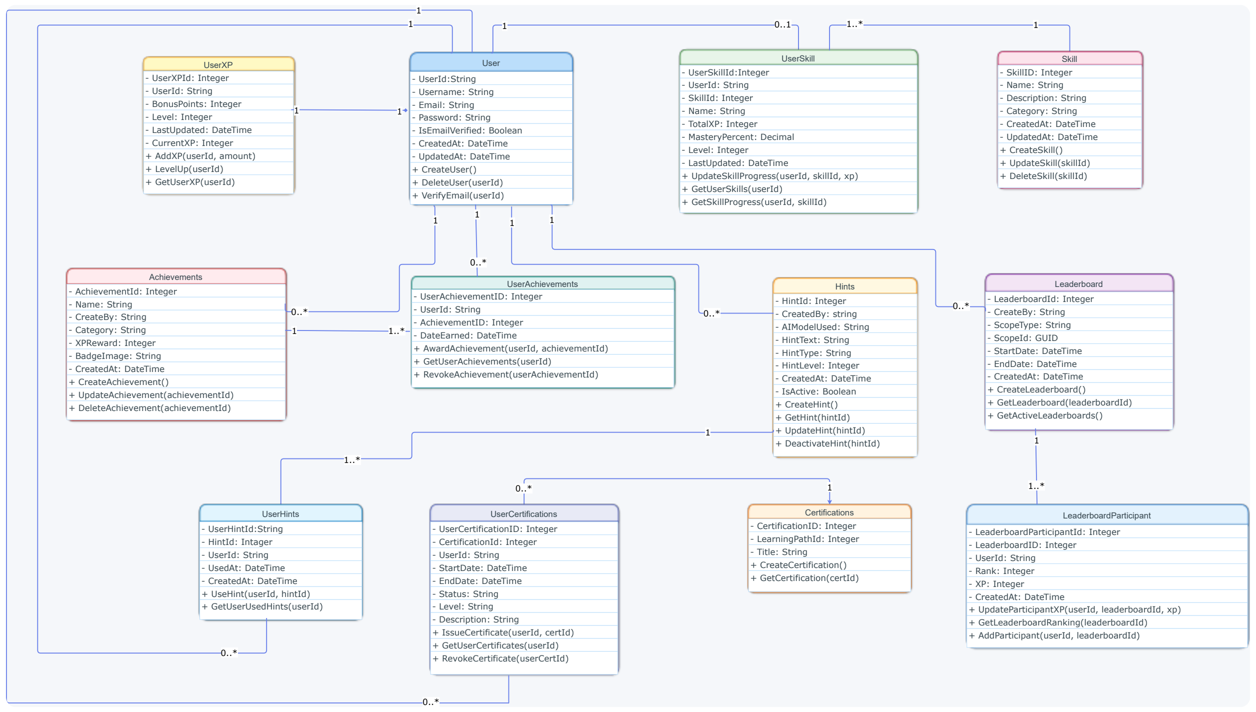

Figure 5.42: Class Diagram - Certification and Gamification

Part 6: Administration and Platform Management

This section illustrates the classes responsible for platform administration, including system monitoring, analytics, content moderation, user management, and reporting capabilities.

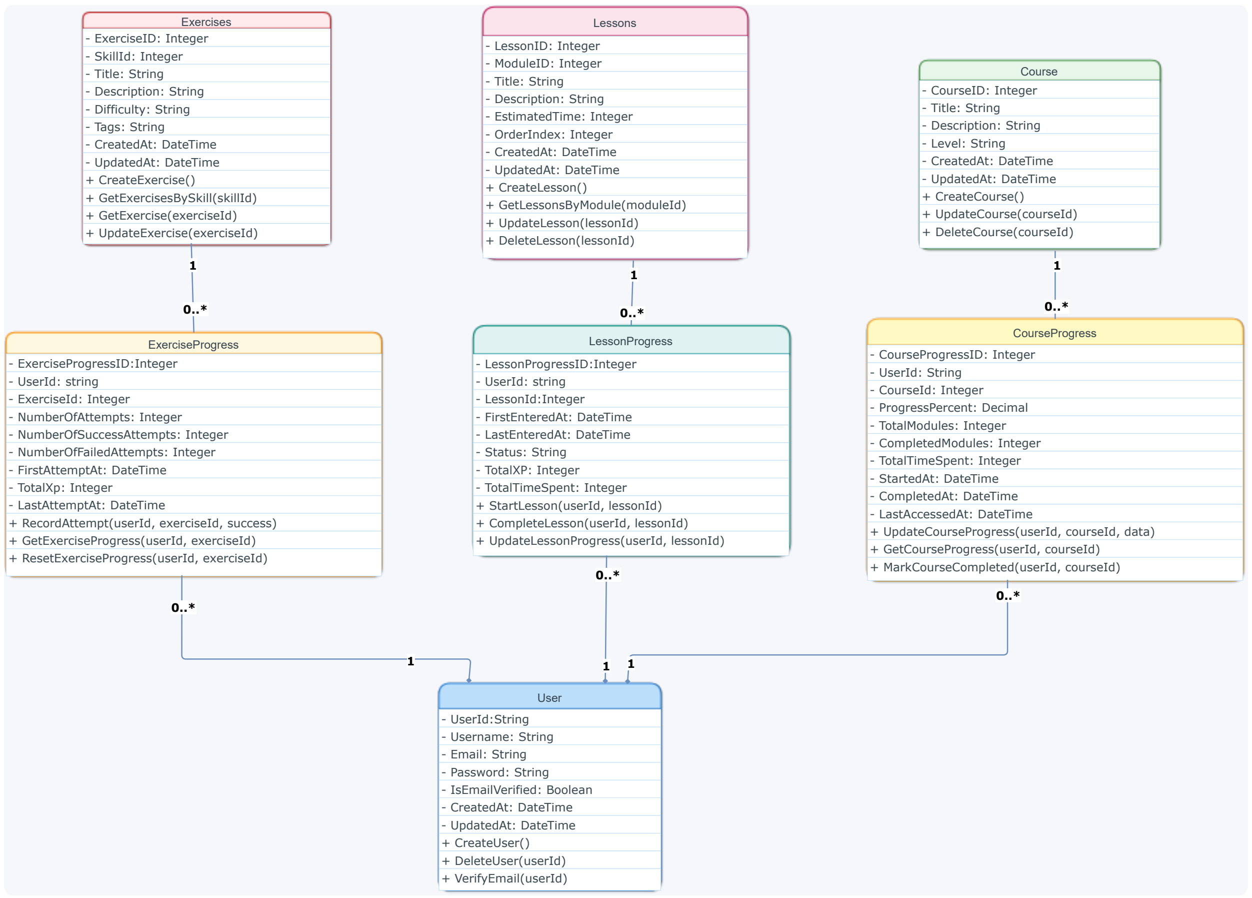

Figure 5.43: Class Diagram - Administration and Platform Management

---

Key Design Patterns and Relationships

The class diagrams above illustrate several important design patterns and relationships:

- **Inheritance** : User roles (Administrator, Content Creator, Learner) inherit from a base User class
- **Composition** : Courses are composed of Lessons, which contain Exercises
- **Association** : Many-to-many relationships between Learners and Courses through enrollment
- **Aggregation** : Learning Paths aggregate multiple Courses
- **Dependency** : Classes depend on authentication and authorization services

These diagrams provide a comprehensive view of the DuoCodo platform's architecture, showing how different components interact to deliver a complete learning experience.

Chapter

Chapter 6: Database Design

6.1 Entity Relationship Diagram

Entity Relationship Diagrams (ERD) represent the data model of the DuoCodo platform, showing the entities, their attributes, and the relationships between them. This comprehensive database design ensures data integrity, efficient querying, and scalability.

Part 1: User Management and Authentication

This section presents the core entities for user management, including user accounts, roles, authentication mechanisms, and profile information. It establishes the foundation for user identity and access control.

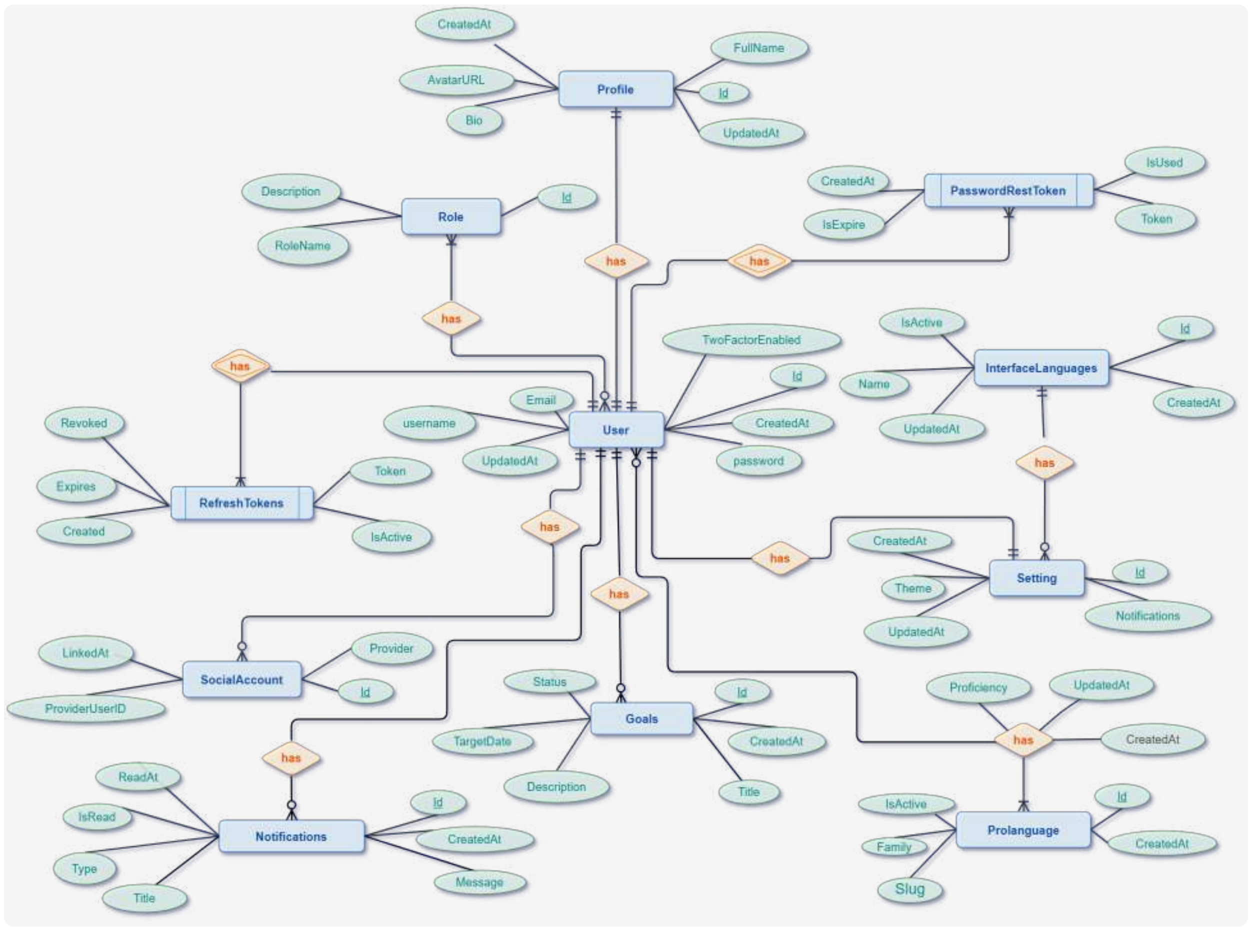

Figure 6.1: Entity Relationship Diagram - User Management and Authentication

Part 2: Learning Content and Course Structure

This section illustrates the entities related to educational content organization, including courses, lessons, modules, exercises, and learning paths. It shows how content is structured and interconnected within the platform.

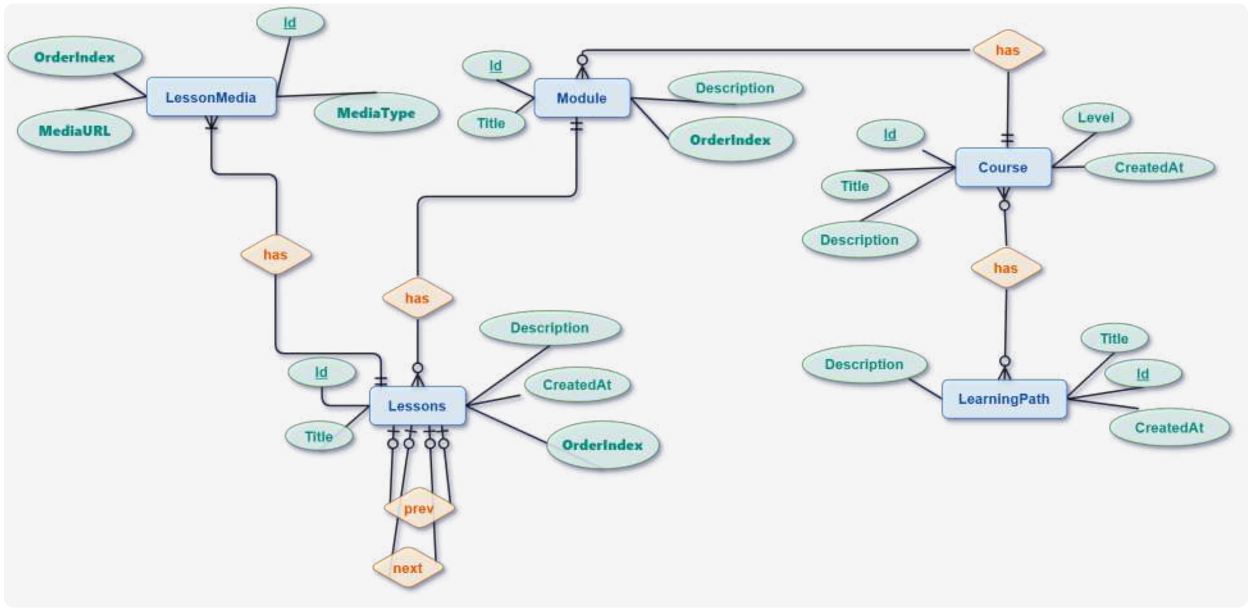

Figure 6.2: Entity Relationship Diagram - Learning Content and Course Structure

Part 3: Submissions and Code Execution

This section demonstrates the entities that track submission and code execution. It shows how the platform motivates learners through gamification elements.

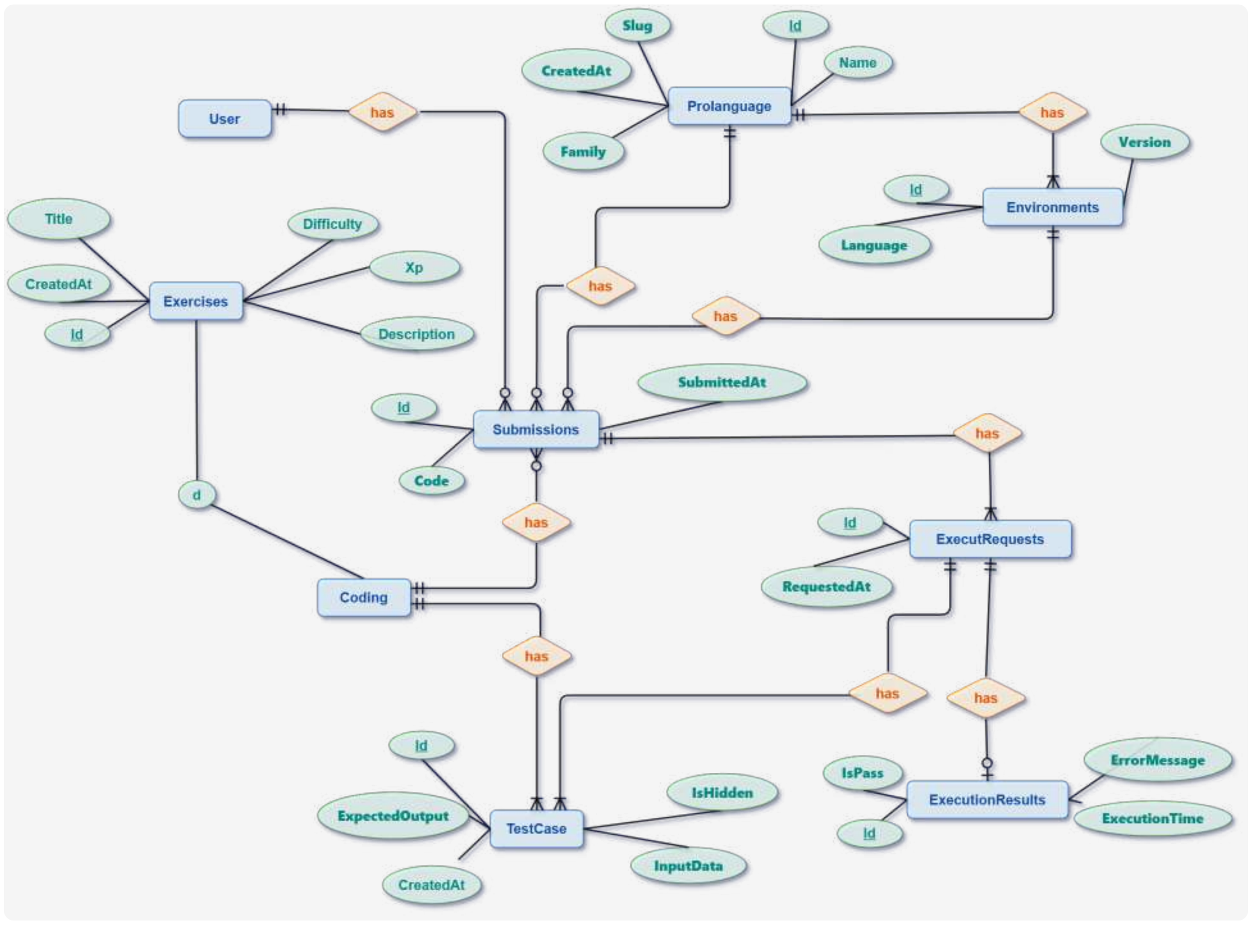

Figure 6.3: Entity Relationship Diagram - Submissions and Code Execution

Part 4: Exercises, Attempts and Code Analysis

This section shows the entities for exercises, attempts and code analysis. It demonstrates how the platform evaluates learner competency and issues credentials.

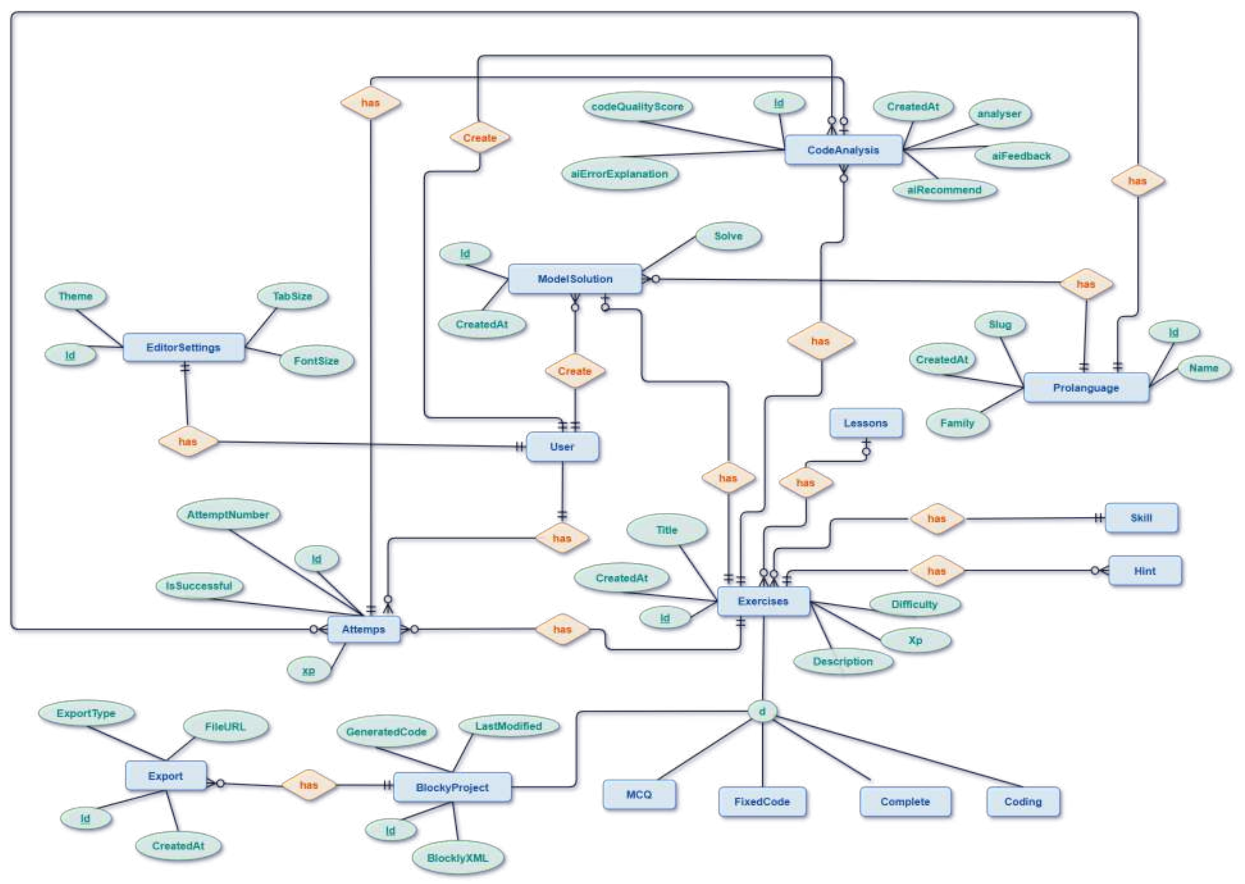

Figure 6.4: Entity Relationship Diagram - Exercises, Attempts and Code Analysis

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Part 5: Certification and Gamification

This section presents the entities that enable certification and gamification, including comments, discussions, friend connections, notifications, sharing, and community engagement features.

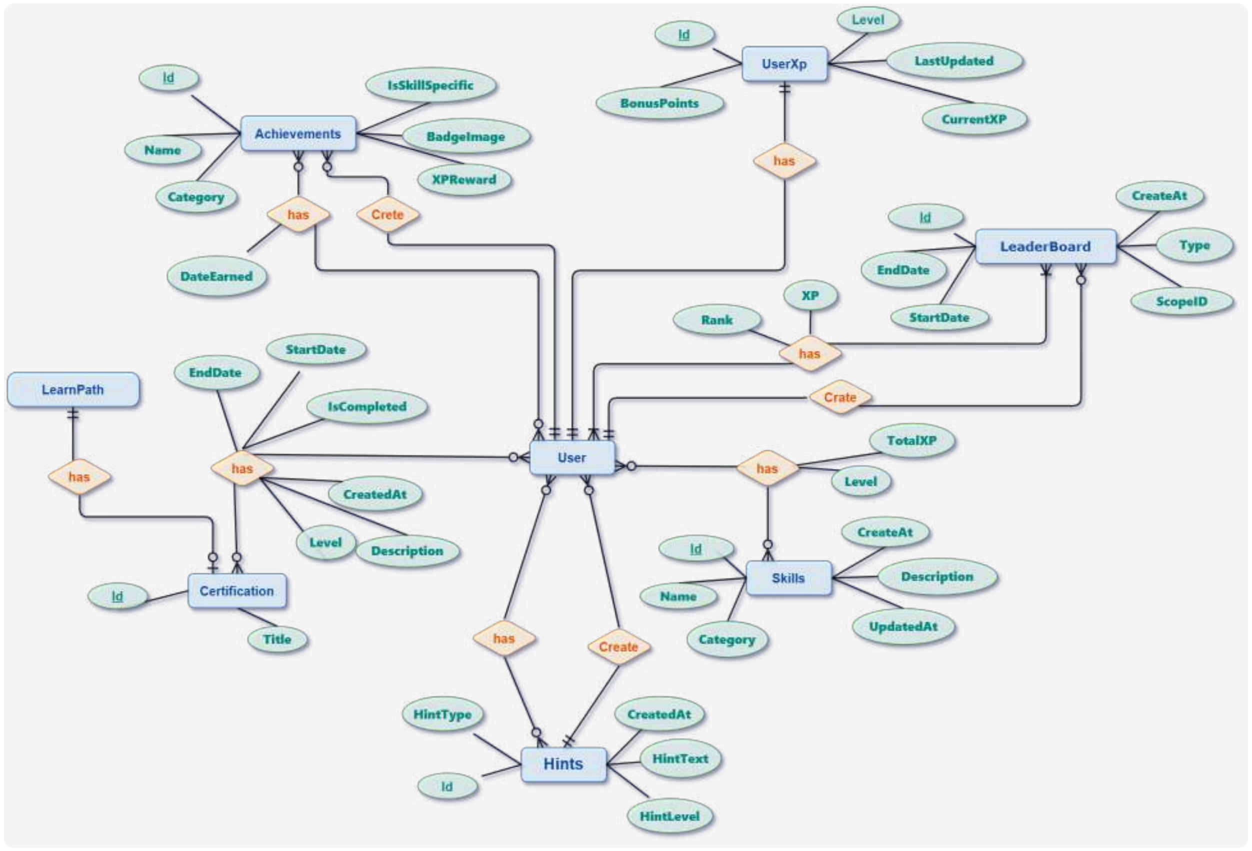

Figure 6.5: Entity Relationship Diagram - Certification and Gamification

Part 6: Administration and System Management

This section illustrates the entities for platform administration, including system logs, analytics, content moderation, reports, backups, and monitoring capabilities.

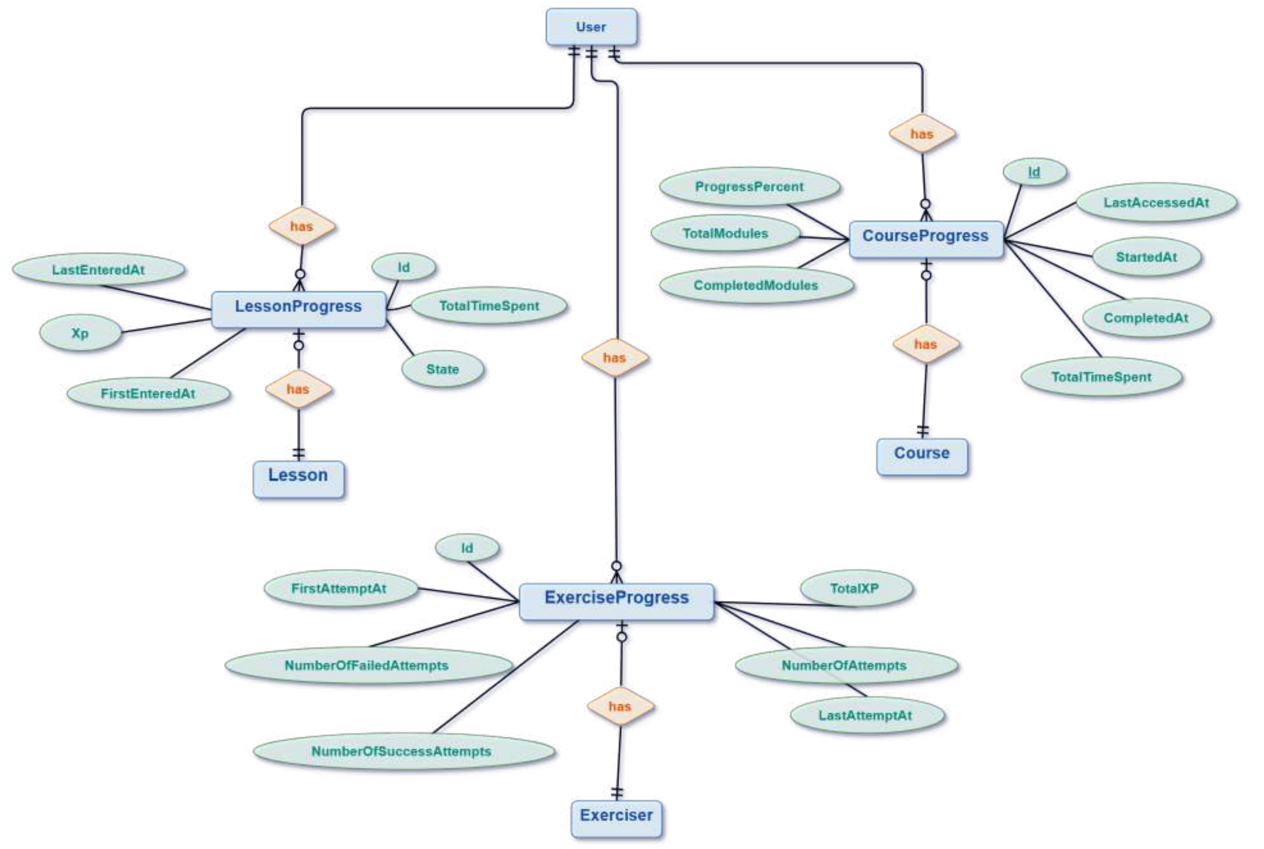

Figure 6.6: Entity Relationship Diagram - Administration and System Management

Database Design Principles

The ERD design follows these key principles:

- **Normalization** : Entities are normalized to reduce data redundancy and improve data integrity
- **Referential Integrity** : Foreign key relationships ensure data consistency across tables
- **Scalability** : Design supports horizontal and vertical scaling for growing user base
- **Performance** : Indexed fields and optimized relationships for efficient queries
- **Flexibility** : Schema allows for future extensions and feature additions
- **Security** : Sensitive data fields include encryption and access control mechanisms

These diagrams provide a comprehensive view of the DuoCodo platform's data architecture, showing how information is stored, organized, and related to support all system functionalities.

6.2 Database Schema

Database Schema represents the logical structure of the DuoCodo platform database, showing tables, columns, data types, constraints, and relationships. This detailed schema design ensures optimal performance, data integrity, and supports all platform functionalities.

Part 1: User Management and Authentication

This section presents the database tables for user management, including user accounts, roles, authentication mechanisms, and profile information. It establishes the foundation for user identity and access control with detailed field specifications.

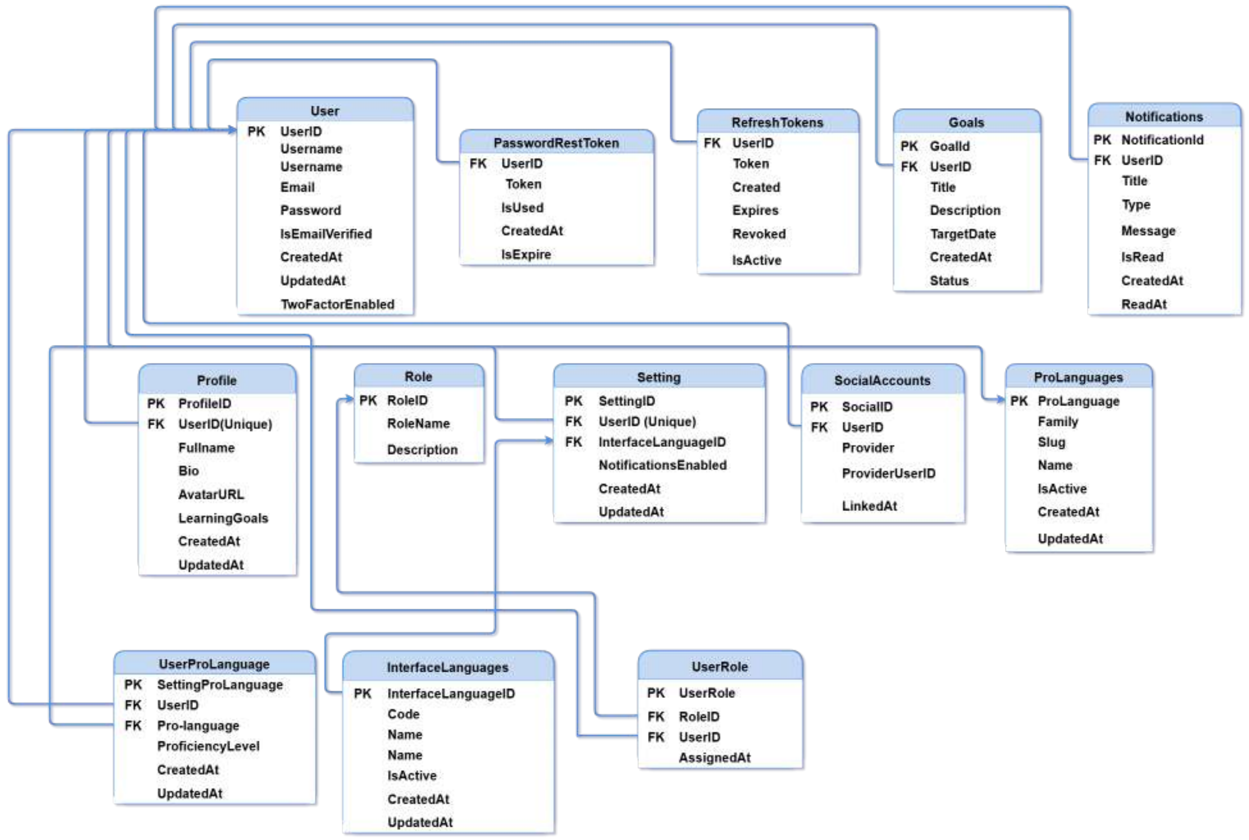

Figure 6.7: Database Schema - User Management and Authentication

Part 2: Learning Content and Course Structure

This section illustrates the database tables related to educational content organization, including courses, lessons, modules, exercises, and learning paths. It shows how content is structured and stored within the database with proper data types and constraints.

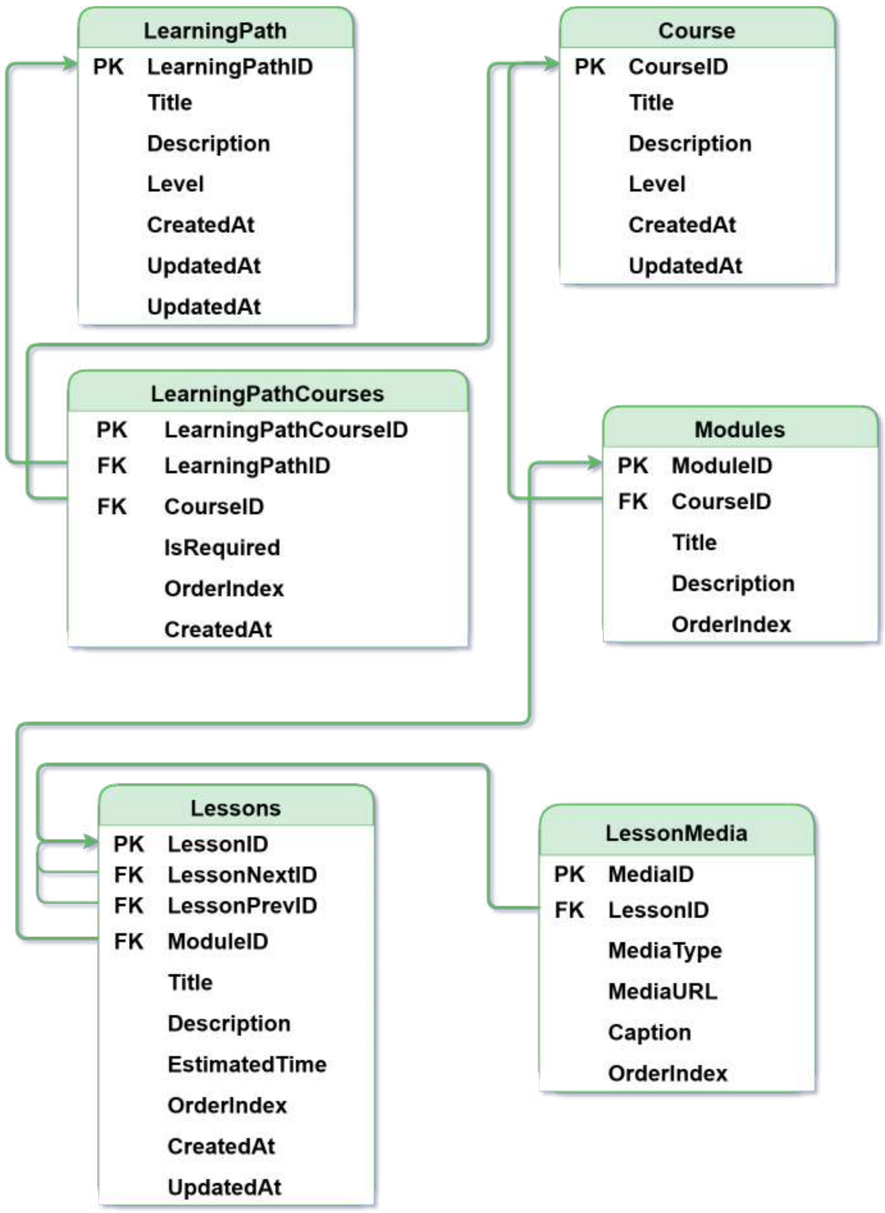

Figure 6.8: Database Schema - Learning Content and Course Structure

Part 3: Submissions and Code Execution

This section demonstrates the database tables that track learner progress, achievements, experience points (XP), badges, streaks, and leaderboard rankings. It shows how the platform stores and manages gamification elements with appropriate indexing.

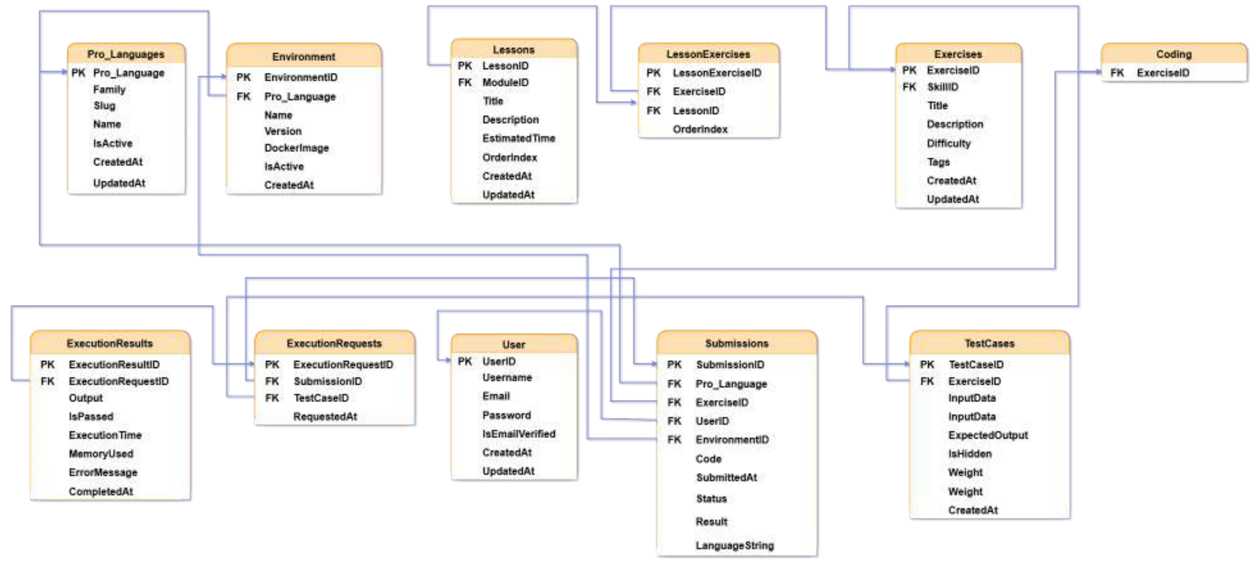

Figure 6.9: Database Schema - Submissions and Code Execution

Part 4: Exercises, Attempts and Code Analysis

This section shows the database tables for quizzes, assessments, test cases, submissions, grading, and certifications. It demonstrates how the platform stores evaluation data and manages credentials with proper validation constraints.

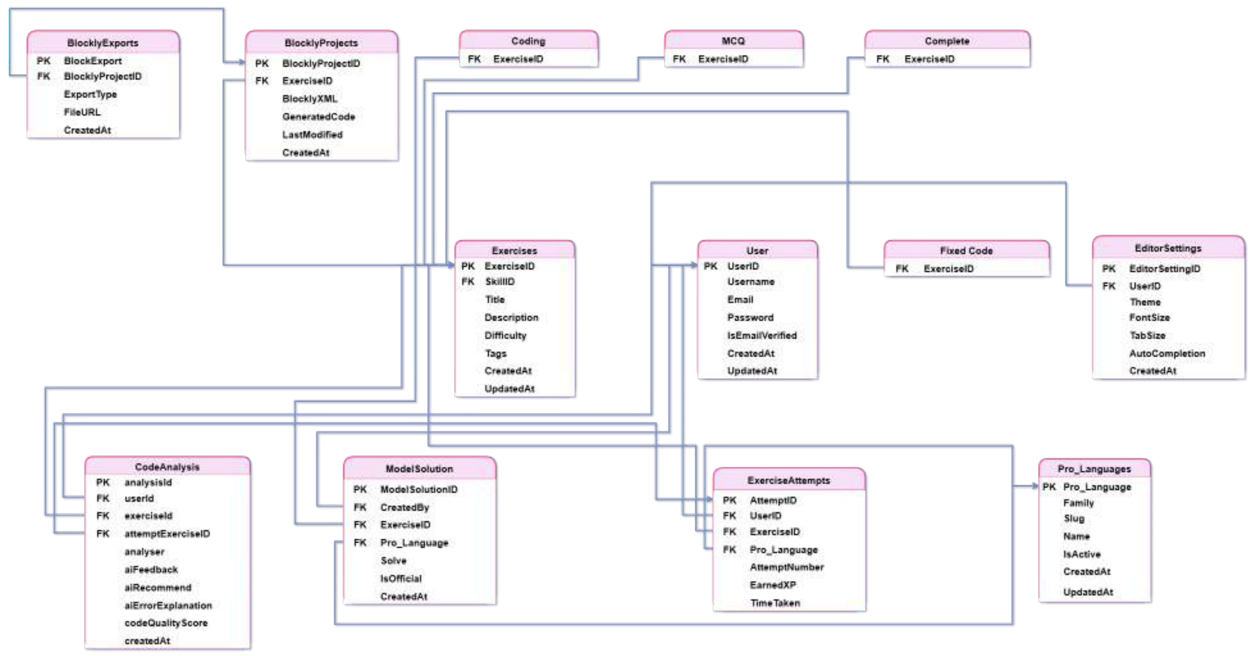

Figure 6.10: Database Schema - Exercises, Attempts and Code Analysis

Part 5: Certification and Gamification

This section presents the database tables that enable social interactions, including comments, discussions, friend connections, notifications, sharing, and community engagement features with optimized query structures.

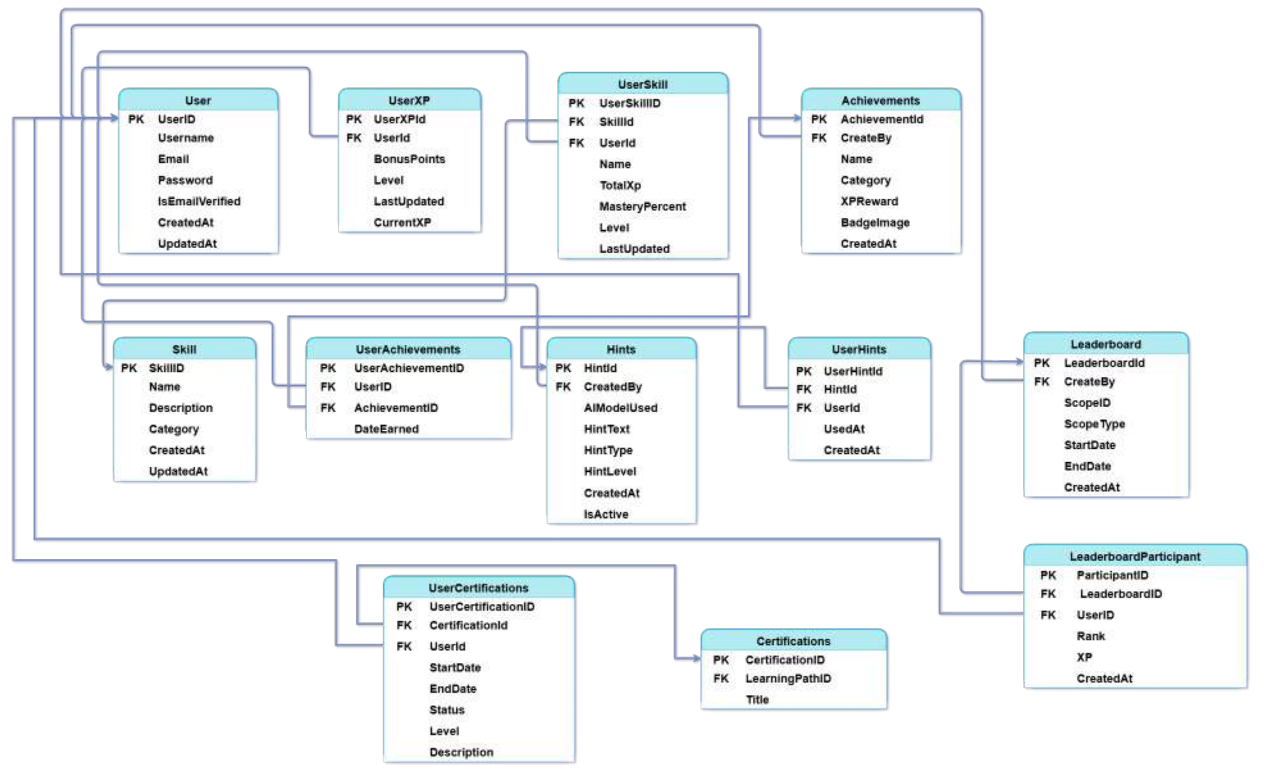

Figure 6.11: Database Schema - Certification and Gamification

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Part 6: Administration and System Management

This section illustrates the database tables for platform administration, including system logs, analytics, content moderation, reports, backups, and monitoring capabilities with appropriate data retention policies.

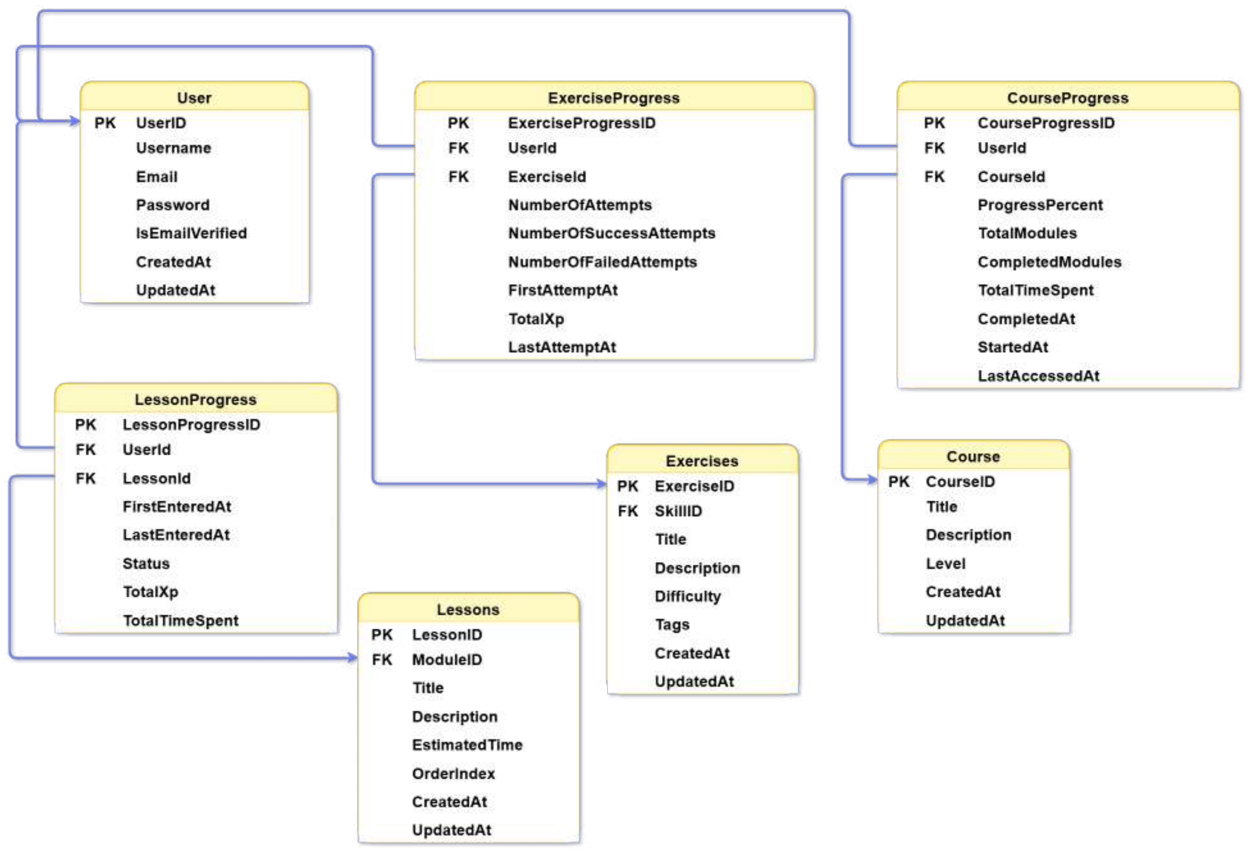

Figure 6.12: Database Schema - Administration and System Management

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Database Schema Specifications

The database schema implementation follows these key specifications:

- **Data Types** : Appropriate data types chosen for optimal storage and performance
- **Constraints** : Primary keys, foreign keys, unique constraints, and check constraints ensure data integrity
- **Indexing** : Strategic indexes on frequently queried columns for optimal performance
- **Normalization** : Tables normalized to 3NF (Third Normal Form) to eliminate redundancy
- **Referential Integrity** : Foreign key relationships maintain consistency across related tables
- **Security** : Sensitive fields include encryption specifications and access control measures
- **Scalability** : Schema design supports partitioning and sharding for future growth
- **Backup Strategy** : Tables include timestamp fields for incremental backup operations

This detailed schema provides the implementation blueprint for the DuoCodo platform's database, ensuring robust data management and optimal query performance across all system components.

Chapter Chapter 7: User Interface

7.1 Authentication Screens

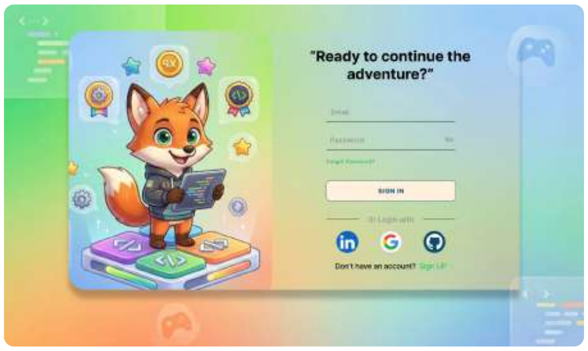

"Ready to continue the adventure?"

Figure 7.1: Login Screen

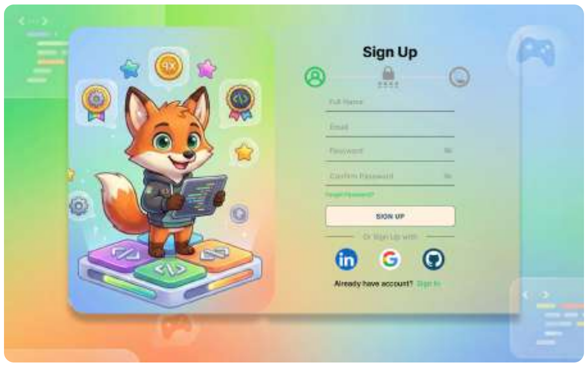
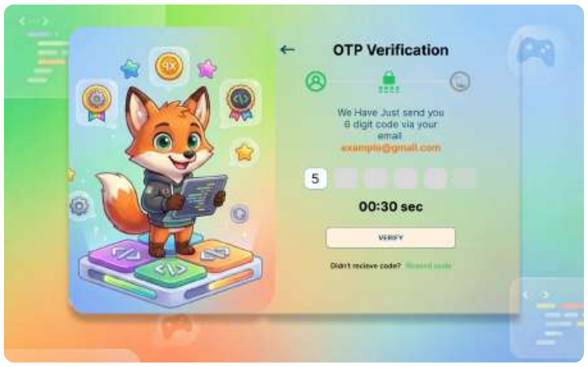
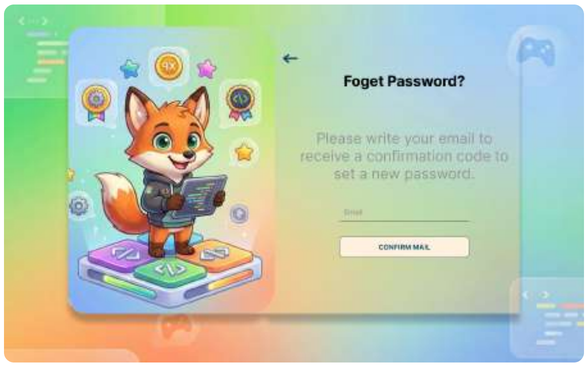


Figure 7.2: Registration Screen



We Have Just send you 6 digit code via your email example@gmail.com

Figure 7.3: OTP Verification Screen



Please write your email to receive a confirmation code to set a new password.

Figure 7.4: Password Entry Screen

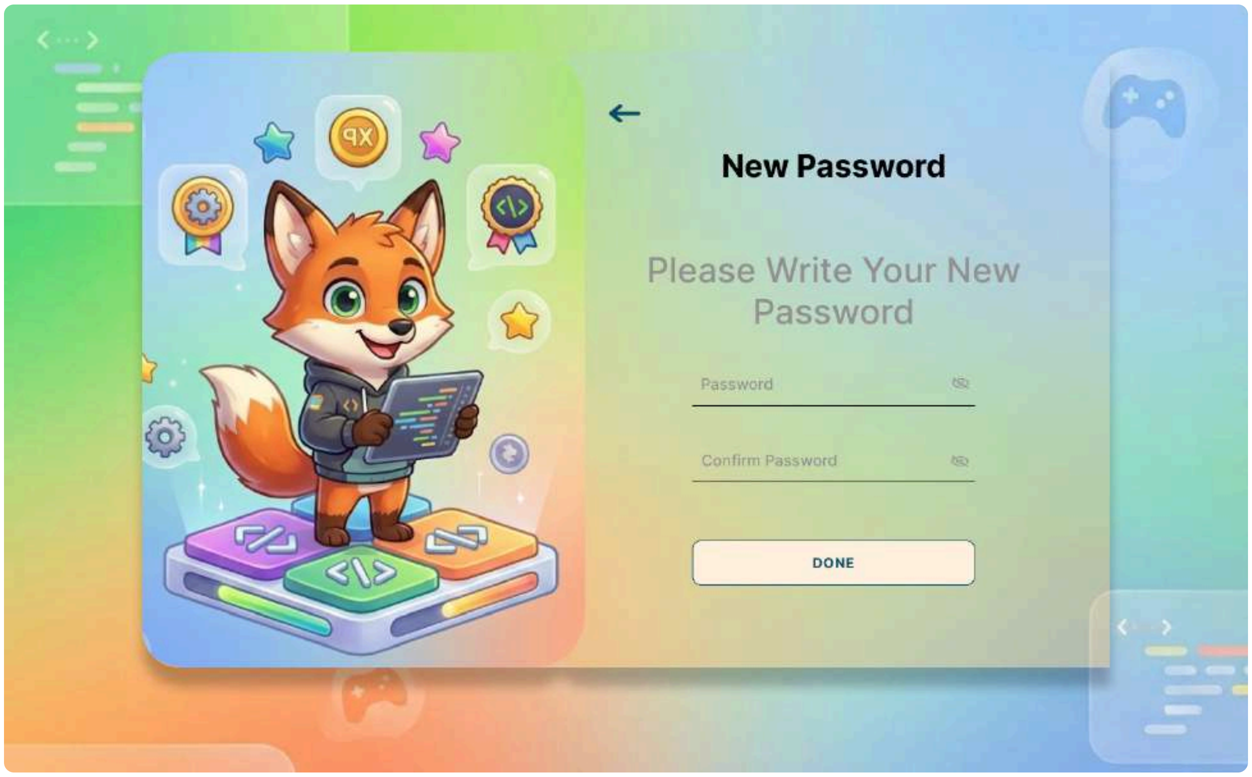


Figure 7.5: New Password Creation Screen

7.2 Main Dashboard

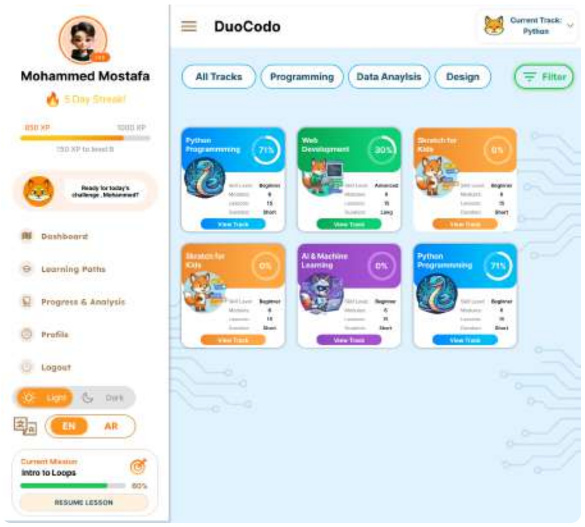
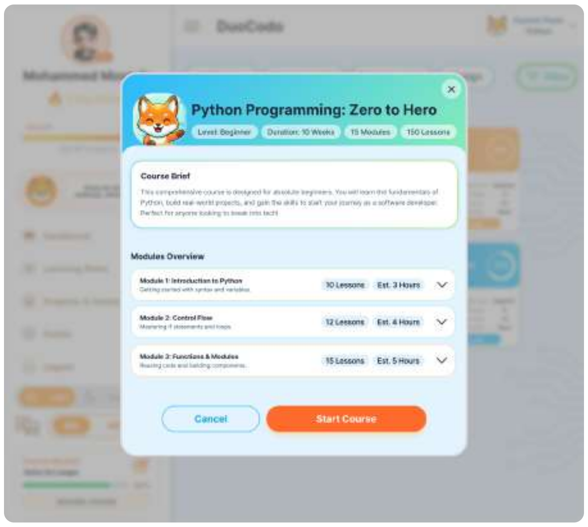


Figure 7.6: Main Dashboard


Python Programming: Zero to Hero
Level: Beginner
Duration: 10 Weeks
15 Modules
150 Lessons
Course Brief

This comprehensive course is designed for absolute beginners. You will learn the fundamentals of Python, build real-world projects, and gain the skills to start your journey as a software developer. Perfect for anyone looking to break into tech!

Modules Overview
Module 1: Introduction to Python
Getting started with syntax and variables
10 Lessons
Est. 3 Hours
Module 2: Control Flow
Mastering if statements and loops
12 Lessons
Est. 4 Hours
Module 3: Functions & Modules
Reusing code and building components
15 Lessons
Est. 5 Hours
Cancel
Start Course

Figure 7.7: Dashboard Details View

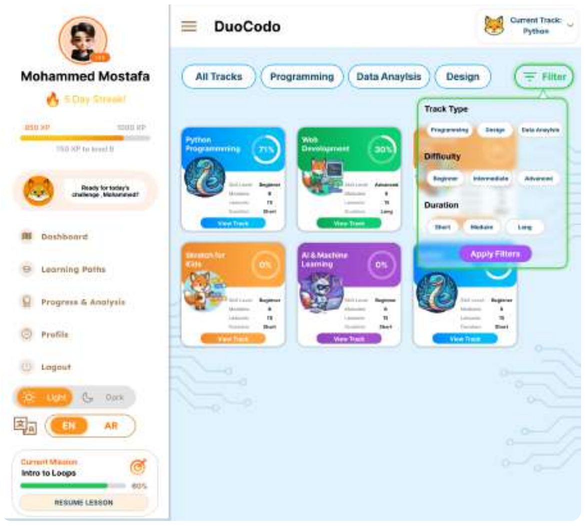


Figure 7.8: Dashboard with Filtration Options

7.3 Learning Features

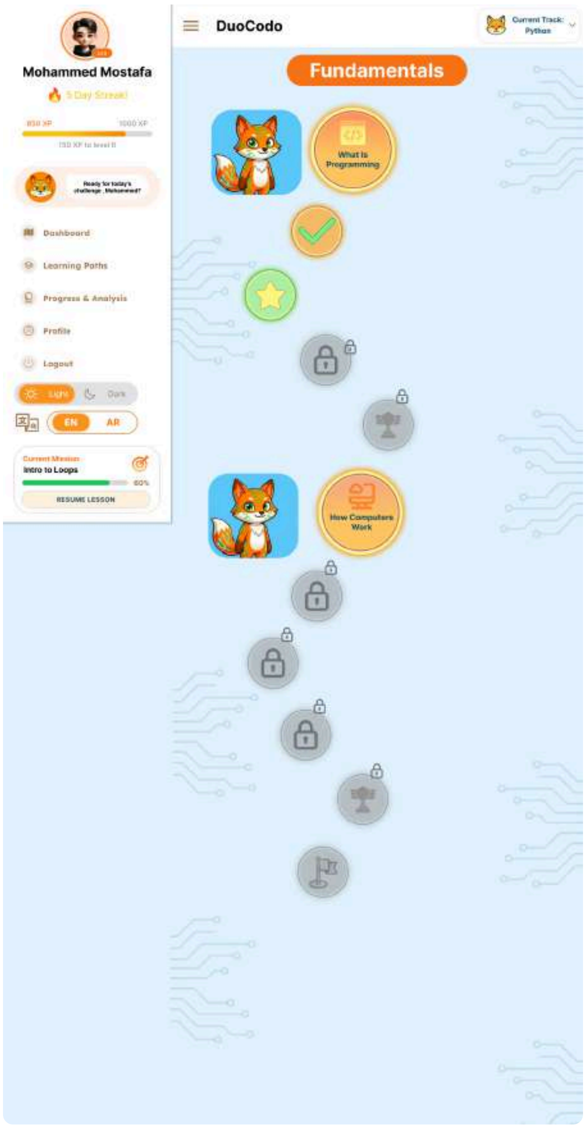
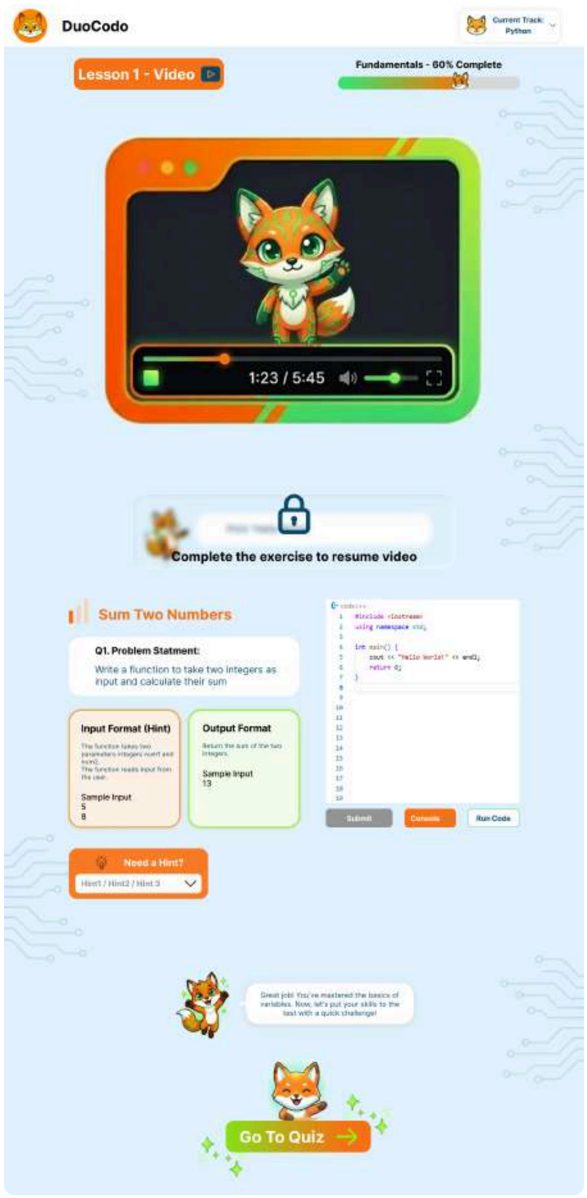


Figure 7.9: Learning Path Interface



Q1. Problem Statment:

Write a flunction to take two integers as input and calculate their sum

The function takes two parameters integers num1 and num2.
The function reads input from the user.

Sample Input
5
8

Return the sum of the two integers.

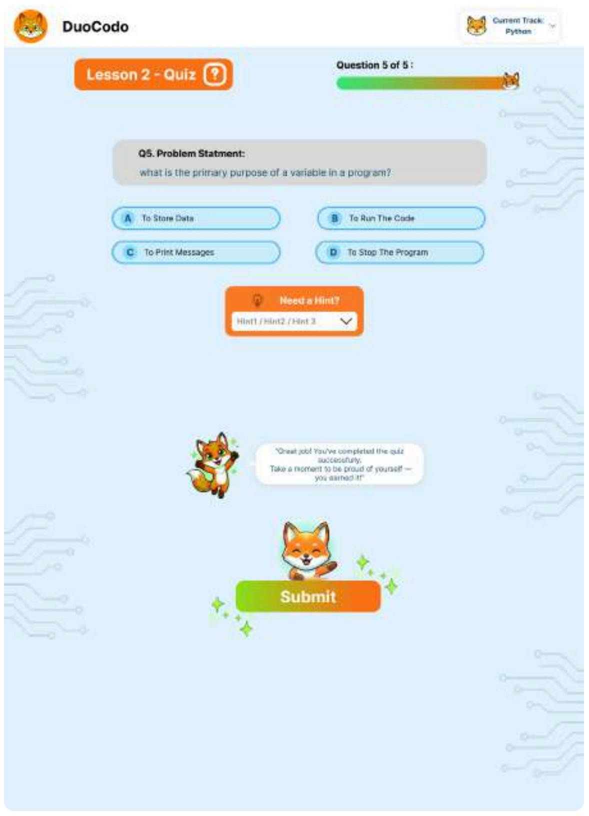
Sample Input
13

```cpp
#include <iostream>
using namespace std;

int main() {
    cout << "Hello World!" << endl;
    return 0;
}
```

Great job! You've mastered the basics of variables. Now, let's put your skills to the test with a quick challenge!

Figure 7.10: Video Player Screen



Q5. Problem Statment:

what is the primary purpose of a variable in a program?

A To Store Data

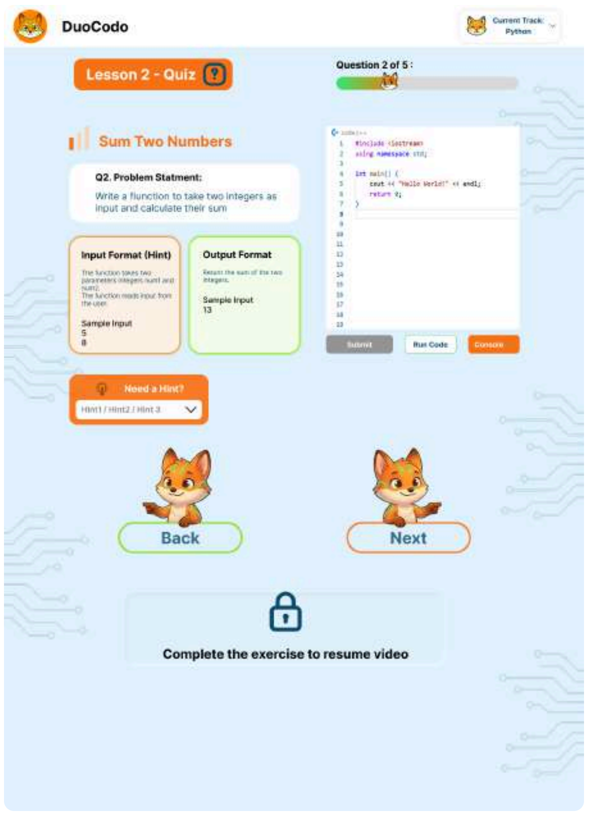
B To Run The Code

C To Print Messages

D To Stop The Program

"Great job! You've completed the quiz successfully. Take a moment to be proud of yourself — you earned it!"

Figure 7.11: Multiple Choice Quiz



Q2. Problem Statment:

Write a flunction to take two integers as input and calculate their sum

Input Format (Hint)

The function takes two parameters integers num1 and num2.
The function reads input from the user.

Sample Input
5
8

Output Format

Return the sum of the two integers.

Sample Input
13

```
#include <iostream>
using namespace std;

int main() {
    cout << "Hello World!" << endl;
    return 0;
}
```

Complete the exercise to resume video

Figure 7.12: Code Quiz Interface

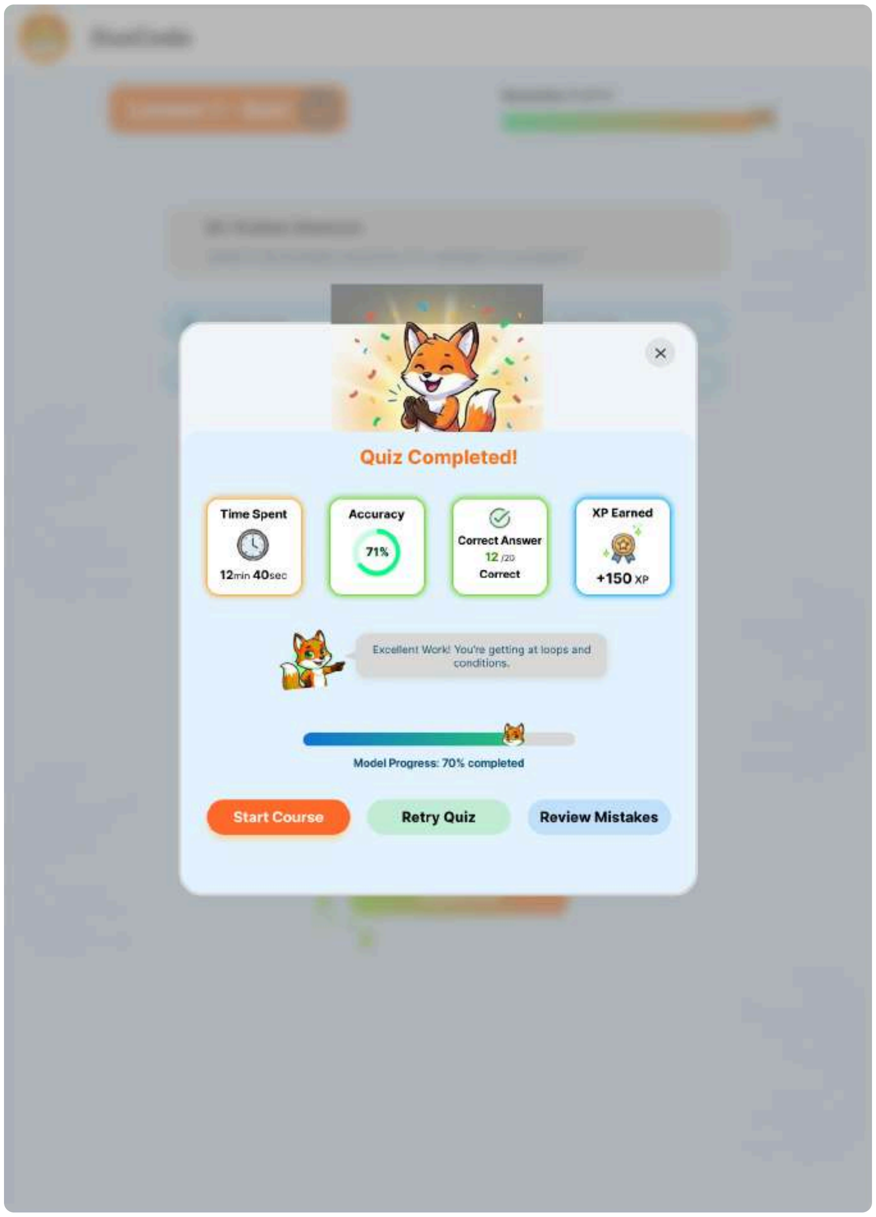


Figure 7.13: Quiz Completion Screen

7.4 Progress Tracking & Analytics

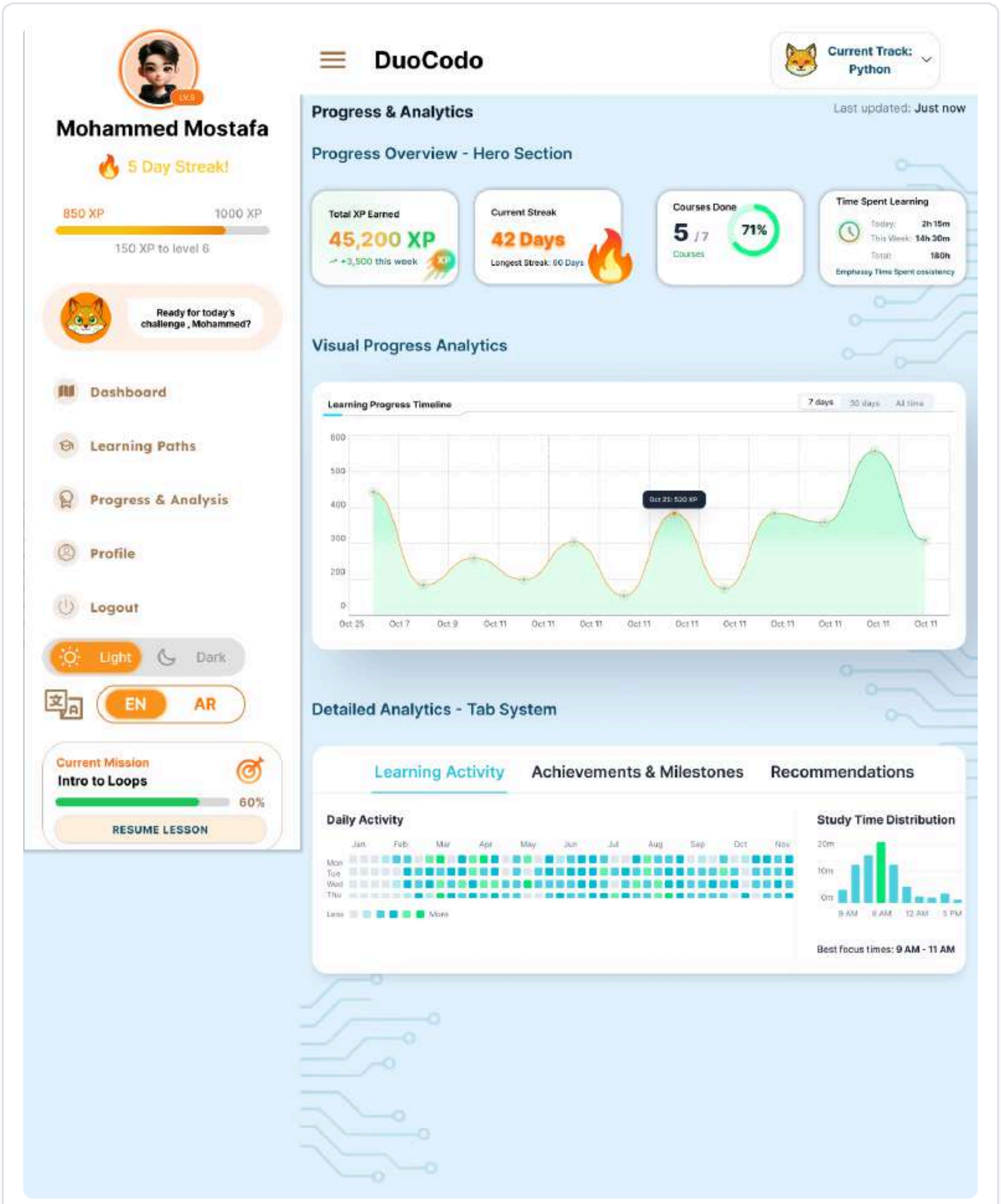
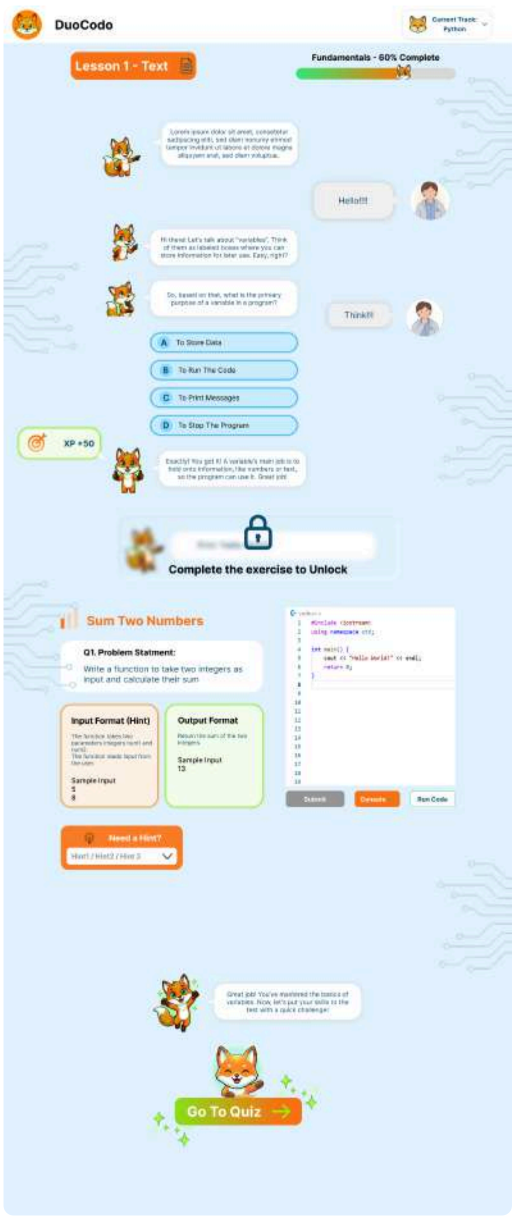


Figure 7.14: Progress & Analysis Dashboard

7.5 Communication & Settings



Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua.

Hi there! Let's talk about "variables". Think of them as labeled boxes where you can store information for later use. Easy, right?

So, based on that, what is the primary purpose of a variable in a program?

A To Store Data
B To Run The Code
C To Print Messages
D To Stop The Program

Exactly! You got it! A variable's main job is to hold onto information, like numbers or text, so the program can use it. Great job!

Q1. Problem Statment:
Write a function to take two integers as input and calculate their sum

Input Format (Hint)
The function takes two parameters integers num1 and num2.
The function reads input from the user.
Sample Input
5
8

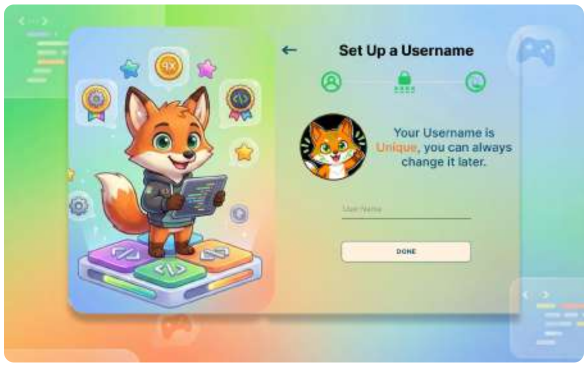
Output Format
Return the sum of the two integers.
Sample Input
13

```
#include <iostream>
using namespace std;

int main() {
    cout << "Hello World!" << endl;
    return 0;
}
```

Great job! You've mastered the basics of variables. Now, let's put your skills to the test with a quick challenge!

Figure 7.15: Chat Interface



Your Username is Unique, you can always change it later.

Figure 7.16: User Profile Screen

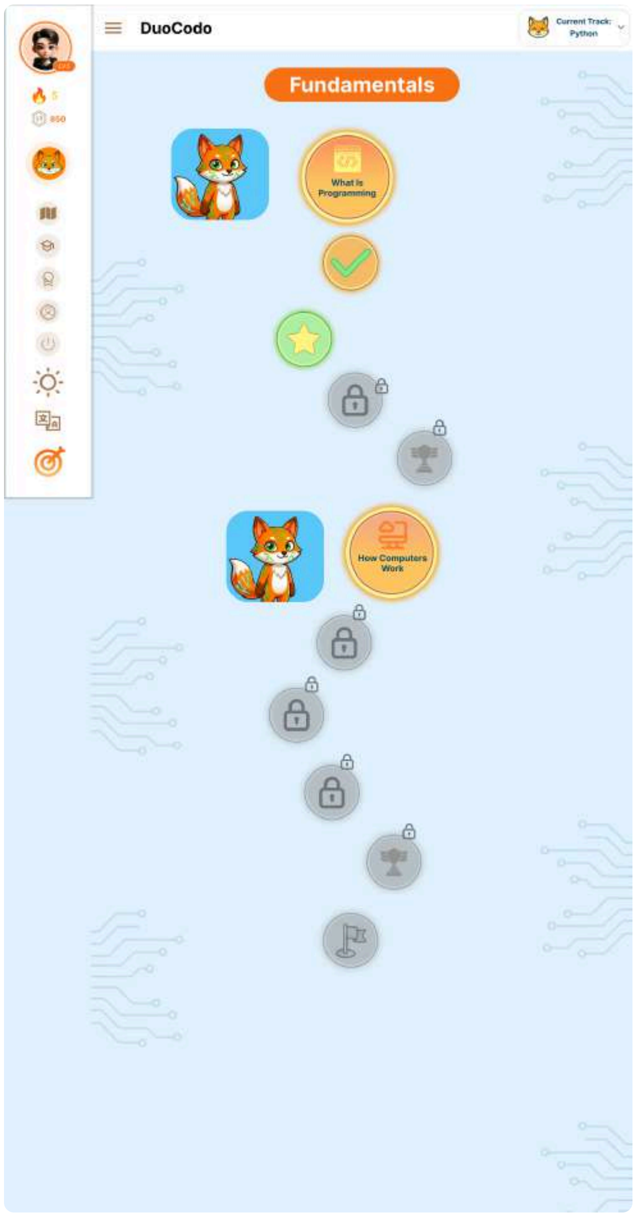


Figure 7.17: Interface with Collapsed Sidebar

7.6 Theme Options

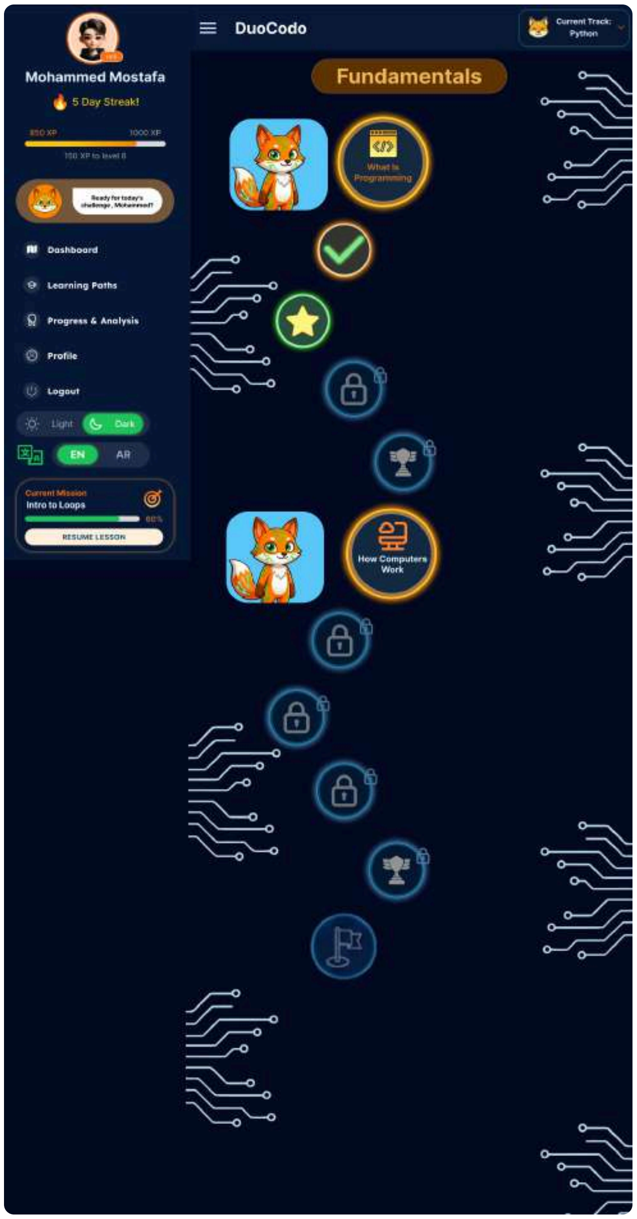


Figure 7.18: Dark Mode Interface