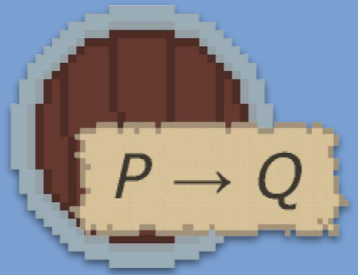

LogicPath

“Level up your thinking”

CS410 – Fall 2025
Team Emerald

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Team Bio

Paul Schacht
Project Lead
He is senior at Old Dominion University, studying Computer Science. His personal interests include software development, music production, gaming, and philosophy.

Caleb Anderson
Programming Lead
Caleb is a senior at Old Dominion University, studying Computer Science with a minor in Cybersecurity. He also recently completed his AWS Cloud Practitioner certification, and is currently working on personal projects involving Java, Python, and Rust.

Krishna Paneru
Design/Programming
Krishna is a senior at Old Dominion University, studying Computer Science. Her personal interests include software development, cooking and social work.

Team Bio cont.

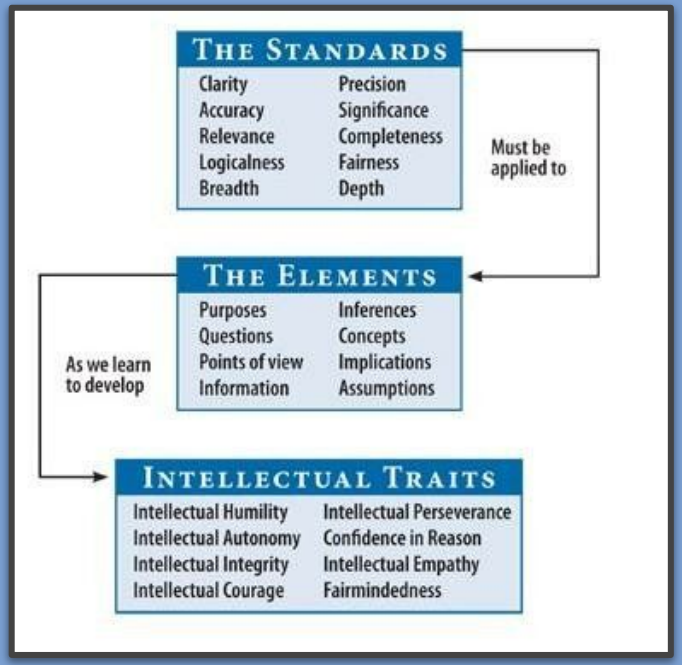
Mia Lai
Webmaster
Mia Lai is a Computer Science Major at Old Dominion University. She is in her fourth year and has some previous experience in web development.

Trent Thorne
Design/Programming
Trent is a Computer Science Major at Old Dominion University. He formally was a member of the US Coast Guard and is looking to start a career in software engineering.

Background

- **Logical thinking** is an essential skill
  - **Logic** is a foundational bedrock of **critical thinking** (Fig 1)
  - Spans across multiple domains like academics, civic engagement, personal decision-making, and more
  - Enables people to evaluate arguments, analyze information, and problem solve more efficiently (Martel et al., 2020).
- *It can be viewed as a fundamental scaling stat where 'leveling it up' improves various aspects of your life*.

Fig 1: Paul-Elder Critical Thinking Framework



Hua, Yanan. (2018)

Background cont.

- In an era of rampant misinformation, the ability to parse and evaluate arguments/information has become more important than ever. However:
  - Many students have poor digital literacy and online critical thinking (Breakstone et al., 2019)
    - “Ninety-six percent of [3,446] students did not consider why ties between a climate change website and the fossil fuel industry might lessen that website’s credibility. “
  - Literacy, numeracy, and problem-solving skills amongst adults “have largely declined or stagnated over the past decade in most OECD countries” (OECD, 2024)
    - “But in most countries, the literacy proficiency of the lowest-performing 10% of the population has declined, with similar declines in numeracy”

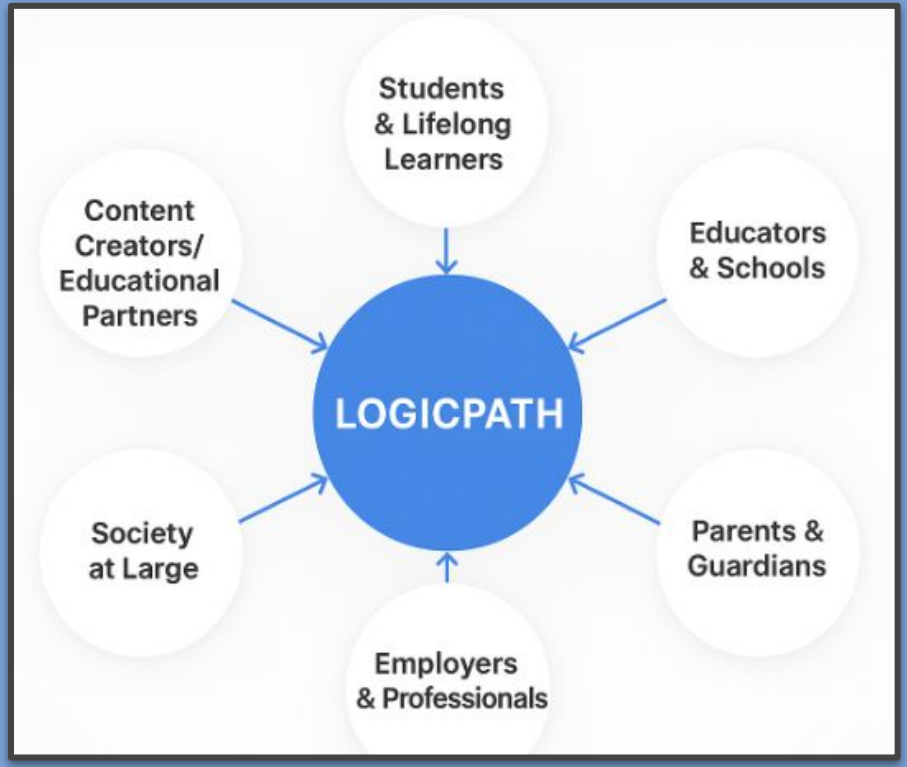
Problem Statement

“Despite logical thinking being an incredibly important skill, there are no comprehensive, yet engaging and accessible resources on logic.”

- The currently existing online educational resources on logic may roughly fall in one of these two categories:
  1) Is engaging, yet fails to cover logic with sufficient depth and structure
  2) Sufficiently covers logic, yet is dry and unengaging

Users/Customers/Stakeholders

- **Users**
  - High School & College Students
  - Lifelong Learners
  - Educators
- **Customers**
  - Individuals
  - Schools / Educational Institutions
- **Stakeholders**
  - Students & Learners
  - Schools & Educators
  - Parents
  - Employers
  - Society



Target Demographic

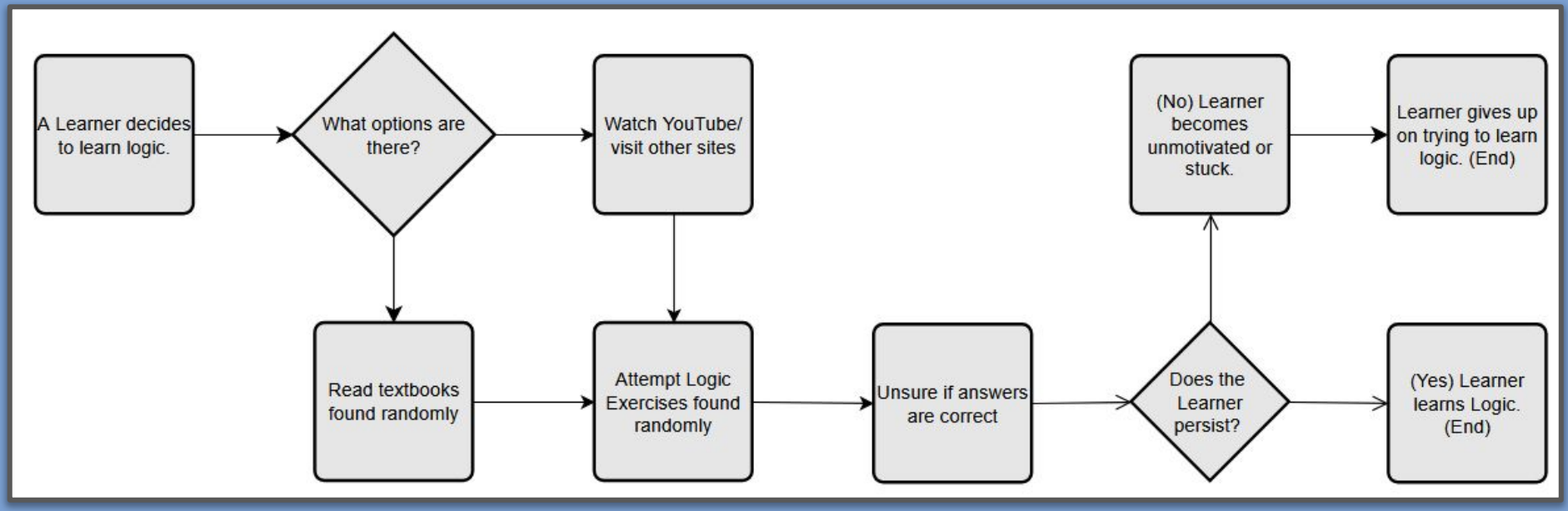
- High school juniors/seniors preparing for standardized tests (SAT, ACT)
- College students in philosophy, law, or STEM programs with logic requirements
- Adult professionals seeking to improve critical thinking for career advancement

Reasoning: Gaming audiences are mostly young people. So targeting a younger demographic with a gamified version of their course material is ideal.

Problem Characteristics

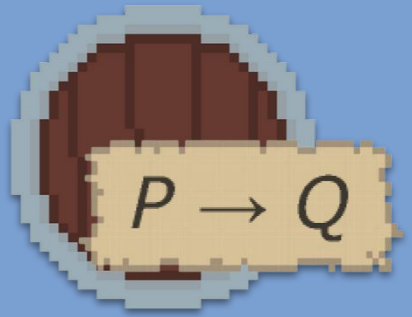
- **Few engaging resources in Logic**
  - Traditional logic resources are text-heavy and dry due to a lack of interactive and engaging content
  - Learners lose their motivation, reducing skill development
- **Lackluster gamification for sustained engagement**
  - Existing resources rarely use game elements like quests or streaks
  - Engagement drops without long term motivation mechanisms
- **Lack of structured progression in logic learning**
  - Most platforms provide scattered or one off exercises
  - Learners lack a guided path from basic reasoning to formal logic learning
- **Poor real-world application**
  - Logic resources often focus on the theory, or at most, applies it to distilled, non-relevant arguments
  - Learners may struggle to apply formal reasoning skills to real-world situation
- **Weak connection between theory and practice**
  - Logic resources present theory without opportunities to apply it
  - Learners fail to make the connection between theory links to real world reasoning
- **Limited focus on informal and formal logic**
  - Few learning tools cover both everyday reasoning and formal logic systems
  - Learners get a loose understanding of logical thinking

Current Process Flow



Solution

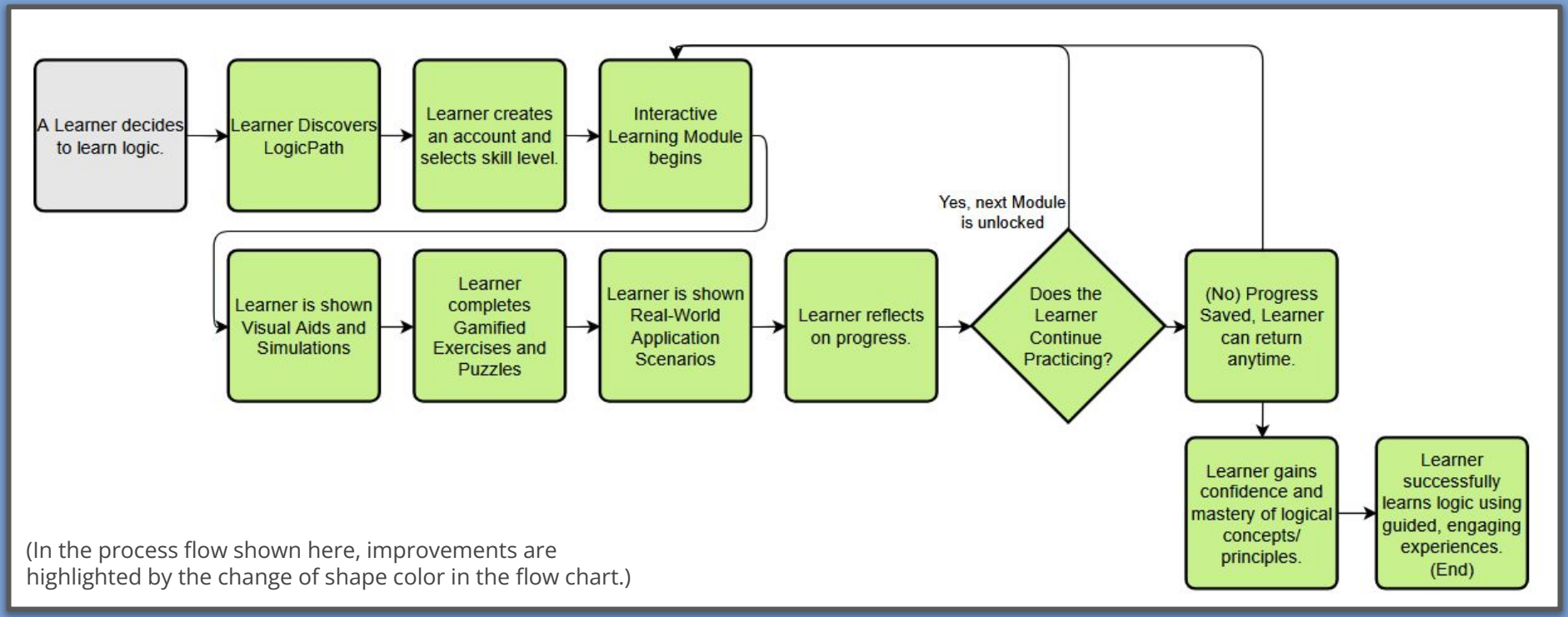
- **LogicPath** is an interactive learning website designed to make learning logic, formal and informal, *engaging, accessible, and fun*.
- **LogicPath** blends education with *interactivity* and *gamification* to create a dynamic learning environment.



Solution Characteristics

- **Interactive Learning Modules**: Step-by-step lessons that gradually introduce concepts from everyday reasoning to formal logic.
- **Gamified Exercises & Puzzles**: Logic quests, challenges, and streak rewards to motivate continued practice.
- **Visual Aids & Simulations**: Diagrams and flowcharts to make abstract concepts easier to understand.
- **Real-World Applications**: Lessons tied to analyzing news and debates, to personalize decision making.

Solution Process Flow



(In the process flow shown here, improvements are highlighted by the change of shape color in the flow chart.)

Monetization Options

- Individual Users: Free (Base Version) / $24.99/year (Premium)
- Organizations/Businesses/Universities:

User Count	Price/User/Year	Discount	Notes
1-49	$24.99	0%	Small Organizations
50-499	$19.99	20%	College Department
500-1,999	$14.99	40%	University Program
2,000-4,999	$9.99	60%	Large Institutions
5,000+	$6.99	72%	System-wide License

Premium Features:

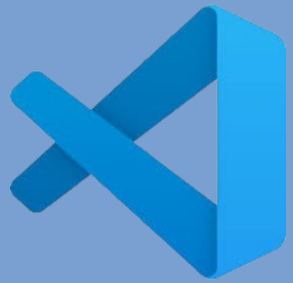
- Access to Relevant Real-World Reasoning Exercises/Examples
- Enhanced Learning Insights
- AI-Driven Adaptive Learning

Major Functional Components

- **Presentation Layer**
  - User Interface
    - Web Application
  - Student/Learner Profile
    - Registration/login
  - Social/Engagement Features
    - Sharing progress
- **Application Layer**
  - Learning Module Engine
  - Gamification & Motivation Engine
  - Adaptive Learning Engine
  - Assessment & Feedback Manager
  - Content Management System
- **Data Layer**
  - User Date
    - Profiles, preferences, learning history
  - Store data
    - Name, Course ID
  - Container Data

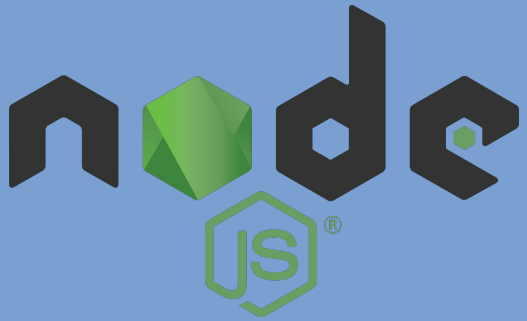
Development Tools

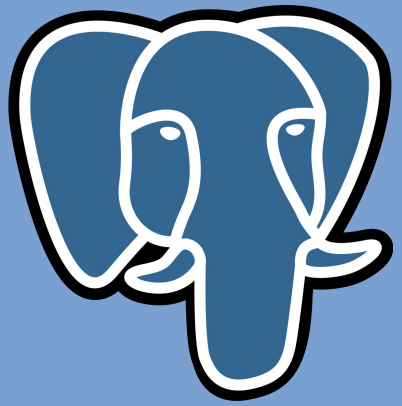
- **IDE**: VSCode
- **Version Control**: Git & GitHub
- **CI/CD**: GitHub Actions & Workflows



Tech Stack

- **Front-end Languages**: HTML, CSS, Javascript, React
- **Back-end Languages**: Node.js
- **Database**: PostgreSQL

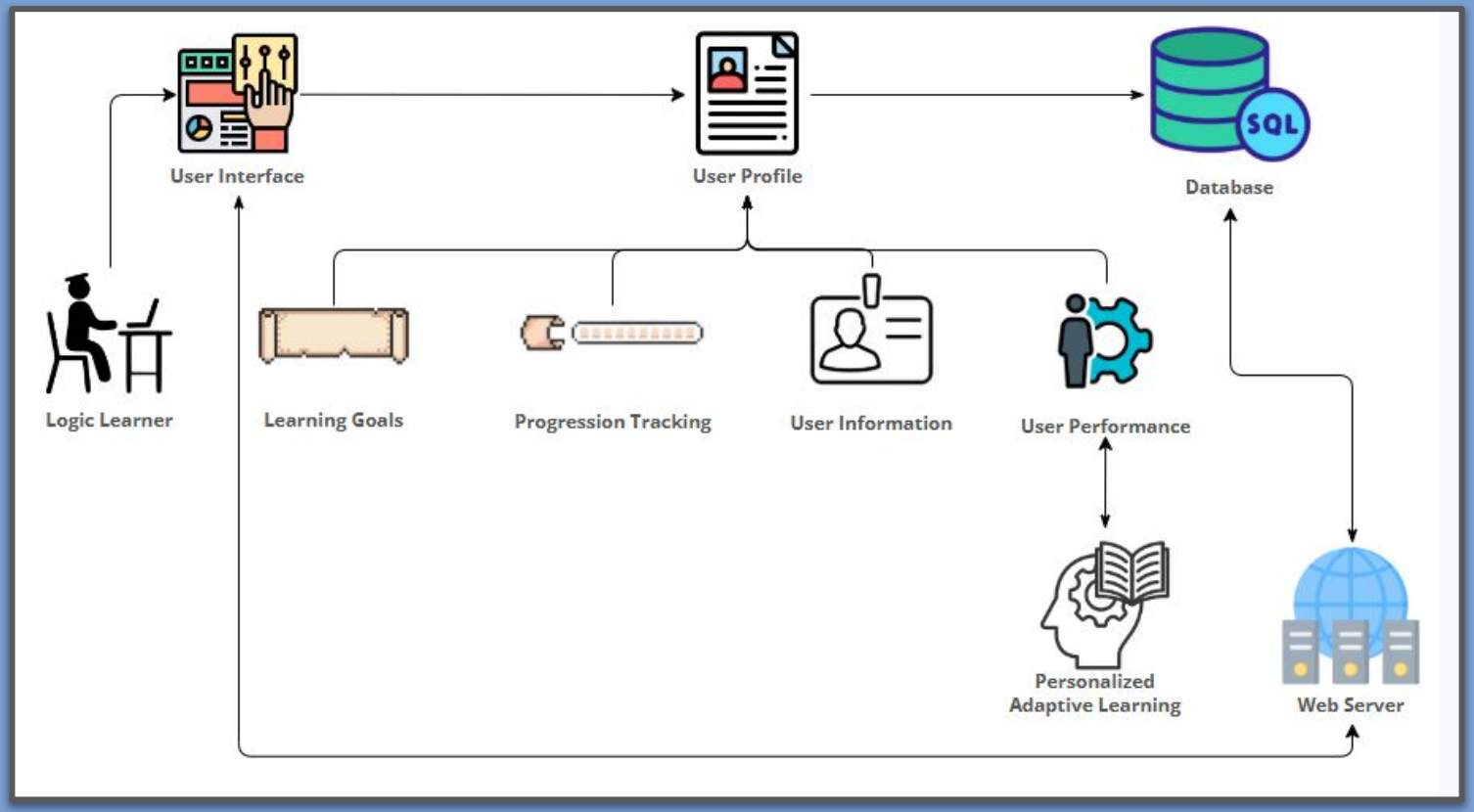




Data & Privacy

- **Data & AI**
  - Track user progress , performance and learning history
  - Uses rule-based logic for adaptive difficulty
  - Future -ready for machine learning integration
- **Privacy & Ethics**
  - Minimum data collection
  - Encrypted storage and secure login
  - User control over data

Major Functional Component Diagram



Interaction Between Layers

The engine lives in the **Application Layer** and acts as the brain of LogicPath. It handles:

- **User input** from the interface (e.g., quiz answers, module progress) **Logic processing** to determine what content to show next
- **Gamification triggers** like streaks, badges, and difficulty adjustments

It communicates with other components in the Application Layer like:

- **Learning Module Engine** → to deliver the right and appropriate lesson based on the learner's current level and goals
- **Assessment & Feedback Manager** → to evaluate responses and provide feedback
- **Gamification Engine** → to update points, levels, and achievement

Interaction Between Layers cont.

The Adaptive Learning Engine constantly reads from and writes to the **Data Layer**, which stores:

- **User Profiles** → name, course ID, preferences
- **Learning History** → completed modules, quiz results
- **Performance Metrics** → accuracy, time spent, retry attempts

This data is used to:

- Adjust lesson difficulty
- Unlock new modules
- Provide personalized feedback
- Track long-term progress

Summary of MFC

The Adaptive Learning Engine is the intelligence core of LogicPath. It connects the user interface, application logic, and data storage to deliver a personalized, secure, and engaging learning experience. This component transforms static lessons into dynamic journeys tailored to each learner's needs.

- **Component name**: Adaptive Learning Engine
- **Purpose** : Personalized logic learning by adjusting difficulty, feedback, and progression
- **Application Layer Role** : Coordinate content delivery, feedback, and gamification
- **Data layer Interaction**: Read/Writes user performance, learning history , and performance
- **Tool Used**: React, NodeJs,javascript, PostgreSQL
- **AI Strategy**: Rule-based logic with future support for machine learning
- **Privacy Measure** : Data minimization, encryption, user control, FERPA/GDPR compliance

What LogicPath Will Do

- **Provide Core Learning Goals**
  - Provide a clear learning modules on the logic
  - Allow learners to apply theoretical concepts to practical contexts
- **Contain Gamified Engagement**
  - RPG Quest-style learning path with skills
  - Levels, points, and achievement tracking to motivate continued engagement
- **Adaptive Learning Features**
  - Personalized difficult adjustments based on user performance
  - Immediate feedback for failed attempts
  - Progress tracking menu for self-assessment
- **Supporting Tools**
  - Glossary/wiki on additional information
  - Tutorials the integrate theory with practice
- **Relevant Real-World Reasoning (Premium)**
  - Regularly updated logic lessons tied to current events to help reinforce learning with real world examples.

What LogicPath Will Not Do

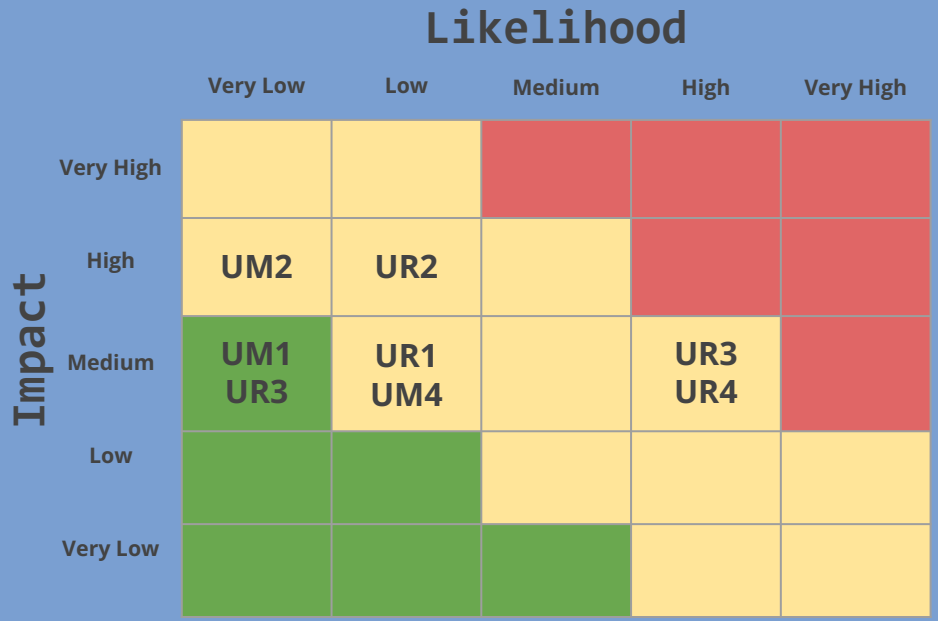
- **Replace formal classroom instruction**
  - This is a supplemental, engaging tool, not a full curriculum replacement.
- **Provide “brain training” without context**
  - Unlike Lumosity, exercises won’t be abstract games with no connection to real-world logic.
- **Act as a debate forum or social media platform**
  - There will not be debate between users. The focus is on building debate skills by analysing examples not through an active forum.

Competition Matrix

	Brilliant.org	Khan Academy	Lumosity	LogicPath
Reasoning	✓ Covers reasoning indirectly through math and problem-solving challenges	✓ Offers some content on critical thinking (mostly in test prep, reading, and argument analysis)	✓ Offers some content on critical thinking (mostly in test prep, reading, and argument analysis)	✓ Dedicated lessons on reasoning, from everyday logic to formal logic
Informal/Formal Logic	✗ Not a focus. Touches on reasoning in math only	✗ Minimal exposure (Basics on arguments in some humanities courses)	✗ None. Only focuses on brain games not structured logic	✓ Core feature is progressive modules on informal and formal logic
Engagement	✗ Limited gamification, mostly traditional problem sets	✗ Engagement relies on video format and quizzes	✓ Strong gamified elements using streaks, leaderboards & mini-games	✓ Gamified quests, challenges, and streaks tied to logic learning
Skill Development	✗ Builds math, CS, and puzzle-solving skills but not transferable logic skills	✗ Academic skills in specific subjects, but weak in general reasoning	✗ Improves short-term memory and focus, not reasoning skills	✓ Structured path to build long-term logic and critical thinking abilities
Theory Development	✗ Some exposure to STEM theories, but no logic theory foundation	✗ Mostly focused on applied content, theory limited	✗ No theory, only experimental games	✓ Lessons explicitly develop both logic theory and application

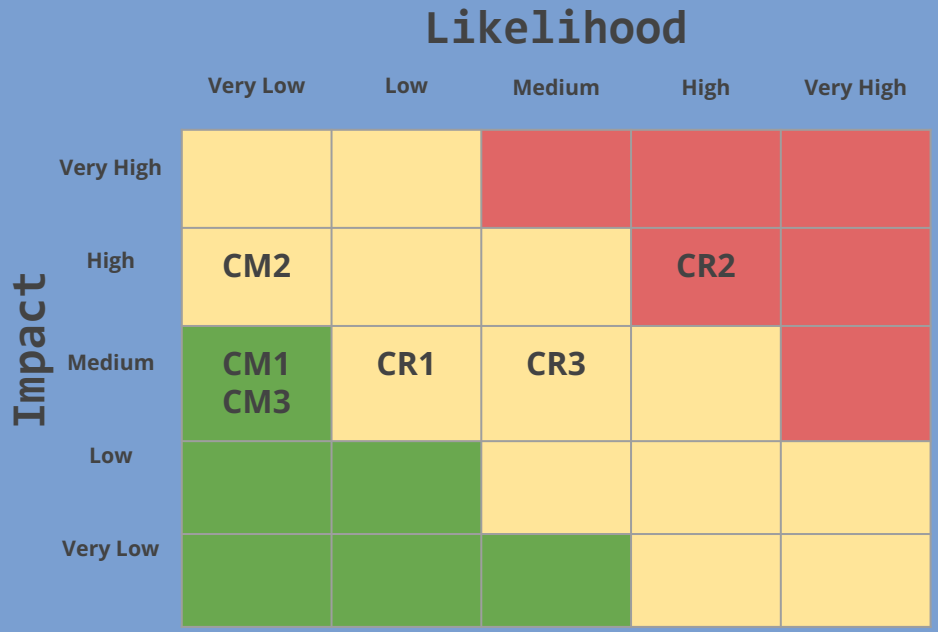
User Risk Matrix

- **Risks**
  - **UR1**: Limited personalization risk
  - **UR2**: Insufficient feedback risk
  - **UR3**: Limited progress tracking risk
  - **UR4**: User may find progression to be too difficult
- **Mitigation**
  - **UM1**: Adaptive learning features that adjust difficulty based on user performance.
  - **UM2**: Immediate feedback on failed attempts with detailed explanations of why answers are wrong.
  - **UM3**: Achievement history displaying badges, streaks and milestones.
  - **UM4**: Break complex topics into smaller lessons



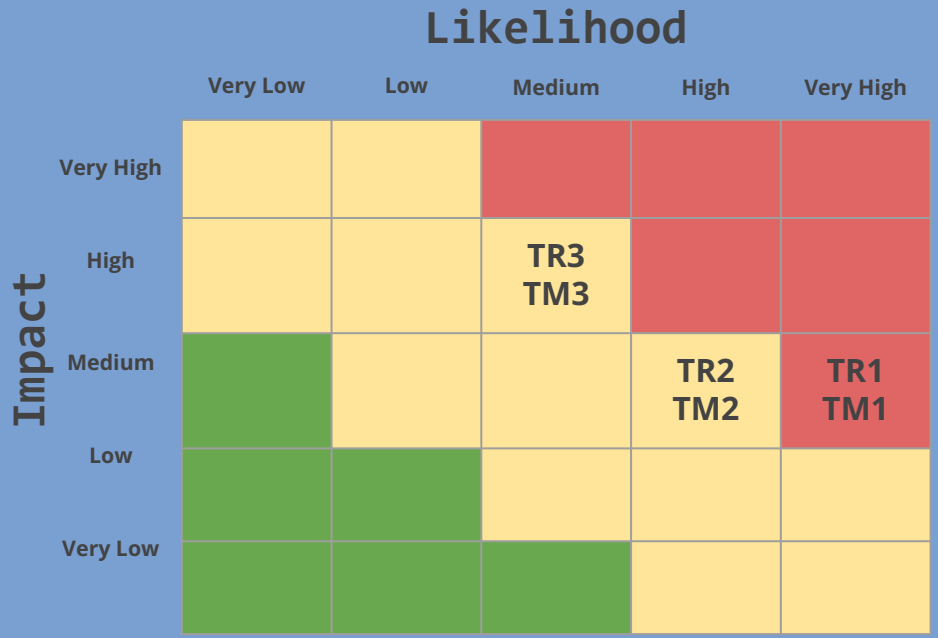
Customer Risk Matrix

- **Risks**
  - **CR1**: Teachers may not think the app is credible.
  - **CR2**: People may not want to pay for premium services.
  - **CR3**: People make find the topic too intimidating still.
- **Mitigation**
  - **CM1**: Partner with logic professors for content validation
  - **CM2**: Tiered pricing for individuals vs institutions
  - **CM3**: Extensive beta testing with target users.



Technical Risk Matrix

- **Risks**
  - **TR1**: Creating high quality content that is engaging may be more time consuming.
  - **TR2**: Creating both web and mobile platforms at the same time may delay development time.
  - **TR3**: Interactive simulations and gamification of the content may be challenging for a college team.
- **Mitigation**
  - **TM1**: Modular content architecture
  - **TM2**: Build web platform first, use proven frameworks (React, Node.js)
  - **TM3**: Prototype complex features before implementation



User Roles

Free user (base user)

- Creates account and selects initial skill level
- Access to core and interactive learning modules
- Tracks progress, streaks, basic achievements
- Limited to base logic curriculum
- Progresses from simple truth tables to complex logical operators

Premium Learner (individual subscriber)

- All Free Learner capabilities PLUS:
- Access to relevant real world reasoning exercises (updated regularly)
- Advanced learning insights and detailed analytics
- Priority support
- Adaptive puzzles adjust difficulty based on performance (increases challenge when excelling, provides hints when struggling)

Educator/Instructor

- Assigns modules and tracks student progress.
- Views performance and generates reports
- Access to educator specific resources
- Manages student accounts and classes
- Creates custom logic problems and provides direct in app feedback on student work
- Identifies struggling students early through performance dashboards

Institutional Administrator

- Manages bulk licenses for schools/universities
- Oversees multiple educator accounts
- Handles billing and subscription management
- LMS integration for automatic enrollment and grade synchronization
- Access to institution-wide analytics for measuring ROI and program effectiveness

User Story 1

- As a learner (free or premium)
- I want to progress through logic modules with adaptive difficulty
- So that I can learn at my own pace and be appropriately challenged

Acceptance Criteria:

- User views module content with visual aids
- Completes exercises with immediate feedback
- Difficulty adjusts based on performance
- Earns XP and maintains streak

Implementation Trace:

Features: Learning Module Engine, Gamification, Adaptive Learning UI

UI: Module Viewer → Exercise Screen → Dashboard

Algorithms: Adaptive Difficulty, XP Calculation, Streak Tracking

DB: READ modules, exercises | CREATE user_exercise_attempts | UPDATE user_progress, user_achievements

User Story 2

- As a premium subscriber
- I want to access logic exercises based on current events
- So that I can apply logic to relevant and practical situations

Acceptance Criteria:

- User subscribes via payment ($24.99/year)
- Premium exercises accessible only to subscribers
- Content updated regularly
- Enhanced analytics available

Implementation Trace:

Features: Payments, Real-World Reasoning, Analytics

UI: Subscription Page → Premium Exercise Library → Analytics Dashboard

Algorithms: Payment Processing , Analytics/Scoring

DB: UPDATE user_profile (subscription_tier) | CREATE subscription_payments | READ exercises (premium=true)

User Story 3

- As an educator
- I want to create a class, assign modules, and view student performance
- So that I can guide learning and identify struggling students

Acceptance Criteria:

- Creates class with enrollment code
- Assigns modules with due dates
- Views progress reports (completion %, accuracy)
- Exports reports as CSV/PDF
- Students receive assignment notifications

Implementation Trace:

Features: Class Management, Assignment Management, Progress Tracking

UI:Create Class Form → Assign Modules → Class Progress Dashboard

Algorithms: Progress Report Generation, Notification Scheduling

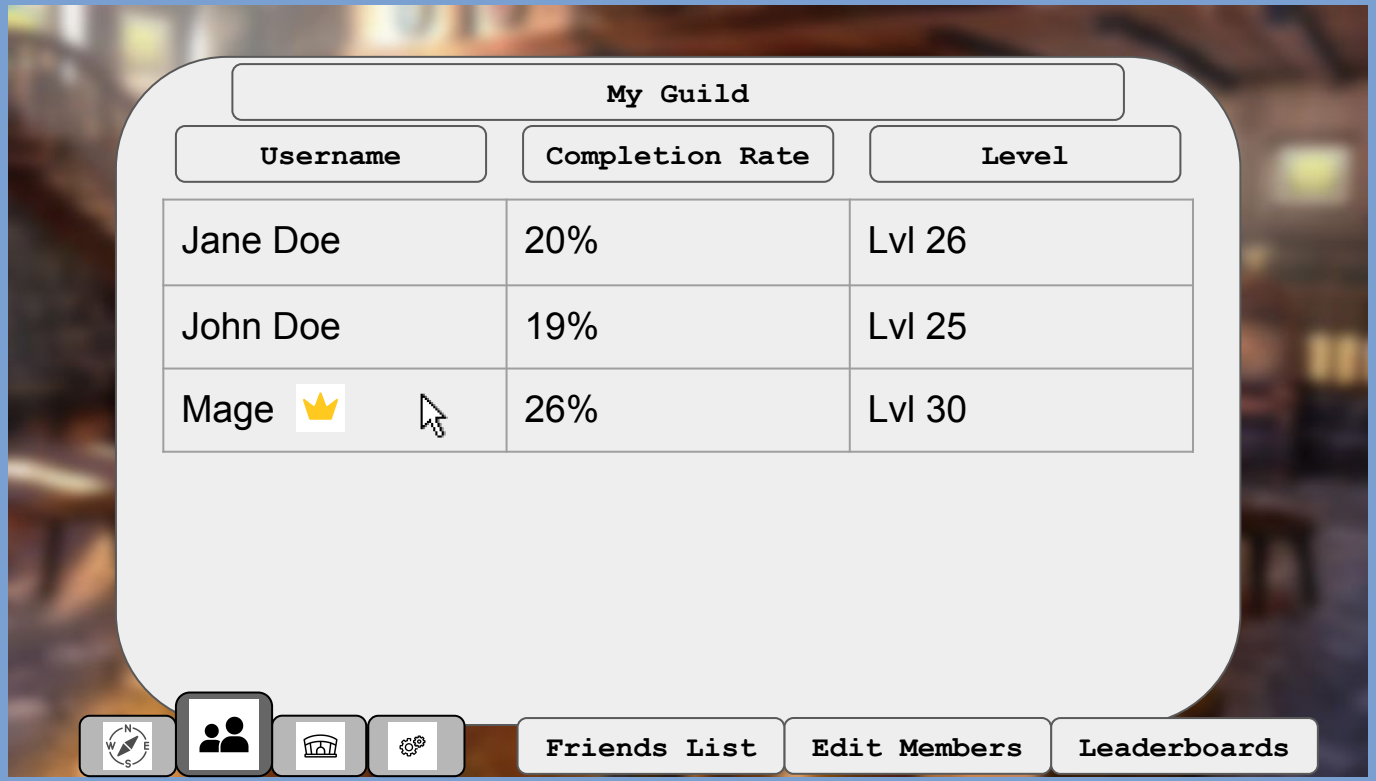
DB: CREATE classes, class_assignments, notifications | READ user_progress

Feature Table

Feature	Free User	Premium Subcriber	Educator/Instructor	Institutional Administrator
Gamified Elements				
Quest System (Modules)	✓	✓	✓	✓
Levels & Experience	✓	✓	✓	✓
Achievements	✓	✓	✓	✓
Lesson Elements				
Relevant Real-World Reasoning		✓	✓	✓
Wiki/Glossary	✓	✓	✓	✓
Diagrams	✓	✓	✓	✓
Interactive Exercises	✓	✓	✓	✓
Personalized Adaptive System				
Difficulty Adapter	✓	✓	✓	✓
Feedback	✓	✓	✓	✓
Performance Tracking	✓	✓	✓	✓
Social				
Friends List	✓	✓	✓	✓
Leaderboard	✓	✓	✓	✓
Daily Challenge		✓	✓	✓
Guild	✓	✓	✓	✓
Administrator				
Learning Management System			✓	✓
Bulk Educator Accounts				✓
Group Performance Tracking			✓	✓
Analytics				✓
Module Editor			✓	✓

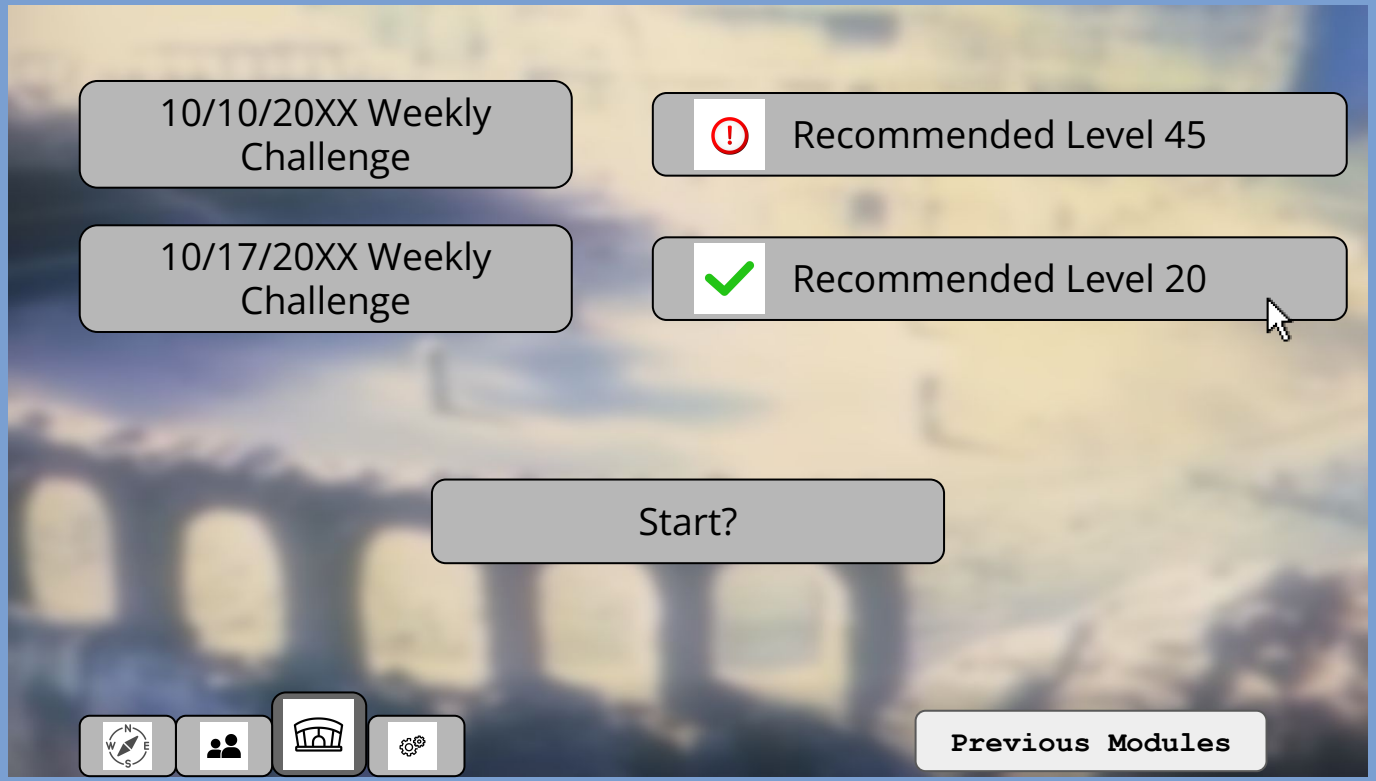
User Interface - World Map (Module Select)

User Interface - Guild (Social)



User Interface - Boss Battle

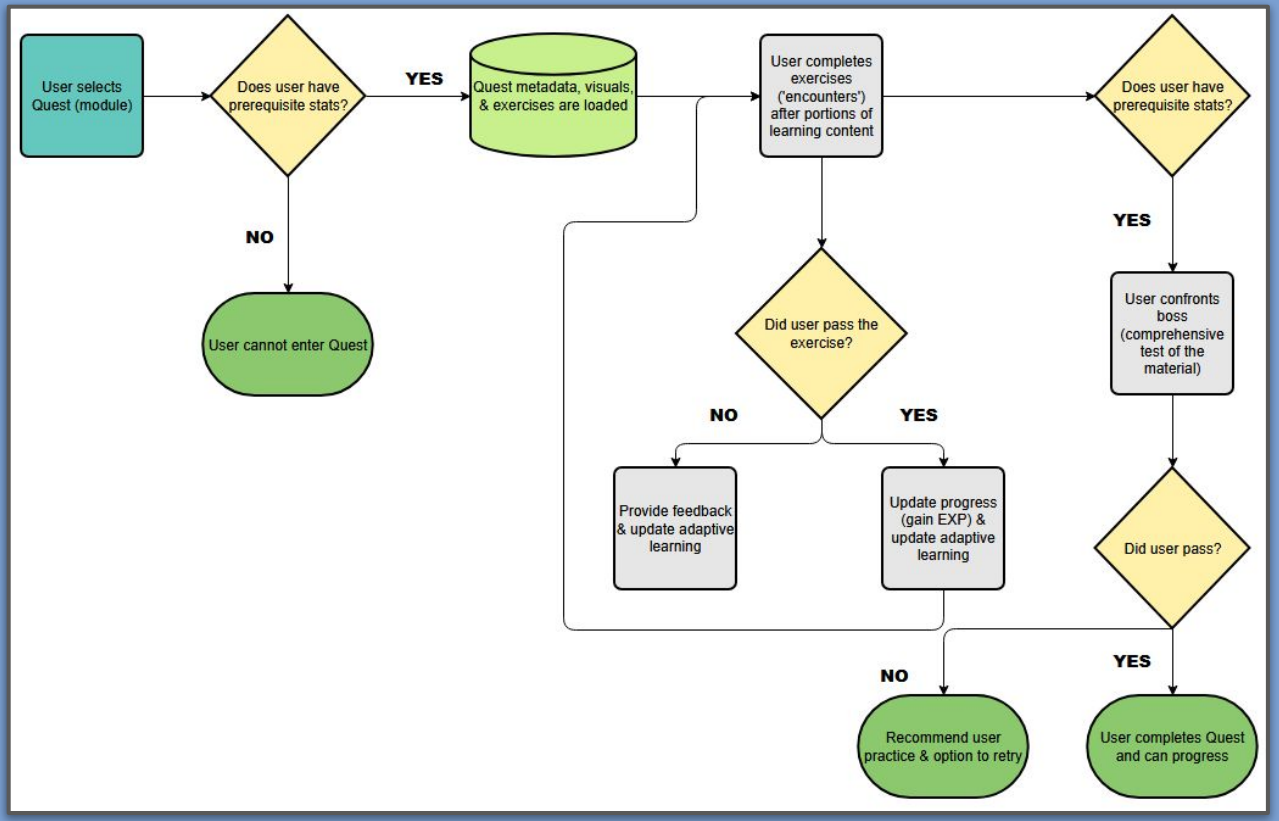
User Interface - Arena (Real World Reasoning)



Algorithm: Quest Module System

INPUTS

- User profile data
- Quest metadata
- User actions
- Adaptive learning feedback data



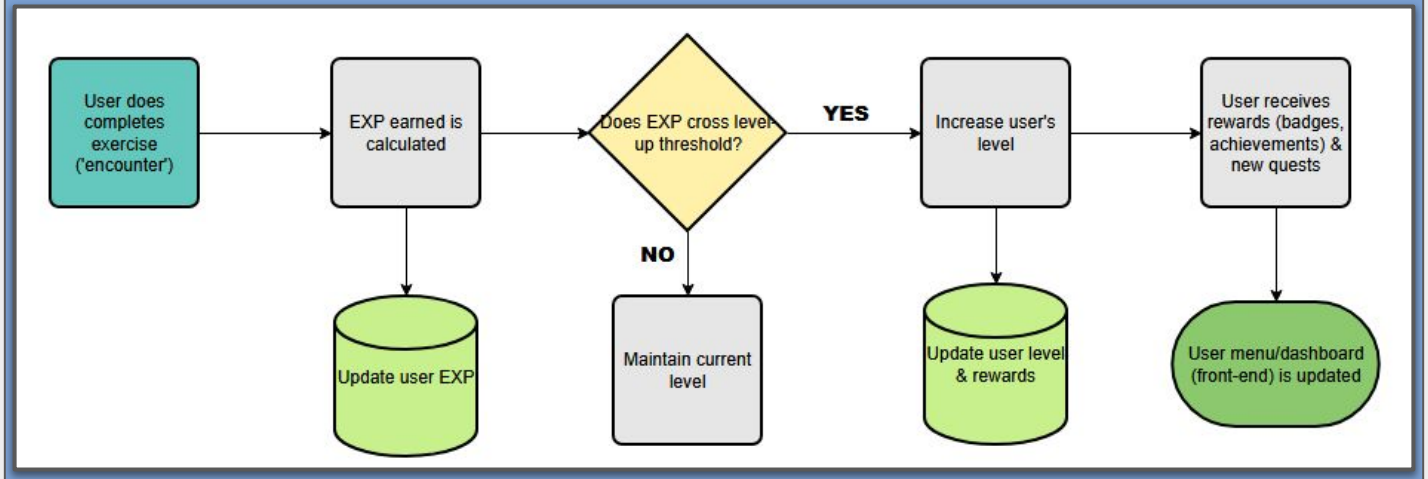
OUTPUTS

- Updated progress data
- Performance metrics
- UI updates (progress bar, achievements)

Algorithm: EXP & Level Progression System

INPUTS

- User exercise action (selecting multiple choice, drag and drop, etc.)
- Adaptive learning feedback data



OUTPUTS

- Updated levels
- Performance metrics
- Database updates

Database Schema

Users

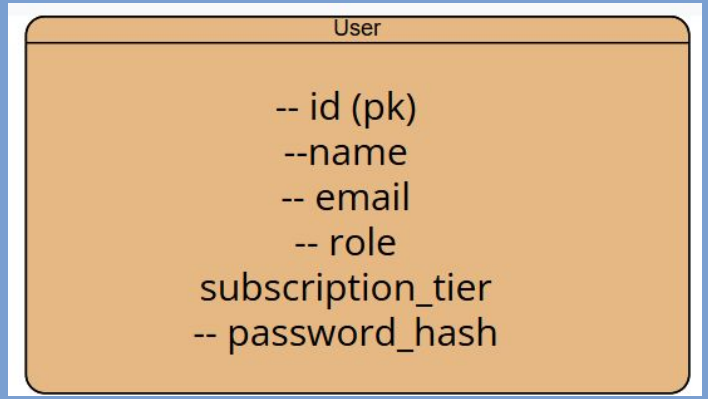
- Stores learner , educator,and admin profile
- Fields:id, name , email, role, subscription_tier, password_hash

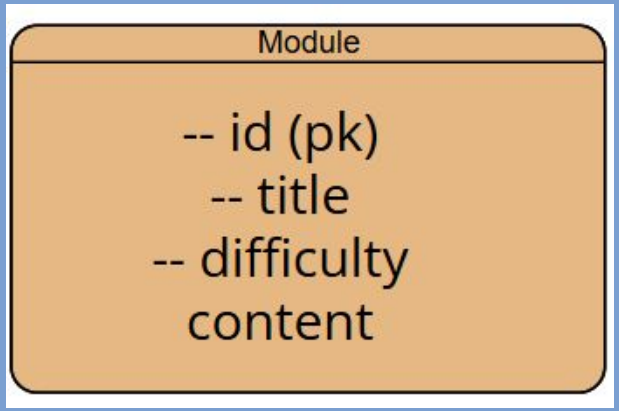
Modules

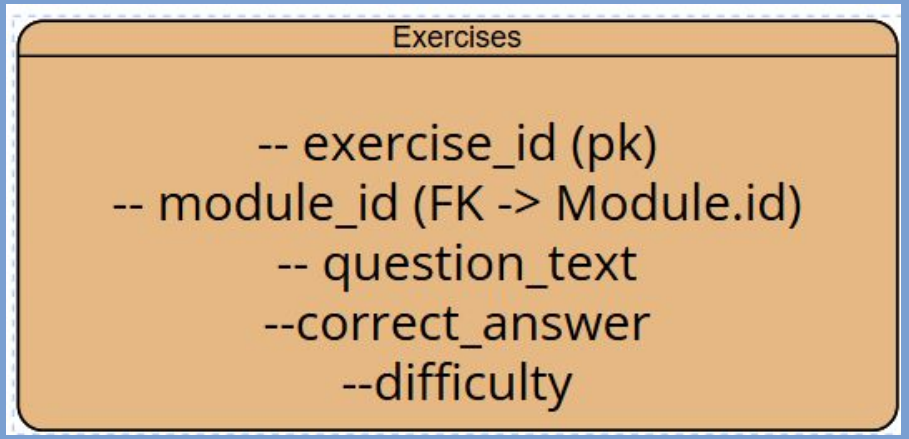
- Contains logic lessons and metadata
- Fields: id, title, difficulty, content

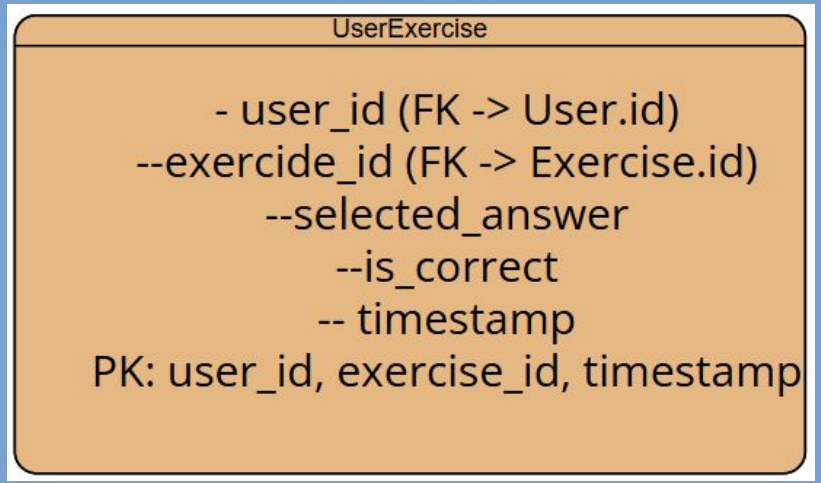
Exercise

- Individual logic questions linked to modules
- Fields: user_id,exercise_id, selected_answer, is_correct,timestamps


User
-- id (pk)
--name
-- email
-- role
subscription_tier
-- password_hash


Module
-- id (pk)
-- title
-- difficulty
content


Exercises
-- exercise_id (pk)
-- module_id (FK -> Module.id)
-- question_text
--correct_answer
--difficulty


UserExercise
- user_id (FK -> User.id)
--exercide_id (FK -> Exercise.id)
--selected_answer
--is_correct
-- timestamp
PK: user_id, exercise_id, timestamp

User Exercise attempts

- Tracks module completion, XP, and streaks
- Fields: user_id,module_id,completion_pct, xp, streak_count

Classes

- Created by educators to group students
- Fields: id, educator_id, class_name, enrollment_code

Sprint Breakdown

- Sprint 1:
  - Basic Front-end, Back-end, Database setup
  - Login/Authentication, Storing Account info
- Sprint 2:
  - Refine UX/UI (ongoing)
  - Learning Module Design Basic Framework (Initial)
- Sprint 3:
  - Implement: Save Progress to User Account
  - Implement: Gamification Framework (initial)
- Sprint 4:
  - Expand upon Learning Module Content
  - Implement Interactive Exercises
  - Implement: Free/Premium Tier System (initial implementation)

Sprint Breakdown, Continued

- Sprint 5:
  - Implement “Relevant Real-World Reasoning” exercises
  - Implement Feedback System
- Sprint 6:
  - Implement Difficulty Adapter
- Sprint 7:
  - Implement Wiki/Glossary
  - Implement Light/Dark UI themes
- Sprint 8:
  - Implement Social Features (Daily Challenge, Guild, Leaderboard, Friends List)

Glossary

- **Logic:** the systematic use of symbolic and mathematical techniques to determine the forms of valid deductive argument.
- **Formal/Informal Logic:** Formal logic is based off deductively valid reasoning. Informal logic is based off natural languages.
- **IDE**: Integrated Development Environment
- **CI**: Continuous Integration
- **CD**: Continuous Deployment

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