Ubien: The Immersive Inquiry-Based Learning Platform

Senior Design Final Demo

Team T2521

Bilkent University
Department of Computer Engineering

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Ahmet Deniz Gelir Efe Can Tatar Kemal Onur Özkan Eren Uslu Simay Uygur
Supervisor: Ugur Güdükbay

1-Minute Pitch

Ubien converts IBL textbooks into an interactive AI tutor that teaches by questioning, not by giving answers.

Problem

- passive learning
- weak long-term retention

Our Response

- inquiry-first dialogue
- guided reasoning
- immersive Unity instructor

Why Existing Tools Fall Short

Comparison on the same concept question: "What is gradient descent?"

Answer-first tools (good at speed)

- ChatGPT (default Q&A mode)
- Perplexity
- Quizlet AI / flashcard tools

Typical interaction

- student asks question
- tool returns definition + summary
- student moves on quickly

Outcome

- fast completion
- weak reasoning trace

Ubien (inquiry-first)

- does not jump to final answer
- asks guiding sub-questions
- requires stepwise reasoning

Typical interaction

- asks: "If loss is high, which direction should parameters move?"
- follows with next reasoning step
- converges to concept with student

Outcome

- slower but deeper understanding

A Real Example of Inquiry

Student question: "What is gradient descent?"

Answer-first AI

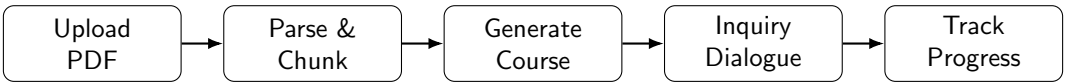
Gradient descent is an optimization algorithm used to minimize a loss function by iteratively updating parameters in the opposite direction of the gradient.

Ubien-style response

Before defining it, let's reason about it. If the model's error is high, what should we change: the data, the parameters, or the loss function?

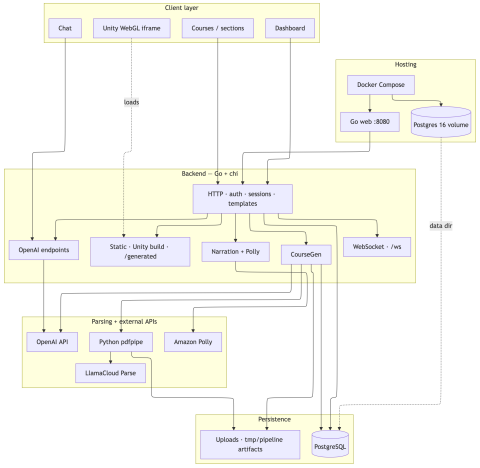
This difference changes the student from a reader into a participant.

How Ubien Works (Visual Flow)



Learning happens through guided interaction, not passive reading.

System Overview



Ubien connects the client interface, Go backend, PDF parsing pipeline, OpenAI API, Amazon Polly, PostgreSQL, and Unity WebGL avatar into one end-to-end learning platform.

Engineering Challenges and Decisions

Challenge	**Decision / Tradeoff**
Large PDF processing	chunking + staged pipeline
Long context tutoring	controlled memory window + prompt structure
Teaching style quality	inquiry-oriented prompt design
Animation sync	response-to-animation event mapping

What We Validated

Validation Point	Result
PDF-to-course pipeline	Uploaded textbooks can be processed into structured course content.
Inquiry dialogue loop	The tutor can guide the student through questions instead of only giving direct answers.
Narration pipeline	Amazon Polly can generate audio narration for instructor responses.
Unity WebGL integration	The animated instructor can be embedded into the learning interface.
Persistence	Courses, users, chat history, and progress are stored in PostgreSQL.

The result is not a mockup; it is an integrated learning system.

Major Risks We Solved

Risk	Why It Mattered	How We Addressed It
AI gives direct answers	Breaks inquiry-based learning	Designed prompts around guiding questions
PDF content is too large	LLM context becomes difficult	Used parsing and chunking strategy
Avatar response feels disconnected	Reduces immersion	Mapped AI responses to animation behavior
Progress is lost	Learning cannot continue	Stored user progress in database
Integration complexity	Many components can fail separately	Built layered architecture

Capstone Journey: CS491 →CS492

What we built over time

- concept & scope definition
- architecture and prototype
- full-stack integration
- final demo system

How we worked as a team

- ownership-based task split
- integration checkpoints
- fast feedback + iteration

Skills Gained and Successes

Skills gained

- LLM system design
- prompt engineering for pedagogy
- Unity-web integration
- collaborative software delivery

Successes

- transformed idea into deployable product
- integrated AI, narration, and avatar pipeline
- delivered full demo under constraints

Limitations and Future Work

Current limits

- API cost
- generation latency
- limited animation variety

Next steps

- richer animation set
- faster generation pipeline
- stronger prompt quality
- mobile support

Team Contributions

Name	Contribution
Ahmet Deniz Gelir	Backend development
Simay Uygur	Backend + Unity integration
Efe Can Tatar	Unity development
Kemal Onur Ozkan	UI + Unity development
Eren Uslu	Testing and validation

Let's see the live demo

Upload → Generate → Inquire → Learn

- Upload an IBL textbook PDF
- Auto-generate course structure
- Follow guided inquiry with AI instructor
- Track progress across the session
- Note: Due to time constraints, we will demonstrate a course generated from a previously uploaded textbook.