MUFG Hackathon

ChemVR

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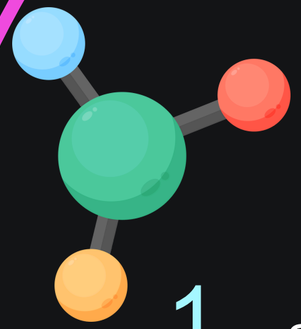
Problem Statement

Immersive AI-Powered Learning Experience Using VR/Metaverse

Use case #3

Why Students Struggle with Chemistry



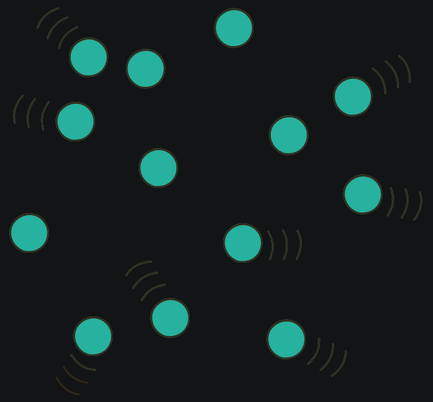
1. Textbooks present complex, 3D molecules as flat, confusing diagrams.
2. This forces students into “rote memorization” instead of fostering true understanding.
3. Invisible forces like electron repulsion and bond angles are nearly impossible to grasp from a page, leading to disengagement.

Introducing ChemVR

ChemVR is an immersive VR platform that transforms abstract chemical concepts into tangible, interactive experiences.

Students don't just see molecules; they build them, manipulate them, and watch them react in a hands-on virtual laboratory.

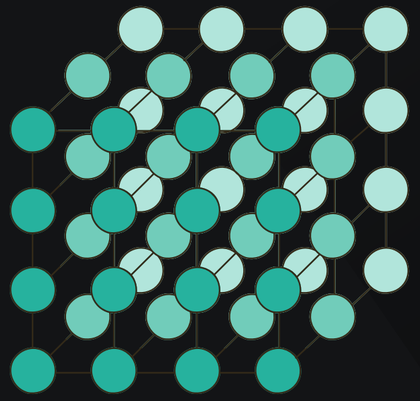
It makes the invisible visible.



The Core Experience: Learn by Building

From Passive Viewing to Active Creation

A simple 3-step process that defines the user experience:

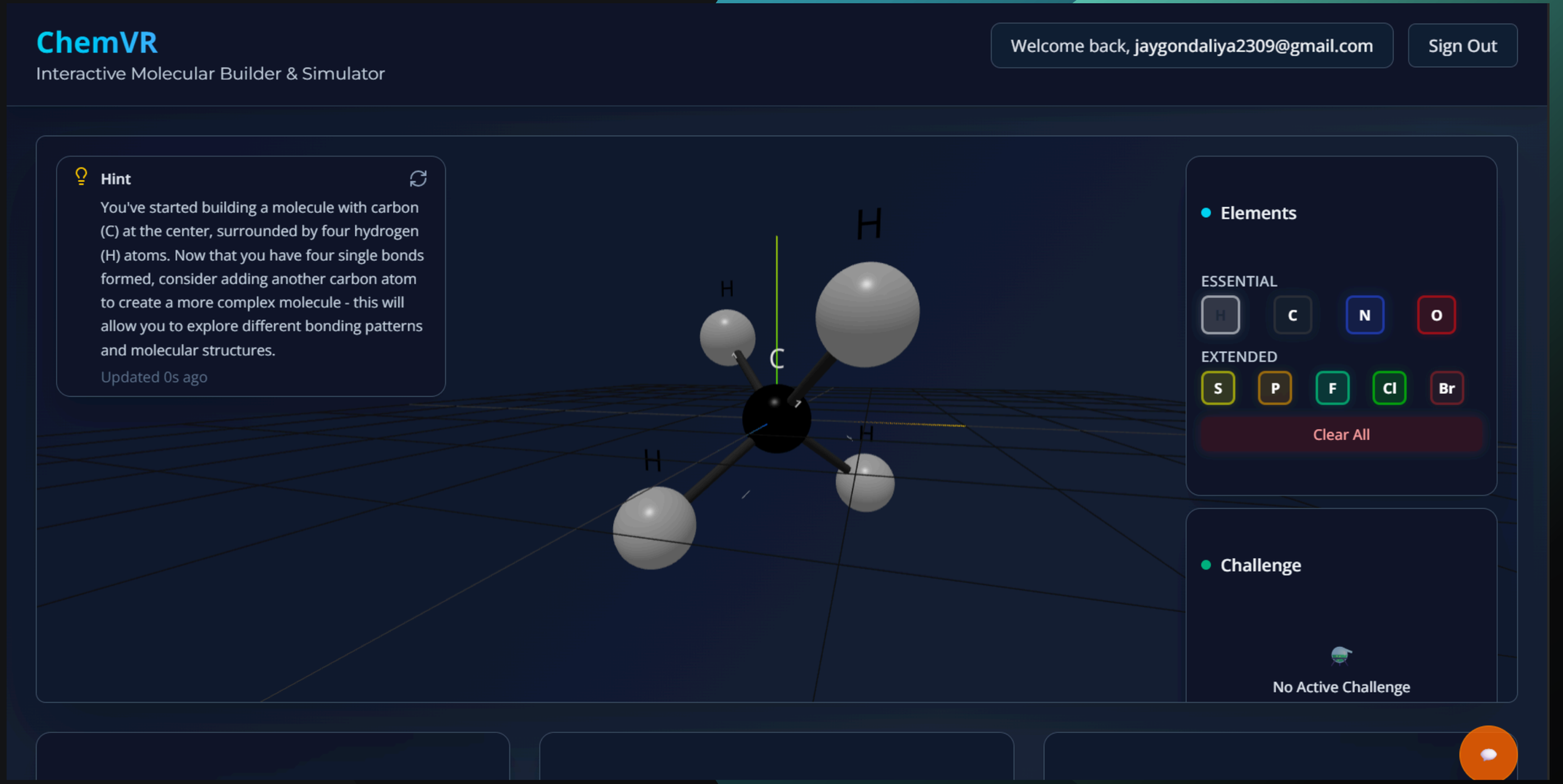


1. Grab: Select atoms from an intuitive, interactive periodic table.

2. Build: Snap atoms together to form molecules. Feel haptic feedback as bonds form correctly or repel from incorrect angles.

3. Explore: Manipulate your creation in 3D space, visualize electron clouds, and trigger reactions to see principles in action.

The Core Experience: Learn by Building



The AI Lab Assistant: Your Personal Tutor

A Guide for Every Student

- **Guided Discovery: The AI provides real-time hints and explanations. For example:”I see you've created ammonia. Notice its trigonal pyramidal shape due to the lone electron pair."**
- **Molecule Predictor: The AI analyzes molecules the user combines, predicts the outcome, and explains the fundamental principles behind the reaction.**

Impact: Fostering a Deeper Understanding

From Rote Memorization to Intuitive Mastery

- **Gamified, hands-on learning makes a difficult subject fun and engaging.**
- **Fosters a true, intuitive feel for chemical principles that textbooks cannot provide.**
- **Kinesthetic learning (learning by doing) is proven to dramatically improve long-term knowledge retention.**

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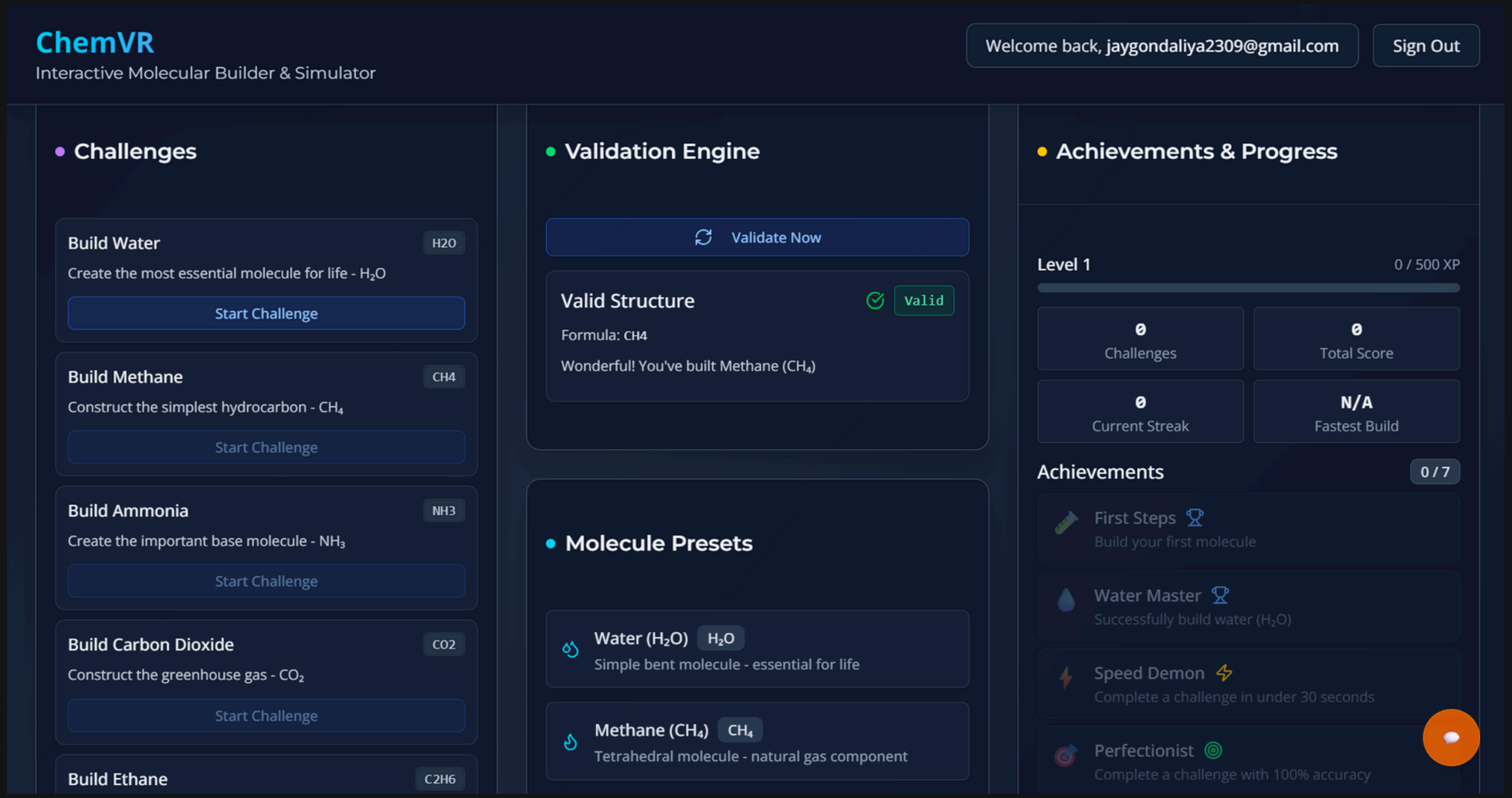

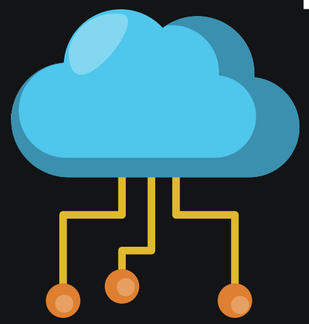

Tech That Makes It Possible

Built for the Future of Education

1. **Frontend:**

- **Next.js: Fast server-side rendering and performance.**
- **React 19: Interactive user interfaces.**
- **React Three Fiber & Drei: Efficient 3D scene management.**
- **Radix UI & Tailwind CSS 4: Responsive, accessible design.**
- **Zustand: Lightweight state management.**

2. **Backend**

- **Node.js, powering custom API endpoints for molecule validation and AI tutor workflow**
- **Firebase Authentication for secure sign-in (Email/Password, Google)**
- **Firebase for real-time database and cloud storage**

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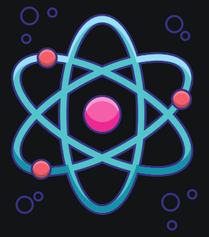
3. AI/ML Integration:

- Google Gemini API, enabling context-aware, conversational AI tutoring and real-time chemistry hints or validations

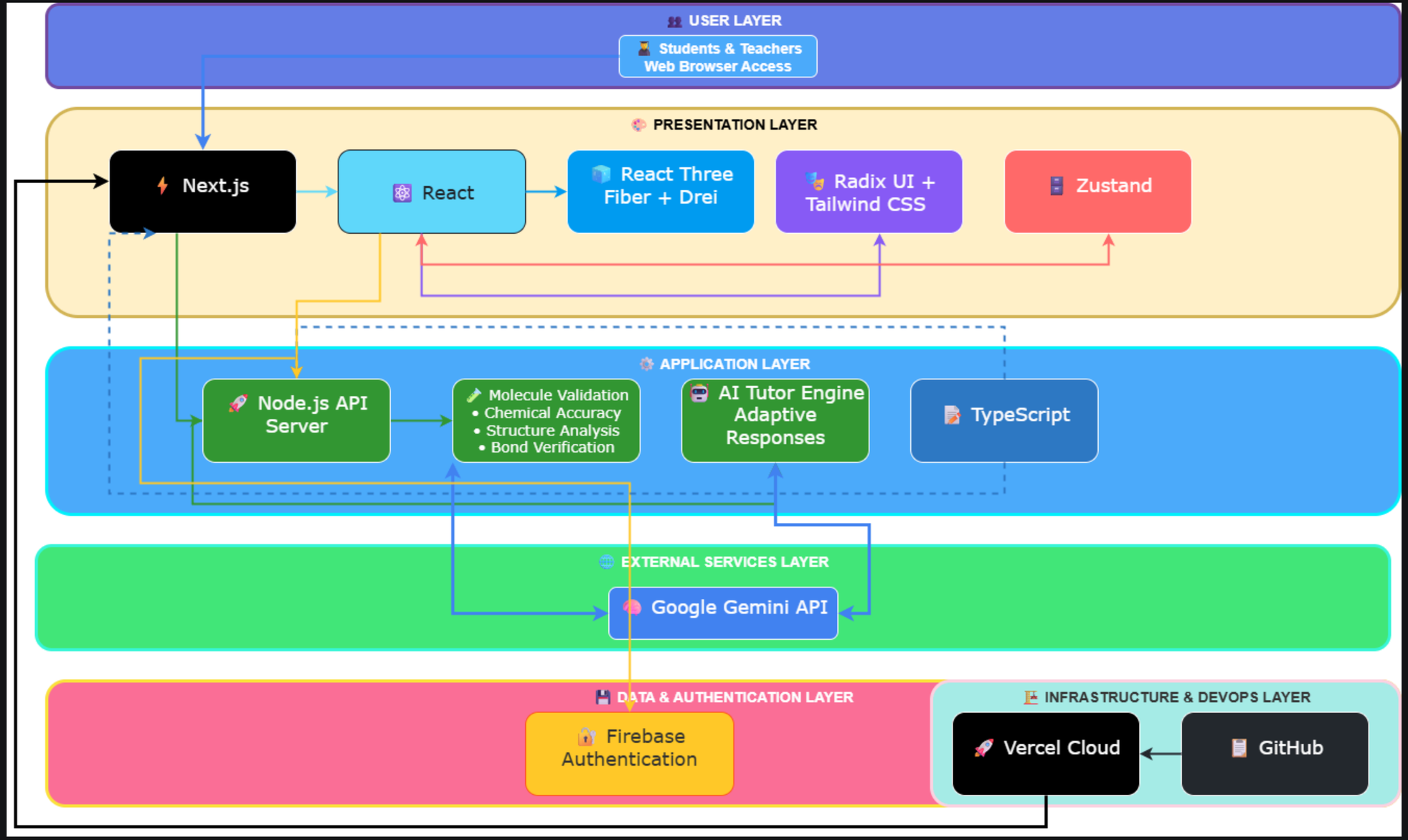
4. DevOps & Deployment:

- Vercel for cloud hosting and instant deployment of the web application
- GitHub for code management, issue tracking, and collaboration.



Gemini

System Architecture



Vision & Scalability: Beyond the First Molecule

The platform is a framework that can be expanded to cover all of high school and university chemistry, from basic concepts to complex organic reactions.

The core technology can be adapted for other complex subjects like biology (protein folding), physics (visualizing magnetic fields), and engineering.

Thank You