Introduction

Problem & Motivation

Mathematics is often taught as a series of isolated concepts, detached from their historical context. This lack of narrative structure makes it difficult for learners to see the connections between different mathematical discoveries and how they evolved over time. Additionally, traditional math education can feel rigid and uninspiring, leading to disengagement.

ChronoMath seeks to address this issue by providing an interactive, gamified learning experience that integrates historical context with mathematical concepts. The platform is designed to make learning math engaging, structured, and more intuitive by placing lessons within a chronological framework, showing how each concept emerged and evolved.

Target Audience

- Elementary to High School: Looking for a more engaging way to learn math beyond standard textbooks.
- Educators: Can incorporate ChronoMath modules into lesson plans for an interactive learning experience.
- General Learners: Anyone interested in the historical evolution of mathematics and its applications.

Specific Learning Outcomes

- Understanding Fundamental Mathematical Concepts: From basic geometry to higher-level algebra and calculus.
- Historical Context: Exploring the cultural and scientific background of major mathematical discoveries.
- Critical Thinking: Connecting abstract principles with real-world applications and historical relevance.
- Engagement & Retention: Using gamification techniques to make learning more interactive and rewarding.

Sample Learning Objects

ChronoMath offers a variety of interactive learning objects, including:

1. Interactive Quizzes: Multiple-choice, fill-in-the-blanks, and short-answer prompts.
2. Historical Timelines: Clickable events displaying the development of mathematical theories over time.
3. Gamified Exercises: Point-based challenges, badges, and streaks to encourage consistent practice.
4. Multimedia Content: Historical anecdotes, images, and short videos providing depth and engagement.

Background

Link Between Math and History

Integrating the history of mathematics into education has been shown to enhance student engagement and understanding. Incorporating historical context, such as the origins of specific topics, the evolution of notation, and biographies of mathematicians, can captivate students and provide deeper insights into mathematical concepts [1].

An analytical survey by the Weizmann Institute of Science further supports this approach, highlighting various models for effectively integrating the history of mathematics into classroom settings [2]. Despite these recognized benefits, many existing educational platforms lack a comprehensive integration of historical narratives with mathematical instruction. ChronoMath addresses this gap by offering an interactive, historically enriched learning experience that not only teaches mathematical theories but also delves into their development and the individuals who contributed to them.

Why Use ChronoMath Over Existing Apps?

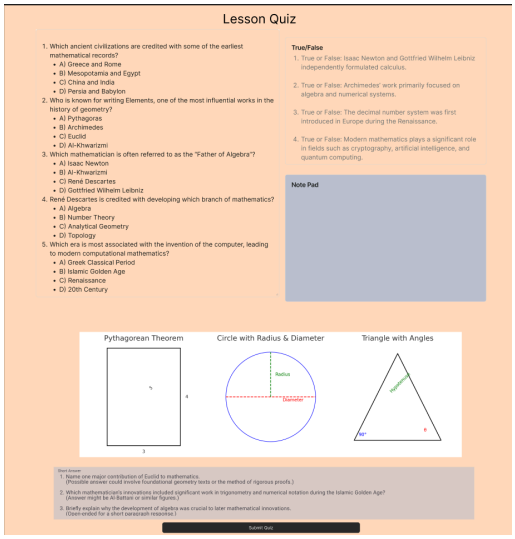
- Chronological Learning Path: Unlike other math apps that isolate topics, ChronoMath integrates history to show how math concepts evolved.
- Gamification & Engagement: Badges, progress tracking, and streaks make learning fun and motivating.
- Interactive Timeline & Visual Learning: Allows users to navigate through historical developments, connecting lessons seamlessly.
- Flexible & Self-Paced Learning: Users can choose structured progression or explore freely based on interest.

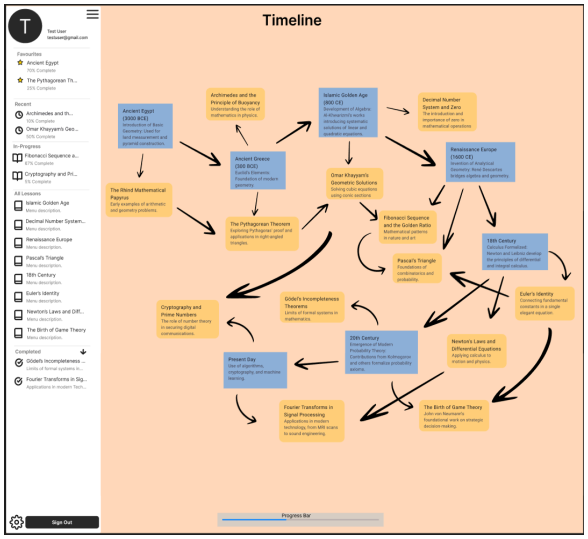
App Design

Branding & Visual Representation

ChronoMath is designed with an engaging and educational aesthetic, blending modern professional UI design with thematic colours and elements inspired by historical manuscripts and mathematical symbols. The branding includes:

- Logo/Icon: A minimalistic hourglass symbol combined with mathematical symbols to represent the concept of learning math through time.
- Mockup Exercise Screen: Features an interactive quiz interface with real-time feedback and point tracking.
- Mockup Home Screen: A clean dashboard showing user progress, streaks, available lessons, and an interactive timeline.





Prototype

Prerequisites

- Python 3.13.2
- Node 22.14.0
- Firebase Project

Web App

Access the web app here - chronomath.duckdns.org

Self-Hosted Installation Guide

1. **Clone the repository** and navigate to the project directory:

```
git clone https://github.com/MdTanjeemHaider/ChronoMath
cd ChronoMath
```

2. **Create a Python virtual environment** and activate it:
    2.1. On Windows:

```
python -m venv venv
venv\Scripts\activate
```

    2.2. On Linux or macOS:

```
python -m venv venv
source venv/bin/activate
```

3. **Install the required Python packages**:

```
pip install -r backend\chronomath\requirements.txt
```

4. **Create a `.env` file** in the `backend/chronomath/configs` directory and add the following lines:

```
FIREBASE_API_KEY=YOUR_FIREBASE_API_KEY
FIREBASE_AUTH_DOMAIN=YOUR_FIREBASE_AUTH_DOMAIN
FIREBASE_PROJECT_ID=YOUR_FIREBASE_PROJECT_ID
FIREBASE_STORAGE_BUCKET=YOUR_FIREBASE_STORAGE_BUCKET
FIREBASE_MESSAGING_SENDER_ID=YOUR_FIREBASE_MESSAGING_SENDER_ID
FIREBASE_APP_ID=YOUR_FIREBASE_APP_ID
FIREBASE_MEASUREMENT_ID=YOUR_FIREBASE_MEASUREMENT_ID
FLASK_SECRET_KEY=YOUR_FLASK_SECRET_KEY
```

5. **Generate a new private key** from the Firebase console and save it as `firebase_creds.json` in the `backend/chronomath/configs` directory.
6. **Run the backend server**:

```
python backend\chronomath\app.py
```

7. **Open a new terminal** and navigate back to the project directory:

```
cd ChronoMath
```

8. **Navigate to the frontend directory** and install the required packages:

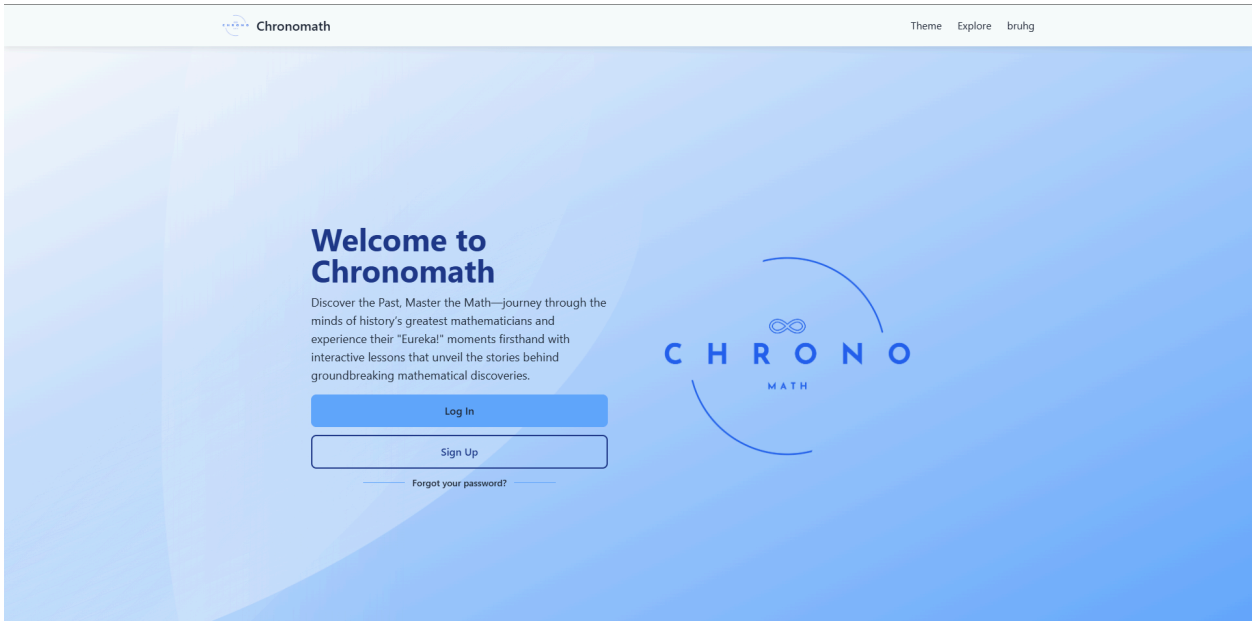
```
cd frontend\chronomath
npm install
```

9. **Run the frontend server**:

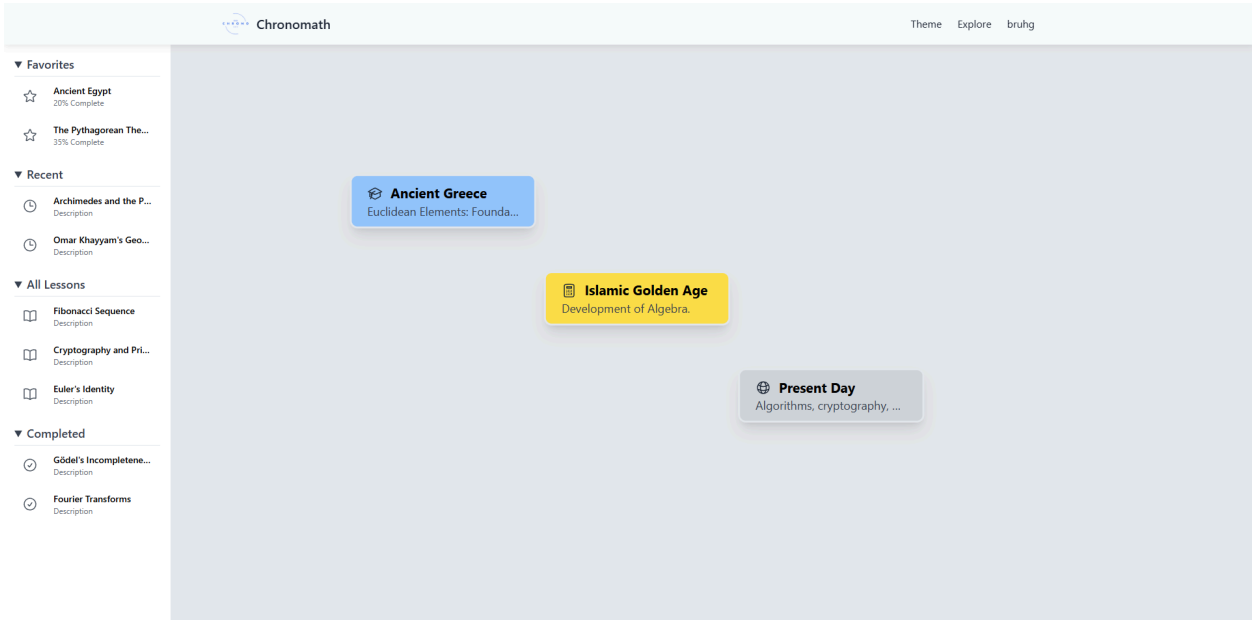
```
ng serve
```

User Guide

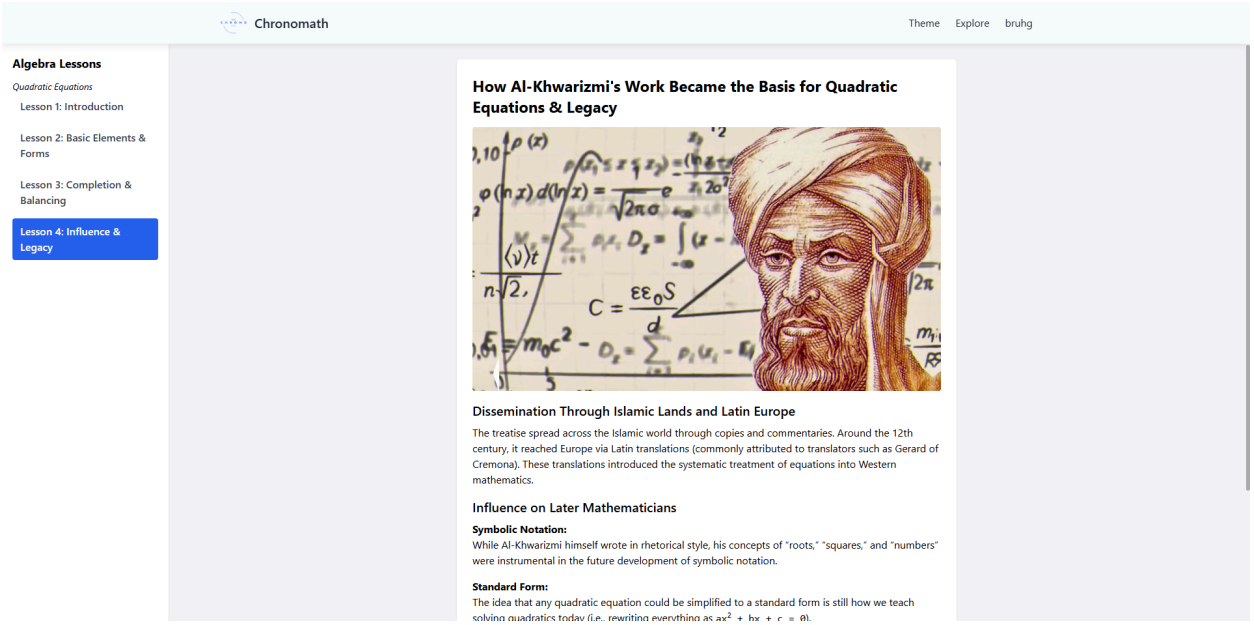
Upon visiting the website, users can **log in** or **sign up** from the front page via a local email registration.



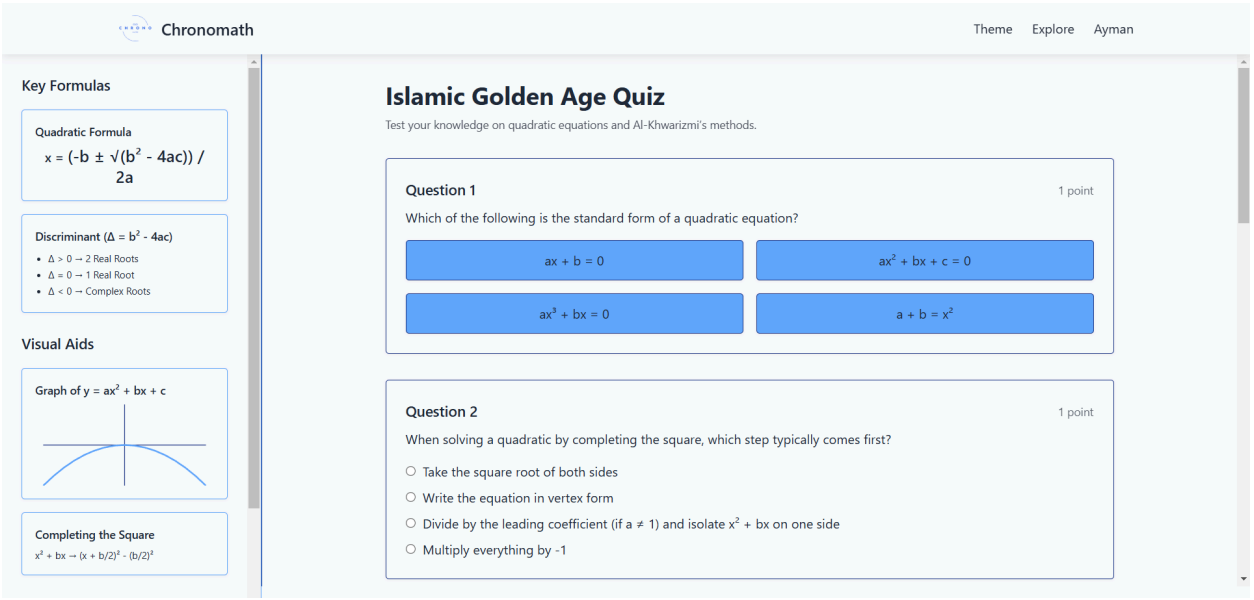
Once logged in, the user is greeted with the home page, showing the timeline structure of lessons, a sidebar to navigate favorite, recent, all, and completed lessons, and a top bar where they can choose a theme, go back to the home page, or check their profile.



When a course is selected, a pop-up provides a **quick summary** of the topics covered. After continuing, the user navigates through lesson pages organized by **unit** and any **subsections** within the unit.



Once lessons are completed, a **quiz** becomes available. Relevant information is displayed on the left side for quick reference, and a text notepad is included for **notes and calculations**.



Current Features

- **Account creation** with local login.
- **Timeline-style home page** displaying lessons in chronological order.
- **Lesson pages** divided by unit and subsection, enhanced with visuals.
- **Quiz Page** where users can test their understanding.
- **Theme selection**, including accessibility-friendly options.
- **Profile page** for viewing and editing personal details.

Features to Be Implemented

- **Timeline overhaul** and improved visual design.
- **Score tracking** to monitor user performance.
- **Interactive lesson pages** for more engaging content.
- **Notebook functionality** upgrades (enhanced note-taking, saving, etc.).
- **Profile page settings** for deeper customization.
- **Additional learning objectives** and expanded lesson content.
- **Favoriting system** to quickly access preferred lessons.

Evaluation Plan

To roll out ChronoMath, we would conduct a phased introduction to both students and educators. First, a small pilot group of classrooms will be given early access to test essential features such as lesson navigation, quiz integration, and progress tracking. During this pilot, we will collect feedback from both students, focusing on their engagement, ease of use, and enjoyment, and educators, who will assess how effectively ChronoMath can be integrated into lesson plans and what resources might improve its classroom utility.

Conclusion

Based on these insights, our team will refine the app by streamlining navigation, enhancing interactive elements, and adding or adjusting content as needed. After improvements are made, we would expand access to a broader audience of schools and individual learners. Educators can take advantage of ChronoMath's historical context features to develop thematic lesson plans, while students can track their progress, challenge themselves with quizzes, and use the built-in notebook for problem-solving. By continually gathering suggestions and insights, ChronoMath aims to remain responsive to the evolving needs of both learners and teachers, ensuring an effective, engaging, and historically enriched math-learning experience.

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