

# **MathQuest: Interactive Puzzles and AI Games for Learning**

sugarlabs



Google  
Summer of Code

**Name:** Abhiraj Ghose

**Major:** Bachelor of Technology ( Computer Science Engineering )

**University:** Bennett University, Greater Noida, Uttar Pradesh, India

**GitHub:** <https://github.com/AetherSparks>

**Email:** ghoseabhiraj0607@gmail.com

**LinkedIn:** <https://www.linkedin.com/in/abhiraj-ghose/>

**Phone:** (+91) 8851679131

**Element/Matrix:** @aether\_sparks:matrix.org

**Language:** English

**Location and Timezone:** Noida, Uttar Pradesh, India; Indian Standard Time (UTC +5:30)

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## **BRIEF BIO:**

I am Abhiraj Ghose, a second-year undergraduate student with a strong foundation in Full-Stack development and AI-driven applications. I bring hands-on experience in Python, HTML, CSS, JavaScript, Python Django, React, Next JS and AI/ML to this project. As a Full-Stack Developer Intern at ChampSpace, I had developed interactive

platforms, including a Project-Hub and Job-Hunting Website using Python Django, HTML, CSS, and JavaScript. As an AI & Next JS Developer at Matrix Technologies, I had worked on an AI based New Jersey Home Buying/Building website with a dedicated International Team. My technical expertise on Full Stack, machine learning and AI, is demonstrated by projects like Mood Classification in Music Therapy using ensemble models, a Customer Churn Prediction system, and a Personality Detection Chatting App achieving 97% accuracy.

I have actively contributed to problem-solving initiatives, securing top rankings in national-level hackathons and earning recognition such as the Dean's List Award for Academic Excellence. As the Technical Team Head at GeeksForGeeks-BU, I lead teams in software development and technical projects.

I am also an Active Open Source Contributor, and had been selected as a contributor in GirlScript Summer of Code in 2024.

My passion for math puzzles and AI aligns with this project, particularly in developing interactive learning games like Number Detective and Sorting Hat AI, integrating rule-based logic and developing a strongly structured interactive system. I am eager to contribute innovative solutions to Sugar's educational ecosystem.

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### **SugarLabs Contributions**

- <https://github.com/sugarlabs/www/issues/593>
  - <https://github.com/sugarlabs/www/pull/578>
  - <https://github.com/sugarlabs/www/issues/575>
  - <https://github.com/sugarlabs/musicblocks/issues/4105>
  - <https://github.com/sugarlabs/musicblocks/issues/4114>
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### **Why am I a Good Fit for This Project?**

I am passionate about educational technology, AI-driven learning, and gamification. My strong Python skills, experience in AI/ML, and full-stack development background make me a strong candidate for building interactive math games for Sugar Labs.

♦ AI & Data Science Expertise: I have built AI-powered projects like: Personality Detection Chatbot (97% Accuracy). Customer Churn Prediction Model (82% Accuracy).

♦ Full-Stack & Game Development: I have developed a Project-Hub & Job-Hunting Website using Python Django & JavaScript during my FullStack Developer Internship at ChampSpace. I have also worked on an AI based New Jersey Home Buying/Building website while I was working as an AI & Next JS Developer at Matrix Technologies. Apart from that, I have worked on JScanner, an OMR Sheet Scanner & Marks Calculator using OpenCV & TesseractOCR and Created ChronoAlert, a Verilog-based Alarm System.

♦ Hackathons & Recognitions:

- Smart BU Hackathon (Rank 78) – Swasth Bharat App.
- Top 100 in India in Atal Catalysts @ ISB – LicenTrack Project.

♦ Strong Educational Background & Leadership:

- CGPA: **9.57** in B.Tech (Computer Science Engineering) at Bennett University.
- Technical Department Head @ GeeksForGeeks-BU (2024-25).
- Head Boy of BBPS Noida (2022-23).

♦ Certifications & AI Skills:

- Azure Data Fundamentals (Microsoft).
- Introduction to Machine Learning (Duke University, Coursera).
- Data Science with Python (IIT Madras & Coincent.ai).

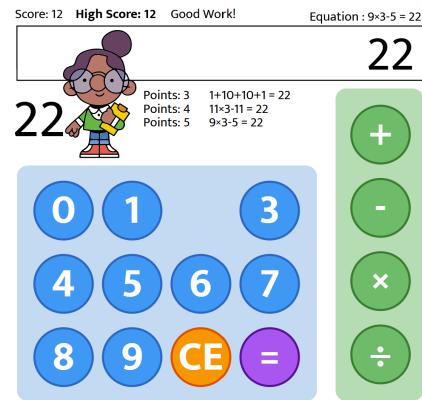
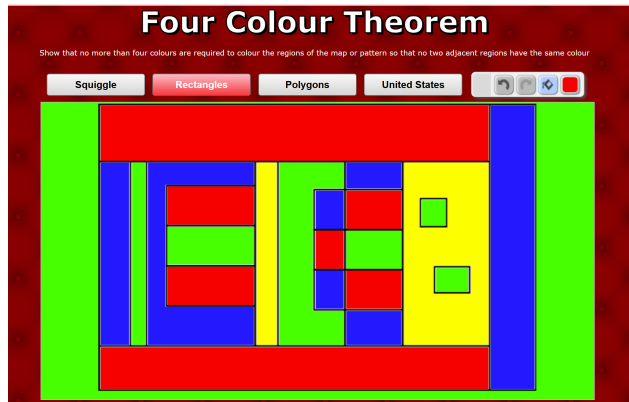
With my blend of technical skills, AI expertise, and passion for educational tools, I am confident that I can build engaging math games that enhance Sugar Labs' open-source learning platform.

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## **PROJECT DETAILS:**

♦ **What Are You Making?**

I am developing eight interactive math games for the Sugar Learning Platform, designed to make math learning engaging, interactive, and AI-enhanced. These games will cover logical reasoning, problem-solving, AI-based learning, and gamified math concepts.



### Planned Math Games:

**1. Four Color Map Game** – Dividing an area into multiple subsections with unique borders, requiring you to colour each section such that no 2 sections sharing a border have the same colour. It teaches graph theory, planning and map coloring using a fun, puzzle-based approach.

**2. Broken Calculator** – A math puzzle where certain calculator buttons are missing, asking the user to arrive at a specific number only using the numbers and operators provided. It enhances and builds quick and creative problem-solving.

**3. Fifteen Puzzle** – A classic tile-sliding puzzle consisting of 15 squares, numbered 1 through 15, which can be slid horizontally or vertically within a four-by-four grid that has one empty space among its 16 locations, requiring the user to shift the tiles such that every tile is in its correct place, improving spatial reasoning.

**4. Euclid's Game** – A 2 player game where users circle 1 number each, then turn by turn circle another uncircled number which is the difference between any 2 circled numbers. Reinforces the concept of GCD (Greatest Common Divisor) through a turn-based strategy game.

**5. Odd Scoring** – A chip is placed at the end of a grid band with N cells. On a move the chip is shifted leftwards 1, 2, or 3 steps. When it reaches the last cell, the total numbers of steps made by you and the computer are counted and the player who made an even number of steps is declared a winner. It is a math-based game where players use strategic scoring patterns to maximize points.

**6. Soma Cubes** – A 3D dissection puzzle made up of 7 pieces, each formed by joining

unit cubes together in different ways, requiring the user to create a perfect cube by combining the irregular pieces. It is a 3D puzzle game teaching spatial visualization and combinatorial mathematics.

**7. Number Detective (AI-powered)** – A fun AI-based game where players input a number sequence, and the AI predicts the next number using pattern recognition.

**8. Sorting Hat AI (AI-powered)** – An interactive game that teaches classification algorithms (k-NN or Decision Trees), allowing players to label objects and train the AI model.

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### **Project Impact**

This project is not just about developing games—it is about **creating an accessible, engaging, and AI-enhanced learning environment** that will **empower students worldwide**. Through **collaboration, innovation, and open-source principles**, this initiative will make a lasting impact on **education, AI literacy, and computational thinking for the next generation**.

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### **Benefits to the Community**

#### **◆ How Will It Impact Sugar Labs?**

**Expanding SugarLab's Educational Offerings** – Sugar Labs aims to provide open-source educational tools for children worldwide. This project will expand Sugar's math activity collection with eight new interactive games, making the platform an even more powerful STEM learning platform for young learners.

**Encouraging AI and Computational Thinking** – Introducing AI-driven games like Number Detective and Sorting Hat AI will expose students to machine learning fundamentals in an accessible, engaging way, fostering early AI literacy.

**Gamifies Math Learning** – By gamifying mathematical concepts through puzzles, AI-driven challenges, and logic-based games, this project will make learning math exciting and intuitive.

**Sustainable Open-Source Contribution** – The project will be fully open-source, allowing future developers and educators to modify, enhance, and extend these activities to meet evolving educational needs.

## ♦ **Why Google and Sugar Labs Would Be Proud to Sponsor This Work?**

**Promoting STEM Education** – Google actively supports STEM and AI education, and this project aligns perfectly with its mission to empower students with technology-driven learning tools.

**Open-Source Impact** – This project directly contributes to open-source educational software, making it a valuable addition to Google's and Sugar Labs' open-source initiatives.

**Demonstrating the Power of AI in Learning** – By implementing AI-powered pattern recognition and classification models in educational games, this project will showcase how AI can be leveraged to enhance interactive learning experiences

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## ♦ **What Technologies Will You Be Using?**

### 1. Programming Languages:

- Python – Core language for game logic and AI models.
- JavaScript – If additional UI enhancements require web-based interactions.

### 2. Frameworks & Libraries:

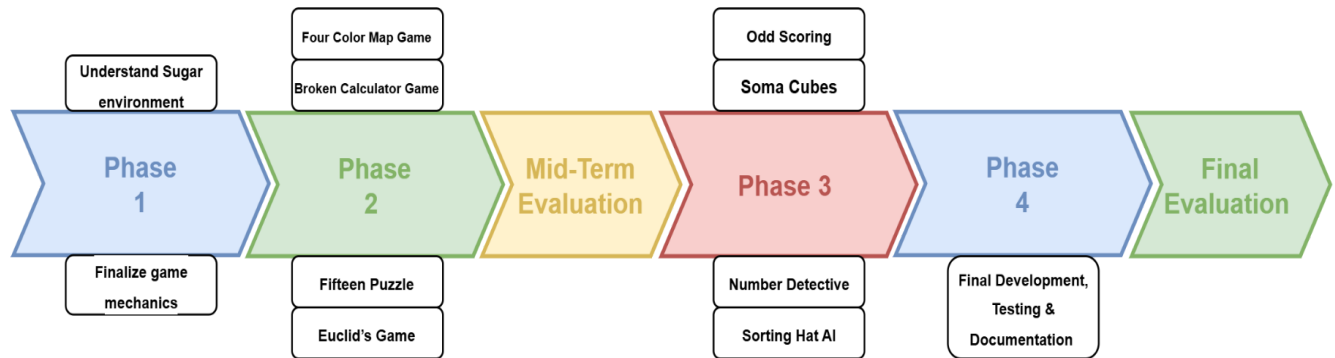
- Sugar Activity Framework – To develop interactive activities within the Sugar environment.
- Pygame or PyGTK – For rendering game graphics and UI.
- Scikit-learn / NumPy / Pandas – For implementing AI-based games (Number Detective, Sorting Hat AI).

### 3. Development Tools:

- Sugar Emulator / OLPC Environment – Testing games on the Sugar platform.
  - Git & GitHub – Version control and open-source collaboration.
  - Jupyter Notebooks (for AI prototyping) – Experimenting with machine learning models before integrating them into the games.
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## Timeline & Weekly Breakdown Structure

I plan to dedicate 40-48 hours per week to the project, ensuring steady progress while maintaining flexibility for adjustments based on mentor feedback. Below is the detailed breakdown of tasks across the 12-week GSoC period, including key milestones, evaluation points, and reporting methods.



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Community Bonding Period (Pre-GSoC) [May 08 - June 01]

♦ **Phase 1 Objective:** Understand the Sugar environment, finalize game mechanics, and prepare a development roadmap.

- Understanding Sugar Environment – Set up the Sugar development environment and explore existing Sugar activities.
- Refining Game Ideas – Collaborate with mentors to finalize game mechanics, AI integration, and UX flow.
- Technical Planning & White Paper – Outline technical design, including game logic, AI models, and interaction mechanics.
- Mock UI Designs – Create wireframes/mockups for each math activity using Figma or Canva.

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♦ **Phase 2 Objective:** Framework Setup, Initial Development & Prototyping

Week 1 (June 02 - June 08): Project Kickoff & Game Framework

- Game Framework Setup – Implement the base structure for math activities in Sugar using Python.
  - Develop reusable game templates for consistent UI/UX across all activities.
  - Start working on Four Color Map Game – Implement game logic and UI interactions.
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### Week 2 (June 09 - June 15): Initial Game Implementations

- Complete Four Color Map Game – Ensure smooth interactions and basic rule enforcement.
  - Start developing Broken Calculator – Implement basic calculator logic with puzzle constraints.
  - Begin early testing and bug fixes for Four Color Map Game.
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### Week 3 (June 16 - June 22): Enhancing First Two Games & Testing

- Finalize Broken Calculator – Add interactive UI and user feedback mechanisms.
  - Conduct testing and optimizations for both completed games.
  - Document the game rules, user flow, and developer implementation details.
  - Get feedback from mentors and incorporate suggested improvements.
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### Week 4 and Week 5 (June 23 - July 06): Developing the Next Two Games

- Start working on Fifteen Puzzle – Implement tile movement logic and win conditions.
  - Begin Euclid's Game – Implement number-based strategy mechanics.
  - Conduct code reviews and refactoring for existing games.
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### Week 6 (July 07 - July 13): Finalizing Mid-Term Evaluation Tasks

- Complete Fifteen Puzzle and Euclid's Game, ensuring smooth gameplay.
  - Conduct thorough unit testing and bug fixes on all four developed games.
  - Submit progress report and mid-term evaluation to Sugar Labs.
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### Mid-Term Evaluation (July 14 - July 18)

- Four completed games: Four Color Map Game, Broken Calculator, Fifteen Puzzle, Euclid's Game
  - Documentation and testing reports submitted
  - Mentor feedback incorporated for further improvements
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### ♦ **Phase 3 Objective: AI Integration & More Game Implementations**

### Week 7 (July 21 - July 27): Developing Next Two Games

- Start implementing Odd Scoring – Develop scoring logic and game mechanics.
  - Begin Soma Cubes – Implement 3D puzzle logic using Python-based visualization.
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#### Week 8 (July 28 - August 03): AI Integration in Number Detective & Sorting Hat AI

- Implement Number Detective – Train a simple ML model for pattern recognition using rule-based logic.
  - Start Sorting Hat AI – Use k-Nearest Neighbors (k-NN) or Decision Trees for classification tasks.
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#### Week 9 (August 04 - August 10): AI Model Tuning & Game Enhancements

- Optimize ML models in Number Detective and Sorting Hat AI for better predictions.
  - Conduct usability testing and UI refinements for AI-based games.
  - Gather mentor feedback and incorporate suggested changes.
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### ◆ **Phase 4 Objective: Final Development, Testing & Documentation**

#### Week 10 (August 11 - August 17): Developing Final Game & Optimization

- Implement the last game, Make An Identity – Develop equations and logic puzzles.
  - Conduct full-scale testing for all eight games, fixing bugs and optimizing performance.
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#### Week 11 (August 18 - August 24): Final Evaluation Preparation

- Conduct final QA testing, ensuring all games are working smoothly.
  - Write developer documentation, including setup guides, game rules, and contributions guide.
  - Submit final project report and documentation.
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#### Final Evaluation (August 25 - September 01)

- All eight math games completed with AI-powered learning features implemented
- Full documentation and testing reports submitted

- Mentor feedback incorporated
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### **Post-GSoC Plans & Continued Contributions**

Even after GSoC ends, I plan to:

- Continue maintaining and enhancing the project – Fix bugs, add new features, and improve AI models.
  - Contribute to Sugar Labs – Help in mentoring future contributors and improving other educational activities.
  - Promote the project – Create blog posts or video tutorials explaining AI concepts in educational games.
  - Explore more AI-integrated learning solutions – Work on expanding Sugar's interactive AI learning experiences.
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### **Progress Reporting & Communication**

To ensure transparency and smooth collaboration, I will:

- Provide weekly progress updates via blog posts or GitHub issues.
  - Regularly communicate with mentors via SugarLabs mailing lists and chat.
  - Submit detailed progress reports at both mid-term and final evaluations.
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