YouZeroed: Machine Learning Based Personalized Math System With An Integrated Large Language Model Based Calculator

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Abstract

This project states the development of a machine learning model based personal math tutoring online platform integrated with a large language model for solving advance math problems. It is a distinguished software tool aimed to help students of all ages and adults learn math not just as a school subject but of their own accord to become skilled at math and make sense of numbers through wide range of aptitude, reasoning and math problems. The concept of learning math our own way will foster fast and better results mathematics and can steer away the fear of maths in students.

The business model explored in this report is not an ed-tech software designed to be sold to educational institutions, schools, colleges and coaching organizations. It is an independent learning platform with the objective of taking math beyond just the numbers to analysis and research and beyond a school or college curriculum, in order to shift the approach towards mathematics from being perceived as tedious to fun and accessible topic.

1.0 Introduction

With evolution in the buzz field of Artificial Intelligence, mathematics has also evolved. Even though there is a lot of enthusiasm to learn to learn artificial intelligence, the recognition that AI at it's core is all math is important. We are witnessing that AI has use cases spanning in all aspects of lives now. Thus, math has become indispensable in all these aspects gaining the title of "learning of the future". With evolution of AI, math has also evolved. An expert in the field of machine learning must be an expert in the application of calculus, statistics, algebra and probability. But the reality is that math is considered difficult and hard because students and learners fail to bridge the gap between it's application and concepts. This has a lot to do with how maths is being taught.

Math is seen only as a part of course curriculum in schools and colleges which takes away the core attribute of it. Not making sense of numbers early on makes mathematics hard for students to approach it with the perspective of problem solving. The application part of the subject is missed out by students. Their learning systems segregate math as a tough subject to pass exam when in

reality math has to do with the cognition, logic building and reasoning in our brain in all matters of life. This is why maths cannot be taught one way. Different persons can have different ways of learning it. This is why there is the need of a personalized math system which focuses on application of the subject in all ways. To meet the different math learning needs of people and help them not consider it any different from their lives, they must tackle questions which bring them examples from real life domains. This way the pressure of passing just an exam can be eradicated. For any discovery to flourish and be proved, great mathematicians are required in every domain.

A personalized math tutor will help learners think of math beyond numbers and treat it differently. YouZeroed is a personalized math tutor based on machine learning with an integrated calculator system based on large language model build as an initiative to serve this purpose. It will lead the way for people to thrive in applied math and be skilled to contribute to machine learning developments as well.

I. **Application Based Questions:** The content of this platform is not restricted to one person's content but a set of problems which are framed from real life examples and not just direct value-variable questions.
   Advantage: Fosters reasoning and analysis.
II. **Integrated Calculator:** A large language model trained to solve only aptitude and math problems.
III. **Blogging Content:** A platform where users can write blogs about math topics, latest discoveries in the field and news of it's application.
IV. **Personalized:** Users can begin learning from any level of math expertise. There will be a progress tracker to keep track of a user's progress in advance topics such as probability, calculus, algebra, statistics.
V. **Math Library:** A list of standard math books to learn and access concepts.
   Advantage: Self paced reading is crucial to visualizing concepts and for a person to be good at math, the ability of visualizing concepts must develop. This also makes a person quick at doing calculations mentally.
VI. **Ensuring Consistency:** A problem thrown in to the learner everyday based from among the concepts they have learned so far. This will help them stick to everyday practice.

1.1 Initial Needs Statement (Times New Roman, 14, left)

- **Students' Needs:** A student needs his/her own tailored learning path. In schools Maths is taught in one particular way which doesn't fit every student's learning style. This is where students happen to think that math is not their cup of tea. At YouZeroed, students can tailor their learning path.
- **Parents' Needs:** Parents struggle to understand their child's learning needs. Not every child is good at memorizing but does solve numbers quick in their minds.

First time users can take a short test to quantify their expertise in reasoning and from their they can tailor their learning path, i.e, those problems will be thrown in which help to build concepts. With the use of machine learning, the software will suggest topics to focus on.

2.0 Customer Needs Assessment

2.0.1Global Perspective

- **Rising STEM Education:** There is a growing emphasis on STEM (Science, Technology, Engineering, Mathematics) education worldwide to prepare students for upcoming developments in technology and science. Personalized learning can enhance math proficiency, a crucial component of STEM education.
- **Analytical Thinking Beyond Passing An Exam:** Math, critical thinking, aptitude and reasoning is approached only from the perspective of part of course curriculum in school or for passing an exam. Math is everywhere and logical reasoning and analysis raises human cognition.
- **Machine Learning and AI:** The integration of machine learning and AI in education represents a significant technological advancement. It can analyze student performance data to provide insights and recommendations, enhancing the learning experience.
- **Data-Driven Insights:** Complex AI software models are built from underlying patterns in data which are extracted through advance mathematical calculations. To aid the construction of new software model in AI, a thorough hand on understanding and practice of math is needed and one must be excellent in analysing facts and figures.

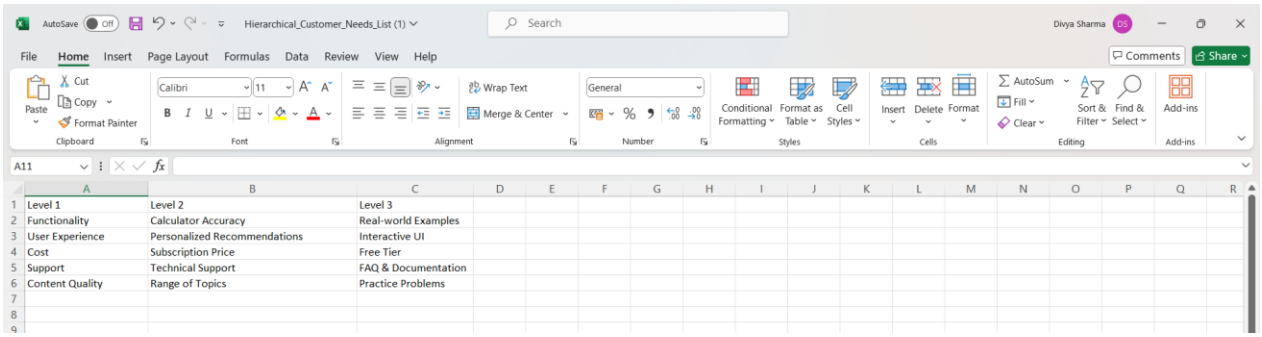
2.0.2 Personal Perspective

- **Individual Learning Styles:** Every student has a unique learning style. A personalized system can adapt to visual, auditory, kinesthetic, and other learning preferences, ensuring a more engaging and effective learning experience.
- **Pacing:** Students can learn at their own pace, spending more time on challenging topics and less on areas they grasp quickly, leading to better retention and understanding.
- **Progress Tracking:** Personalized progress trackers and point reward systems can motivate students by providing a sense of accomplishment and clear goals to strive for.
- **Reduced Anxiety:** Personalized learning can help reduce math anxiety by providing a supportive and non-judgmental environment where students can practice without fear of failure.
- **Incremental Challenges:** Gradually increasing the difficulty of problems helps build confidence as students master each level before moving on to more complex topics.
- **Anytime, Anywhere Learning:** A digital platform allows students to learn from anywhere at any time, providing flexibility that traditional classroom settings cannot offer.

2.0.3 Broader Implications

- **Continual Skill Improvement**
- **Adaptability:** The system can evolve with the learner, providing increasingly complex and relevant content as their skills develop.

Table 1. Initial Customer Needs List Obtained from Interviews and Observations



Level 1	Level 2	Level 3
Functionality	Calculator Accuracy	Real-world Examples
User Experience	Personalized Recommendations	Interactive UI
Cost	Subscription Price	Free Tier
Support	Technical Support	FAQ & Documentation
Content Quality	Range of Topics	Practice Problems

2.1 Weighting of Customer Needs

2.1.1 Introduction

Weighting customer needs is a crucial step in the design process as it helps prioritize the features and functionalities that matter most to the users. This prioritization ensures that the most critical aspects of the product receive the appropriate focus and resources during development. The Analytical Hierarchy Process (AHP) is one effective method for systematically weighting customer needs. This section describes how AHP was utilized to create a weighted hierarchical customer needs list for the personalized machine learning-based math learning platform.

2.1.2 Analytical Hierarchy Process (AHP)

The AHP involves several steps:

1. **Define the Problem and Goal:** Establish the overall objective, which in this case is to develop an effective personalized math learning platform.
2. **Identify the Criteria:** Determine the primary customer needs categories, such as usability, content quality, performance, security, and cost.
3. **Structure the Hierarchy:** Arrange these criteria hierarchically from general categories to specific needs.
4. **Pairwise Comparisons:** Compare each criterion against every other criterion to determine their relative importance.
5. **Calculate Weights:** Use the comparison results to calculate the relative weight of each criterion.
6. **Consistency Check:** Ensure the comparisons are consistent and adjust if necessary.

3.0 Revised Needs Statement and Target Specifications

After a short informational session with three considered persons who come under target users of different ages, a precise set of customer needs is curated. One of them who is a student in international board implied the need of a calculator software where questions could either be uploaded or written on calculator screen with a stylus(device pen). From a student's perspective, this is to reduce time of manually entering the problem on a handy calculator through buttons even if it is digital. Also, this customer stated if there could be an explanation to the problems and stepwise solution generated by such a calculator. So the idea of an integrated calculator based on large language model is apt and benefits the student segment of the target customers. While the current LLM based products do provide answers, they are general purpose programs. In the age of digitization, it is important to ensure students' focus.

Another customer, a parent described how her child was indecisive when he had to choose between applied math and theoretical math in high school. While we know that theoretical math is a very small part of mathematics, segregating the two branches means pulling child back from working on actual problems which will foster their cognition.
Even though focus is now shifting on automating and fine-tuning machine learning models, core mathematical concepts cannot be overlooked or skipped. Data scientists are working on problems on every single domain to extract insights. A good data scientist is one who can draw these inferences by using inferential statistics or descriptive statistics, use right parameters by thriving in calculus and analysing results with help of probability.

Everything in this and upcoming era is an input, a new information which can be fed to computer to get new unimaginably amazing results. But this data is dealt with by considering it a matrix. A vector space and many possibilities, i.e., instances of data in that vector space. This is why algebra is important.

Another reason why math is perceived as tedious and tough is because the applications of it are not known to general masses. It is seen as something very complex but if it is happened to be explained by mathematicians or scientists, it seems fun. This knowledge gap has always made people think that to be good at math is to have something exceptional. But new mathematical theories or it's newest application and ideas are read by people as a generic habit or an easy task, people's mental approach towards math can be very different.

When these needs are addressed, the popular question "How much math is needed for machine learning?" will fade away. This narrows down are goals from generic to specific as enlisted below:

- ✓ **Large Language Model Based Integrated Calculator**
- ✓ **Machine Learning Based Expertise Assessment**
- ✓ **Blogs, Articles And Posts On Mathematic**
- ✓ **Personalized Learning Journey**
- ✓ **Aptitude And Analysis Practice**
- ✓ **A Library Of Standard Math Books**

4.0 External Search

The idea of this business model's development is supported by published articles and interviews of mathematicians.

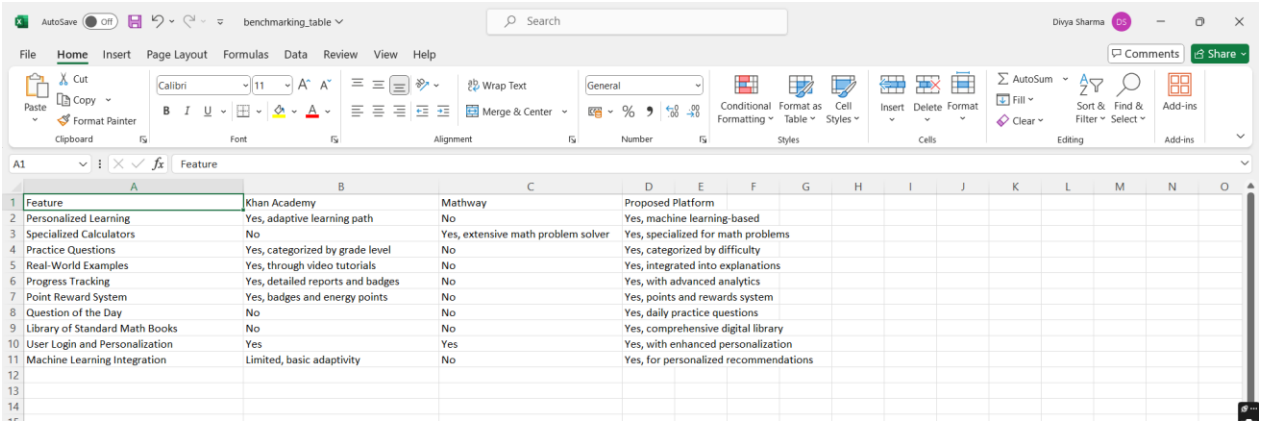
"Why is math so important for the Future?" by Kashish, mathematicalspace.in
"Learning Math Without Fear" Professor Jo Boaler, Stanford Research Stories
"YouCubed" by Professor Jo Boaler

4.1 Benchmarking

Khan Academy and Mathway are well-established platforms that offer various features aimed at enhancing math learning. Khan Academy provides a comprehensive learning experience with video tutorials, practice exercises, and progress tracking, while Mathway focuses on algebra problem-solving with step-by-step solutions and a specialized calculator. The comparison will be based on several key features relevant to our project's goals.

Key Features Compared

1. **Personalized Learning**
2. **Large Language Based Specialized Calculators**
3. **Practice Questions (Categorized by Difficulty)**
4. **Real-World Examples**
5. **Progress Tracking**
6. **Point Reward System**
7. **Question of the Day**
8. **Library of Standard Math Books**
9. **User Login and Personalization**
10. **Machine Learning Integration**



	A	B	C	D
1	Feature	Khan Academy	Mathway	Proposed Platform
2	Personalized Learning	Yes, adaptive learning path	No	Yes, machine learning-based
3	Specialized Calculators	No	Yes, extensive math problem solver	Yes, specialized for math problems
4	Practice Questions	Yes, categorized by grade level	No	Yes, categorized by difficulty
5	Real-World Examples	Yes, through video tutorials	No	Yes, integrated into explanations
6	Progress Tracking	Yes, detailed reports and badges	No	Yes, with advanced analytics
7	Point Reward System	Yes, badges and energy points	No	Yes, points and rewards system
8	Question of the Day	No	No	Yes, daily practice questions
9	Library of Standard Math Books	No	No	Yes, comprehensive digital library
10	User Login and Personalization	Yes	Yes	Yes, with enhanced personalization
11	Machine Learning Integration	Limited, basic adaptivity	No	Yes, for personalized recommendations

4.2 Applicable Patents

Platform for implementing a personalized learning system, March 19, 2019: A platform can be employed to implement a personalized learning system that is simple to use, streamlined and scalable thereby enabling such systems to be seamlessly implemented in any learning environment. The platform can be implemented in a client-server environment in which a server or servers maintain a number of data structures which can be used to define students, assignments, classes, flashcards, videos, and learning standards definitions, among many others. A number of backend processes, websites, and web APIs can be configured to allow users to access the content of these data structures as well as to create new entries in these data structures to thereby facilitate the implementation of a personalized learning system that incorporates automation and machine learning in a school, workplace or other learning environment.

The above explanation helped in implementation of design of YouZeroed but our business model is not aimed at being utilized by teachers for a class of students to tailor the syllabus according to students' needs.

4.3 Applicable Standards

When developing a personalized machine learning-based math learning platform, several standards, rules, and regulations need to be considered. These standards ensure that the platform is safe, reliable, and compliant with legal and industry requirements. The key areas of concern include health and safety, data privacy and security, accessibility, and environmental regulations.

4.4 Applicable Constraints

4.4.1 Internal Constraints

- **Budget Constraints:** Developing a sophisticated AI-driven platform necessitates substantial financial investment, including software development, cloud infrastructure, machine learning model training, and user interface design. Initial budget constraints may limit the scope of features or affect the hiring of expert developers and educators. Prioritizing core features and seeking funding through investors, grants, or partnerships can help mitigate budget limitations. Detailed financial planning and phased development will ensure effective use of resources**.**
- **Expertise and Resource Constraints:** The project demands a diverse team with expertise in AI, machine learning, educational pedagogy, and user experience design. Limited availability of such talent may impact development pace and quality. Investing in continuous training programs for existing staff, collaborating with academic institutions, and considering strategic partnerships or outsourcing for specialized tasks can address

these constraints. Building a versatile team with a strong interdisciplinary approach will be crucial.

- **Time Constraints:** Timely market entry is crucial to gaining a competitive edge. Balancing thorough development and testing with market entry deadlines requires efficient project management. Implementing agile development methodologies will facilitate iterative improvements and quicker feature rollouts. A detailed project timeline with milestones and buffer periods will help manage time effectively.
- **Space Constraints**: While physical space requirements are minimal, digital storage and data management need careful planning to ensure scalability and security. Utilizing cloud storage solutions and robust database management systems will be essential for handling user data and content without compromising performance. Future-proofing the platform with scalable infrastructure will support growth and evolving user needs.

4.4.2 External Constraints

- **Market Constraints:** The educational technology market is highly competitive, with established players offering similar services. Differentiating our platform through unique features such as story-based math problems, an intuitive AI chatbot, and personalized learning paths is crucial. Comprehensive market research and competitor analysis will help identify gaps and opportunities. Marketing strategies focusing on unique value propositions and user engagement will enhance market penetration.
- **Environmental Constraints:** Sustainability is a key consideration, with a focus on optimizing server usage and energy consumption to minimize environmental impact. Partnering with eco-friendly cloud service providers and adopting green coding practices will support our sustainability goals. Regular audits and optimizations will ensure ongoing environmental responsibility.
- **Health and Safety Constraints:** Ensuring user data privacy and compliance with regulations like GDPR and COPPA is critical. The platform must implement robust security measures to protect user information and provide a safe online learning environment. Regular security audits, updates to protocols, and transparent data handling practices will maintain compliance and user trust. User education on data privacy and security will further enhance safety.

4.4.3 Impact on Development

These constraints necessitate strategic planning and prioritization. Budget limitations require phased development, starting with essential features and expanding as funding allows. Expertise constraints emphasize the need for continuous training and strategic partnerships. Market competition underscores the importance of unique value propositions to attract and retain users.

Compliance with privacy regulations and environmental considerations will guide infrastructure and policy decisions, ensuring ethical practices and user trust.

4.5 Business Opportunity

4.5.1 Overview

The personal math learning platform offers a transformative opportunity to address widespread math anxiety and enhance numeracy skills across diverse age groups. By integrating advanced AI technology with engaging educational content, we aim to revolutionize math learning, making it accessible, enjoyable, and effective. The platform's unique approach combines story-based problem-solving with adaptive learning paths, offering a personalized and interactive math education experience**.**

4.5.2 Business Opportunity Statement

Our platform targets a diverse audience, including students, parents, educators, and adult learners, providing personalized learning paths tailored to individual needs. With features like a specialized math chatbot, story-based problem-solving, adaptive learning paths, and a comprehensive library of resources, users will experience a holistic learning journey that builds confidence and competence in math. Please refer to the Business Opportunity Statement in the Appendix for detailed insights and strategic goals.

5.0 Concept Generation

5.1 Problem Clarification

To clarify the problem, we utilized the Energy-Material-Signal (EMS) model, identifying key components and interactions within the platform:

- **Energy**: Server resources required for AI computations and data processing.
- **Material:** Digital content, including math problems, educational resources, and user-generated data.
- **Signal:** User interactions with the platform, feedback loops, and AI responses.

Understanding these components helps define the platform's scope and guides the development of efficient and effective solutions**.**

5.2 Concept Generation

5.2.1 Key Concepts

1. **Story-Based Problem Solving:**
    - Math problems presented as engaging narratives linked to real-world scenarios.
    - Potential to improve visualization and engagement by contextualizing math concepts.
2. **Adaptive Learning Paths:**
    - Algorithms personalize learning experiences based on user performance and preferences.
    - Offers tailored difficulty adjustments to maintain optimal challenge levels.
3. **Gamification Elements:**
    - Incorporation of points, badges, and leaderboards to motivate users.
    - Creates a rewarding and interactive learning experience.
4. **Dynamic Visualization Tools:**
    - Interactive graphs and animations to illustrate mathematical concepts.
    - Enhances comprehension through visual learning.
5. **Integrated Feedback System:**
    - Immediate feedback and hints provided by the chatbot during problem-solving.
    - Supports iterative learning and reduces frustration.

5.3 Initial Screening for Feasibility and Effectiveness

5.3.1 Feasibility Analysis

1. **Story-Based Problem Solving:**
    - Technically feasible with current content creation tools.
    - High user desirability due to engaging format.
    - Competitive advantage in offering unique content.
2. **Adaptive Learning Paths:**
    - Feasible through existing machine learning algorithms.
    - Strong market viability as personalization is a growing trend.
3. **Gamification Elements:**
    - Technically straightforward with existing frameworks.
    - Enhances user engagement and retention.
4. **Dynamic Visualization Tools:**
    - Feasible with modern web technologies.
    - High user engagement due to visual learning preferences.
5. **Integrated Feedback System:**
    - Feasible using advanced natural language processing (NLP) techniques.
    - Increases learning effectiveness through timely feedback.

6.0 Concept Selection

6.1 Data and Calculations for Feasibility and Effectiveness Analysis

For the selected concepts, detailed feasibility and effectiveness analyses were conducted using simulations and research:

- **Story-Based Problem Solving:**
  - Content development simulations to estimate time and resources required.
  - User testing to gauge engagement and comprehension improvements.
- **Adaptive Learning Paths:**
  - Machine learning model simulations to determine accuracy in adapting difficulty.
  - Analysis of user data to refine personalization algorithms.
- **Gamification Elements:**
  - Calculations of user engagement metrics and retention rates.
  - A/B testing to identify the most effective reward systems.
- **Dynamic Visualization Tools:**
  - Performance testing to ensure smooth interactions and responsiveness.
  - User feedback to refine visual elements and improve usability.
- **Integrated Feedback System:**
  - NLP model testing to ensure accuracy and relevance of feedback.
  - Continuous improvement based on user interactions and feedback.

6.2 Concept Screening

6.2.1 Customer Feedback and Screening Process

We gathered feedback from potential users, including students, parents, and educators, to refine our concepts. The screening process involved:

- **User Surveys and Focus Groups**: Collected qualitative and quantitative data on concept appeal and usability.
- **Prototype Testing**: Developed low-fidelity prototypes to test key features and gather insights.
- **Refinement and Combination**: Integrated feedback to enhance concepts, combining features for optimal effectiveness.

6.3 Concept Development, Scoring, and Selection

6.3.1 Development and Evaluation Process

We employed a Pugh Chart to score and evaluate concepts, focusing on criteria such as usability, engagement, and scalability. The process included:

- **Scoring Methodology:**
  - Weighted scores assigned based on alignment with project goals and user needs.
  - Continuous feedback loops incorporated into the decision-making process.

- **Concept Refinement:**
    - Iterative design cycles used to refine concepts, ensuring alignment with user expectations and technical feasibility.
    - Emphasis on creating a cohesive and seamless user experience.

6.3.2 Selected Concept

The final concept selected for further development includes:

- **Core Features:**
    - Story-based problem-solving with dynamic visualization tools.
    - Adaptive learning paths with personalized content recommendations.
    - Gamification elements integrated throughout the platform.
    - Integrated feedback system to provide immediate guidance and support.
- **Detailed Design:**
    - Sketches and CAD drawings illustrating user interfaces and interactions.
    - Prototypes showcasing key features and user journeys.

7.0 Final Design

7.0.1 System Level Description

The personalized machine learning-based math learning platform is designed to provide a comprehensive and interactive learning experience for students of various levels. The system integrates a specialized calculator, a learning system with practice questions, a progress tracker, a 'Question of the Day' feature, a library of standard math books, and personalized user login information. The platform utilizes machine learning algorithms to adapt to the individual learning needs of each user, providing a tailored educational experience.

7.0.2 Subsystems and Components

1. **Specialized Calculator System**
    - **Functionality**: Solves math problems, explains solutions step-by-step, and offers alternative problem-solving methods.
    - **Components**: User interface (UI), mathematical logic engine, machine learning module for solution explanation.
2. **Learning System**
    - **Functionality**: Provides practice questions categorized by difficulty (easy, medium, hard), real-world examples, and instant feedback.
    - **Components**: Question database, difficulty categorization algorithm, feedback generation system.
3. **Progress Tracker and Point Rewarder**
    - **Functionality**: Tracks user progress, awards points for completed tasks, and displays progress through visual charts.

    - **Components**: User activity logger, points calculation module, progress visualization tools.
4. **Question of the Day Feature**
    - **Functionality**: Presents a daily math question to encourage consistent practice.
    - **Components**: Daily question generator, notification system, answer submission interface.
5. **Library of Standard Math Books**
    - **Functionality**: Provides access to a digital library of math books for reference.
    - **Components**: Digital book repository, search and access interface.
6. **Personalized User Login Information**
    - **Functionality**: Securely manages user login and personal data.
    - **Components**: Authentication system, user profile management, data encryption.

7.0.3 Thermal and Mechanical Design Aspects

While the platform primarily involves software components, ensuring that the server infrastructure can handle high loads efficiently is critical. The thermal and mechanical design aspects pertain to the server hardware, ensuring proper cooling and maintenance to avoid overheating and hardware failure.

1. **Server Cooling System**
    - **Design Consideration**: Efficient heat dissipation to maintain optimal operating temperatures.
    - **Components**: High-performance cooling fans, heat sinks, temperature monitoring sensors.
2. **Server Rack Design**
    - **Design Consideration**: Optimal arrangement of hardware components to ensure proper airflow and easy maintenance.
    - **Components**: Modular rack units, cable management system, vibration dampening.

7.0.4 FMEA (Failure Modes and Effects Analysis)

To ensure the safety and effectiveness of the platform, a thorough FMEA was conducted. The critical design areas were identified, and potential failure modes were analyzed to prioritize risks and focus the design effort.

1. **Hazard Identification**: Identifying all possible hazards associated with the platform's operation.
2. **Risk Evaluation**: Assessing the severity, occurrence, and detection of each potential failure mode.
3. **Mitigation Strategies**: Developing strategies to reduce the Risk Priority Numbers (RPN) to acceptable levels.

7.0.5 FMEA Results:

- **User Data Security**: High RPN due to the critical nature of personal information. Mitigation includes robust encryption and regular security audits.
- **System Downtime**: Medium RPN, mitigated by implementing redundant server architecture and regular maintenance schedules.
- **Incorrect Answers from Calculator**: Low RPN, mitigated by continuous algorithm updates and validation processes.

(Actual FMEA worksheets are included in the appendix.)

7.0.6 Design Analysis and Justification

Key analysis was performed to justify design decisions, including:

1. **Algorithm Validation**: Ensuring that machine learning models accurately solve and explain math problems.
2. **User Interface Testing**: Conducting usability tests to ensure the platform is user-friendly and accessible.
3. **Server Load Testing**: Simulating high user loads to ensure server stability and performance.

7.0.7 Significant Design Decisions:

- **Encryption Standards**: Chosen based on current best practices to ensure user data security.
- **Machine Learning Models**: Selected for their accuracy and ability to provide detailed explanations.
- **Server Architecture**: Designed for scalability and redundancy to handle peak loads without downtime.

7.1 How Does It Work?

The platform operates by providing an interactive and personalized math learning experience. Users log in with their personalized credentials, access the specialized calculator, engage with the learning system, track their progress, and receive daily math questions. The digital library of math books is available for reference, and the entire system is designed to adapt to the user's learning pace and style.

7.1.1 User Operation

1. **Logging In**: Users enter their credentials to access the platform.

2. **Using the Calculator**: The specialized calculator allows users to input math problems and receive step-by-step solutions.
3. **Learning and Practicing**: Users engage with practice questions, receive feedback, and view real-world examples.
4. **Tracking Progress**: The progress tracker displays user performance over time, awarding points for completed tasks.
5. **Daily Questions**: Users receive a 'Question of the Day' to encourage daily practice.
6. **Accessing the Library**: Users can search and read digital math books for additional reference.

7.1.2 Maintenance and Service

The platform requires regular maintenance to ensure optimal performance and security:

1. **Server Maintenance**: Regular checks and updates to the server hardware and software.
2. **Algorithm Updates**: Continuous improvements to the machine learning models to maintain accuracy.
3. **User Support**: Providing customer support to assist with any issues or questions.

7.1.3 Assembly Steps

For customers, the assembly steps involve:

1. **Account Setup**: Creating a personalized account with secure credentials.
2. **Profile Customization**: Setting learning preferences and goals.
3. **Device Configuration**: Ensuring compatibility with personal devices (computers, tablets, smartphones).

This comprehensive design ensures that the personalized machine learning-based math learning platform is effective, secure, and user-friendly, meeting the needs of students and educators globally.

7.2 How is it manufactured and assembled, and what does it cost?

7.2.1 Manufacturing and Assembly Plan

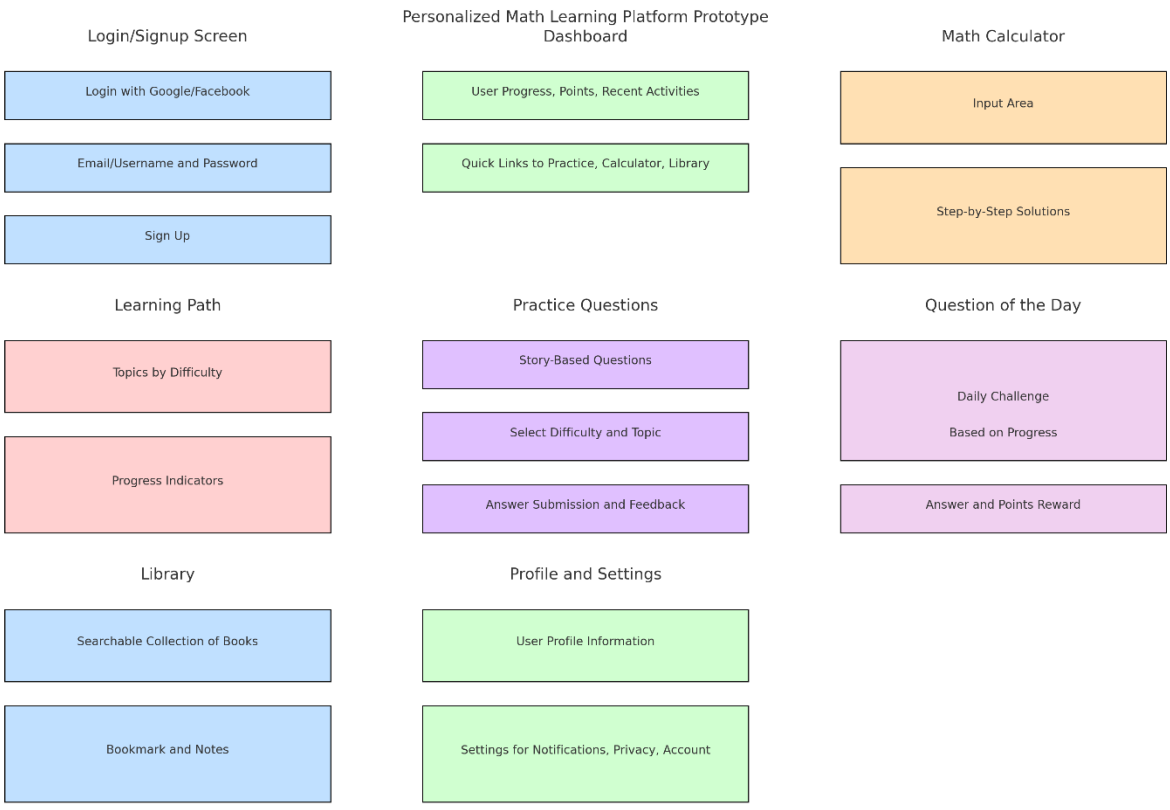
Overview: The personalized machine learning-based math learning platform is an online system requiring a robust backend infrastructure, cloud-based services, and software development. The focus is on software engineering, cloud infrastructure setup, and subscription-based cost management.

7.2.2 Software Development and Cloud Infrastructure

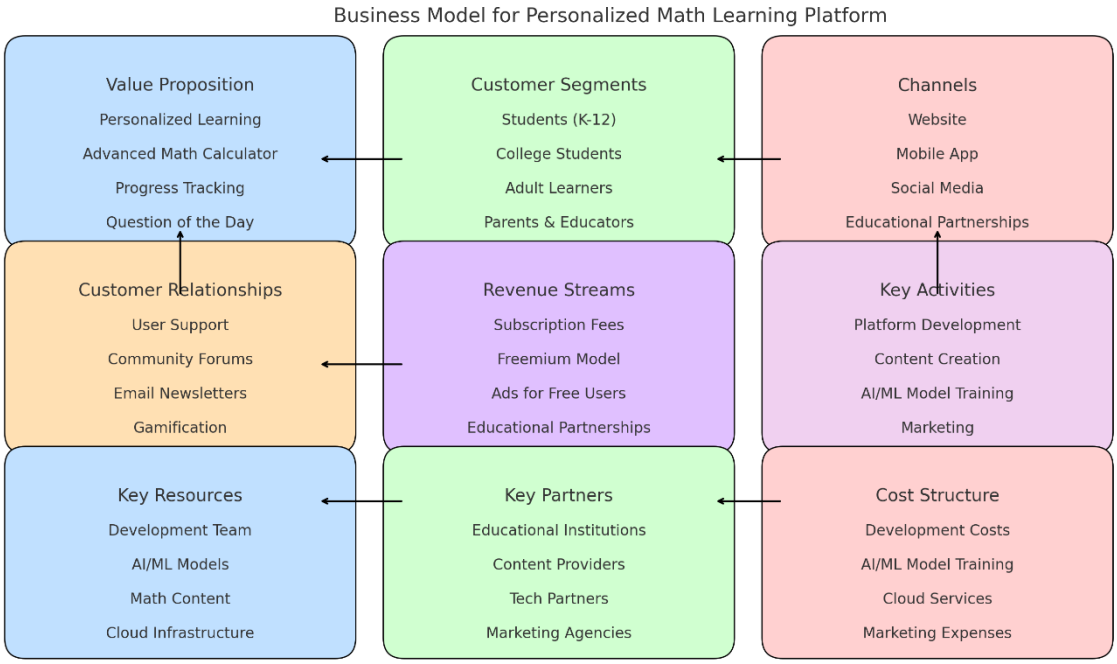
1. **Software Development:**
    - **Step 1:** Requirements gathering and analysis
    - **Step 2:** System architecture design

- **Step 3:** Frontend development (user interface and experience)
- **Step 4:** Backend development (server-side logic, database integration)
- **Step 5:** Machine learning model integration
- **Step 6:** Testing (unit, integration, system, and user acceptance testing)
- **Step 7:** Deployment planning

2. **Cloud Infrastructure Setup:**
   - **Step 1:** Choose a cloud provider (e.g., AWS, Google Cloud, Azure)
   - **Step 2:** Provision virtual machines and necessary instances
   - **Step 3:** Set up load balancers and auto-scaling groups
   - **Step 4:** Configure databases (e.g., SQL, NoSQL)
   - **Step 5:** Implement security measures (firewalls, data encryption, IAM roles)
   - **Step 6:** Set up continuous integration/continuous deployment (CI/CD) pipelines
3. **Subscription Management:**
   - **Step 1:** Develop a subscription management system
   - **Step 2:** Integrate with payment gateways (e.g., Stripe, PayPal)
   - **Step 3:** Implement tiered subscription plans (e.g., Basic, Premium, Enterprise)
   - **Step 4:** Set up automated billing and invoicing



7.3 Design Drawings, Parts List and Bill of Materials



7.3.1 System-Level Drawings:

1. **System Overview Diagram:**
   - This diagram illustrates the main components of the platform, including the user interface, backend servers, databases, and cloud services.
2. **User Flow Diagram:**
   - This diagram shows the steps a user takes to interact with the platform, from logging in to completing a math problem and tracking progress.
3. **Data Flow Diagram:**
   - This diagram details how data moves through the system, from user input to data processing, storage, and retrieval.
4. **Cloud Infrastructure Layout:**
   - This diagram provides an overview of the cloud infrastructure, including virtual machines, load balancers, databases, and storage services.

7.3.2 Subsystem-Level Drawings:

1. **Frontend Development:**
   - Detailed UI wireframes and component hierarchy for web and mobile interfaces.

- Example: A wireframe showing the dashboard, practice problem interface, and progress tracker.

2. **Backend Development:**
   - API design and database schema diagrams.
   - Example: An API design diagram showing endpoints for user management, problem-solving, and progress tracking.
3. **Machine Learning Model Integration:**
   - Flowchart of model training, deployment, and inference processes.
   - Example: A flowchart showing data preprocessing, model training, and deployment stages.

7.3.3 Bill of Materials (BOM):

The BOM for a software-based online platform includes software licenses, cloud services, and development tools. It does not include physical hardware like nuts and bolts but focuses on the components necessary for software development and deployment.

	A	B	C	D
1	Item	Cost per Year (USD)		
2	Development Team Salaries	150000		
3	Development Tools and Licenses	20000		
4	Maintenance and Updates	30000		
5	Virtual Machines	6000		
6	Database Services	1200		
7	Storage	138		
8	Bandwidth	120		
9	Payment Gateway Fees	2450		
10	Subscription System Maintenance	10000		
11	Machine Learning Model Licenses	5000		
12				
13				
14				
15				

7.3.4 Additional Considerations:

1. **Materials and Specifications:**
   - For cloud infrastructure components (virtual machines, databases, storage), select providers with high reliability and scalability (AWS, Google Cloud, Azure).
   - Ensure software tools and licenses are up-to-date and suitable for the development needs (IDEs, version control, CI/CD tools).
2. **Manufacturing Method:**
   - The "manufacturing" process involves setting up and configuring software environments, deploying code, and maintaining cloud services.

- Follow agile methodologies to ensure iterative development and continuous improvement.

3. **Surface Finish and Tolerances:**
    - For software components, ensure clean code practices and adherence to coding standards to maintain quality and readability.
    - Regular code reviews and automated testing to catch and fix issues early.

7.3.5 Assembly Drawings

1. **Frontend Assembly:**
    - Diagram showing the integration of UI components with backend APIs.
2. **Backend Assembly:**
    - Diagram illustrating the integration of backend services, databases, and cloud infrastructure**.**
3. **Machine Learning Model Integration:**
    - Diagram depicting the flow of data from user input through preprocessing, model inference, and result output**.**

7.4 Design Validation Through Test Results and Operating Experience

In the development of the personalized math learning platform, a series of tests were conducted to validate the performance, usability, safety, and other features. This section details the testing process, including the need for information, test design, metrics, measurement system, results, lessons learned, and design changes.

7.4.1 Performance Validation

Need for Information: We needed to ensure that the platform's performance, including response time, accuracy of problem-solving, and system stability, met user expectations.

Test Design: Simulated a typical user load by creating scenarios where multiple users accessed the platform simultaneously, performed calculations, and solved practice problems.

Metrics:

- Response time (should be under 2 seconds)
- Accuracy of calculations (should be 100%)
- System uptime (should be 99.9%)

7.4.2 Usability Testing

Need for Information: We needed to ensure the platform was user-friendly and intuitive, especially for users with varying levels of tech-savviness and math proficiency.

Test Design: Conducted usability tests with a diverse group of users, including students, educators, and parents, to navigate through the platform and complete specific tasks.

Metrics:

- Task completion rate (should be 95% or higher)
- User satisfaction (measured via surveys, target 4.5/5)
- Error rate (should be minimal)

7.4.3 Feature Validation

Need for Information: We needed to ensure all features, including the progress tracker, point reward system, and 'Question of the Day', functioned as intended and enhanced the learning experience.

Test Design: Implemented A/B testing to compare user engagement and performance with and without these features**.**

Metrics:

- User engagement (time spent on platform, number of problems solved)
- Learning outcomes (improvement in scores over time)
- Feature usage rates

8.0 Conclusions

In conclusion, YouZeroed, our personalized math learning platform successfully met the project objectives by providing an effective solution to the identified business opportunity. The platform addresses the original needs statement by offering a comprehensive, user-friendly, and secure online environment for learning and practicing math.

8.1 Report Conclusion

YouZeroed stands out as a distinguished platform for life long learning of mathematics and take the burden off the school's math curriculum. However it is not production ready because of multiple models being used. Such a complex system requires both time and efficiency in building. It will require a team of data engineers, machine learning engineers, expertise in large language models and a team of content creators and researchers who can bring the most appropriate set of problem set.

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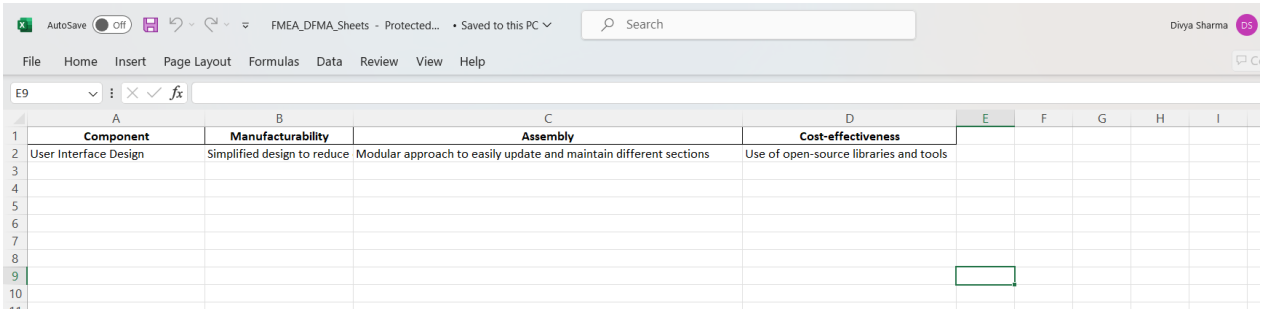
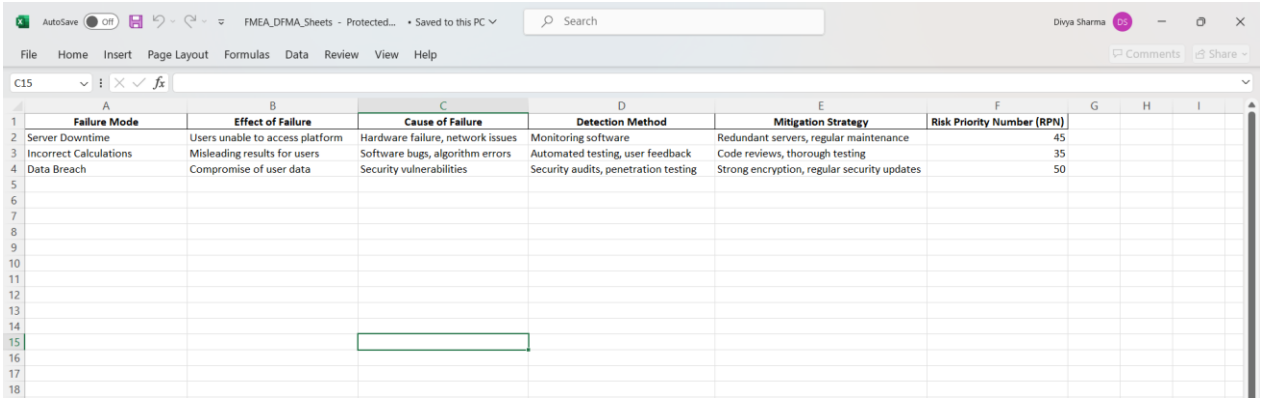
Appendices

DFMA Sheet



Component	Manufacturability	Assembly	Cost-effectiveness
User Interface Design	Simplified design to reduce	Modular approach to easily update and maintain different sections	Use of open-source libraries and tools

FMEA Sheet



Failure Mode	Effect of Failure	Cause of Failure	Detection Method	Mitigation Strategy	Risk Priority Number (RPN)
Server Downtime	Users unable to access platform	Hardware failure, network issues	Monitoring software	Redundant servers, regular maintenance	45
Incorrect Calculations	Misleading results for users	Software bugs, algorithm errors	Automated testing, user feedback	Code reviews, thorough testing	35
Data Breach	Compromise of user data	Security vulnerabilities	Security audits, penetration testing	Strong encryption, regular security updates	50