Agile Software Projects Report

“Mathote”

Authors: Team member 1, Team member 2, Team member 3, Team member 4, Team member 5

Table of Contents

Table of Figures

Introduction

This document provides an in-depth exploration of our journey towards creating an innovative solution in the realm of educational technology - a Maths Assisting Web Application - Mathote. Mathote is a tool designed to bridge the gap between complex mathematical problems and intuitive understanding. It is a side helper for students, teachers, professionals, and anyone who interacts with maths in their daily life.

By the end of this module, we aim to have a fully functional version of Mathote, ready to assist users in their mathematical journey.

Concept

The primary purpose of this application is to revolutionise the way users take notes, particularly in mathematical and scientific fields. It aims to make notes easy, providing a comprehensive tool for students, teachers, or anyone who needs to note down ideas and solve complex mathematical problems on the go.

Aims and Objectives

Our web application aims to assist our users with their mathematical problems and also help them take notes for mathematics. With the integration of a Scientific Calculator, a Graphic Calculator and an Equation solving feature which offers step-by-step solutions for a variety of simple linear to complex differential equations, the aim of this application is to provide the users with an all rounded Mathematics software which can help with any mathematical ambiguity that they may have.

For this aim, we initially commenced with market research for note taking applications based on Mathematics, having found a few of them, we studied what they offered the user and noted down their weaknesses or what they did not offer. From there, we took their weaknesses and transformed them into what form the strengths of our application.

Stakeholders

The users for this application will primarily be mathematics enthusiasts, students, teachers, and in future, professionals as well. The app's extensive note-taking features and mathematics tools can assist students of all academic levels with their studies. Teachers and educators can use Mathote to better explain complex mathematical concepts through visualisations. Additionally, Mathote can eventually prove to be an invaluable tool for increasing productivity and accuracy in the work of experts in sectors like engineering, science, and research that frequently require mathematical calculations and documentation. By serving these diverse user groups, Mathote strives to simplify note-taking and mathematical problem-solving.

Scope

1. User Base: The app is intended for a diverse range of users, including students at all levels of education (high school, undergraduate, and postgraduate), teachers and researchers in mathematical and scientific fields, and professionals who must incorporate mathematical concepts into their work.

2. Functionality: The application will offer a seamless experience for creating notes and solving mathematical equations all in one spot. It will not only support a wide range of mathematical notations but will also be able to solve equations and illustrate mathematical ideas.

3. Platform: The app will be built for several platforms to enable accessibility. This covers desktop platforms (Windows, macOS, Linux) and mobile platforms [(iOS, Android) (if our app is responsive)].

Reasons for selecting this application

1. **Integrated Math Features**: Unlike many other note-taking apps, this application has integrated maths features. This makes it easier for users to write and solve mathematical equations right within their notes.
2. **Increased productivity**: With maths features readily available within the note-taking app, users can efficiently create, edit, and manipulate mathematical content without interruption, thus boosting their productivity.

3. **Convenience**: Users often need to take notes during maths-related lectures, classes, or meetings. Having maths features directly integrated into the note-taking app eliminates the need for switching between multiple applications, saving time and streamlining the note-taking process.
4. **Learning and Education support**: Having maths features integrated into the note-taking app can prove to be a valuable learning support for students. Features such as step-by-step equation solving, interactive tutorials, or built-in calculators can help reinforce understanding and improve academic performance.

SWOT Analysis

Strengths

Mathote is a well-rounded application catering to the note taking users in the mathematics niche. With its various features such as an integrated Scientific Calculator, a Graphical Calculator, an Equations Solver and a note taking space, it aims to become a game changer in the field of mathematics note taking. Proceeding to break down the features one by one, the scientific calculator aims to assist the users with a live calculation whilst jotting down notes in the same app. Users would not have to switch to another calculator software as Mathote will have one of its own. The graphical calculator on the other hand processes the equation that the user inputs and converts that very equation to a graph. The equations solver is an innovative feature that will solve equations step by step for the user.

Weaknesses

Where Mathote has its strengths, it also lacks in a few areas. For instance, the note taking feature does not offer extensive functionalities. It does not integrate formatting text features such as changing the text colour, increasing or decreasing text in size, bolding, underlining or italicising the text etc. The note taking feature only allows the user to create a note, write and delete text in it. It also does not allow the user to pencil write on the text area with fingertips or tools such as a stylus. Moreover, Mathote does not have markdown integration for the user to incorporate equations into their notes. Aliases from the keyboard will have to be used to write mathematical symbols and formulas.

Opportunities

As a result of the post-pandemic technological shift coupled with advancement in technology, the demand for electronic note taking will continue to grow. Additionally, the absence of enough note taking applications with integrated maths features, proves the potential of Mathote possibly leading the realm of mathematics note taking.

Besides, with the notion of reducing deforestation for extraction of paper and emitting less carbon dioxide by switching to technological devices, Mathote is a very favourable alternative to physical note taking using paper. If leaders demand a move towards environmentally friendly options, people in masses are very much likely to adopt it.

Threats

Due to the political situation in Congo regarding violation of human rights and environmental degradation, there may arise hindrances in mining Coltan, the very material that produces the technology supporting electronic note taking. If the respective authorities decide to act and curb mining of Coltan, this may hinder the creation of tablets and other technological devices and hence the world will have to conform to traditional paper note taking.

PESTLE Analysis

Political Factors

The production of modern technological devices such as cell phones (web browser), laptops, and computers on which Mathote is to run, requires rare metals like Coltan, short for columbite-tantalite, which are mined in politically and environmentally sensitive regions like Congo. As a result of its severe human rights violation and environmental degradation, the Demographic Republic of Congo has raised significant concerns.

As a result of Coltan mining, according to extensive research, there is large-scale environmental degradation with devastating consequences for the region such as losing 8.6% of its tree cover since 2000 making Coltan extraction a major driver of deforestation. It is also to note that environmental impact assessments are rarely conducted before Coltan is mined which leads to “violation of historical heritage sites such as Kahuzi-Biega National Park”.

The extraction of Coltan has also resulted in severe human rights abuses, perpetuating a cycle of poverty and violence". What is worse is that the Coltan mining business rarely compensates the affected communities. This results in leaving these communities even more vulnerable to violence and displacement. What is even worse than worse is that despite there being reforms to penalize child labour, over "40,000 child miners continue to illegally toil in dangerous condition". Moreover, there are multiple cases of "forced evictions and grievous human rights abuses" at the hands of local government authorities and mining corporations. And as said by Donat Kambola, the president of IBGDH - Initiative pour la Bonne Gouvernance et les Droits Humains, "there was no grievance mechanism, accountability or access to justice [1]."

Economic Factors

There has been a notable surge in the worldwide market for educational technology (EdTech) especially owing to the COVID-19 epidemic which expedited the uptake of online and remote learning programs. A substantial amount of venture capital funding has been flowing into the EdTech industry. Global EdTech firms raised $16.1 billion in venture capital funding in 2020 alone. Even as schools go back to in-person instruction, a McKinsey & Company survey reveals that there is a sustained need for digital learning resources [2]. Fuelled by the rising use of digital learning tools in both higher education institutions and classrooms, according to a report by HolonIQ, the global EdTech market is projected to develop at a compound annual growth rate (CAGR) of 16.3% to reach $404 billion by 2025 [3]. Thus, economic stability and growth can enhance this demand, offering Mathote a significant chance to establish itself as a major participant in the field of mathematics education. The growth rate further indicates strong investor confidence in educational technology's potential, which Mathote can capitalise to secure funding for product development and market expansion. Many governments also provide grants and subsidies to support the development and adoption of educational technologies. This access to venture capital and funding opportunities can influence Mathote's ability to innovate and support its growth initiatives.

Social Factors

The use of digital note-taking apps has significantly increased over the years. According to research, the note-taking market, specifically, will grow from $8.28 billion in 2023 to $9.74

billion in 2024 at a compound annual growth rate (CAGR) of 17.6%. A significant growth to $19.46 billion is expected by 2028 at a CAGR of 18.9% [4].

Students prefer note-taking apps for better and more effective note-taking, while professionals and educators use these reliable tools to prepare and share notes with students. This broad target audience shows the widespread usage of note-taking apps. Current trends, especially post-COVID-19, show a tremendous increase in demand for digital note-taking, collaborative learning, and digital tools that support interactive learning.
The increasing adoption of Artificial Intelligence (AI) further enhances the growth of note-taking apps as it improves user efficiency with features such as voice-to-text conversion and automatic sentence completion [5]. The demand for traditional note-taking apps is substantial and will continue to grow.

Considering this demand, specialised note-taking apps, such as our math-focused app, can address specific user requirements and build a loyal user base. However, there are restraining factors that play a crucial role in shaping the future of note-taking apps. Security concerns, such as protecting user data, must be addressed properly. Additionally, the market is highly competitive, with many note-taking apps available [5].

Our math-focused note-taking app stands out from the majority of apps due to its specialised features. Additionally, excessive feature integration can overwhelm users, making it a challenge to keep them engaged. Our app's simple design is expected to retain user attention effectively.

Technological Factors

The technological landscape can significantly impact the development, functionality, and user experience of a note-taking maths web app.

Advancements in web technologies like HTML5, CSS3, and JavaScript have significantly enhanced the capabilities of web applications. These advancements will allow for the eventual development of more interactive and dynamic features within Mathote, such as real-time collaboration, and interactive problem-solving functionalities tailored for maths note-taking [6].

For a note-taking app that incorporates mathematical tools through APIs, staying ahead of the latest developments in API technology is crucial as well. The app's technological prowess should also extend to its performance, with robust functionality that can handle complex calculations without compromising speed or accuracy. Embracing cloud technology can offer scalability and enhanced security measures for users' data storage and processing needs. The revolution AI has brought about in the landscape of note-taking applications enhancing usability and efficiency [7], can further enrich the functionality of Mathote by offering tailored recommendations based on note-taking habits, personalising user experiences.

However, ensuring compatibility across various devices, operating systems, and browsers can pose a significant challenge. Hence, paying meticulous attention to browser compatibility and ensuring best practices are necessary to ensure a seamless user experience across diverse platforms [8]. Moreover, the app's performance can be contingent upon internet connectivity. In regions with unreliable or slow internet connections, users may encounter lag or difficulty accessing their notes, underscoring the importance of optimising web app performance under varying network conditions [9].

Legal Factors

In the realm of application development, legal considerations play a pivotal role in shaping the framework within which an app operates. For an app that integrates note-taking with advanced mathematical functionalities, adherence to intellectual property rights is paramount. This ensures that the APIs used for graphic calculators, scientific calculators, and equation solvers do not infringe upon existing patents or copyrights [10].

Furthermore, compliance with data protection regulations such as the General Data Protection Regulation (GDPR) in the European Union or the California Consumer Privacy Act (CCPA) in the United States is essential to safeguard user privacy. The app must also conform to accessibility standards, such as the Web Content Accessibility Guidelines (WCAG), to ensure inclusivity for users with disabilities [11].

Environmental Factors

With the development of applications that integrate note taking, there is a shift from the use of papers to the use of technology to jot down notes. As a result of creation of note taking

applications, students, and even professionals can take notes on tablets, mobiles, and computers hence they utilise what they already have - technology. There is no need for papers.

It is said that one sheet of paper without any recycled material results in the atmospheric release of approximately 0.02 kg of Carbon Dioxide. The use of recycled material on the other hand reduces the impact by just half. An iPad on the other hand consumes 3 watts per hour and emits approximately 0.02 kg of Carbon Dioxide. Hence, an iPad will take more than 7 hours of note-taking to produce more greenhouse gas emissions than a single sheet of paper [12].

The use of technology for note taking also reduces deforestation - cutting down trees. Deforestation results in the decrease of biodiversity by “90 to 95 percent”. Deforestation to make room for eucalyptus trees and loblolly pines - used for making paper - also requires pesticides and herbicides which impact water quality thus making it inhabitable for water animals [13].

Market Research

A crucial aspect of designing and planning this application was researching and taking inspiration from existing applications in the same niche. Though there are relatively a handful of note-taking applications that focus specifically on mathematical note-taking, there are quite a few that have this aspect integrated as a feature in an otherwise larger application. Such as GoodNotes which can easily be used as a mathematical note-taking application but is also widely used as a general note taking application for things like medical education. However, for the purpose of this project, we will only be looking at the mathematical aspects of these applications to stay relevant and focused to our research topic.

Goodnotes

The first application we looked at while researching was the infamous Goodnotes. Goodnotes is feature packed and rich with content, it mainly aims to replace traditional notepads and pens/pencils that are still commonly used in the education industry. Inside a single application there can be created hundreds of notebooks consisting of as many pages as desired and as many page types as wanted; for maths specifically, there are options such as the square page and the graph page, and the apple pencil can also be used as a single all in one tool. From a pen, to a

pencil, an eraser, a protractor, the apple pencil replaces literally every single traditional form of stationery and some features in the application like “the ruler” really set this in stone.

The in-built ruler and protractor can be used to create or calculate various angles, and the graphing paper can be easily utilised to display graphs and much more. Additionally, Goodnotes recognizes equations, hence, it can easily transform handwriting into proper mathematical equations, and these equations can be conveniently moved around anywhere on the page using the “lasso tool.” Furthermore, the latest version of Goodnotes also introduces an AI Math Assistant that can help you in rechecking and solving complex equations and calculations, it really is the multi-purpose, revolutionary method of taking notes.

Obsidian

Obsidian caters to a wide audience of users interested in writing personal notes, journaling, project management etc. Its features include creating links between your notes, visualising relationships between notes, a canvas for researching, brainstorming and ideating, and various other features using plugins that users can install for their own purpose. It is using those plugins that the user is able to integrate mathematics onto their notes, writing equations, making graphs, etc.

Using plugins for mathematics, users can take maths notes, compute algebra, render graphs etc. Plugins such as Mermaid and Excalidraw are used for creating graphs, whereas for writing mathematical equations, a user has to use LaTeX within his/her notes.

Notability

Following the previous entries, we continued our research with yet another application that is mainly designed and used on the apple ecosystem called “Notability.” Notability is the greatest competitor to Goodnotes, and just like the previous application, has the ability to replace all pens and paper with a single tablet and apple pencil. However, it has some unique strengths of its own.

Notability gives users the ability to work on multiple documents simultaneously, and it does so with the most intuitive interface from a design perspective. For a maths student, it could be very useful to look at a document with exam questions, or otherwise complex equations discussed

in class and either try to solve them or dissect them otherwise side by side on the same screen on a rough sheet or blank paper that is digitally created by the tablet. It simply makes things more convenient by having everything you need right in front of you in your field of vision.

Another versatile aspect that is available with only the premium version of notability is the "Math conversion" tool. This tool allows users to easily convert handwritten calculations into common mathematical expressions. For example, a user may handwrite a certain formula discussed in class, notability will pick up on this formula, compare it to its large database of existing mathematical formulas, and if it forms a connection, will easily convert the handwritten formula into a more standard, general and easier to understand mathematical equation. The user does not even have to think about it, the feature is automatic.

Mathist

The Mathist is another versatile maths problem-solving and note taking app which is designed to be used on any device. This app has a wide range of impressive features which aid in learning maths, making it a lot more fun and easier. It has a simple and intuitive interface and allows easy retrieval of mathematical formulas and greek letters. The app has an integrated calculator which helps in solving a wide range of mathematical tasks i.e from basic arithmetic calculations to complex computations. Furthermore, it includes powerful graphing tools such as Desmos for visualising functions and data and also provides step-by-step solutions. It comes with autocomplete latex equations so that users don't have to remember latex codes.

The note taking area includes undo, redo, copy and paste functions and has an integrated QUERTY keyboard. To keep record of the notes, the app allows you to save the notes on Google Drive. In short, the Mathist is a comprehensive resource for students and professors seeking to improve their mathematical skills.

LiquidText

The final application that we analysed, researched and tried to take inspiration from is "LiquidText." LiquidText is a completely different and unique type of application. It works by creating two dedicated work spaces, first, the user opens a file within the app, and the document is then imported into the digital workspace. Then, a separate workspace is created alongside the document on the same page and the same screen that takes up half the screen. Now, the user

has two workspaces on the same screen, the document that he can view, scroll through and analyse, and the blank workspace that he can use to annotate the document, supplement it with further information or data, or anything else.

Essentially, it creates a stage where a single document takes central focus, such as a practice exam paper, or a sheet of complex mathematical formulae. Then, the rest of the screen becomes the canvas to manipulate as pleased. This can help brainstorm ideas, get a deeper understanding of complex maths equations, etc.

LiquidText also has an infinite workspace, so space is simply not an issue, multiple documents can be added onto the same workspace, web pages can be easily imported as PDFs, and documents can be squeezed/expanded as per wish.

Thus, using these applications, our team was able to form a good understanding of existing note-taking apps that currently work in the market. We explored many different types of applications and ecosystems to make our research comprehensive. For example, we placed some focus on the apple ecosystem because we have a team member that uses this very system for his own note-taking uses, including during maths lessons. Hence, by conducting this market research, we were able to get a feel for what it is that users like or dislike and how exactly we can go about designing a helpful application that users would find intuitive.

Design Modelling

Initial Prototype Wireframe

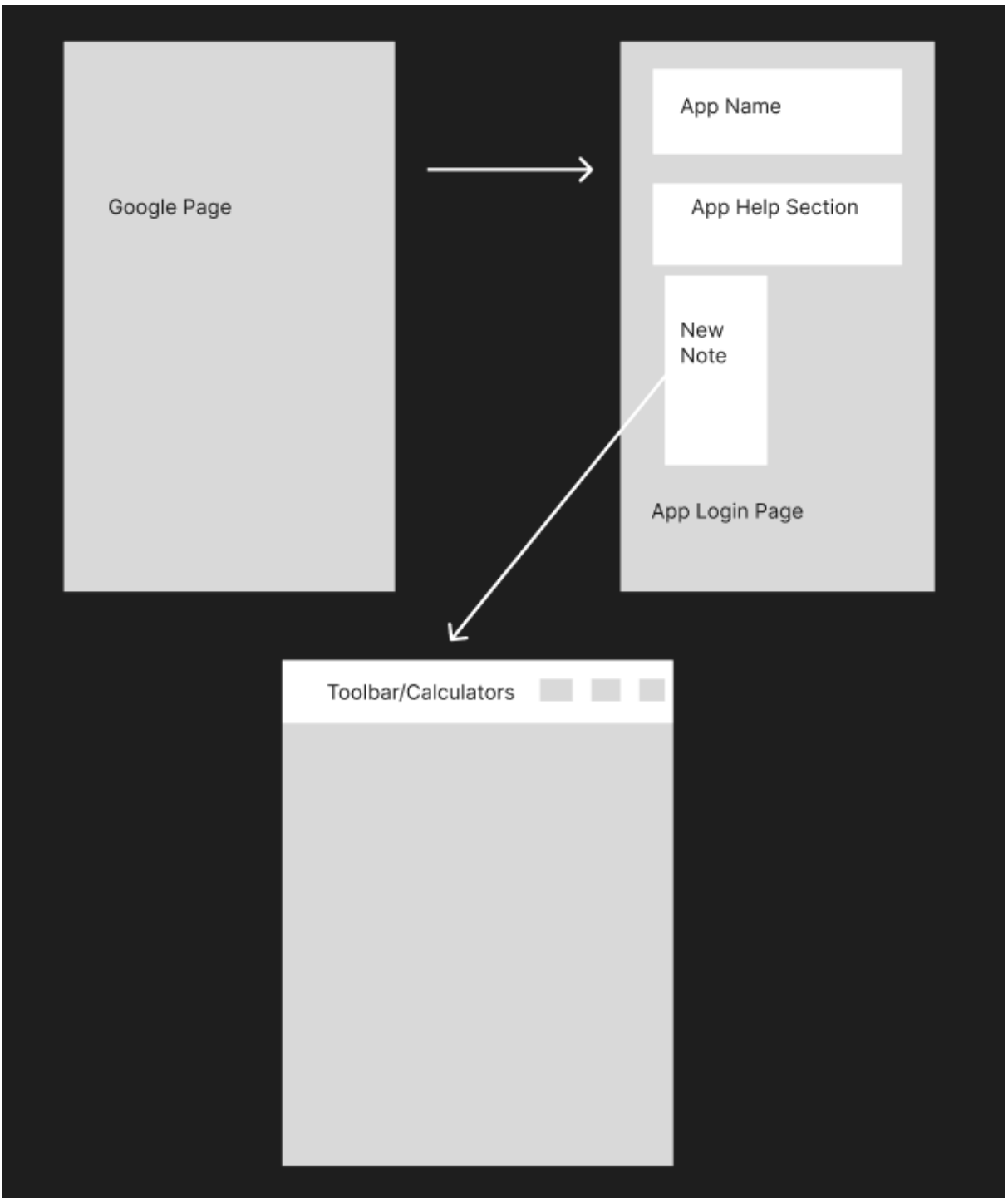

Figure 1: Initial Prototype

After landing on the homepage of the application, the user selects whether they want to create a new note or choose from the existing notes (if any) to work on. Either of the two options will

take them to a webpage with a text editing space and a toolbar placed at the top of the page. The toolbar will consist of tools such as the scientific calculator, graphical calculator and the equation solver in the form of buttons that will be functional using APIs.

Low Fidelity

1st Iteration

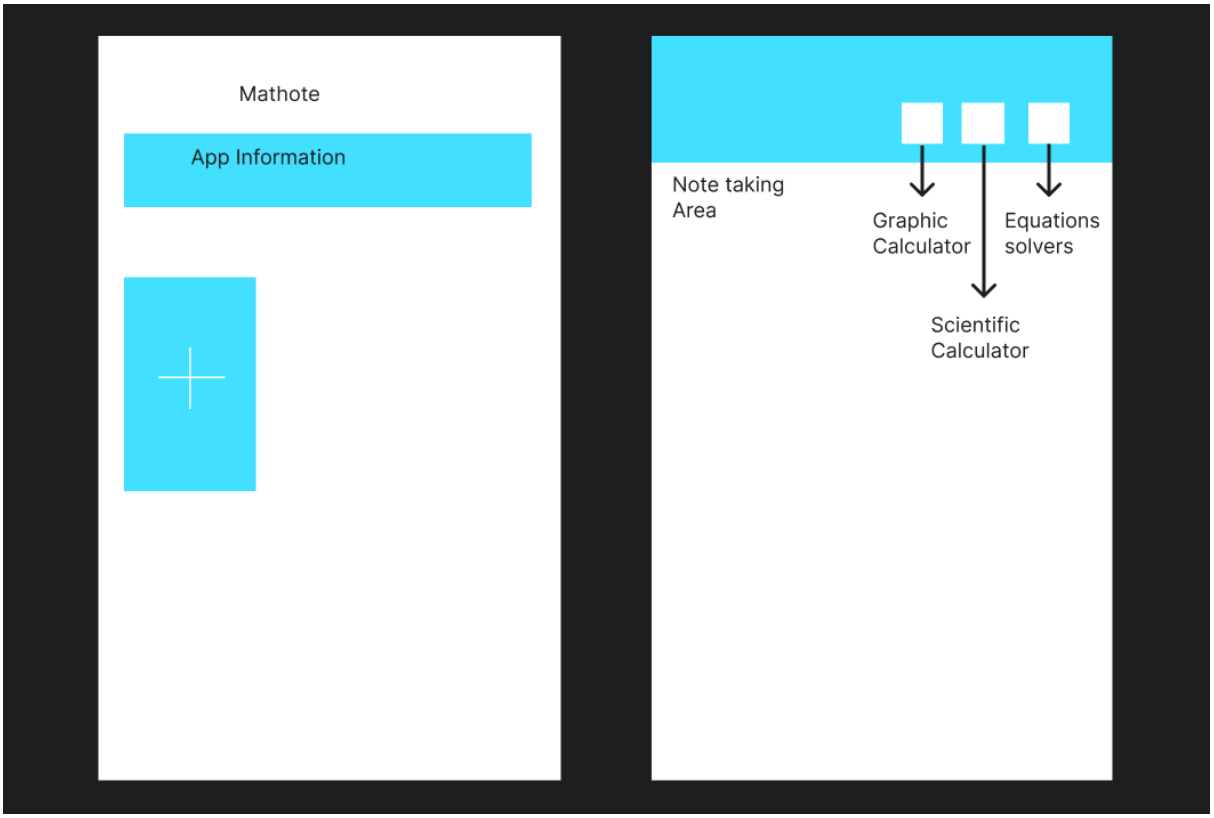

Figure 2: Our Application Design - 1st iteration

In our first iteration of designing the wireframes, we collectively agreed upon making a simple interface, much like Google Docs. Thus, we designed a rectangle placing a "+" sign on top of it in the centre to symbolise that a new note can be created by clicking on this rectangle. Once clicked, the site would redirect the user to a new webpage with a toolbar displayed at the top of the page and a text editor area below it. This toolbar will contain buttons for the APIs - scientific calculator, graphical calculator and equations solver will go on the right of the toolbar and formatting options will be displayed on the left. Whereas, the text editor area will enable the user to write, edit and delete their notes.

To gauge the user's satisfaction with the design of our application, a 10-question survey was generated asking about the aesthetics of the design and what could be done to improve our design (Appendix A).

The responses that we received through the survey on our first iteration wireframe were mostly suggesting us to change the colour scheme and also advising for the wireframes to be more detailed. The responders suggested that we make all the notes colourful and that we should add further detail in the wireframe what the interfaces of the scientific and graphical calculators and the equations solver would look like.

2nd Iteration

Implementing these suggestions, we redesigned and detailed the following wireframe:

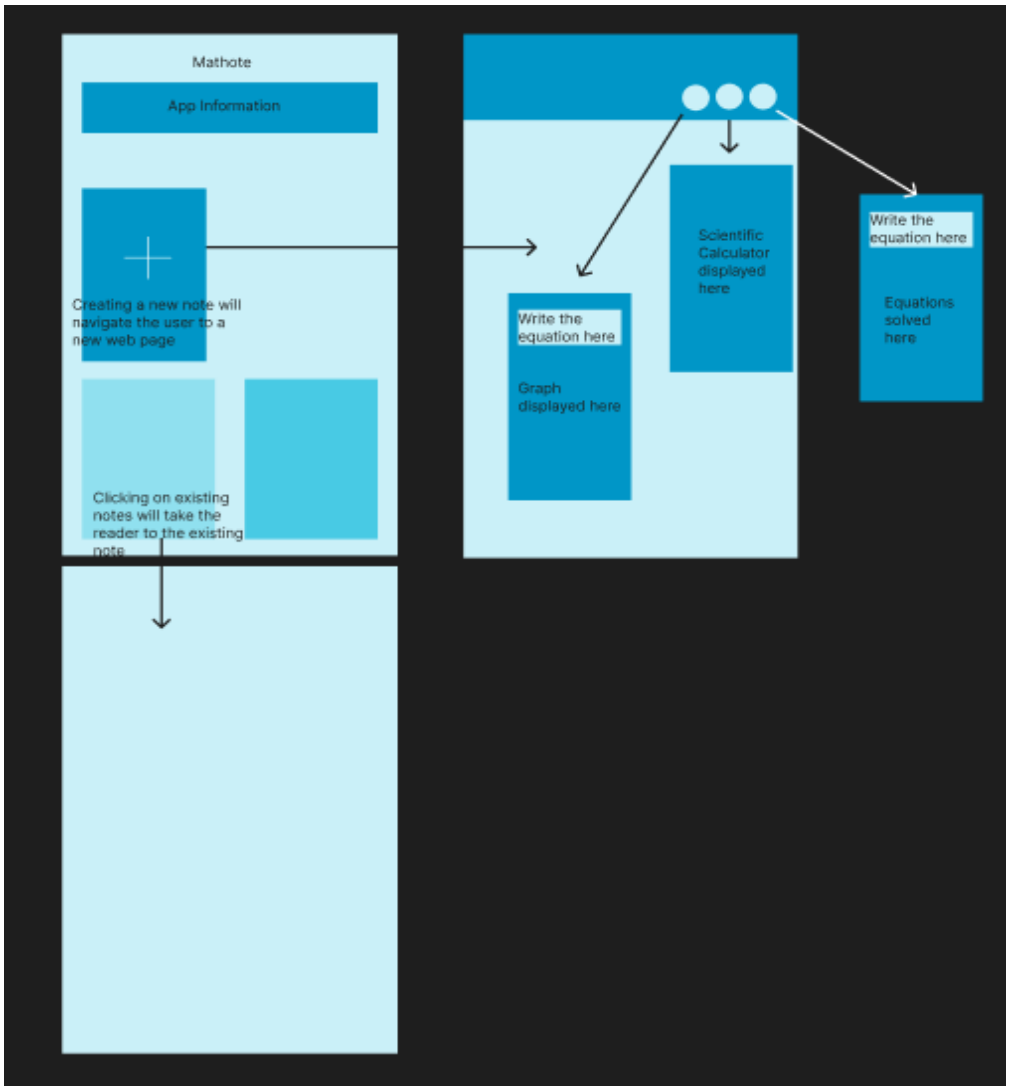

Figure 3: Improved application design post survey responses from 1st iteration survey

After attaching the updated wireframe design to the existing survey (Appendix A), it was regenerated. The results of this iteration's survey were to further improve on our colour scheme for the interface. To cater to this suggestion, we consensually picked and changed the colours of our wireframe and moved on to the User Testing phase of our journey.

User Testing

We have used SUS user testing technique to user test our wireframes. SUS survey consists of 10 questions where the odd numbered questions demonstrate positive sentiments towards the application and even numbered questions demonstrate negative sentiment towards the application.

1st Iteration

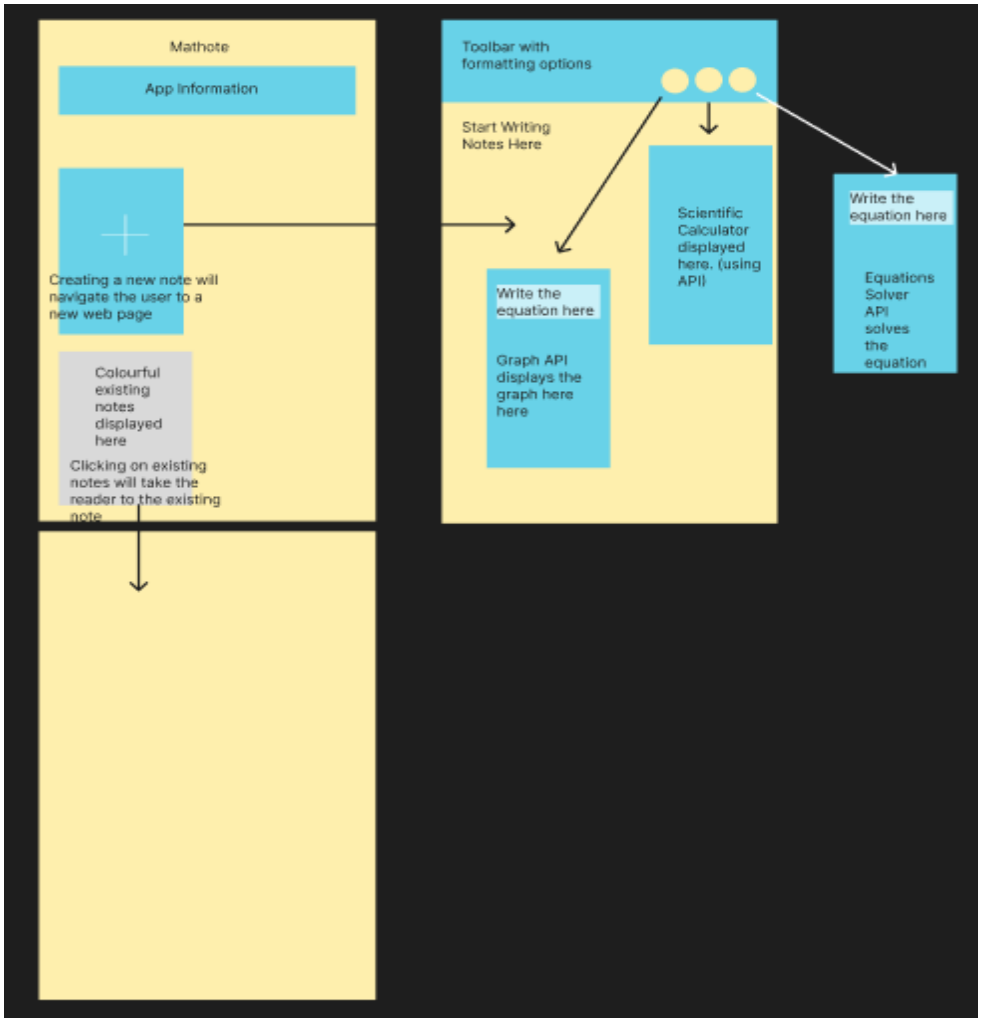

Figure 4: 1st iteration Design of our user testing

A survey (Appendix B) was conducted for user testing as well. The combined survey results generated a SUS score of 59.5. We received 5 responses for our first iteration. After analyzing the received responses, we were able to conclude that the participants had not understood how our intended application would work. They found it difficult to navigate our application via our figma design and hence we went onto adding more textual guidance on our design to help users understand how our intended application is to be navigated.

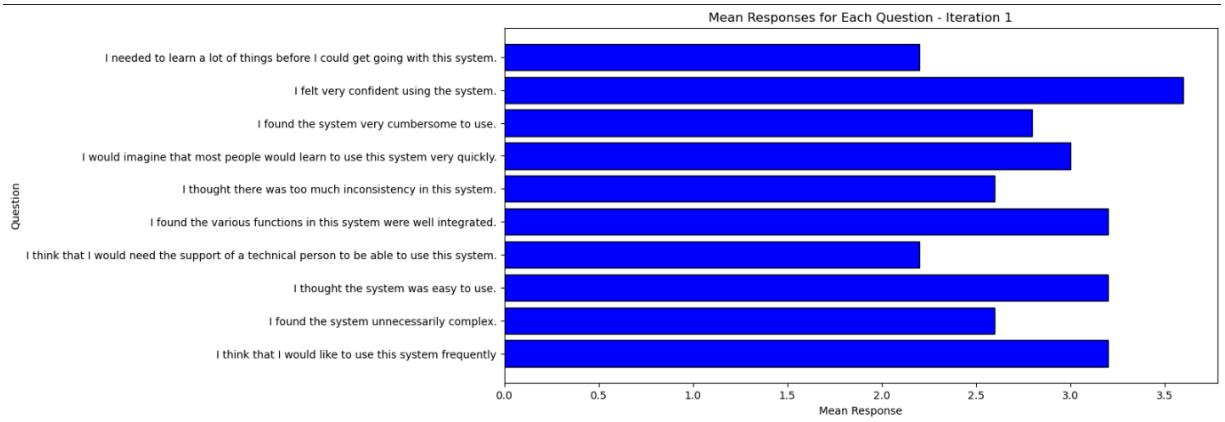

Figure 5: Mean responses for each question (Iteration 1)

Above is the overall image of the responses received on our first iteration of user testing. In a SUS test, the odd numbered questions are positive sentiments related to the application and even numbered questions are negative sentiments related to the application.

Following below is the positive and negative display of responses.

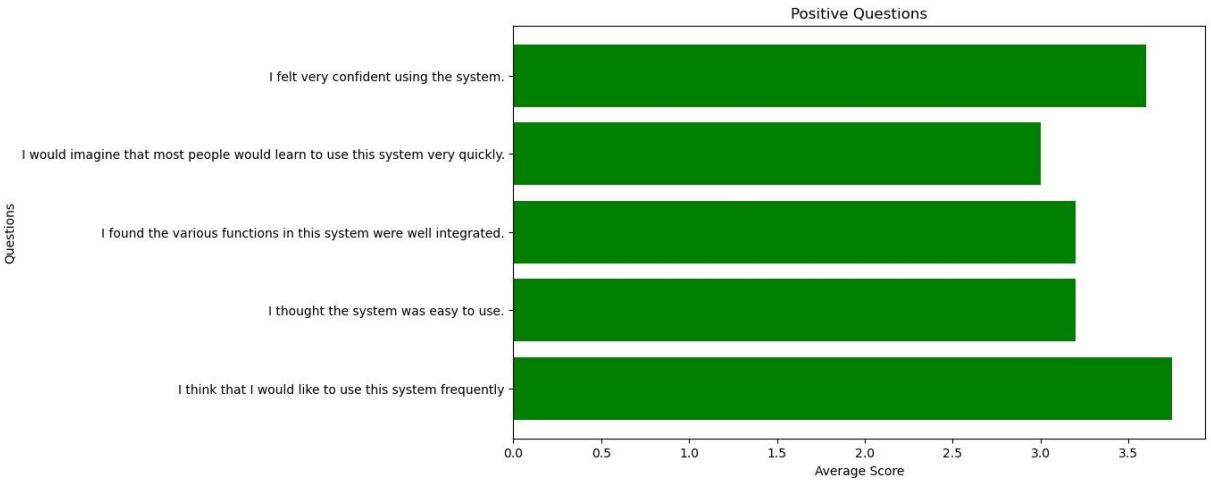

Figure 6: Mean score for positive worded questions for Iteration 1

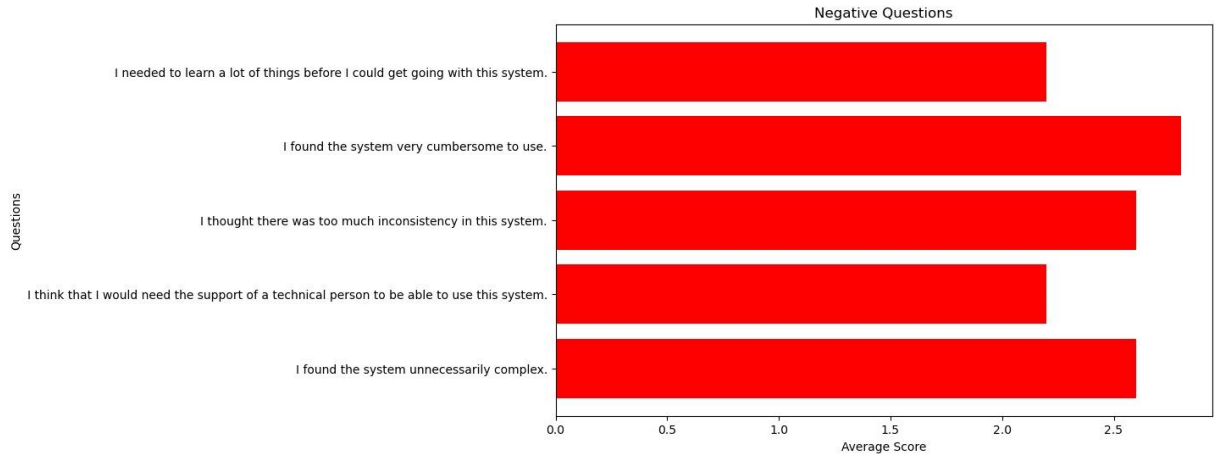

Figure 7: Mean score for negative worded questions for Iteration 1

The higher the length of the bar in positive graph, the more the users have picked that they agree with the question. And the lower the length of the negative bar, the more people disagree with the negative statements. Hence length of the x axis goes up to 3.5 as opposed to "Negative Questions" graph.

Keeping the above in mind, negative graph plotted has lengths that are mostly above 2.5 hence demonstrating that the users agree with the negative statements.
Subsequently, we made relevant changes to our design and moved on to the 2nd iteration of user testing.

2nd Iteration

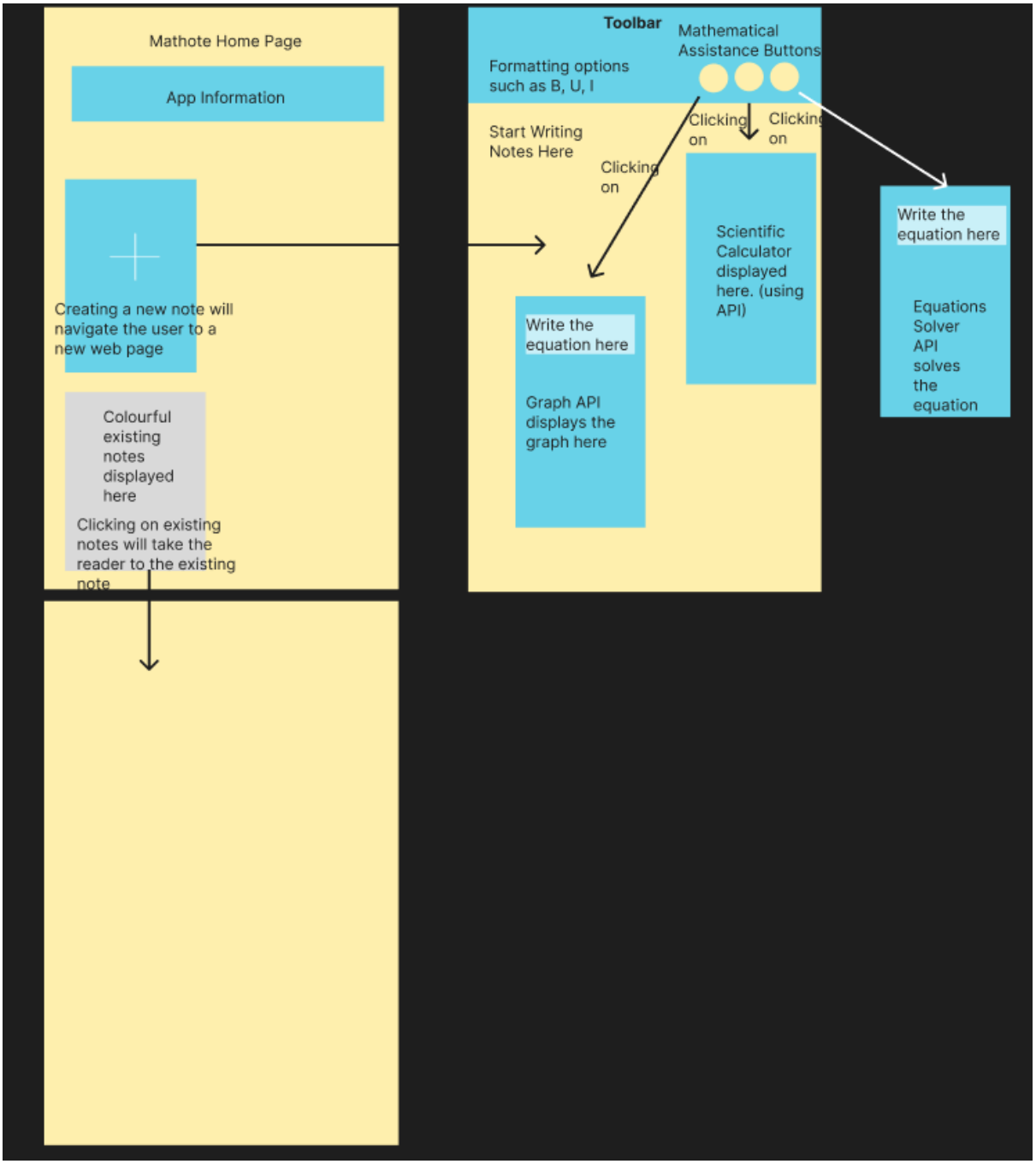

Figure 8: User Testing Second Iteration Design

Integrating the relevant changes, our survey was redistributed and this time the results generated a SUS score of 65.25 (Appendix B).

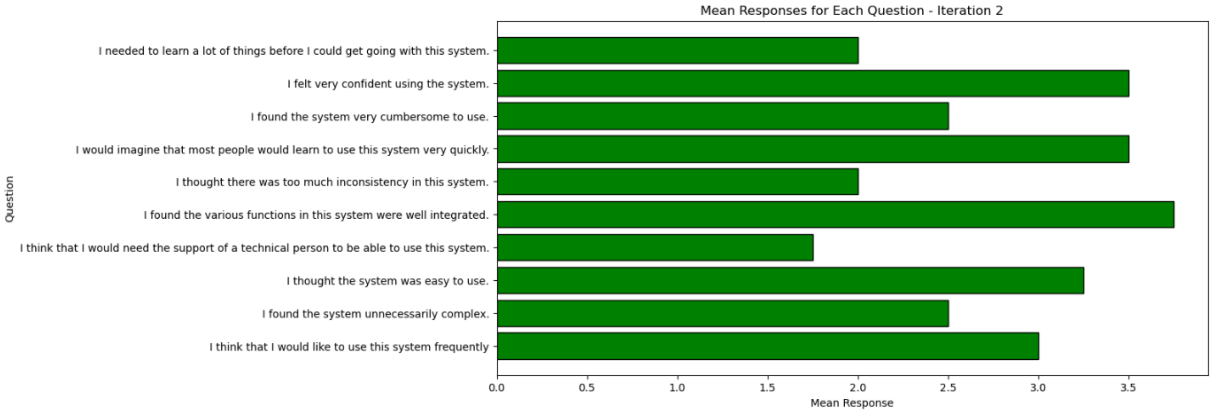

Figure 9: Mean score for each question (Iteration 2)

Above is the overall image of the responses received on our Second Iteration of user testing.

Lets dissect the positive and negative responses graph plotted below.

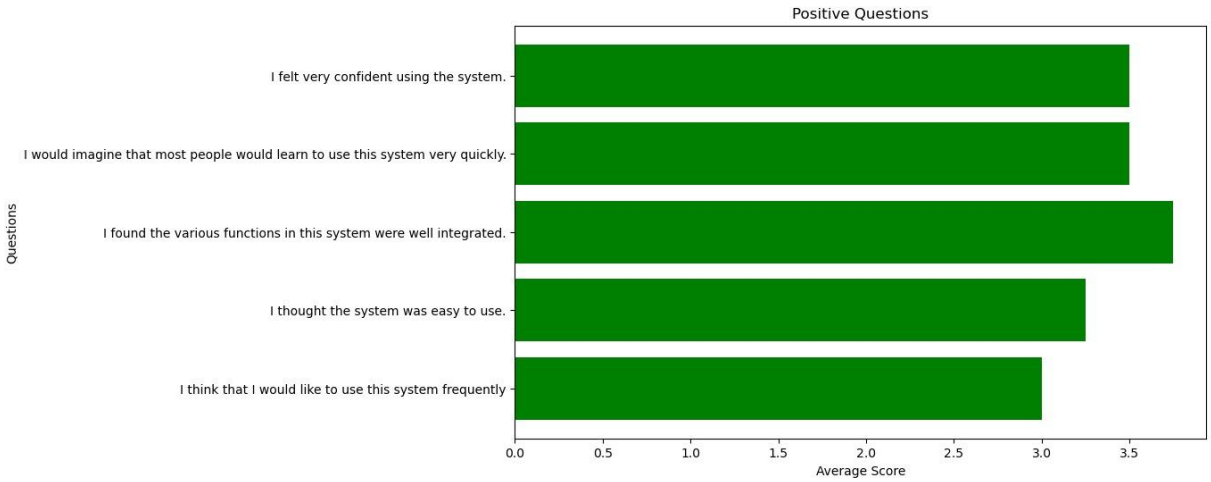

Figure 10: Mean score for positive worded questions for Iteration 2

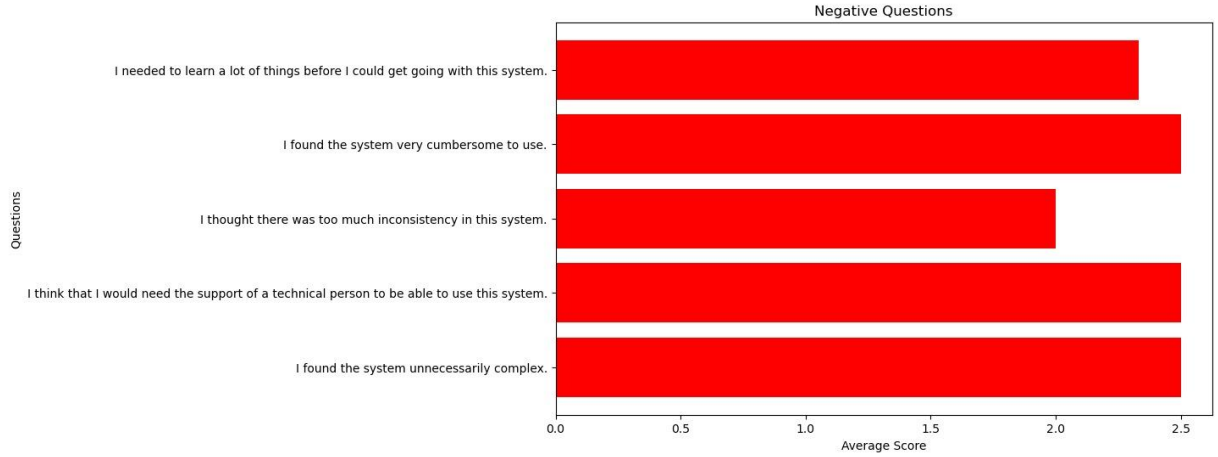

Figure 11: Mean score for negative worded questions for Iteration 2

This time the negative responses are more or less (perhaps the lack of difference is due to the number of responses received in the two iterations is different) the same as the negative responses in the previous iteration however the positive responses in this iteration far exceed the length of the bars in previous iteration.

Combined Graphs for both Iterations:

Looking at the two iterations side by side, the positive questions in iteration 2 have lengths of bars greater than the bars in iteration 1 hence signifying that more people agreed with the positive questions in iteration 2 than iteration 1.

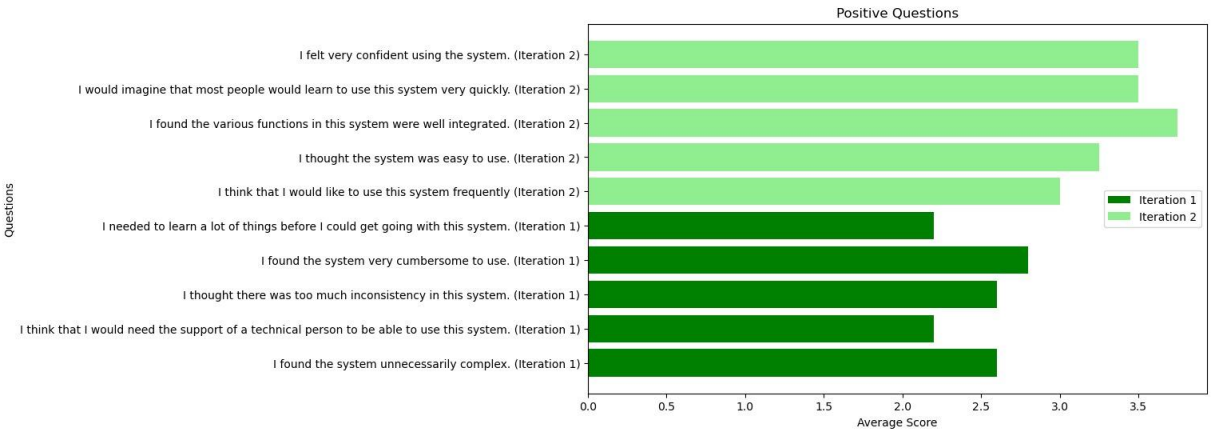

Figure 12: Mean of positive worded questions side by side for both Iterations

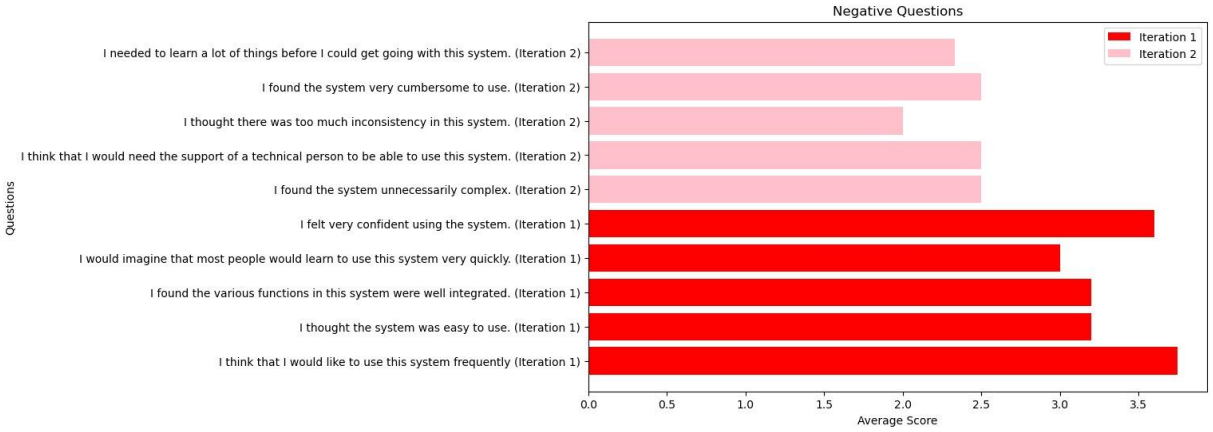

Figure 13: Mean of negative worded questions side by side for both Iterations

Additionally, the lengths of the bars related to negative questions in iteration 2 are shorter than the bars in iteration 1 hence signifying that the number of people disagreeing with the negative statements in iteration 2 are more than in iteration 1.

This result concludes our User Testing Phase of the Agile Methodology.

Technical and Functional Specification

Purpose

This application is a note taking app with integrated maths features in the form of APIs such as Graphics Calculator, Scientific Calculator and a step by step Equations Solver. We expect this application to provide a user-friendly interface for the users to take notes, perform live calculations, generate graphs and get equations solved step by step.

System Overview

At the start of the project, each of the team members filled out a table stating where each of their strengths and weaknesses lay and what relevant experience they have had in the technology department.

Following is the team evaluation table that we filled out individually:

	Team Member 1	Team Member 2	Team Member 3	Team Member 4	Team Member 5
Strength	Programming in JavaScript Working with primary languages for Front-end Web Development - HTML, CSS, and JS Researching Writing reports	Front end Web development (Using HTML, CSS & JS) Researching Writing a report Programming in JavaScript A bit of familiarity with Python	Programming JavaScript A lot of familiarity with Python Using Excel sheets Front end Web development	Programming in JavaScript. Programming in C++ Working on Web Development front end using HTML, CSS, and JavaScript	JavaScript Python Programming Language and report writing Research
Weaknesses	Need to further polish my OOP concepts Need time to familiarize myself with Back-end technologies as I have just started getting familiar with it through UoL DNW module. Designing a UI	-Not much proficiency in OOP concepts & terminal based C++ projects Backend development Designing & Planning	I do not have much proficiency in OOP(C++) concepts At the moment, I cannot work with backend development Designing	Backend since I have just started working on it in the Databases Module so I feel I am not yet well versed in it. C++ projects using terminal. I feel I have yet to have a good grasp on C++ projects where the output is on the terminal.	Not strong in programming. Bad good at communication. Very inexperienced and inefficient while working with teams because I tend to do things last minute as a result of trying to balance other aspects of life. Not very good in C++
Experience	ITP I Game Project using JS and p5.js library ITP II Music Visualizer using JS and p5.js Web Development project using HTML, CSS, & JS OOP DJ Application using C++	-ITP I: Game Project using p5.js -ITP II: Data Visualizer using p5.js Web Development project: using HTML CSS & JS OOP: DJ App using C++ Online course in Python	Game project and Music Visualiser in JS Front-end Web development DJ App (C++) Learnt excel sheets in a course No project in Python, but learnt online	ITP I Game Project using JavaScript ITP II Music Visualiser using JavaScript Web Development project using HTML, CSS and JavaScript OOP DJ App using C++	Some prior Data science programming using python ITP I/II JavaScript OOP, DJ App/Crypto exchanges C++

In lieu of the skills that we have in our hands, we decided to make Mathote Application, a Web Application.

Our Front End would be developed using HTML, CSS and JavaScript as that is the commonality in all of our strengths and experiences. While we would be utilising Node.js and MySQL database for our Back-end.

APIs

The Mathote app incorporates four different types of APIs to enhance its functionality across various mathematical tools. First, the Desmos API powers the Graphic Calculator feature, enabling users to create interactive graphs and visualise complex equations. This API provides a visual representation that aids in understanding mathematical concepts with clarity and precision.

For the Scientific Calculator, the Math.js API will be integrated. Known for its robust capabilities in JavaScript and Node.js environments, Math.js supports a wide range of mathematical functions and computations. This integration empowers the app to handle complex calculations efficiently, catering to the needs of both students and professionals alike.

The Equation Solver feature utilises the Wolfram Alpha Full Results API, allowing users to submit mathematical queries and receive computed solutions in real-time. This API excels in solving a variety of equations, providing detailed results that enhance problem-solving capabilities within the Mathote app.

Additionally, across all these features, Graphic Calculator, Scientific Calculator, and Equation Solver, the Symbolab - AI Math Calculator API adds significant value. This AI-powered tool simplifies intricate mathematical problems and offers step-by-step solutions, thereby aiding users in comprehending and mastering mathematical concepts effectively.

By leveraging these APIs, Mathote will deliver a comprehensive set of tools for studying, solving, and understanding mathematics. Whether for educational purposes or professional applications, the app provides a user-friendly interface enriched with powerful mathematical functionalities, catering to a diverse audience of learners.

Colours

Since Mathote is a note taking and mathematics application, for our interface we thought of opting for colours that boost productivity. Among the colours that are known for boosting productivity - red, blue, yellow, green - we opted for the combination of blue and yellow colours as our base for the application from ColorHunt.

Figure 14: Colour Palette used in our application design: 2nd and 4th (from top)

From the colour palette above we choose the bottom-most yellow colour and the second blue colour from the top.

Blue for the reason that it “calms the mind and aids concentration” thus enhancing wakefulness. Blue also encourages better mind flow and performance by lowering blood pressure and slowing the heartbeat hence promoting a relaxing atmosphere to study in. Stronger shades support brain’s thought processes, while lighter shades help improve concentration [14].

Yellow on the other hand is chosen for the reason that it is energising and “radiates positivity”. Yellow gets you right in the mood for producing great work [15].

Functional Requirements

Class Diagram

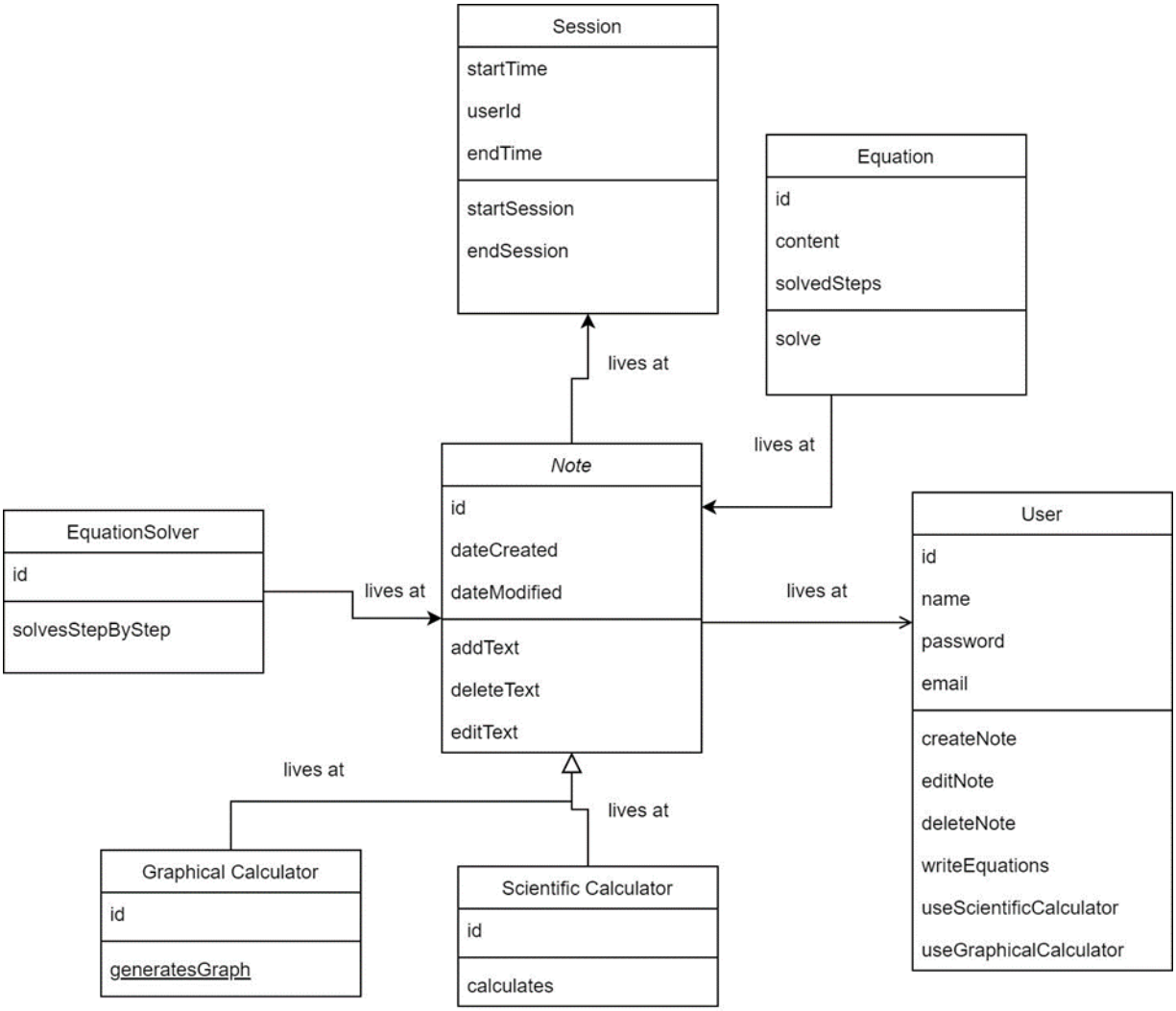

Figure 15: Class Diagram

Use Case Diagram

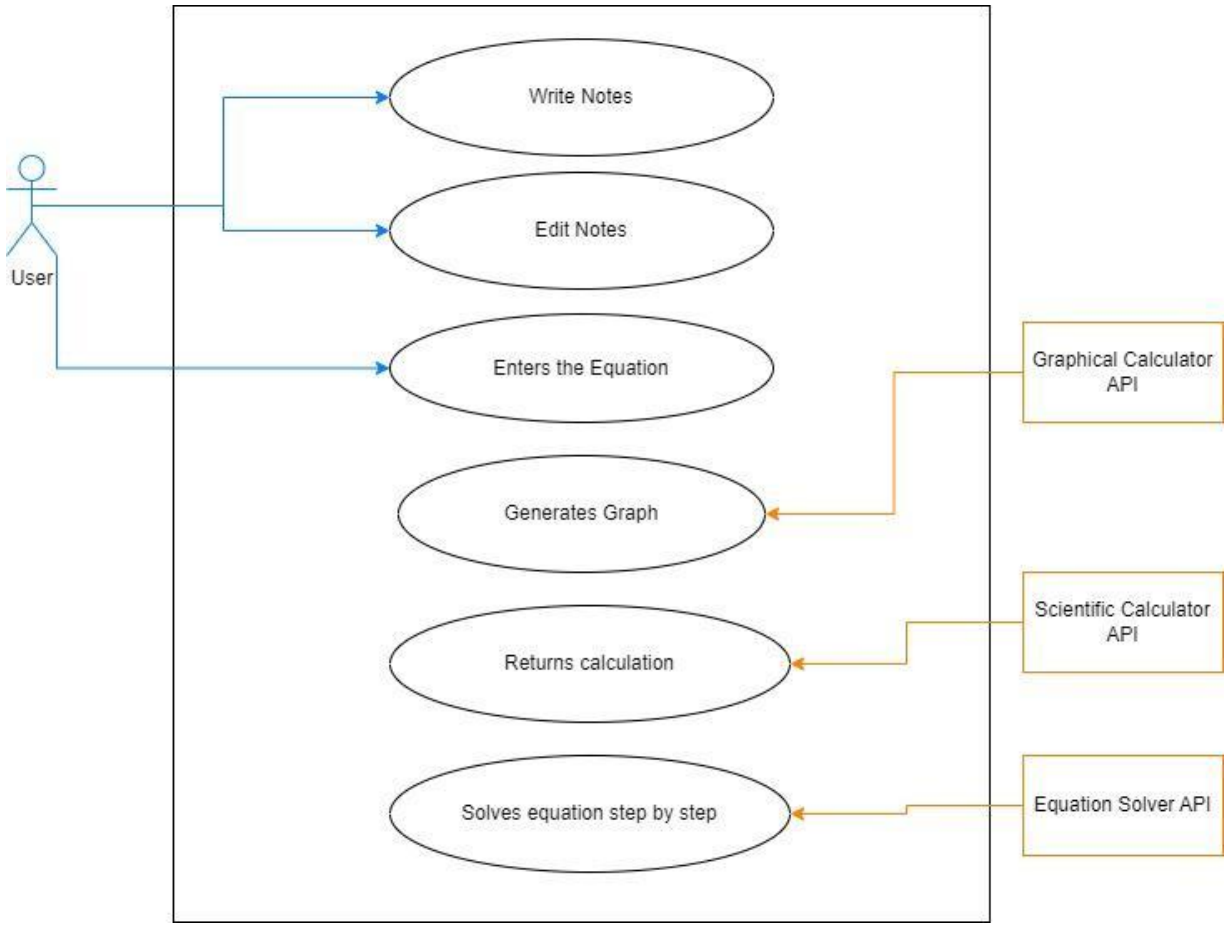

Figure 16: Use Case Diagram

Using the Online Diagram Software, we created the aforementioned use case diagram. The use cases of Mathote that the user has control of include the ability to write, edit and delete notes. The user can also input equations into the equation solving API interface and the API returns a step by step solved equation. Moreover, the scientific calculator API accounts for the live calculations that the user is able to perform side by side. The graphical calculator API enables the user to enter equations and generates a subsequent graph as final output.

User Stories

UC1: Write Notes

Scope: Mathote Application

Level: User Goal

Primary Actor: User

Stakeholders and Interests:

- user wants to enter data in the form of text to have them stored as notes

Preconditions: User is identified and has authorised himself/herself with the application

Success Guarantee or Postconditions:

- text appears in the text editor area
- user can edit, delete the text

Main Success Scenario:

Actor Action	**System Responsibility**
1. User arrives on the landing page of the application	
2. User then selects "new note" option	
	3. System navigates the user to a new webpage
	4. System displays the toolbar on the screen to the user and also the text editor area
5. User chooses amongst the tools to write text in the text editor area	

Extensions:

a. If the system fails and shuts down, there is no way for the application to restore to its original state

b. If the user is using a desktop computer and does not have a functioning keyboard then he/she will not be able to enter text as the application does not provide a built-in keyboard

UC2: Edit Notes

Scope: Mathote Application

Level: User Goal

Primary Actor: User

Stakeholders and Interests:

- user wants to edit the already entered text

Preconditions: Authorised user has already created a note and has entered something

Success Guarantee or Postconditions:

- text appears in the text editor area
- user can edit, delete the text

Main Success Scenario:

Actor Action	**System Responsibility**
1. User arrives on the landing page of the application	
2. User then selects from the existing notes	
	3. System navigates the user to a the note selected
	4. System displays the toolbar on the screen to the user and also the text editor area
5. User chooses among the tools to edit text in the text editor area	

Extensions:

a. If the system fails and shuts down, there is no way for the application to restore to its original state
b. If the user is using a desktop computer and does not have a functioning keyboard then he/she will not be able to enter text as the application does not provide a built-in keyboard

UC3: Enter the Equations

Scope: Mathote application

Level: User Goal

Primary Actor: User

Stakeholders and Interests:

- user wants to enter equations that they want solved step by step.

Preconditions: User is identified and has authorised him/herself with the application

Success Guarantee or Postconditions:

- graph for the equation entered is displayed for the user

Main Success Scenario:

Actor Action	**System Responsibility**
1. User arrives on the landing page of the application	
2. User then selects "new note" or existing note option	
	3. System navigates the user to a note taking webpage
	4. System displays the toolbar on the screen to the user and also the text editor area
5. User clicks on the Equation Solver	

API in the toolbar	
6. User enters the Equation that they want solved	7. API returns them the step by step solution

Extensions:

a. If the system fails and shuts down, there is no way for the application to restore to its original state

b. If the user is using a desktop computer and does not have a functioning keyboard then he/she will not be able to enter text as the application does not provide a built-in keyboard

Non-functional Requirements

- **1. Sticky Toolbar in the app**: The sticky toolbar is a necessary non-functional requirement for the app. It ensures that the toolbar remains visible and accessible at all times, regardless of the user's scroll position. This feature enhances user experience by providing quick access to essential editing tools, thereby improving productivity and ease of use. The sticky toolbar allows users to format their notes, insert mathematical equations, and access other functionalities without having to scroll back to the top of the page.
- **2. Colourful Notes**: The ability to create colourful notes is another important non-functional requirement. This feature allows users to highlight and categorise their notes using different colours, making it easier to organise information. Colourful notes can enhance visual appeal and increase users' ability to rapidly recognize and distinguish between different parts of their notes in order to enhance cognitive processing. This functionality is particularly useful for students and professionals who need to manage large volumes of information efficiently.
- **3. Performance Optimization**: The application should be optimised for performance to ensure it loads fast and has smooth interactions. This includes efficient handling of API calls, minimising the use of heavy resources, and implementing caching strategies. Performance optimization is essential for maintaining user engagement and satisfaction [16].

- **4. Usability**: The application should be user-friendly and intuitive. This involves designing a clean and straightforward user interface, providing clear instructions and feedback, and ensuring that all features are easily accessible. Usability testing should be conducted to identify and address any potential issues.
- **5. Scalability**: The application should be designed to handle increasing amounts of data and users without compromising performance. This involves using scalable architecture and technologies that can accommodate growth. Scalability ensures that the application can support future expansion and increased demand.
- **6. Cross-browser Compatibility**: The application should be compatible with all major web browsers, including Chrome, Firefox, Safari, and Edge. Cross-browser compatibility ensures that users have a consistent experience, regardless of the browser they are using [17].

  By addressing these non-functional requirements, the application will provide a robust, user-friendly, and secure platform for taking and managing mathematical notes. These features will not only enhance the overall user experience but also ensure the application's long-term success.

Performance Analysis

Ideating

Our ideating phase commenced as soon as our group members were revealed on the 16th of May and spanned over a time of 2 weeks. We were adamant on making a note taking application but hit a roadblock when it came to finding the niche. Looking at other note taking applications, we found that they did not integrate some aspect of mathematics into their apps and hence we decided to build an application that integrates a fair amount of mathematical aspects like graphs, calculators and equation solver. This is how the aim of the project - to make a mathematical note taking application - became clear to us.

Requirements Analysis

Our requirements analysis was performed by majorly looking at other applications in the market and seeing what and what not they offered the users. Their weaknesses became our requirements for our project and we went onto making a use case diagram out of them.

Designing

We commenced our design phase with designing the flow of our application from when we land on the site's landing page to the options displayed to the user while navigating the site. This was followed by the first iteration of designing. We created a design and a survey through which we could gauge responses to better understand whether our design lacked anything. We were advised by our responders to work more on the visual appeal of the application and for that we changed up a few colours, updated the survey (Appendix A) and regenerated it - 2nd iteration. The response again stated the lack of the application's appeal. Hence, we further amended it and delved into user testing.

User Testing

With the altered colour scheme, we then submitted it for user testing - System Usability Scale (SUS). The first iteration landed us a score of 59.5. Upon exploring the responses and making apparent relevant changes that we could gather from the SUS, we ran the second iteration which ultimately landed us a score of 75, concluding our user testing journey.

Report Writing

Report writing was done side by side with the practicalities of the journey. Keeping in mind the Example Report provided to us, we were able to work on the report comfortably.

Gantt Chart

The Gantt chart below outlines our journey of expectations made initially (marked in silver) and the reality (marked in yellow) with the threats we faced (marked in red).

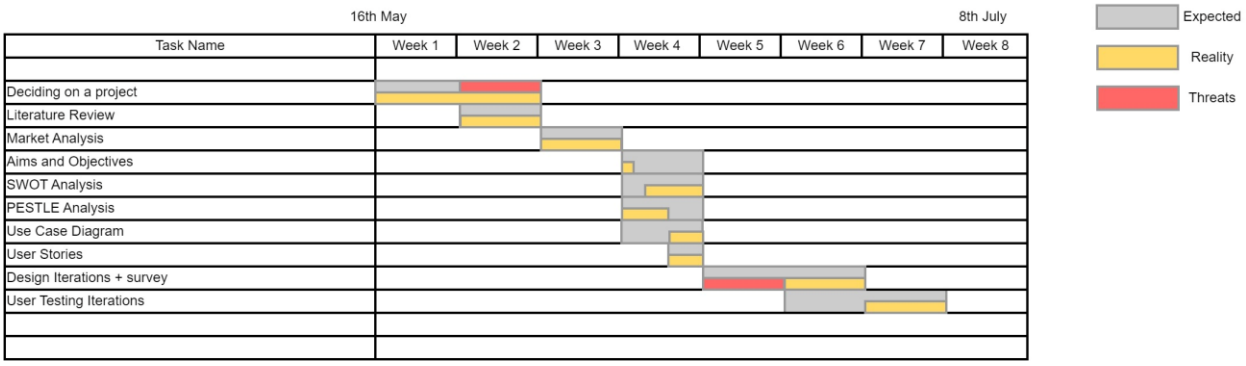

Figure 17: Gantt Chart

Our journey from when the teams were released to the midterm submission deadline had been one with both negatives and positives. Beginning with the project itself - week 1 -, we faced difficulty (a threat) in finding out the exact niche of the idea that we wanted to uptake for the module submission. It took us two weeks - week 1 and week 2 - to conclude what our application would be. Literature review - week 1 and 2 - itself had helped us ideate a niche for our note taking application. Then having done market research - week 3 - further helped us with our Aims and Objectives - 2 days - of the project. We then proceeded with our SWOT and PESTLE analyses that we had expected would take us a week to complete both however they both took less time than anticipated. PESTLE took 3 days while we were done with SWOT analysis in 2.

Making a Use Case Diagram and writing use stories again became a lot easier now that we had the exact idea of our application features. We expected design iterations and conducting surveys to last us 2 weeks - week 5 and 6. But due to the celebration of religious festivities in Pakistan, we had national holidays which resulted in team members travelling and thus not being able to make themselves available for the meetings. This caused a halt (posed as a potential threat) in meeting our internal deadlines. Hence, we had to wind up our design iterations in a week in order to stay right on track. We then moved onto user testing and completed it within a week as well since the submission deadline was around the corner.

Conclusion

There were several outcomes of our research. By conducting strong market research, SWOT Analysis, and PESTLE Analysis we were able to make a very systematic and informed decision. We took inspiration, understood the complexity behind design, functionality and specification and tried our best to figure out what exactly makes a good note taking application. Of course, there were some hurdles, for example the fact that most note taking apps are very general, and ours was more maths focused, but we mitigated this by focusing only on the mathematics related aspects of these various applications.

To wrap things up, throughout the extensive journey of writing this report, we have found a strong basis to create an actual practical mathematical note taking application that is relevant, focused and versatile. We believe that this entire process has greatly helped us gear up for the next stage of this project, and certainly, will play a role in organising, and systematically implementing all the ideas, features and functionalities that pertain to this application.

References

[1] I. W. Allie Constantine, “The Dark Side of Technology: Coltan Mining in the DRC and its Human Rights and Environmental Impacts,” Global Forest Coalition, 17 November 2023. [Online]. Available: https://globalforestcoalition.org/the-dark-side-of-technology-coltan-mining-in-the-drc-and-its-human-rights-and-environmental-impacts/. [Accessed 15 June 2024].

[2] C. K. V. M. K. O. J. S. S. Z. Claudio Brasca, “How technology is shaping learning in higher education,” McKinsey and Company, 15 June 2022. [Online]. Available: https://www.mckinsey.com/industries/education/our-insights/how-technology-is-shaping-learning-in-higher-education. [Accessed 15 June 2024].

[3] Education Intelligence Unit, “10 Charts for a Changing Education Market,” HolonIQ, 12 November 2020. [Online]. Available: https://www.holoniq.com/notes/10-charts-for-a-changing-education-market#:~:text=EdTech%20is%20growing%20at%2016.3,global%20education%20market%20in%202025. [Accessed 15 June 2024].

[4] “Note Taking App Global Market Report 2024 – By Product (Windows Systems, Android Systems, iOS Systems, Other Products), By Application (Commercial Users, Private Users) - Market Size, Trends And Global Forecast 2024-2033,” The Business Research Company., January 2024. [Online]. Available: https://www.thebusinessresearchcompany.com/report/note-taking-app-global-market-report. [Accessed 22 June 2024].

[5] “Global Note Taking App Market Growth Insights by Types (Windows, Andriod, iOS, MacOS), by Applications Covered (Healthcare, Education, Retail, Others) and Region - Forecast to 2031,” Global Growth Insights, 22 June 2024. [Online]. Available: https://www.globalgrowthinsights.com/market-reports/note-taking-app-market-100690. [Accessed 25 June 2024].

[6] Revinr, “Evolution of Web Development Technologies: A Visual Timeline,” Revinr, 13 June 2024. [Online]. Available: https://www.revinr.com/evolution-of-web-development-technologies-a-visual-timeline/. [Accessed 25 June 2024].

[7] “How AI is Revolutionizing Note-Taking: A Historical Deep Dive,” Mem, 6 May 2024. [Online]. Available: https://get.mem.ai/blog/how-ai-is-revolutionizing-note-taking-a-historical-deep-dive. [Accessed 25 June 2024].

[8] A. Das, “What is Browser Compatibility? (With Best Practices),” BrowserStack, 23 September 2023. [Online]. Available: https://www.browserstack.com/guide/what-is-browser-compatibility. [Accessed 26 June 2024].

[9] Aruljothy, “Disadvantages of Web Apps,” Medium, 31 May 2023. [Online]. Available: https://medium.com/@aruljothy007/disadvantages-of-web-apps-9b8cef9041d8. [Accessed 26 June 2024].

[10] M. Komnenic, “9 Legal Requirements for Apps and Tips to Meet Them,” Termly, 27 May 2022. [Online]. Available: https://termly.io/resources/articles/legal-requirements-for-apps/. [Accessed 26 June 2024].

[11] "GDPR, CCPA, and WCAG compliance readiness," Photon, [Online]. Available: https://www.photon.com/what-we-do/gdpr-ccpa-wcag-compliance. [Accessed 26 June 2024].

[12] "Sustainable Note-Taking – Make The Switch," Play It Green, 27 January 2023. [Online]. Available: https://playitgreen.com/sustainable-note-taking-make-the-switch/. [Accessed 27 June 2024].

[13] B. Palmer, "Green Your Notes!," Slate, 06 SEPT 2011. [Online]. Available: https://slate.com/technology/2011/09/paper-versus-the-ipad-is-taking-notes-on-a-tablet-computer-or-a-notepad-more-environmentally-responsible.html. [Accessed 27 June 2024].

[14] "3 Colours that Improve Concentration & Productivity," Barker Whittle, 5 December 2014. [Online]. Available: https://www.barker-whittle.com.au/blog/3-colours-improve-concentration-productivity. [Accessed 30 June 2024].

[15] H. Genever, "4 Colors That Give You an Unexpected Productivity Boost," Redbooth, [Online]. Available: https://redbooth.com/hub/colors-unexpected-productivity-boost/. [Accessed 30 June 2024].

[16] M. Yuskevych, "A Guide to Writing Non-Functional Requirements for Your Mobile App," Perpet.io, March 2024. [Online]. Available: https://perpet.io/blog/a-guide-to-writing-non-functional-requirements-for-your-mobile-app/. [Accessed 30 June 2024].

[17] Indeed Editorial Team, "9 Nonfunctional Requirements Examples," Indeed, 25 June 2022. [Online]. Available: https://www.indeed.com/career-advice/career-development/non-functional-requirements-examples. [Accessed 30 June 2024].

Appendices

Appendix A: Design Modelling Survey

1. What changes would make the website more user-friendly? *

- [ ] Simplifying the navigation menu
- [ ] Improving the consistency of the design across pages
- [ ] Offering more customization options (e.g. color coding the notes)
- [ ] Adding more interactive elements (live chat, FAQs)
- [ ] Other...

2. How do you feel about the overall visual design of the product? *

- ( ) Very appealing
- ( ) Moderately appealing
- ( ) Slightly appealing
- ( ) Not appealing at all

3. Do you find the color scheme appealing? *

- ( ) Very appealing
- ( ) Moderately appealing
- ( ) Slightly appealing
- ( ) Not appealing at all

4. Are there any specific design elements that you would like to see improved? *

Short-answer text

5. Any suggestions for enhancing the visual appeal? *

Short-answer text

6. As someone who frequently works with mathematical notations and diagrams, do you find the interface intuitive? *

- Yes
- No
- Maybe

7. Do you think this wireframe design can efficiently accommodate these tools? *

- Yes
- Partially yes
- No

8. Do you think this application interface looks easy or confusing to use as a first time user? *

- Easy
- Confusing

9. As a student studying math, do you believe this wireframe requires any additions? If so, how would you improve the design? *

Short-answer text

10. What do you dislike about our note-taking app? *

Short-answer text

Appendix B: User Testing Survey

I think that I would like to use this system frequently

- 1 (Strongly Disagree)
- 2
- 3
- 4
- 5 (Strongly Agree)

I found the system unnecessarily complex.

- 1 (Strongly Disagree)
- 2
- 3
- 4
- 5 (Strongly Agree)

I thought the system was easy to use.

- 1 (Strongly Disagree)
- 2
- 3
- 4
- 5 (Strongly Agree)

I think that I would need the support of a technical person to be able to use this system.

- ○ 1 (Strongly Disagree)
- ○ 2
- ○ 3
- ○ 4
- ○ 5 (Strongly Agree)

I found the various functions in this system were well integrated.

- ○ 1 (Strongly Disagree)
- ○ 2
- ○ 3
- ○ 4
- ○ 5 (Strongly Agree)

I thought there was too much inconsistency in this system.

- ○ 1 (Strongly Disagree)
- ○ 2
- ○ 3
- ○ 4
- ○ 5 (Strongly Agree)

I would imagine that most people would learn to use this system very quickly.

- ○ 1 (Strongly Disagree)
- ○ 2
- ○ 3
- ○ 4
- ○ 5 (Strongly Agree)

I found the system very cumbersome to use.

- ○ 1 (Strongly Disagree)
- ○ 2
- ○ 3
- ○ 4
- ○ 5 (Strongly Agree)

I felt very confident using the system.

- ○ 1 (Strongly Disagree)
- ○ 2
- ○ 3
- ○ 4
- ○ 5 (Strongly Agree)

I needed to learn a lot of things before I could get going with this system.

- ○ 1 (Strongly Disagree)
- ○ 2
- ○ 3
- ○ 4
- ○ 5 (Strongly Agree)

1st Iteration Survey responses for User Testing generated using python

I think that I would like to use this system frequently	I found the system unnecessarily complex.	I thought the system was easy to use.	I think that I would need the support of a technical person to be able to use this system.	I found the various functions in this system were well integrated.	I thought there was too much inconsistency in this system.	I would imagine that most people would learn to use this system very quickly.	I found the system very cumbersome to use.	I felt very confident using the system.	I needed to learn a lot of things before I could get going with this system.
4	4	4	4	2	4	2	5	4	3
3	3	3	2	4	2	3	2	3	1
1 (Strongly Disagree)	3	1	3	2	4	3	5	2	4
4	2	3	1	4	2	3	1	4	2
4	1	5	1	4	1	4	1	5	1

2nd Iteration Survey responses for User Testing generated using python

I think that I would like to use this system frequently	I found the system unnecessarily complex.	I thought the system was easy to use.	I think that I would need the support of a technical person to be able to use this system.	I found the various functions in this system were well integrated.	I thought there was too much inconsistency in this system.	I would imagine that most people would learn to use this system very quickly.	I found the system very cumbersome to use.	I felt very confident using the system.	I needed to learn a lot of things before I could get going with this system.
2	2	4	1 (Strongly Disagree)	4	2	4	2	4	2
4	2	4	1 (Strongly Disagree)	3	2	4	2	4	1 (Strongly Disagree)

Appendix C: Meeting Log

Date	Agenda	Minutes of Meeting	Meeting Breakdown	Tasks Assigned
16th May 2024	Discussing team rules and regulations to be followed throughout the duration of the team project Deciding on a team project to be working on. Assigning a member to be working on the meeting document side by side.	45 minutes	**1 - 20mins:** Discussing some team rules and documenting them with the team members present **20 - 35 mins:** Discussing the project that we are to work on. – We decided to work on Note Taking Web Application	**Team Evaluation**- each member is to document their strengths, weaknesses and experiences related to Computer Science in the document shared with everyone. **Research Work:** Each member will Look at 5 each other Note Taking Apps and see what features they have and what we could add in our own project.

			5 mins: Deciding who is responsibe for working on the meeting agenda document side by side **5 mins:** Assigning tasks to be done before the next meeting	
20th May 2024	Discussing the research that we did Creating a timeline of what we are supposed to do in the next weeks till midterm, creating a gantt chart out of it- possibly a task assigned to one of the team members Discussing aims and objectives about the project		Meeting didnot happen due to unavailability of one of the team members	
21st May 2024	Discussing our project timeline till midterm Discussing aims and	45 Minutes	**1-30mins**: Discussed sample report. Discussed what	

	objectives Discussing sample report and all our confusions and questions regarding the project Discussion on research task assigned in previous meeting		we need to do before midterm Discussed SWOT and PESTLE Analysis Briefly discussed our researched apps and the technological advancements in those apps Discussed Gantt chart Discussed how we will take requirements and make use case diagrams **30-40mins:** Allocated time to our tasks in gantt chart (4 weeks requirement analysis and 4 weeks design) Discussing the	

			making of our first prototype **40-45 mins:** Discussed the things that we need to ask our programme instructor. Writing down the questions to ask. Summary of the meeting	

27th May 2024		1 hour	**9:10-9:20pm:** Discussed the questions that we asked ma'am Discussed about literature review and market research Discussed what our future research will be **9:20- 9:40:** Discussed our target audience Discussed possible limitations of our app Discussed to focus more on	To find out the issues in already existing apps and how do we cater it. To research what features we can introduce in our app to overcome the researched issues.

			desktop apps **9:40 - 9:50:** Discussed how to do PESTLE Analysis Discussed possible limitations/ time constraints in gantt chart **9:50-10** Discussed gantt chart Tasks assigned	
2nd June 2024	To discuss the new idea of making a maths note taking app instead of a simple note taking app	45 Minutes	**1-30 Minutes:** Discussed different math note taking apps and their features Discussed and finalised the features of our own app	To further research maths note taking apps Come up with survey questions for our app design

			30-45 minutes: Started making use case diagram for our app	
7 June 2024	Discussing survey questions for design of our app	1 hour 22 minutes	**1-20 minutes:** Briefing the app features. Briefing of the discussion with our program lead to other team members. **20-50 minutes:** Making wireframe for our web app. Discussing the survey questions Making a low-fidelity prototype **50-60 minutes:** Finalising the survey questions from	One team member was assigned to make a survey form. Compiling the survey questions. Write a introductory note of the app for the survey form Send screenshot of finalised low fidelity prototype

			all the proposed survey questions **60-80 minutes:** Assigning tasks to the members	
21 June 2024	Discussing second iteration of our design survey	30 minutes	**1-15 minutes:** Discussing feedback on our design survey **15-30 minutes:** Making new wireframe according to survey responses Improving colour scheme	Making a new survey with the improved wireframe and uploading it on slack for response.
25 June 2024	Discuss third iteration of our design survey	1 hour	**1-15 minutes:** Discussed survey responses **15-35 minutes:**	

			Discussed our future strategy and decided when to finish working on the project. **35-55 minutes:** Discussed and finalised the changes we need to make in our wireframe according to the survey responses Decided a new colour scheme. **55-60 minutes:** Concluding the meeting	
25 June 2024	Discuss first iteration of User Testing	20 minutes	**1-20 minutes:** Discussed SUS survey Analysed responses from SUS survey	Conduct second iteration of User testing.

			Improved the wireframe keeping in view the SUS survey responses	
5 July 2024	Final Meeting for finalising the project.	30 minutes	Reviewed the report and discussed all the improvements that needed to be done in it so that all the members are on the same page.	