

**CMPE287 – Software Quality Assurance and Testing**  
**Deliverable #1 – Conventional Test Report**



**Group-3 Team Members**

Tirumala Saiteja Goruganthu – 016707210

Harish Marepalli – 016707314

Sowjanya Bheemineni – 016672214

Sohan Leburu – 017408768

**Guided By**



Prof. Jerry Gao

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## 1. Introduction

### 1.1 Mobile App Information



**Photo Math**

**Photo Math:** Photo Math is an AI based educational mobile application owned and maintained by Google. It operates as a computer algebra system combined with an advanced optical character recognition system tailored for utilization with a smartphone's camera to scan and identify mathematical equations. Following the scanning process, the application proceeds to display methodical explanations directly on the screen.

### 1.2 Test Information

- Apply different Black-box Testing Methodologies
- Use Image input to test the AI identification function.
- Image Processing
  - Importing the image or taking photo image.
  - Analyzing the image.
  - Output in which results can be an altered image or a report which is based on analyzing that image.

### 1.3 Task Partition

Group Member	Task Partition
Tirumala Saiteja Goruganthu	<i>Exponential and Logarithmic functions</i> testing with Error Management, collect test cases, collect bugs in detail for photo math application.

Harish Marepalli	<i>Polynomial Equations</i> testing with Error Management, collect test cases, collect bugs in detail for photo math application.
Sowjanya Bheemineni	<i>Quadratic Equations</i> testing with Error Management, collect test cases, collect bugs in detail for photo math application.
Sohan Leburu	<i>Linear Equations</i> testing with Error Management, collect test cases, collect bugs in detail for photo math application.

#### 1.4 Project Schedule:

Schedule Dates	Description
September 5 – September 12	Research the mobile application and collect test requirements.
September 13 - September 22	Select models and methods for testing, partition tasks, and choose test case template.
September 23 - September 30	Develop test cases and test design documents (Deliverable #1).
September 30 - October 10	Collect AI testing requirements and select AI test models for the App AI function.
October 11 - October 20	Develop AI function test cases and test data based on the AI test model, record the test results and bugs. (Deliverable #2A)
October 20 - October 30	Collect AI testing requirements and select AI test models for the App AI function.
October 31 – November 18	Develop AI function report and test data based on the AI test model, record the test results and bugs. (Deliverable #2B)
November 18 - November 27	Conduct AI function test automation, develop test scripts to support test automation with the test data.
November 28 - December 3	Develop test automation report, includes all test results based on the test cases, and related testing analysis (Deliverable #3)
December 4 – December 15	Final project package with google drive link.

## 2. Test Requirements

### 2.1 Requirement Specifications

This test project is mainly focused on mobile identified applications for iOS and Android platforms.

For the Photo Math application, following are the specifications

**iOS:**

- Requires iOS 13 or later
- 31MB of memory
- User must allow camera access

**Android:**

- Requires Android 5.0 or later
- 7.5MB of memory
- User must allow camera access

### 2.2 Test Function Scope

- Testing a Mathematics Algebra problem

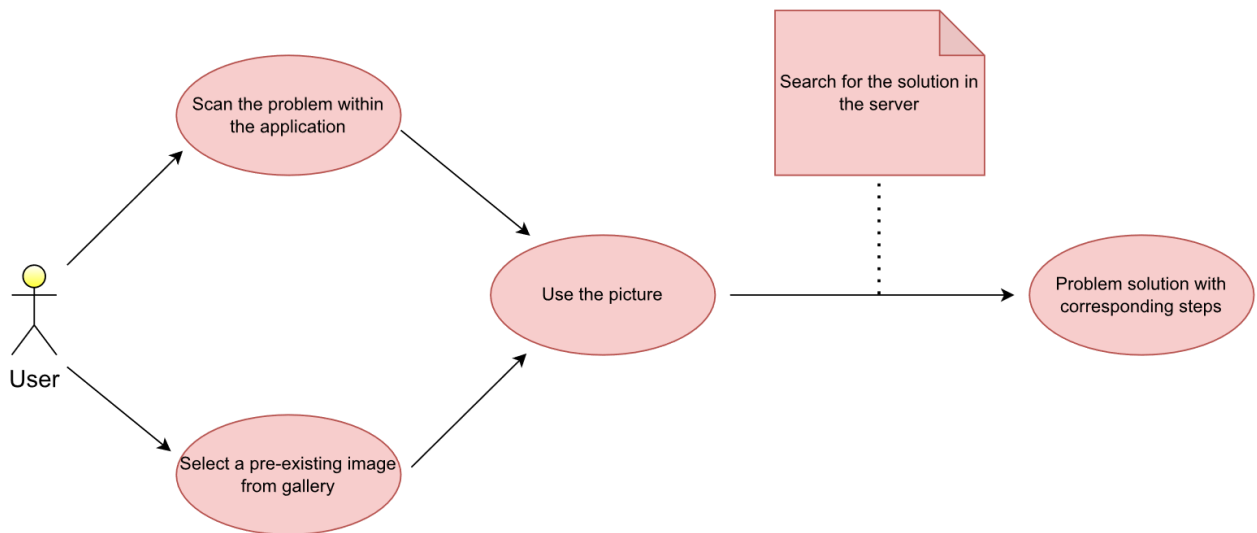
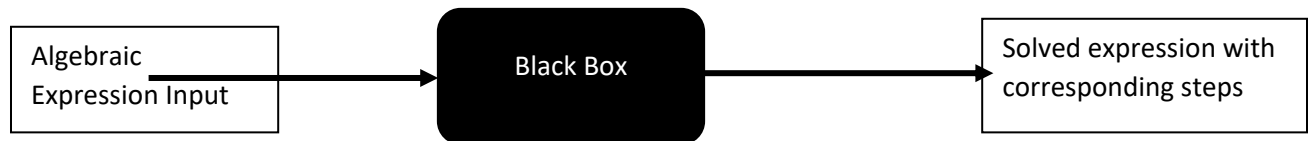


Figure 2.2 – AI Function Scenario Diagram

### 3. Conventional Test Design

#### 3.1 Test Methods

The testing phase will play a crucial role in the development of software. Not only will it determine the quality of a product, but it will also provide the ability to modify and upgrade that product so that it will be user friendly and usable.



We are going to use the following conventional Blackbox testing methods.

- Boundary Value Testing
- Category Partition Testing
- Equivalence Partition Testing
- Scenario Testing

Let us go through few important definitions of the above four conventional testing methods.

Boundary value testing is the process of testing the data which lies between the extreme ends/boundaries including the boundaries (Minimum value. Maximum value). In addition to that, the test criteria are for each boundary value, we must write a test case to cover the boundary condition.

Category partition testing divides input domains into various partitions, it creates test cases by choosing one value from each input domain. Each categorized partition must have a test case created from it, and test frames must include the greatest possible combination of possibilities in the partitioned category.

Equivalence testing is a kind of black box testing in which the input data is divided into equivalent partitions and test cases are generated for each partition. It reduced the time required for testing as we only generate a smaller number of test cases.

Scenario testing uses real-world experiences to create test scenarios. Test coverage is based on user scenarios. It is done to make sure that the end-to-end software functionalities are operating properly. It is mainly focused from the user perspective.

## 3.2 Boundary Value Test Method

### 3.2.1 Method Design for AI Feature

Boundary testing is the process of testing between extreme ends or boundaries between divisions of input data.

#### Topic: Exponential and Logarithmic Functions

Following images depict the boundaries of the exponential as well as logarithmic based algebraic expressions.

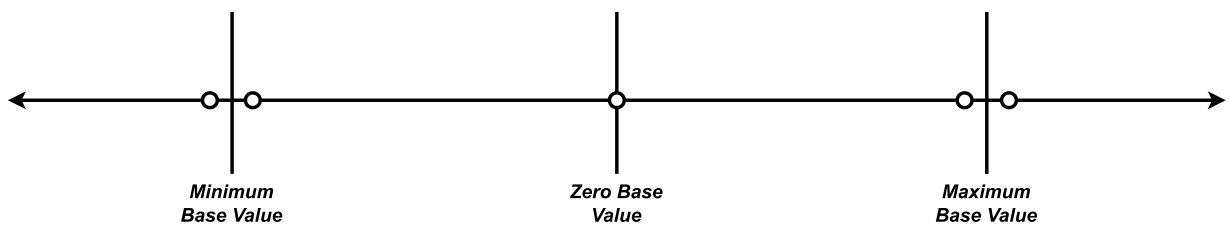


Figure 3.2.1.1 Boundary Value Cases for Base

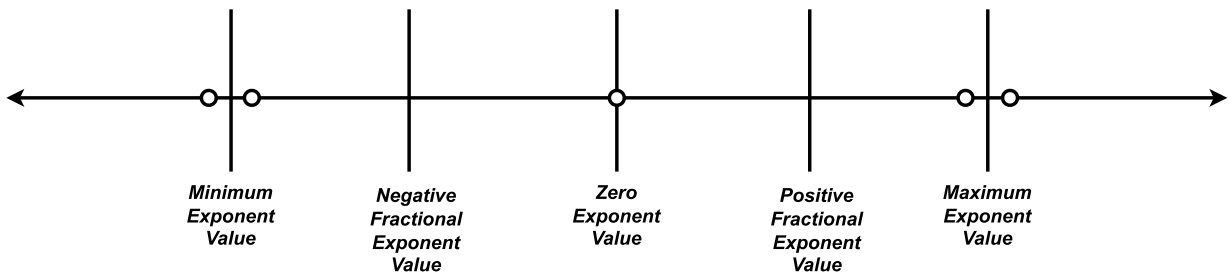


Figure 3.2.1.2 Boundary Value Cases for Exponent

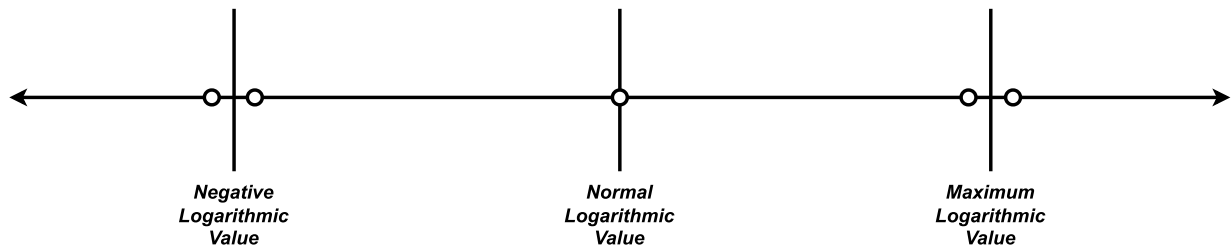
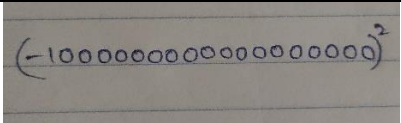
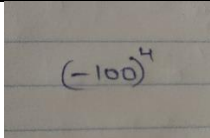
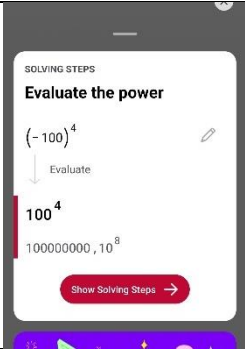


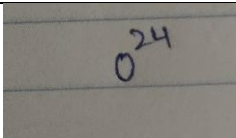
Figure 3.2.1.1 Boundary Value Cases for Logarithmic


### 3.2.2 Test Cases

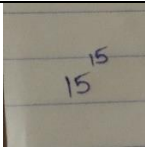
Test Case ID	1	2
Test Topic	Algebra (Exponential and Logarithmic Functions)	
Test Description	Minimum base value for an exponential function	
Test Case Input Method	Image	Text
Test Case Input		$(-100000000000000000000)^2$
Performed By	Tirumala Saiteja Goruganthu	
Execution Date	26 <sup>th</sup> September 2023	
Expected Result	$10^{36}$	
Actual Result	Couldn't recognize the image	$10^{36}$
Test Case Result	Fail	Pass

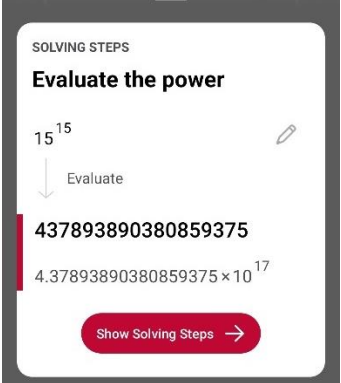


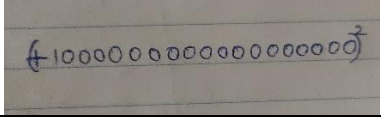
Test Case ID	3	4
Test Topic	Algebra (Exponential and Logarithmic Functions)	
Test Description	Negative base value for an exponential function	
Test Case Input Method	Image	Text
Test Case Input		$(-100)^4$
Performed By	Tirumala Saiteja Goruganthu	
Execution Date	26 <sup>th</sup> September 2023	
Expected Result	$10^8$	
Actual Result		$10^8$
Test Case Result	Pass	Pass

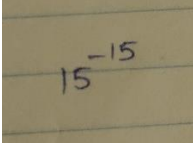
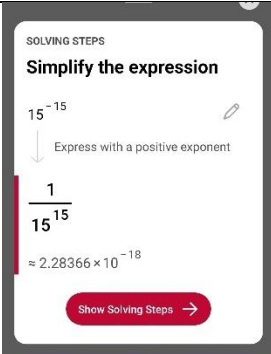
Test Case ID	5	6
Test Topic	Algebra (Exponential and Logarithmic Functions)	
Test Description	Zero base value for an exponential function	
Test Case Input Method	Image	Text
Test Case Input		$0^{24}$

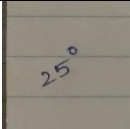
Performed By	Tirumala Saiteja Goruganthu	
Execution Date	26 <sup>th</sup> September 2023	
Expected Result	0	
Actual Result		0
Test Case Result	Pass	Pass

Test Case ID	7	8
Test Topic	Algebra (Exponential and Logarithmic Functions)	
Test Description	Positive base value for an exponential function	
Test Case Input Method	Image	Text
Test Case Input		$15^{15}$
Performed By	Tirumala Saiteja Goruganthu	
Execution Date	26 <sup>th</sup> September 2023	
Expected Result	$4.37 \times 10^{17}$	

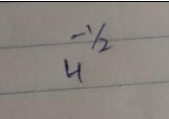
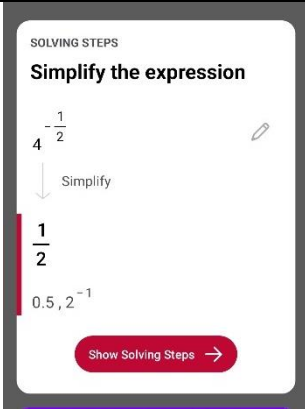
Actual Result		$4.37 \times 10^{17}$
Test Case Result	Pass	Pass

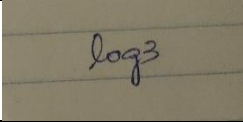
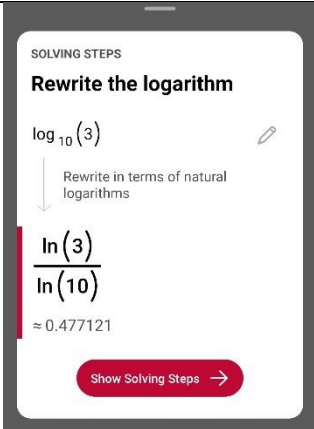
Test Case ID	9	10
Test Topic	Algebra (Exponential and Logarithmic Functions)	
Test Description	Maximum base value for an exponential function	
Test Case Input Method	Image	Text
Test Case Input		$(1000000000000000000)^2$
Performed By	Tirumala Saiteja Goruganthu	
Execution Date	26 <sup>th</sup> September 2023	
Expected Result	$10^{36}$	
Actual Result	Couldn't recognize the image	$10^{36}$
Test Case Result	Fail	Pass

Test Case ID	11	12
Test Topic	Algebra (Exponential and Logarithmic Functions)	
Test Description	Negative exponent value for an exponential function	
Test Case Input Method	Image	Text
Test Case Input		$15^{-15}$
Performed By	Tirumala Saiteja Goruganthu	
Execution Date	26 <sup>th</sup> September 2023	
Expected Result	$2.28 \times 10^{-18}$	
Actual Result		$2.28 \times 10^{-18}$
Test Case Result	Pass	Pass

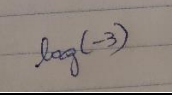
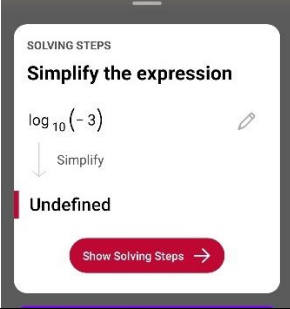
Test Case ID	13	14
Test Topic	Algebra (Exponential and Logarithmic Functions)	
Test Description	Zero exponent value for an exponential function	
Test Case Input Method	Image	Text
Test Case Input		$25^0$

Performed By	Tirumala Saiteja Goruganthu	
Execution Date	26 <sup>th</sup> September 2023	
Expected Result	1	
Actual Result	Acute angle	1
Test Case Result	Fail	Pass

Test Case ID	15	16
Test Topic	Algebra (Exponential and Logarithmic Functions)	
Test Description	Negative Fractional exponent value for an exponential function	
Test Case Input Method	Image	Text
Test Case Input		$4^{-1/2}$
Performed By	Tirumala Saiteja Goruganthu	
Execution Date	26 <sup>th</sup> September 2023	
Expected Result	$1/2$	
Actual Result		$1/2$
Test Case Result	Pass	Pass

Test Case ID	17	18
Test Topic	Algebra (Exponential and Logarithmic Functions)	
Test Description	General Logarithmic Function	
Test Case Input Method	Image	Text
Test Case Input		log(3)
Performed By	Tirumala Saiteja Goruganthu	
Execution Date	26 <sup>th</sup> September 2023	
Expected Result	0.477	
Actual Result		0.477
Test Case Result	Pass	Pass

Test Case ID	19	20
Test Topic	Algebra (Exponential and Logarithmic Functions)	
Test Description	Negative Logarithmic Function	
Test Case Input Method	Image	Text

Test Case Input		$\log(-3)$
Performed By	Tirumala Saiteja Goruganthu	
Execution Date	26 <sup>th</sup> September 2023	
Expected Result	Error or Undefined	
Actual Result		Undefined
Test Case Result	Pass	Pass

Test Case ID	21
Test Topic	Algebra (Polynomial Equations)
Test Description	Quartic Equation
Test Case Input Method	Text - Image
Test Case Input	$2x^4 - 2x^3 - 14x^2 + 2x + 12 = 0$
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = -2, x = -1, x = 1, x = 3$
Actual Result	<div> <b>Solution</b>  <math>x_1 = -2, x_2 = -1, x_3 = 1, x_4 = 3</math> </div>
Test Case Result	Pass

Test Case ID	22
Test Topic	Algebra (Polynomial Equations)
Test Description	Cubic Equation
Test Case Input Method	Text - Image
Test Case Input	$x^3 - 1 = 0$
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = 1, x = -1/2 + (\text{sqrt}(3)/2)i, x = -1/2 - (\text{sqrt}(3)/2)i$
Actual Result	<div> <div>Solution</div> <math display="block">x_1 = \cos(0) + i \times \sin(0)</math> <math display="block">x_2 = \cos\left(\frac{2\pi}{3}\right) + i \times \sin\left(\frac{2\pi}{3}\right)</math> <math display="block">x_3 = \cos\left(\frac{4\pi}{3}\right) + i \times \sin\left(\frac{4\pi}{3}\right)</math> <div>Alternative Form</div> <math display="block">x_1 = 1</math> <math display="block">x_2 = -\frac{1}{2} + \frac{\sqrt{3}}{2}i</math> <math display="block">x_3 = -\frac{1}{2} - \frac{\sqrt{3}}{2}i</math> </div>
Test Case Result	Pass

Test Case ID	23
Test Topic	Algebra (Polynomial Equations)
Test Description	Quadratic Equation
Test Case Input Method	Text - Image
Test Case Input	$x^2 - 25 = 0$
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023

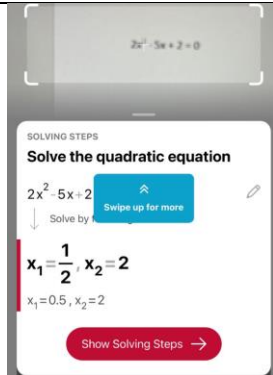


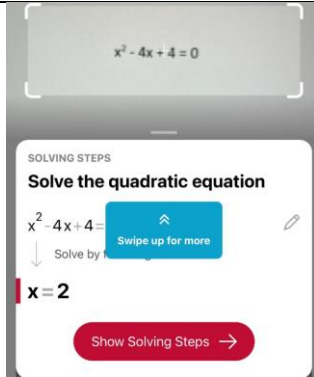
Expected Result	$x = 5, x = -5$
Actual Result	<div>Solution</div> $x_1 = -5, x_2 = 5$
Test Case Result	Pass

Test Case ID	24
Test Topic	Algebra (Polynomial Equations)
Test Description	Quartic Equation
Test Case Input Method	Text - Image
Test Case Input	$x^4 - 4x^2 + 4 = 0$
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = -\sqrt{2}, x = \sqrt{2}$
Actual Result	<div>Solution</div> $x_1 = -\sqrt{2}, x_2 = \sqrt{2}$ <div>Alternative Form</div> $x_1 \approx -1.41421, x_2 \approx 1.41421$
Test Case Result	Pass

Test Case ID	25
Test Topic	Algebra (Polynomial Equations)
Test Description	Quadratic Equation
Test Case Input Method	Text - Image

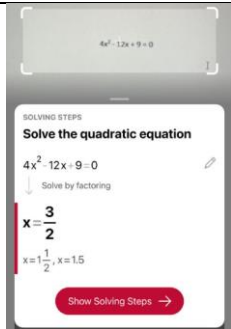
Test Case Input	$2x^2 + 3x + 1 = 0$
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = -1/2, x = -1$
Actual Result	<div> <div>Solution</div> <math display="block">x_1 = -1, x_2 = -\frac{1}{2}</math> <div>Alternative Form</div> <math display="block">x_1 = -1, x_2 = -0.5</math> </div>
Test Case Result	Pass

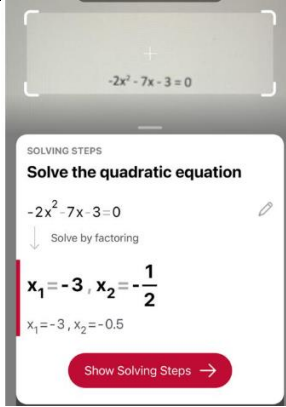
Test Case ID	26
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with Two Real Roots
Test Case Input Method	Image
Test Case Input	$2x^2 - 5x + 2 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = 0.5$ and $x = 2$
Actual Result	
Test Case Result	Pass

Test Case ID	27
Test Topic	Algebra (Quadratic Equations)
Test Description	Simple Quadratic Equation
Test Case Input Method	Image
Test Case Input	$x^2 - 4x + 4 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = 2$ (single real root)
Actual Result	
Test Case Result	Pass

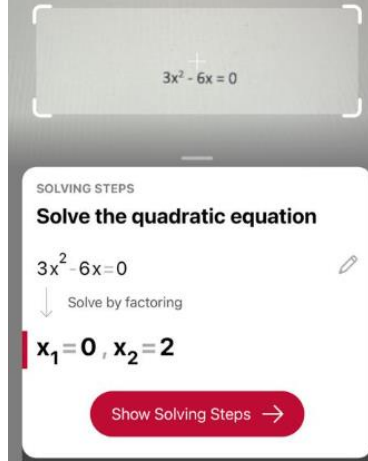
Test Case ID	28
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with No Real Roots
Test Case Input Method	Image
Test Case Input	$x^2 + 3x + 9 = 0$

Performed By	Sowjanya Bheemineni
Execution Date	27 <sup>th</sup> September 2023
Expected Result	No real roots
Actual Result	<p><b>Solving Steps</b></p> $x^2 + 3x + 9 = 0$ <p>Identify the coefficients</p> $a=1, b=3, c=9$ <p>Substitute the coefficients into the expression</p> $3^2 - 4 \times 1 \times 9$ <p>Simplify</p> $-27$ <p>The quadratic equation has no real solutions</p> <p><b>Solution</b></p> <p><b>No real solutions</b></p>
Test Case Result	Pass

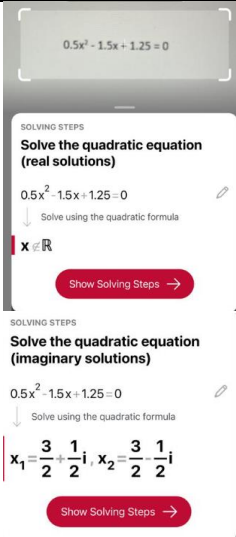
Test Case ID	29
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with Equal Roots
Test Case Input Method	Image
Test Case Input	$4x^2 - 12x + 9 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = 1.5$ (double root)
Actual Result	
Test Case Result	Pass

Test Case ID	30
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with Negative Coefficients
Test Case Input Method	Image
Test Case Input	$-2x^2 - 7x - 3 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = -3$ and $x = -1/2$
Actual Result	
Test Case Result	Pass

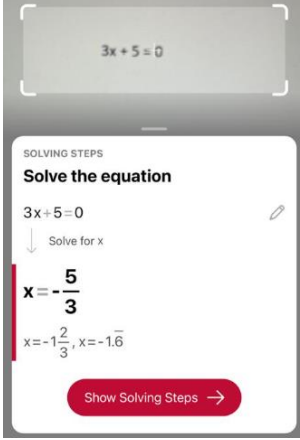
Test Case ID	31
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with No Constant Term
Test Case Input Method	Image

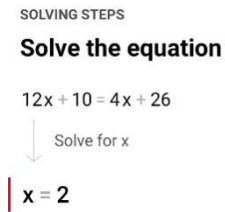
Test Case Input	$3x^2 - 6x = 0$
Performed By	Sowjanya Bheemineni
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = 0$ and $x = 2$
Actual Result	
Test Case Result	Pass

Test Case ID	32
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with Fractional Coefficients
Test Case Input Method	Image
Test Case Input	$0.5x^2 - 1.5x + 1.25 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = (1.5 + 0.5i), x = (1.5 - 0.5i)$

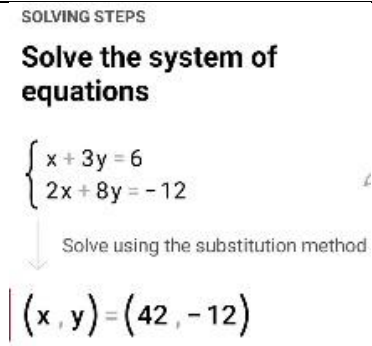
Actual Result	
Test Case Result	Pass

Test Case ID	33
Test Topic	Algebra (Quadratic Equations)
Test Description	Linear Equation (a = 0)
Test Case Input Method	Image
Test Case Input	$3x + 5 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = -5/3$ (single real root)

Actual Result	
Test Case Result	Pass

Test Case ID	35
Test Topic	Algebra (Linear Equations)
Test Description	With Single Variable
Test Case Input Method	Image
Test Case Input	$12x + 10 = 4x + 26$
Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	$x = 2$
Actual Result	
Test Case Result	Pass



Test Case ID	36
Test Topic	Algebra (Linear Equations)
Test Description	With Two Variables
Test Case Input Method	Image
Test Case Input	$\begin{aligned} x + 3y &= 6 \\ 2x + 8y &= -12 \end{aligned}$
Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	$X = 42, y = -12$
Actual Result	 <p><b>SOLVING STEPS</b></p> <p><b>Solve the system of equations</b></p> $\begin{cases} x + 3y = 6 \\ 2x + 8y = -12 \end{cases}$ <p>Solve using the substitution method</p> $(x, y) = (42, -12)$
Test Case Result	Pass

Test Case ID	37
Test Topic	Algebra (Linear Equations)
Test Description	With Three Variables
Test Case Input Method	Image
Test Case Input	$\begin{aligned} 4x + 8y + z &= 2 \\ x + 7y - 3z &= -14 \\ 2x - 3y + 2z &= 3 \end{aligned}$

Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	$x = -3, y = 1, z = 6$
Actual Result	<p><small>SOLVING STEPS</small></p> <p><b>Solve the system of equations</b></p> $\begin{cases} 4x + 8y + z = 2 \\ x + 7y - 3z = -14 \\ 2x - 3y + 2z = 3 \end{cases}$ <p><small>Solve using the elimination method</small></p> <p><b><math>(x, y, z) = (-3, 1, 6)</math></b></p>
Test Case Result	Pass

<b>Test Case ID</b>	<b>38</b>
Test Topic	Algebra (Linear Equations)
Test Description	Division of Linear equations
Test Case Input Method	Image
Test Case Input	$(2x + 5) / (x + 4) = 1$
Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	$x = -1$

Actual Result	<p>SOLVING STEPS</p> <p><b>Solve the equation</b></p> $\frac{2x + 5}{x + 4} = 1$ <p>↓ Solve for x</p> <p><b>x = -1</b></p>
Test Case Result	Pass

### 3.2.3 Test Result Analysis and Summary

#### 3.2.3.1 Test Coverage

For all the chosen Algebra based topics, we have the following summary for the boundary value test method.

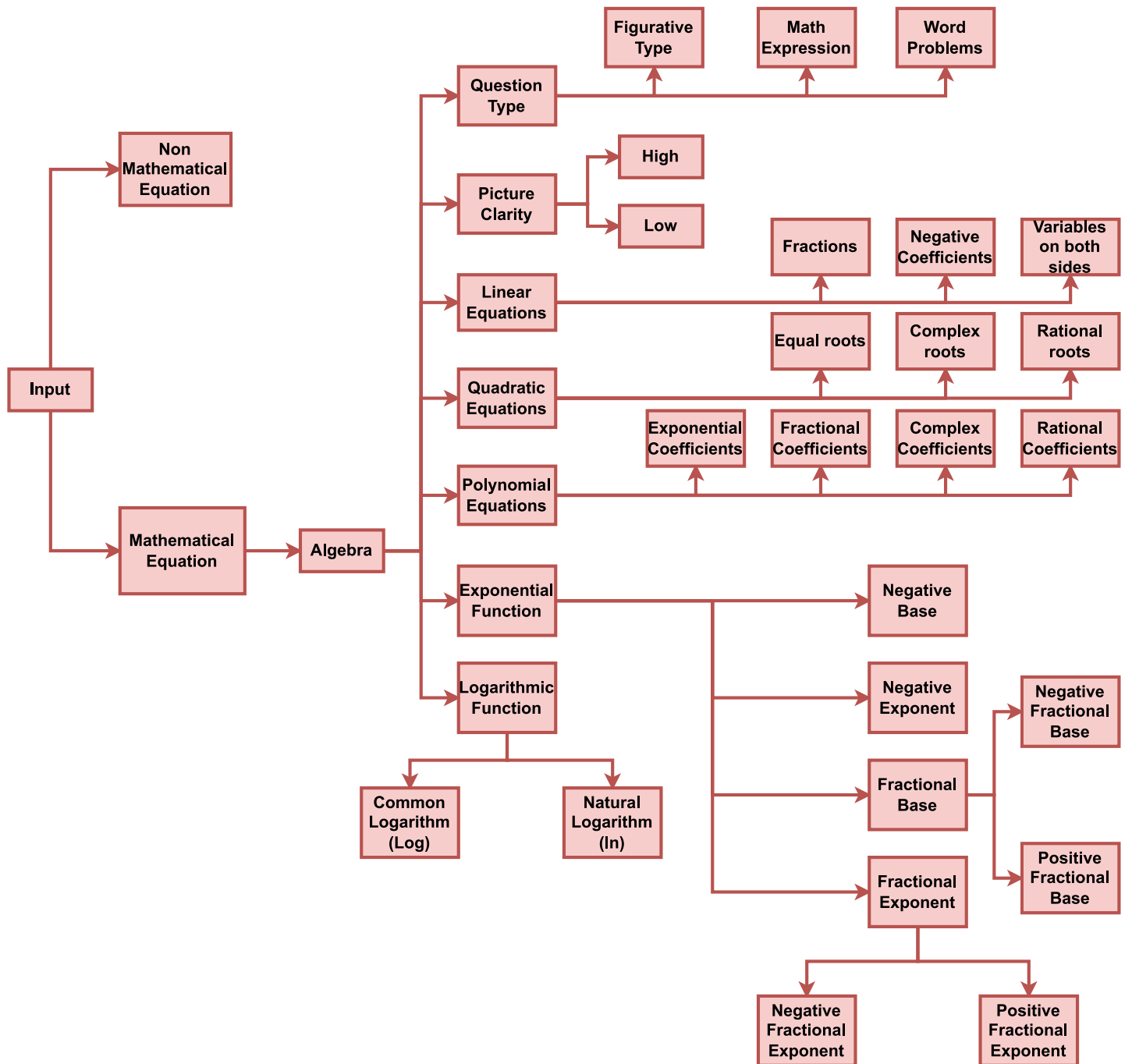
#### 3.2.3.2 Test Results Summary

Photo Math	Exponential and Logarithmic		Linear Equations	Quadratic Equations	Polynomial Equations
	Image	Text	Image	Image	Text - Image
Pass rate	7/10	10/10	4/4	7/7	5/5
Pass Percentage	70%	100%	100%	100%	100%

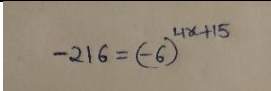
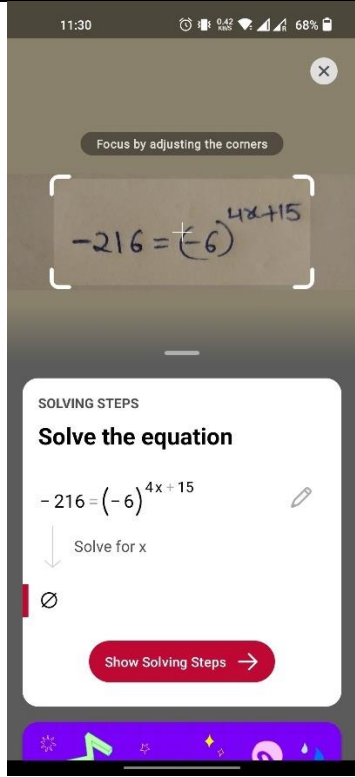
### 3.3 Category Partition Test Method

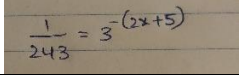
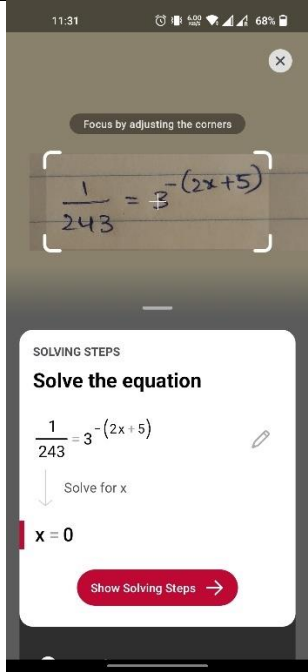
#### 3.3.1 Method Design for AI Feature

The categories for our AI feature are depicted in the following graph

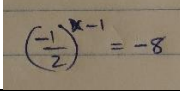
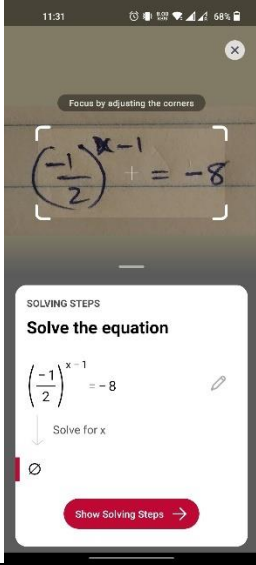


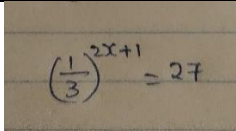
### 3.3.2 Test Cases

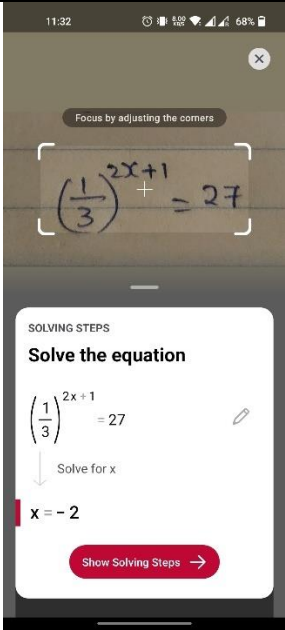
Test Case ID	1
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	Negative Base
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	27 <sup>th</sup> September 2023
Expected Result	-3
Actual Result	
Test Case Result	Fail

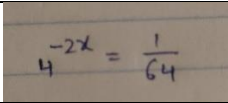
Test Case ID	2
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	Negative Exponent
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	27 <sup>th</sup> September 2023
Expected Result	0
Actual Result	
Test Case Result	Pass

Test Case ID	3
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	Negative Fractional Base

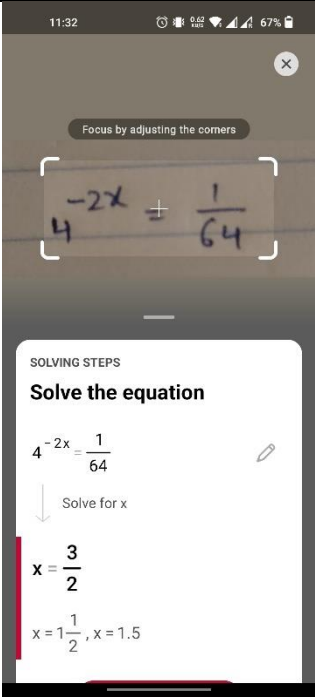
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	27 <sup>th</sup> September 2023
Expected Result	-2
Actual Result	
Test Case Result	Fail

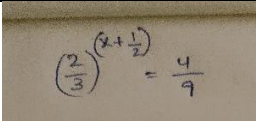
<b>Test Case ID</b>	<b>4</b>
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	Positive Fractional Base
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu

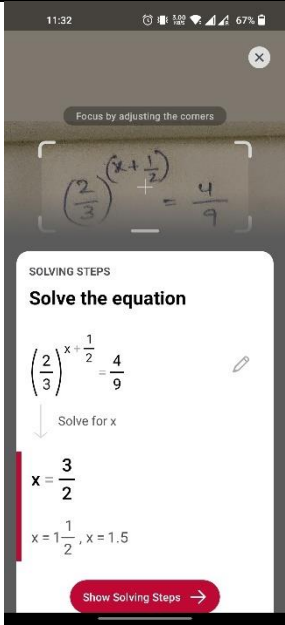
Execution Date	27 <sup>th</sup> September 2023
Expected Result	-2
Actual Result	
Test Case Result	Pass

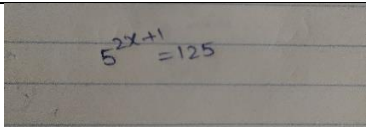
Test Case ID	5
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	Negative Fractional Exponent
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	27 <sup>th</sup> September 2023
Expected Result	3/2

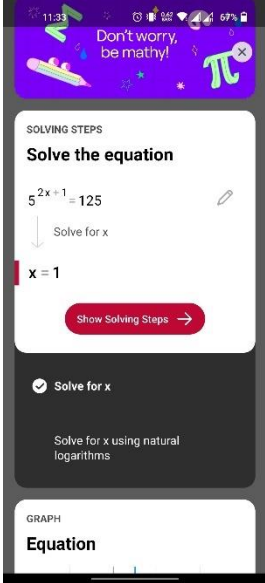


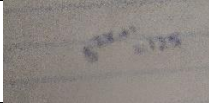
Actual Result	
Test Case Result	Pass

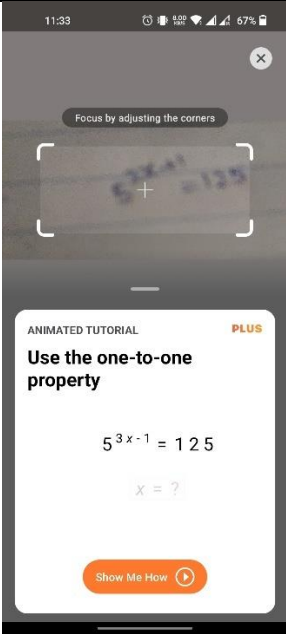
Test Case ID	6
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	Positive Fractional Exponent
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	27 <sup>th</sup> September 2023
Expected Result	1 1/2

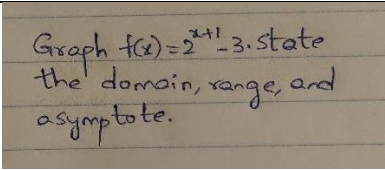
Actual Result	
Test Case Result	Pass

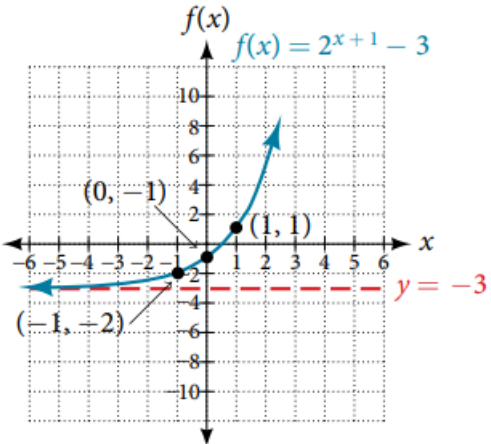
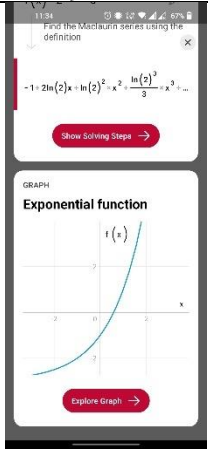
Test Case ID	7
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	High Clarity Image
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	27 <sup>th</sup> September 2023
Expected Result	1

Actual Result	
Test Case Result	Pass

Test Case ID	8
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	Low Clarity Image
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	27 <sup>th</sup> September 2023
Expected Result	1

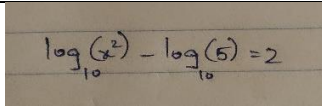
Actual Result	
Test Case Result	Fail

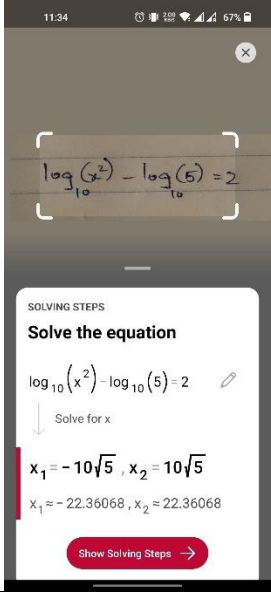
Test Case ID	9
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	Figurative Type
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	27 <sup>th</sup> September 2023

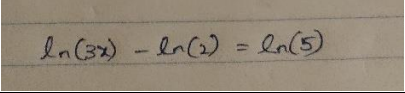
Expected Result	
Actual Result	
Test Case Result	Pass

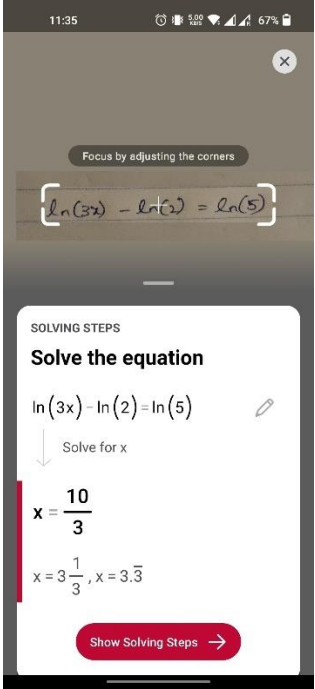
Test Case ID	10
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	Word Problem
Test Case Input Method	Image

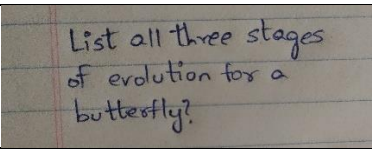
Test Case Input	Suppose you have a bank account with an initial balance of \$1,000, and you are considering two different investment options: Option A and Option B. Option A offers a fixed annual interest rate of 5%, while Option B offers a variable annual interest rate that increases by 2% each year. You want to determine after how many years the balance in Option B will exceed the balance in Option A. Create a table to compare the balances in both options over the years.
Performed By	Tirumala Saiteja Goruganthu
Execution Date	27 <sup>th</sup> September 2023
Expected Result	2.2
Actual Result	Cannot Solve Word Problems
Test Case Result	Fail

Test Case ID	11
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	Common Logarithms
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$\pm 10\sqrt{5}$

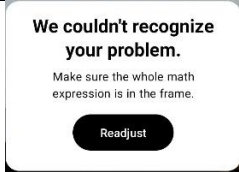
Actual Result	
Test Case Result	Pass

Test Case ID	12
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	Natural Logarithms
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	27 <sup>th</sup> September 2023
Expected Result	10/3

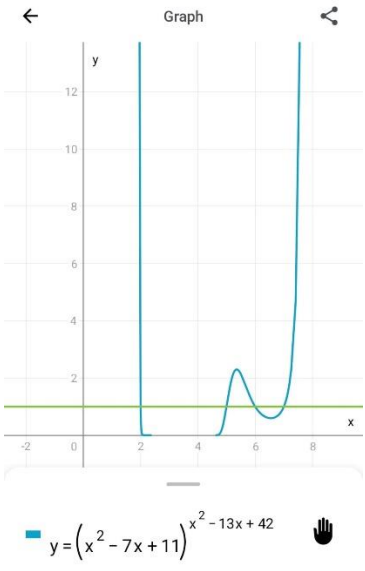
Actual Result	
Test Case Result	Pass

Test Case ID	13
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	Non-Mathematical Equations
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	27 <sup>th</sup> September 2023
Expected Result	Cannot Solve the Given Problem
Actual Result	Cannot Solve the Given Problem
Test Case Result	Pass


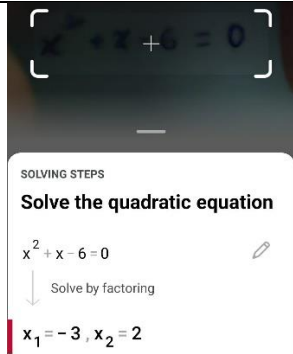


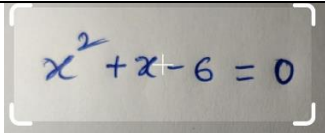
Test Case ID	14
Test Topic	Algebra (Polynomial Equations)
Test Description	Non-mathematical problem
Test Case Input Method	Text - Image
Test Case Input	Username + Password = Access
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	Error
Actual Result	
Test Case Result	Pass

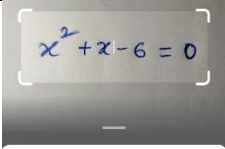
Test Case ID	15
Test Topic	Algebra (Polynomial Equations)
Test Description	Figurative
Test Case Input Method	Text - Image
Test Case Input	$(x^2 - 7x + 11)x^2 - 13x + 42 = 1$
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = 2, x = 3, x = 4, x = 5, x = 6, x = 7$

Actual Result	 <p>Graph</p> <p><math>y = (x^2 - 7x + 11)^{x^2 - 13x + 42}</math></p>
Test Case Result	Fail (It gives only four solutions)

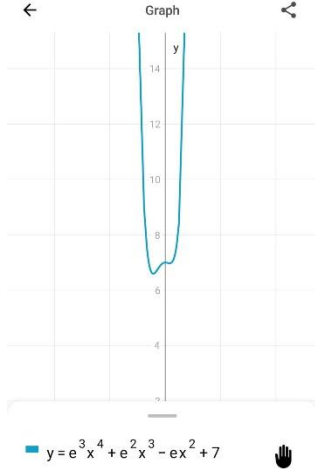
Test Case ID	16
Test Topic	Algebra (Polynomial Equations)
Test Description	Word problem
Test Case Input Method	Text - Image
Test Case Input	Find the value of a, if $x - a$ is a factor of $x^3 - ax^2 + 2x + a - 1$
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$a = 1/3$
Actual Result	<p><b>Solution</b></p> <p><math>a - 1 + 2x - ax^2 + x^3</math></p>
Test Case Result	Fail

Test Case ID	17
Test Topic	Algebra (Polynomial Equations)
Test Description	Low clarity question
Test Case Input Method	Text - Image
Test Case Input	
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = -3, x = 2$
Actual Result	
Test Case Result	Pass

Test Case ID	18
Test Topic	Algebra (Polynomial Equations)
Test Description	High clarity question
Test Case Input Method	Text - Image
Test Case Input	

Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = -3, x = 2$
Actual Result	 <p>SOLVING STEPS Solve the quadratic equation</p> $x^2 + x - 6 = 0$ <p>Solve by factoring</p> $x_1 = -3, x_2 = 2$
Test Case Result	Pass

Test Case ID	19
Test Topic	Algebra (Polynomial Equations)
Test Description	Complex coefficient equation
Test Case Input Method	Text - Image
Test Case Input	$(42+42i)x^2 + (7+i)x + 15i + 5 = 0$
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = \frac{-7-i+\sqrt{1728-3346i}}{2(42+42i)}, x = \frac{-7-i-\sqrt{1728-3346i}}{2(42+42i)}$
Actual Result	<p><b>Solution</b></p> $x_1 = \frac{-7-i+\sqrt{1728-3346i}}{2(42+42i)}, x_2 = \frac{-7-i-\sqrt{1728-3346i}}{2(42+42i)}$
Test Case Result	Pass

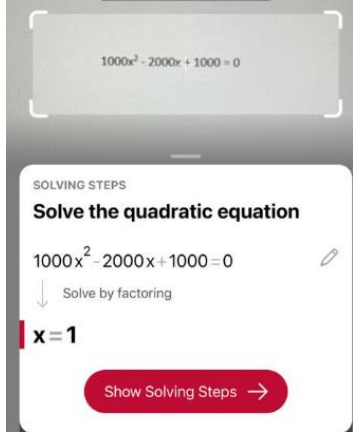
Test Case ID	20
Test Topic	Algebra (Polynomial Equations)
Test Description	Exponential coefficient equation
Test Case Input Method	Text - Image
Test Case Input	$e^3x^4 + e^2x^3 - ex^2 + 7 = 0$
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = -1$
Actual Result	
Test Case Result	Fail

Test Case ID	21
Test Topic	Algebra (Polynomial Equations)
Test Description	Fractional coefficient equation
Test Case Input Method	Text - Image
Test Case Input	$(1/2)x^2 + (1/2)x - 10 = 0$

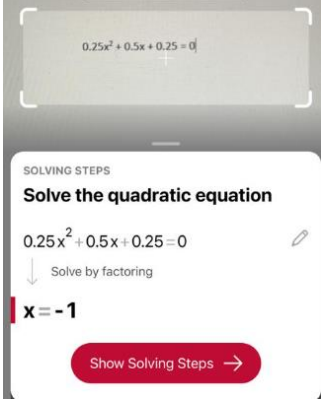
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = -5, x = 4$
Actual Result	<div>Solution</div> $x_1 = -5, x_2 = 4$
Test Case Result	Pass

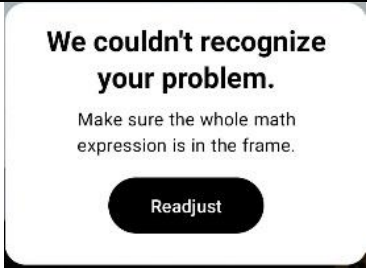
Test Case ID	22
Test Topic	Algebra (Polynomial Equations)
Test Description	Rational coefficient equation
Test Case Input Method	Text - Image
Test Case Input	$4x^4 - 8x^3 - 3x^2 + 5x + 2 = 0$
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = -1/2, x = 1, x = 2$
Actual Result	<div>Solution</div> $x_1 = -\frac{1}{2}, x_2 = 1, x_3 = 2$ <div>Alternative Form</div> $x_1 = -0.5, x_2 = 1, x_3 = 2$
Test Case Result	Pass

Test Case ID	23
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic equations with large coefficients

Test Case Input Method	Image
Test Case Input	$1000x^2 - 2000x + 1000 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = 1$
Actual Result	 <p>The screenshot shows a math solver interface. At the top, the equation <math>1000x^2 - 2000x + 1000 = 0</math> is displayed. Below it, the text 'SOLVING STEPS' is followed by 'Solve the quadratic equation'. The equation is repeated, and then it says 'Solve by factoring'. The solution <math>x = 1</math> is shown in a red box. At the bottom, there is a red button that says 'Show Solving Steps' with a right arrow.</p>
Test Case Result	Pass

<b>Test Case ID</b>	<b>24</b>
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic equations with a discriminant of zero
Test Case Input Method	Image
Test Case Input	$0.25x^2 + 0.5x + 0.25 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$X = -1$

Actual Result	
Test Case Result	Pass

Test Case ID	25
Test Topic	Algebra (Linear Equations)
Test Description	Word Based Input
Test Case Input Method	Image
Test Case Input	Two(x) + Three(x) = Ten
Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	Error
Actual Result	
Test Case Result	Pass



Test Case ID	26
Test Topic	Algebra (Linear Equations)
Test Description	Contradiction equation
Test Case Input Method	Image
Test Case Input	$4(x - 2) + 12 = x + 3(x + 4)$
Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	$x \in \emptyset$
Actual Result	<p>SOLVING STEPS</p> <p><b>Solve the equation</b></p> $4(x - 2) + 12 = x + 3(x + 4)$ <p>↓ Solve for x</p> <p><b> </b> <math>\emptyset</math></p>
Test Case Result	Pass

Test Case ID	27
Test Topic	Algebra (Linear Equations)
Test Description	Rational equation
Test Case Input Method	Image
Test Case Input	$4(x - 5) + 4 = x + 3(x + 2) - 22$
Performed By	Sohan Leburu
Execution Date	09/26/2023

Expected Result	$x \in R$
Actual Result	<p>SOLVING STEPS</p> <p><b>Solve the equation</b></p> $4(x - 5) + 4 = x + 3(x + 2) - 22$ <p>↓ Solve for x</p> <p><b><math>x \in R</math></b></p>
Test Case Result	Pass

Test Case ID	28
Test Topic	Algebra (Linear Equations)
Test Description	Linear equation
Test Case Input Method	Image
Test Case Input	$6x - 19 = 3x - 10$
Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	$x = 3$
Actual Result	<p>SOLVING STEPS</p> <p><b>Solve the equation</b></p> $6x - 19 = 3x - 10$ <p>↓ Solve for x</p> <p><b><math>x = 3</math></b></p> <p>Show Solving Steps →</p>

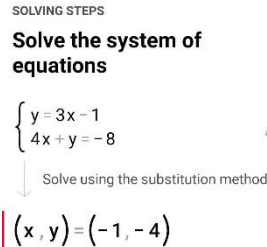
Test Case Result	Pass
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Test Case ID	29
Test Topic	Algebra (Linear Equations)
Test Description	Linear equation on both sides
Test Case Input Method	Image
Test Case Input	$6x - 10 - 4x = 7 - 2x$
Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	$4x=17 / x=17/4$
Actual Result	<p>SOLVING STEPS</p> <p><b>Rewrite the equation</b></p> $6x - 10 - 4x = 7 - 2x$ <p style="text-align: center;">↓ Rewrite in standard form</p> <p><b><math>4x = 17</math></b></p>
Test Case Result	Pass

Test Case ID	30
Test Topic	Algebra (Linear Equations)
Test Description	Linear equation with m as variable
Test Case Input Method	Image

Test Case Input	$9m - 4(2m - 3) = 11$
Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	$m = -1$
Actual Result	<div> <div>SOLVING STEPS</div> <div>Solve the equation</div> <div> <math>9m - 4(2m - 3) = 11</math> </div> <div> <div>↓</div> <div>Solve for m</div> </div> <div> <math>m = -1</math> </div> </div>
Test Case Result	Pass

Test Case ID	31
Test Topic	Algebra (Linear Equations)
Test Description	Fractional Linear Equation
Test Case Input Method	Image
Test Case Input	$5 - 2(x - 1) = 4(3 - x) - 2x$
Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	$x = 5/4, 4x = 5$
Actual Result	<div> <div>SOLVING STEPS</div> <div>Solve the equation</div> <div> <math>5 - 2(x - 1) = 4(3 - x) - 2x</math> </div> <div> <div>↓</div> <div>Solve for x</div> </div> <div> <math>x = \frac{5}{4}</math> </div> <div> <math>x = 1\frac{1}{4}, x = 1.25</math> </div> </div>
Test Case Result	Pass

Test Case ID	31
Test Topic	Algebra (Linear Equations)
Test Description	Fractional Linear Equation
Test Case Input Method	Image
Test Case Input	$y = 3x - 1$ $4x + y = -8$
Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	$x = -1, y = -5$
Actual Result	 <p>SOLVING STEPS</p> <p>Solve the system of equations</p> $\begin{cases} y = 3x - 1 \\ 4x + y = -8 \end{cases}$ <p>Solve using the substitution method</p> $(x, y) = (-1, -4)$
Test Case Result	Fail

### 3.3.3 Test Result Analysis and Summary

#### 3.3.3.1 Test Coverage

For all the chosen Algebra based topics, we have the following summary for the Category Partition Test method.

#### 3.3.3.2 Test Results Summary

Photo Math	Exponential and Logarithmic	Linear Equations	Quadratic Equations	Polynomial Equations
	Image	Image	Image	Text - Image
Pass rate	9/13	6/6	2/2	6/9
Pass Percentage	69.2%	100%	100%	66.66%

### 3.4 Scenario Based Testing

#### 3.4.1 Method Design for Conventional Features

Scenario 1	Take a new photo with the in-app scanner in bright light
1	User opens the Photo Math app
2	User uses the in-app scanner to take a picture of an expression (with ample amount of light)
3	App displays the solution with steps or appropriate error

Scenario 2	Take a new photo with the in-app scanner in low light
1	User opens the Photo Math app
2	User uses the in-app scanner to take a picture of an expression (with low light)
3	App displays the solution with steps or appropriate error

Scenario 3	Select an existing photo from the camera roll
1	User opens the Photo Math app
2	User uses the Camera Roll option to upload a picture of an expression from his/her phone gallery
3	App displays the solution with steps or appropriate error

<b>Scenario 4</b>	<b>UI Testing – In-built calculator</b>
1	User opens the Photo Math app
2	User uses the in-built calculator option to enter an expression
3	App displays the solution with steps or appropriate error

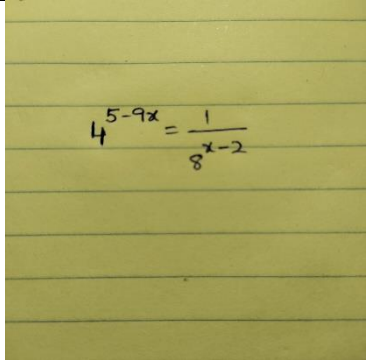
<b>Scenario 5</b>	<b>UI Testing – Flashlight</b>
1	User opens the Photo Math app
2	User uses the flashlight option to increase the amount of lighting while taking a picture of an expression
3	App displays the solution with steps or appropriate error

<b>Scenario 6</b>	<b>UI Testing – History Functionality</b>
1	User opens the Photo Math app
2	User uses the history button to review all the expressions that they searched
3	App displays the solution with steps or appropriate error

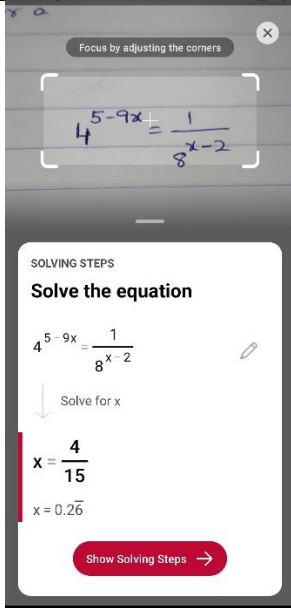
<b>Scenario 7</b>	<b>UI Testing – Textbooks for Learning</b>
1	User opens the Photo Math app
2	User uses the textbooks button to review all the textbooks related to the content they searched for
3	App displays the solution with steps or appropriate error

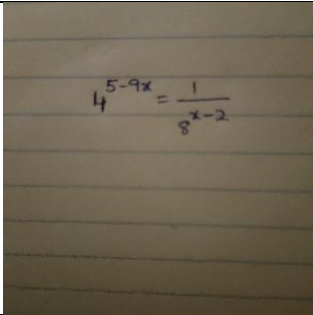
Scenario 8	UI Testing – Hamburger menu
1	User opens the Photo Math app
2	User uses the hamburger menu to customize the settings and language
3	App displays the solution with steps or appropriate error

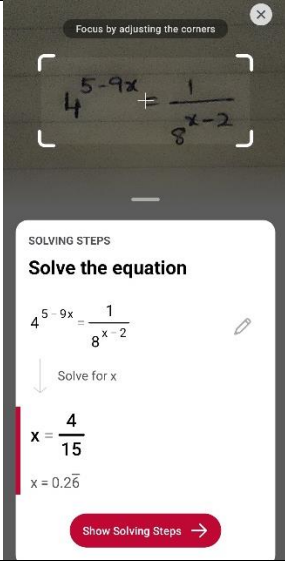
### 3.4.2 Test Cases

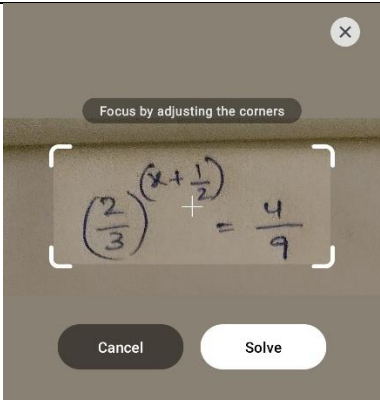
Test Case ID	1
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	User scans image with bright light
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	28 <sup>th</sup> September 2023
Expected Result	4/15

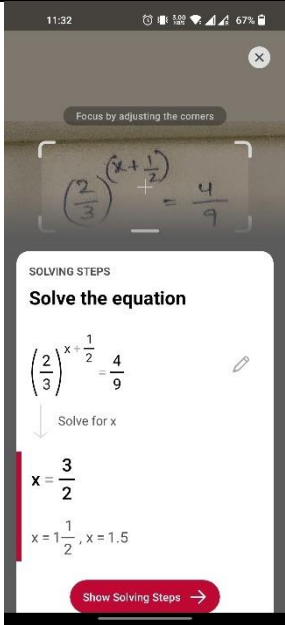


Actual Result	
Test Case Result	Pass

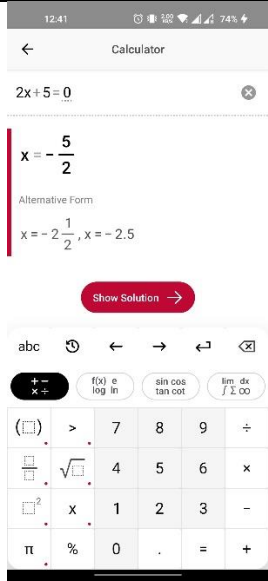
Test Case ID	2
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	User scans image with dim light
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	28 <sup>th</sup> September 2023
Expected Result	4/15

Actual Result	
Test Case Result	Pass

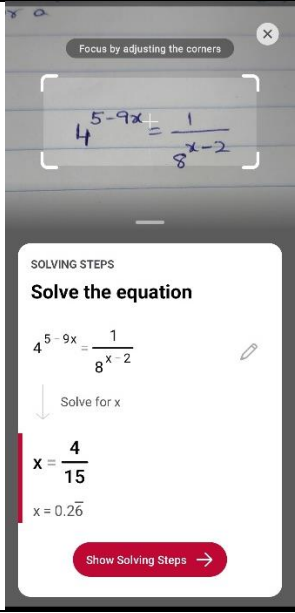
Test Case ID	3
Test Topic	Algebra (Exponential and Logarithmic Functions)
Test Description	User selects an existing image from their gallery
Test Case Input Method	Image
Test Case Input	
Performed By	Tirumala Saiteja Goruganthu
Execution Date	28 <sup>th</sup> September 2023
Expected Result	3/2

Actual Result	
Test Case Result	Pass

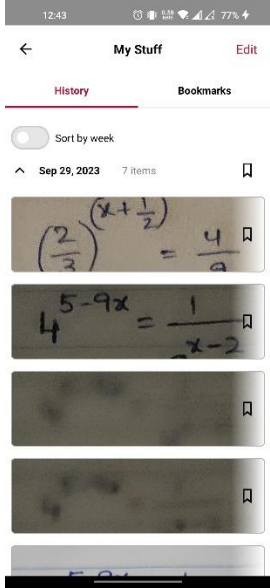
Test Case ID	4
Test Topic	UI Testing
Test Description	User clicks on the in-built calculator option
Test Case Input Method	Click
Test Case Input	User clicks on the in-built calculator option
Performed By	Tirumala Saiteja Goruganthu
Execution Date	28 <sup>th</sup> September 2023
Expected Result	Calculator must be in working condition

Actual Result	
Test Case Result	Pass


Test Case ID	5
Test Topic	UI Testing
Test Description	User clicks on the in-built flashlight option to enhance the brightness of the scan
Test Case Input Method	Click
Test Case Input	User clicks on the in-built flashlight option to enhance the brightness of the scan
Performed By	Tirumala Saiteja Goruganthu
Execution Date	28 <sup>th</sup> September 2023
Expected Result	Flashlight must be in working condition

Actual Result	
Test Case Result	Pass

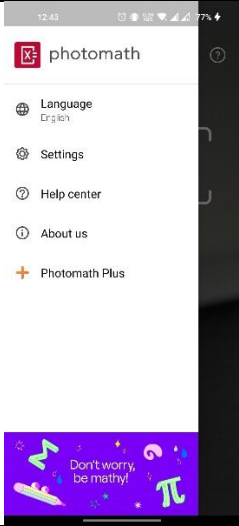
Test Case ID	6
Test Topic	UI Testing
Test Description	User clicks on the history button to access the previously solved expressions
Test Case Input Method	Click
Test Case Input	User clicks on the history button to access the previously solved expressions
Performed By	Harish Marepalli
Execution Date	28 <sup>th</sup> September 2023
Expected Result	History button must be in working condition


Actual Result	
Test Case Result	Pass

Test Case ID	7
Test Topic	UI Testing
Test Description	User clicks on the 'view textbooks' button to access the textbooks related to current expression
Test Case Input Method	Click
Test Case Input	User clicks on the 'view textbooks' button to access the textbooks related to current expression
Performed By	Sowjanya Bheemineni
Execution Date	28 <sup>th</sup> September 2023
Expected Result	Textbooks button must be in working condition

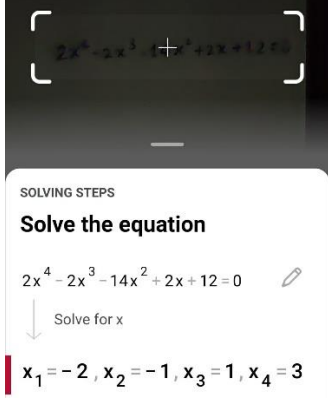
Actual Result	
Test Case Result	Pass

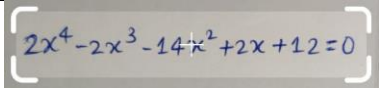
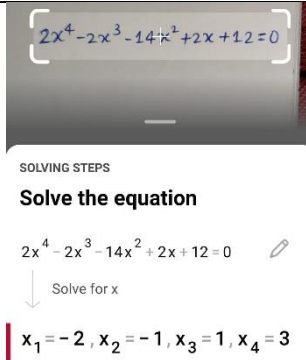
Test Case ID	8
Test Topic	UI Testing
Test Description	User clicks on the hamburger menu to customize the settings
Test Case Input Method	Click
Test Case Input	User clicks on the hamburger menu to customize the settings
Performed By	Sohan Leburu
Execution Date	28 <sup>th</sup> September 2023
Expected Result	Hamburger menu must be in working condition

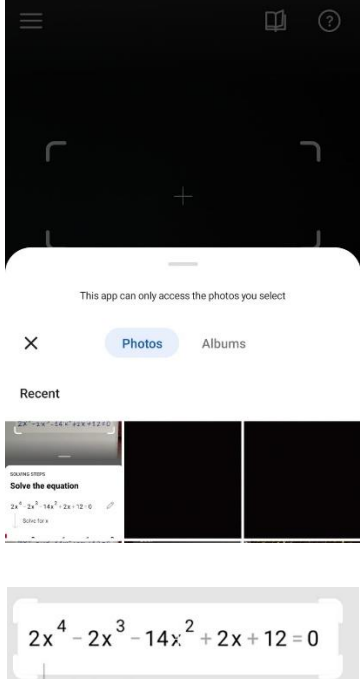
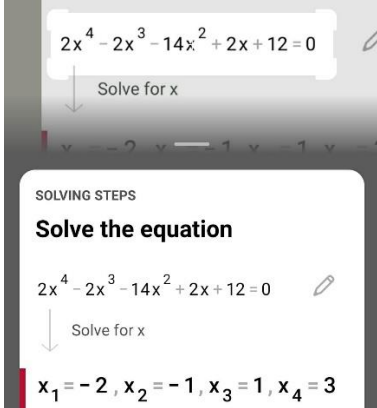
Actual Result	
Test Case Result	Pass

Test Case ID	9
Test Topic	Algebra (Polynomial Equations)
Test Description	Bad light equation
Test Case Input Method	Text - Image
Test Case Input	
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = -2, x = -1, x = 1, x = 3$

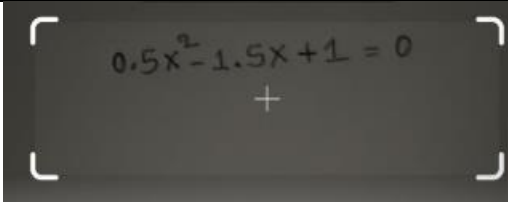
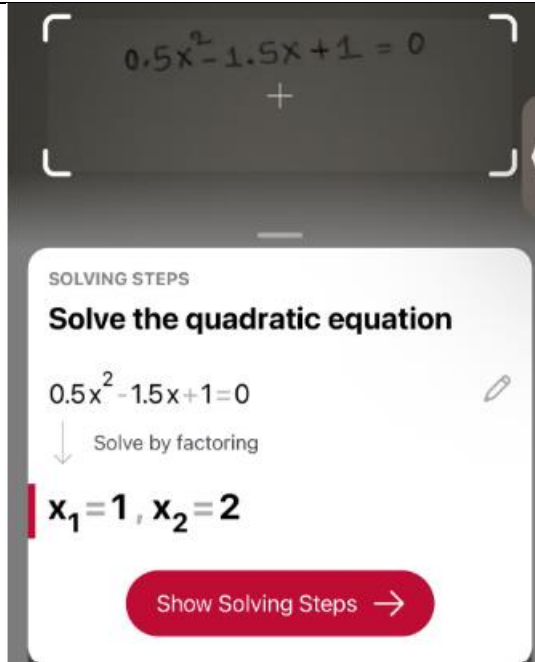


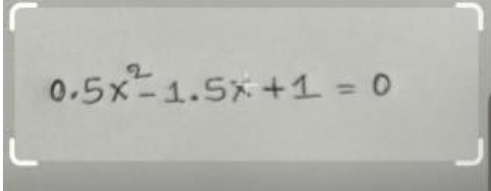
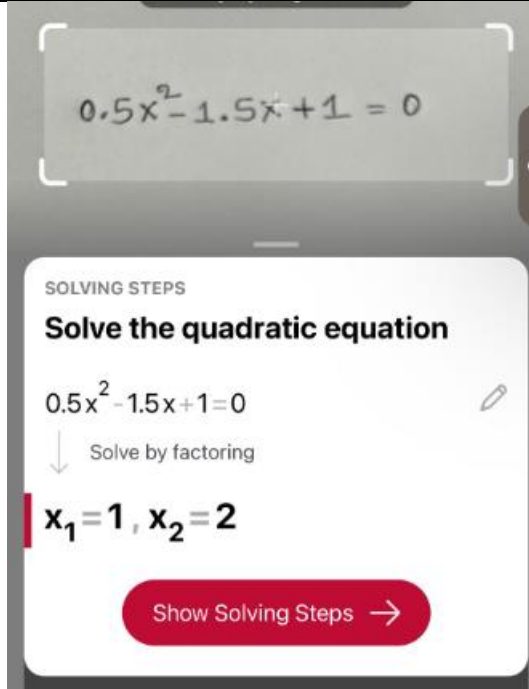
Actual Result	
Test Case Result	Pass

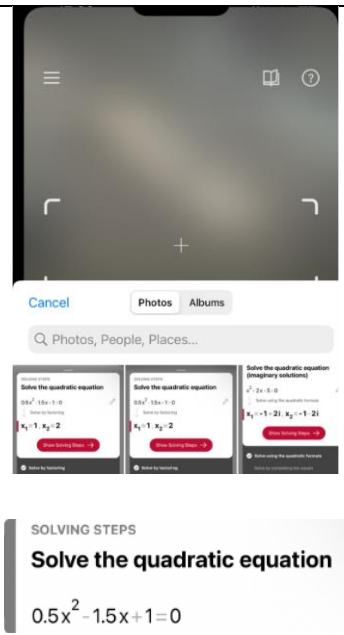
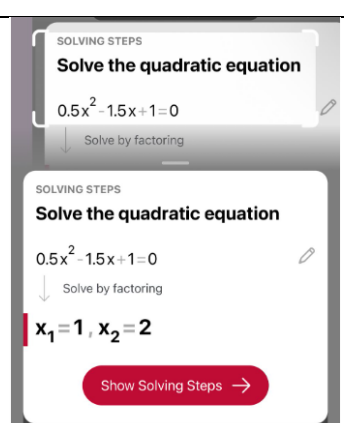
Test Case ID	10
Test Topic	Algebra (Polynomial Equations)
Test Description	Good light equation
Test Case Input Method	Text - Image
Test Case Input	
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	x = -2, x = -1, x = 1, x = 3
Actual Result	
Test Case Result	Pass

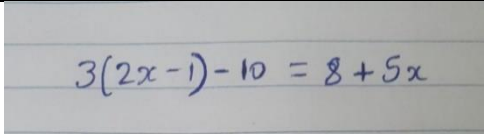
Test Case ID	11
Test Topic	Algebra (Polynomial Equations)
Test Description	Gallery Upload
Test Case Input Method	Text - Image
Test Case Input	
Performed By	Harish Marepalli
Execution Date	27 <sup>th</sup> September 2023
Expected Result	$x = -2, x = -1, x = 1, x = 3$
Actual Result	

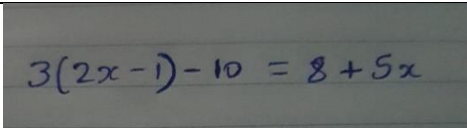
Test Case Result	Pass
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Test Case ID	12
Test Topic	Algebra (Quadratic Equations)
Test Description	Bad light equation
Test Case Input Method	Text - Image
Test Case Input	
Performed By	Sowjanya Bheemineni
Execution Date	30 <sup>th</sup> September 2023
Expected Result	$x = 1, x = 2$
Actual Result	
Test Case Result	Pass

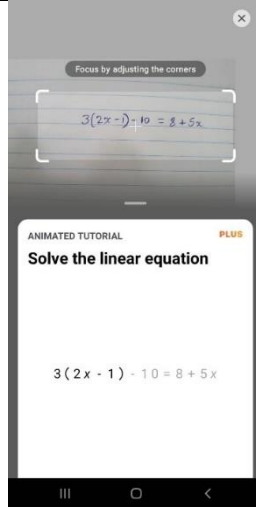
Test Case ID	13
Test Topic	Algebra (Quadratic Equations)
Test Description	Good light equation
Test Case Input Method	Text - Image
Test Case Input	
Performed By	Sowjanya Bheemineni
Execution Date	30 <sup>th</sup> September 2023
Expected Result	$x = 1, x = 2$
Actual Result	
Test Case Result	Pass

Test Case ID	14
Test Topic	Algebra (Quadratic Equations)
Test Description	Gallery Upload
Test Case Input Method	Text - Image
Test Case Input	 <p>The screenshot shows a mobile app interface. At the top, there's a navigation bar with a menu icon, a document icon, and a help icon. Below the navigation bar is a search bar with the text 'Photos, People, Places...'. Under the search bar, there are three cards, each showing a quadratic equation and its solutions. The first card shows the equation <math>0.5x^2 - 1.5x + 1 = 0</math> with solutions <math>x_1 = 1, x_2 = 2</math>. The second card shows the equation <math>0.5x^2 - 1.5x + 1 = 0</math> with solutions <math>x_1 = 1, x_2 = 2</math>. The third card shows the equation <math>0.5x^2 - 1.5x + 1 = 0</math> with solutions <math>x_1 = 1, x_2 = 2</math>. Below the cards, there is a section titled 'SOLVING STEPS' with the heading 'Solve the quadratic equation' and the equation <math>0.5x^2 - 1.5x + 1 = 0</math>.</p>
Performed By	Sowjanya Bheemineni
Execution Date	30 <sup>th</sup> September 2023
Expected Result	$x = 1, x = 2$
Actual Result	 <p>The screenshot shows the 'Solving Steps' section for the quadratic equation <math>0.5x^2 - 1.5x + 1 = 0</math>. It shows the equation and the steps to solve by factoring. The final solutions are <math>x_1 = 1, x_2 = 2</math>. There is a red button labeled 'Show Solving Steps' with a right arrow.</p>
Test Case Result	Pass

Test Case ID	15
Test Topic	Algebra (Linear Equations)
Test Description	Scanning equation in bright light condition scenario
Test Case Input Method	Text - Image
Test Case Input	
Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	$x = 21$
Actual Result	<div> <div>SOLVING STEPS</div> <div>Solve the equation</div> <div> <math display="block">3(2x - 1) - 10 = 8 + 5x</math> </div> <div> <div>↓</div> <div>Solve for x</div> </div> <div> <div></div> <div><math>x = 21</math></div> </div> </div>
Test Case Result	Pass

Test Case ID	16
Test Topic	Algebra (Linear Equations)
Test Description	Scanning equation in dark light condition scenario
Test Case Input Method	Text - Image
Test Case Input	

Performed By	Sohan Leburu
Execution Date	09/26/2023
Expected Result	$x = 21$
Actual Result	<div> <div>SOLVING STEPS</div> <div>Solve the equation</div> <div> <math display="block">3(2x - 1) - 10 = 8 + 5x</math> </div> <div> <div>Solve for x</div> <div><math>x = 21</math></div> </div> </div>
Test Case Result	Pass

Test Case ID	17
Test Topic	Algebra (Linear Equations)
Test Description	Gallery Upload
Test Case Input Method	Text - Image
Test Case Input	
Performed By	Sohan Leburu
Execution Date	09/26/2023

Expected Result	x = 21	
Actual Result		SOLVING STEPS <b>Solve the equation</b> $3(2x - 1) - 10 = 8 + 5x$ ↓ Solve for x <b>x = 21</b>
Test Case Result	Pass	

### 3.4.3 Test Result Analysis and Summary

#### 3.4.3.1 Test Coverage

For all the chosen Algebra based topics, we have the following summary for the Scenario Testing method.

#### 3.4.3.2 Test Results Summary

Photo Math	Algebra
Pass rate	17/17
Pass Percentage	100%

## 4. Conventional Testing Summary

### 4.1 Test Complexity

- For this project, there is one application that needs to be tested with minute details using the Algebra topic with the chapters limited to Polynomial Equations, Exponential and Logarithmic Functions, Quadratic Equations, and Linear Equations.
- Mathematics has a lot of Algebra topics including within it, so we have used different test cases using different kind of equations to do the testing of the application.



- We have used various testing methods developing several test cases covering maximum scenarios.

## 4.2 Test Cost

The following table depicts the time taken to implement each testing method.

Function	Cost
Discussion	180 min
Test Methods	120 min
Test Case	80 min
Test Data	40 min
Test Analysis and Summary	30 min

## 4.3 Test Summary

The following table depicts the result in percentage for each conventional testing method.

Test Method	Photo math
Boundary Value Testing	100%
Category Partition Testing	78.62%
Scenario Testing	100%

From the above table, it can be analyzed that

- In case of boundary value testing, Photo math app performed very well by not failing any test case even though there are complex algebra equations.
- Coming to Category Partition Testing, Photo Math app failed to perform as it performed in the case of boundary value testing. It failed to do the calculations for very complex equations, figurative questions, exponential coefficient questions, and a couple of other question types. Hence, it had lost its performance by more than 20%.

- Finally, in case of Scenario Testing, it performed very well by giving answers to questions in different scenarios. Although, it failed to detect the question at the first time, it then passed the other times for the same question under dark light conditions.

