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Utilizing MATLAB Computing Package as a Conceptual Tool for Solving Algebraic Problems

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Abstract
MATLAB is a high-level computer language and interactive environment used for numerical computation, technical data analysis, programming, simulation, and visualization. It allows matrix manipulations, function plotting, and solving various equations like quadratic, linear, and simultaneous equations. The paper explains how to solve algebraic problems in mathematics using MATLAB. The aim is to demonstrate that MATLAB is user-friendly, and suitable not only for higher institution students but also for secondary school students, making it easy to handle algebraic problems at the secondary school level. Inbuilt commands are used with simple syntax to manage algebraic processes effectively.

Keywords: MATLAB, Computing Package, Conceptual Tool, Algebraic Problems

Introduction

The rapid progress of society today, driven by the information age, relies heavily on advancements in math education. With the shift towards a knowledge-based economy, industries increasingly rely on software tools, making mathematical skills essential. This demand for math-savvy individuals has led to a growing need for educators with a strong grasp of technology. Mathematics education programs now prepare students for careers as technologists, technicians, and science teachers.

The use of software for teaching Mathematics is becoming more common worldwide, including in Nigeria. Software applications for mathematics teaching are constantly evolving, so educators need to adapt. According to Ahmet and Ahmet (2008), technology education aims to prepare individuals to keep pace with advancements in science and technology, benefiting from the latest innovations. Using software captivates students' attention, sparks their curiosity, and helps them grasp concepts better. When Mathematics teachers use software, they can illustrate ideas in a way that students can visualize in three dimensions. Additionally, since industries rely on computerized equipment for tasks like quality control, learning software skills can increase students' employability.

In secondary schools, improving mathematics education means embracing technology in the classroom. By integrating technology, we can create a better learning environment, spark students' interest, and foster motivation (Orji et al., 2021; Olelewe et al., 2021). The use of software packages has become a common practice in math education globally, including in Nigeria. To keep up with these changes, educators must be adaptable. Software applications not only capture students' attention but also help them grasp complex concepts. By visualizing mathematical principles in a three-dimensional format, software tools enhance understanding. Moreover, as industries increasingly rely on computerized systems, teaching with software gives students valuable skills for future employment.

MATLAB is one such interactive software that enriches the learning environment and boosts students' Mathematics skills. It offers various built-in tools for problem-solving and graphical illustrations, making it a valuable resource for teaching technology-related courses (Attaway, 2012). It's considered useful for teaching technology-related courses. Houcque (2005) described MATLAB as a powerful computer language and interactive environment used

for mathematics calculations, data analysis, programming, simulations, and making visual representations. The combination of MATLAB with MuPAD expands its capabilities, allowing for tasks like formula writing, equation solving, and plotting functions (Kazimovich et al., 2012).

Using MATLAB can alleviate some of the challenges students face in algebra. By creating virtual labs or workshops, we can provide hands-on learning experiences that enhance understanding (Ogbuanya et al., 2021). As MATLAB continues to advance in mathematics, it's crucial to explore its potential for teaching and learning algebra.

Aim and Objectives of the Study

The study aims to demonstrate ways of applying MATLAB software in teaching algebra. Specifically, the study intends to:

1. Identify the steps involved in the expansion.
2. Demonstrate how to factorize using the MATLAB computing package.
3. Show the steps for solving quadratic equations and simultaneous equations

MATLAB as a software computing package

MATLAB is a computer program created and managed by MathWorks, Inc. in Massachusetts. It's mainly used in engineering, science, technology, and education (Attaway, 2012). You can use MATLAB on different types of computers like MS Windows, Macintosh, UNIX, and open VMS systems. With MATLAB, you can handle variables, import and export data, do calculations, make plots, and manage files.

In the 1970s, Cleve Muller developed MATLAB for tasks involving matrices, linear equations, and numerical analysis. Over the years, MATLAB has been tested and improved, gaining more features and capabilities (Juraev, 2023). It comes with built-in tools called toolboxes, which can perform specialized tasks like image and signal processing, financial analysis, and control system design. Although you can buy these toolboxes separately, you need the main MATLAB program to use them.

MATLAB is user-friendly, allowing you to combine computation, visualization, and programming in a simple environment using familiar Mathematics symbols. It's important to note that MATLAB is case-sensitive. Overall, MATLAB is widely used for various purposes, including:

1. Mathematics and Computing
2. Creating Algorithms
3. Building Models, Simulating, and Prototyping
4. Analyzing Data, Exploring, and Visualizing
5. Making Scientific and Engineering Graphs
6. Developing Applications, Building Graphical User Interfaces

MATLAB WINDOWS

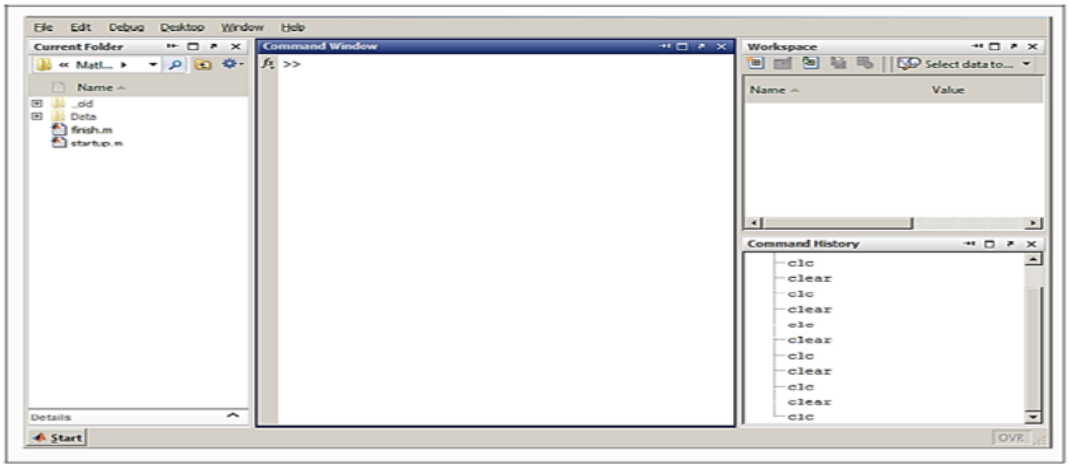

Fig 1: MATLAB window

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MATLAB uses several windows; the default view is shown in Fig1 above: To start the program, you select or double-click the MATLAB icon on the desktop, and the default MATLAB desktop window will then open on your screen. As shown in the fig1, the screen is divided into four main elements namely:

1. **Command window:** this is the most central, largest and main part of the MATLAB window where you type directly your commands that control MATLAB including computational statements and statements that execute built-in functions and functions developed by the students. in the command window, we have two greater-than signs with a cursor blinking in front of it, which indicates MATLAB is ready for use.
2. **Command History:** this is located at the right side of the command window below the workspace and lists all variables, numbers and statements you enter in the command window. You can drag commands from this window to the command window or copy and paste them. You can clear the command history by right-clicking in the window and choosing the desired item from the menu.
3. **Workspace browser**: this window shows you the variables which have been defined. You can use the MATLAB command "clear" to remove variables you don't need from the workspace, or you can select and delete right on the workspace browser window. One of the uses of the browser is to check that the array you have defined has the right dimensions.
4. **Current Directory window:** this window is located at the left side of the command window and displays all the MATLAB files that are saved in the current directory.

Various Algebraic Expressions

Algebra is a part of math that uses symbols to represent operations, and letters to stand for numbers and quantities. In algebra, we use letters to represent numbers, which we call variables. These variables, along with real numbers, make up algebraic expressions like 4x, 3x + 2, 2x^2 + 3x + 4, and more. An algebraic expression involves letters (variables) and real numbers (constants), combined using addition, subtraction, multiplication, division, and exponentiation. Each part of the expression, separated by addition, is called a term. For example, in the expression 3x^2 + 4x + 7, there are three terms: 3x^2, 4x, and 7. Terms with variables, like 3x^2 and 4x, are called variable terms, while numbers like 7 are constant terms. The number before a variable term is called its coefficient; for example, in the term x, the coefficient is 1. Algebra, taught in high schools, involves solving equations and graphing different types of equations. Although these equations are related, they can be solved in different ways. This study focuses on specific aspects of algebra.

1. **Substitution:** in algebra, we know that letters in algebraic expressions stand for numbers sometimes it is desirable to find the values of this expression by putting or substituting the letters with numbers.
2. **Expansion:** algebraic expression may be expanded or factorized by the basic rules of arithmetic. It is sometimes necessary to introduce or remove brackets when simplifying algebraic expressions. This is usually done when expanding or factorizing algebraic expression, expansion is a process of removing all brackets that are presented in an expression when simplifying the expression. For instance, c (a + b) = ac + bc. ac + bc is the expansion of c (a + b). Therefore, expansion removes the brackets.
3. **Factorization:** to factorize an algebraic expression means to write the expression as the producer of its factors which usually involves the introduction of brackets. We can say that factorization is the opposite of expansion and vice versa. For instance, the expression ac + bc has c as a common factor so bringing the common factor out, we need to introduce a bracket. Thus ac + bc = (a+b), therefore expansion can be a reverse operation of factorization.
4. **Linear Equation**: the linear equation is the kind of equation that takes the form ax + b = o where **a** and **b** are constants and **x** is the unknown variable with a power of one. Since the highest power of the expression of **x** is one that means there will be only one value of unknown **x** that satisfies the equation. Examples of linear equations are 3x + 5, 4x + 6 etc.
5. **Quadratic Equation**: an equation of the general form $ax^2 + bx + c = 0$ where **a, b**, and **c** are constants such that **a** is not equal to zero is called a quadratic equation in the unknown variable x with two as the highest power of the unknown. Since the highest power is two, it implies that there will be two values of **x** that satisfy the equation. These values are sometimes called the roots of the equation. Quadratic equations can be solved by the following methods namely; Factorization Method, Completing the Square, Use of Formulae Graph Method.
6. **Simultaneous Equation:** Simultaneous equations occur when two or more equations with two or more unknown variables are solved together, resulting in values that satisfy all the equations. When the equation involved is two linear equations, they are called simultaneous linear equations. For example ax + by =, dx +

ey = f where a, b, c, d, e and f are constants and x and y are unknown variables that are simultaneous linear equations in x and y. They are so because the two equations are linear in **x** and **y**. The simultaneous equation can be solved by two methods namely: substitution and elimination.

MATLAB Symbolic Expression

The 'sym' function in MATLAB helps create symbolic objects. If you give it a string, it makes a symbol that stands for a number or a variable. For example, typing 'x = sym('x')' makes a variable named x, and 'y = sym('y')' makes one called y. Another function, 'syms', lets you do multiple things at once. If you type 'syms x', it's like saying 'x = sym('x')', and 'sym xyz' creates symbols for x, y, and z. When you type 'syms' without anything else, it shows all the symbols you have. But if you need to make constant symbols, it's better to use 'sym'. These symbolic variables can be used in math expressions and as inputs for functions. You can use math symbols like +, -, *, /, ^, and built-in functions just like with regular numbers. For example, if you type these commands in order:

a. Syms x y
b. s = x + y;
c. r = sqrt(x^2+y^2)

Creates the symbolic variable s and r. The terms s = x + y and r = sqrt (x^2+y^2) are examples of symbolic expression.

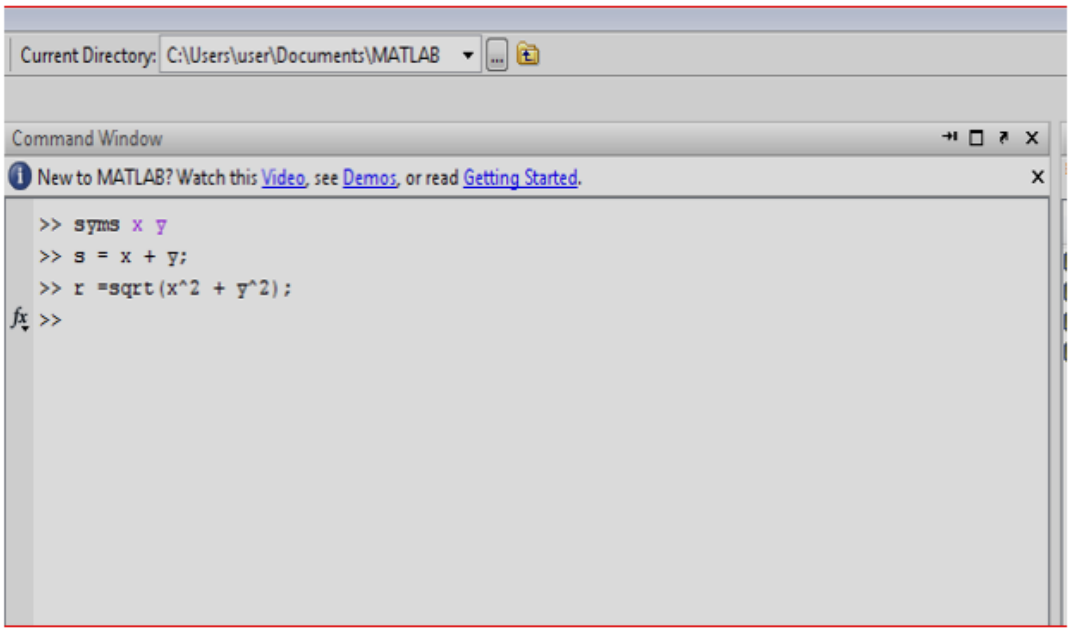

Fig 2: Symbolic expression of variable using MATLAB

Algebraic Expressions and MATLAB Application

The following functions can be used to manipulate algebraic expression by collecting coefficients of like terms, expanding power and factorizing expression. The table below shows the MATLAB commands for manipulating algebraic expression in mathematics and symbolic expression in MATLAB.

Table 1: MATLAB algebraic commands

Commands	Descriptions
Collect (E)	Collects coefficient of like powers in the expression
Expand (E)	Expands the expression E by carrying out power
Factor (E)	Factors the expression E
pretty (E)	Display the expression E in the screen in a form that resembles type set mathematics
Simplify (E)	Simplifies the expression E using Maple's simplification rule
Subs (E, old, new)	Substitutes new for old the expression E. where old can be a symbolic variable or expression, new can be a symbol variable, expression or number or matrix or numeric value or matrix

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Use of the commands in MATLAB command windows

The function collect (E) is one of the MATLAB algebraic commands used for collecting the coefficient of like powers in the expression E. If there is more than one variable, you can use the optional form collect (E, y), which collects the coefficients with the power of y. This is shown in the command window below: typing in the following order for the expression $(x-5)^2 + (y-3)^2$ collects the value of x by expanding it

a. syms x y
b. E = (x-5) ^2+(y-3) ^2;
c. collect (E)

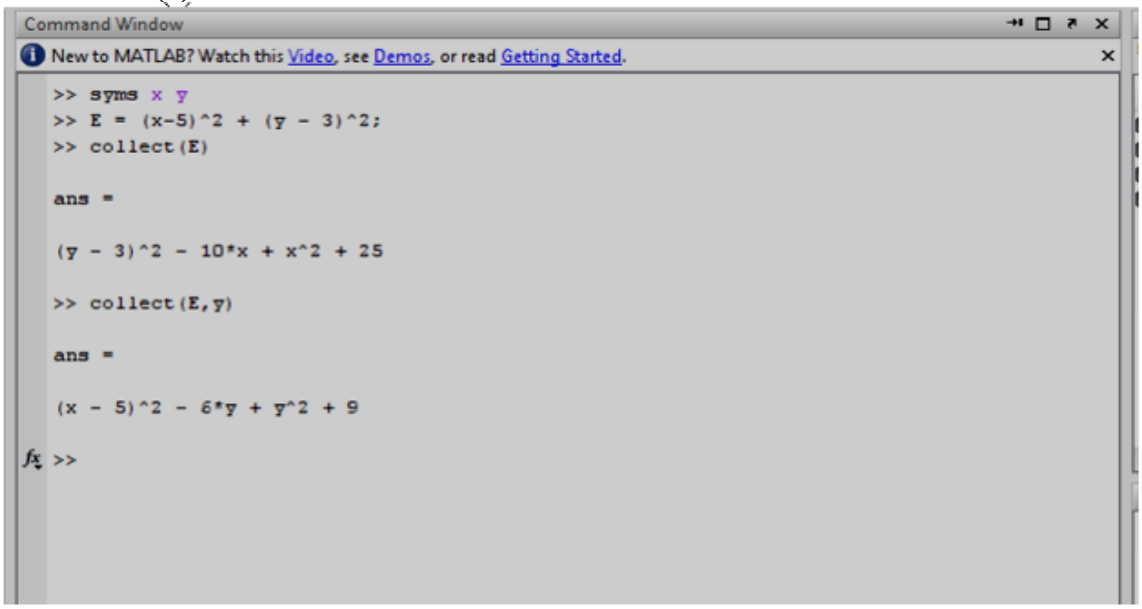

Fig 3: illustration of collect command in MATLAB command window

NB: *the semi-colon is used to suppress expression from echoing out in the command window*.

Expansion command

This command is denoted by expand (E) and it is used for expanding the expression E by carrying out powers where the expression is an algebraic expression. For instance, if you want to expand $(x + y)^2$ using MATLAB. You can achieve this by taking the following steps:

a. Declare the variables x and y using a symbolic tool box. type syms x y in the command window
b. assign the expression to the variable of your choice for instance k = (x + y) ^2
c. Enclose the variable in the expand command that is Expand (k)

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Fig 4: illustration of expand command in MATLAB command window

Pretty command

The pretty command displays MATLAB expression in resemblance to mathematics format. This is done by enclosing the expression in pretty command. For instance, a student can type *pretty* of the above answers to give us a resemblance of mathematics format as shown below:

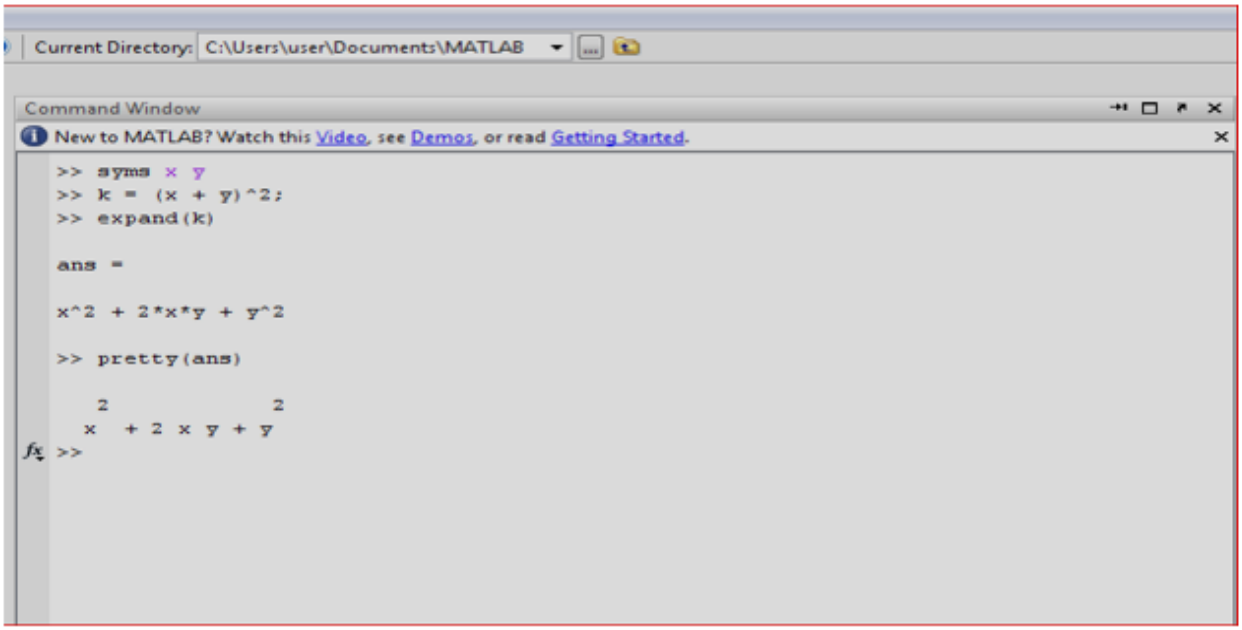

Fig 5: illustration of pretty command in MATLAB command window

Factor command

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The factor command is used for factorizing any given algebraic expression. It is denoted by factor (E). The command factors the expression E. For instance to factorize x^2 -1 using MATLAB can be achieved by students taking the following steps:

a. declare your variable by typing syms x y in front of the two greater-than signs
b. Enclose the expression in the factor command for instance factor (x^2-1)

Fig 6: illustration of factor command in MATLAB command window

Simplify command

The simplify command simplifies algebraic expressions using maple simplification rules. It is denoted by simplify (E). E can take any algebraic expression. For example, to simplify $\sqrt{x^8 + y^2}$ students can equally take these steps:

a. declare the variables that is, syms x, y
b. Enclose the expression in the simplify command. for instance (x*sqrt (x^8*y^2))

Fig 7: illustration of simplify command in MATLAB command window

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Solve command

The Symbolic Math Toolbox in MATLAB can solve both algebraic and transcendental equations, including systems of such equations. The function "solve(E)" handles symbolic expressions of equations represented by the expression E. If E represents an equation, it must be enclosed in single quotes. If E represents an expression, the solution obtained will be the root of the expression E, meaning the solution of the equation E=0. Multiple expressions or equations can be solved by separating them with commas, like "solve(E1, E2, ..., En)". It's important to note that you don't need to declare symbolic variables with the "syms" function before using "solve". The "solve" command works for linear, quadratic, and simultaneous equations. For example, to solve the following equations using MATLAB:

1. $x + 5 = 0$
2. $y^2 + 3y + 2 = 0$
3. $6x + 2y = 14$
   $3x + 7y = 31$

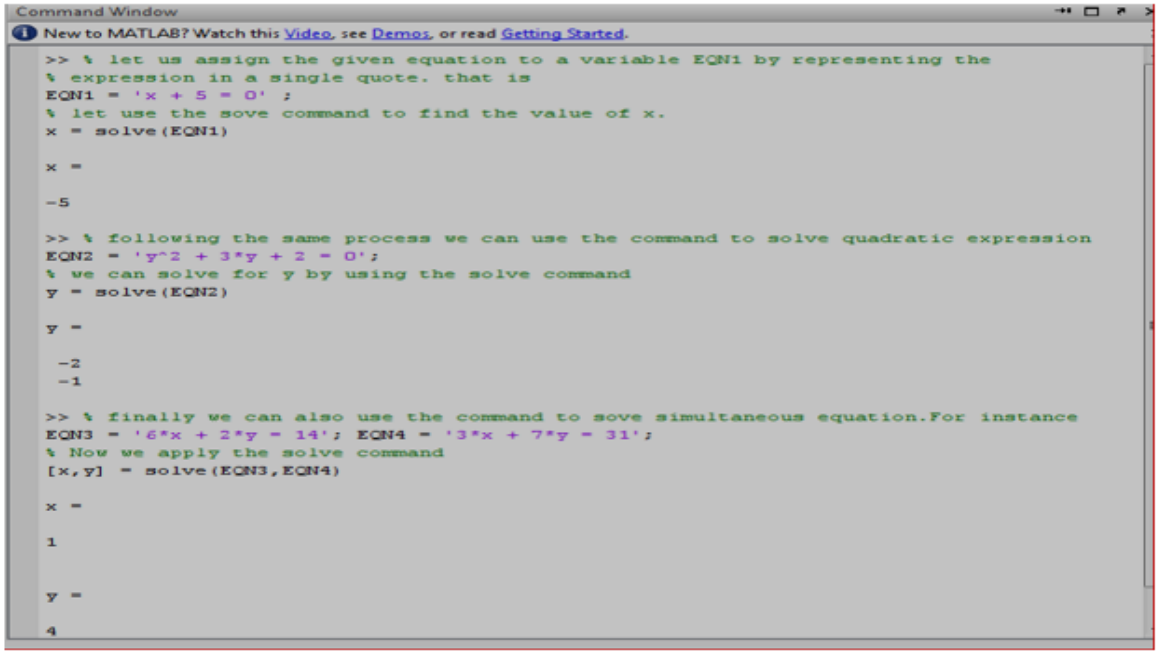

Fig 8: illustration of solve command in MATLAB command window

Conclusion

Using MATLAB software can make students more engaged in classroom learning and improve their performance. It can be used to teach various topics like vectors, matrices, and algebra, making it easy and quick to solve algebraic problems. MATLAB is powerful for solving quadratic, linear, and simultaneous equations, as well as for factorization and expansion. It helps secondary school students understand algebra better, especially where there are challenges. To use MATLAB effectively, active learning strategies are needed to help students learn algebra better. MATLAB allows students to focus on mathematical ideas and problem-solving in a way that's easier and more efficient. Studies have shown that using MATLAB can improve students' skills in solving algebra problems and motivate them to learn. Additionally, MATLAB helps show connections between different algebraic processes during teaching and learning.

Suggestions

1. Teachers of mathematics should use MATLAB software to teach hard Algebra topics and help students do better.
2. The government should give schools the tools they need to teach algebra better.
3. Mathematics teachers should learn how to use MATLAB.
4. Math teachers should regularly use MATLAB to teach algebra

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