Effects of Using MATLAB in Improving Students' Skills in Mathematics

Naser M.A.M. Alkandari and Meshael Khaled Abushiebah
The public authority for applied education and training
High institute of energy-Kuwait

Abstract

This paper aims to investigate and measure the effects of using MATLAB in mathematics teaching system at high applied education and training institutes. The aim of the paper is to compare the saving in time between traditional (hand solving) and solving the same math problem using MATLAB and also compare the accuracy and precision of the final solution. It was found that that MATLAB software can be effective for improving performance in mathematics. The results showed that using MATLAB in solving mathematic problems can save about 50-70% of the time taken by manual solutions. Also, it was found that the degree of confidence in getting the final solution using Matlab is ranging from 95-100% for a 10 average students under test, while it was 65-80% for the same group using manual methods of math problems solutions.

Keywords: MATLAB, mathematical operations, performance, skills, math teaching system.

Introduction

Traditional mathematics lectures typically provide theoretical content, perhaps with examples from real-world situations. Typically, the instructor writes the essential details on the board. But in the modern world, technology is a necessary instrument for performing mathematical operations. The majority of introductory mathematics classrooms now include technology-based math instruction. It may be applied in several ways to strengthen and advance mathematical learning. Students of engineering mathematics in particular must have access to suitable computer technology since engineering programs are becoming more and more sophisticated [1], [2].

One of the most well-liked applications that is frequently utilized in math classes, particularly at the collegiate level, is MATLAB. It's important to research and evaluate the software's potential applications in mathematics instruction as more and more colleges embrace its use in the classroom [3], [4].

An environment for multi-paradigm numerical computation is called MATLAB (matrix laboratory). Developed by Math-Works, MATLAB is a proprietary programming language that facilitates various tasks like as manipulating matrices, visualizing functions and data, implementing algorithms, creating user interfaces, and integrating with programs written in other languages including C, C++, C#, Java, Fluent, and Python. A software suite for mathematics and graphics is called MATLAB. It is capable of programming, graphics, and numbers. Numerous operations may be performed using its built-in functions, and other toolboxes can be added to enhance these capabilities (e.g., for signal processing). Professional and student editions are available, as well as versions for several hardware platforms [5].

While the main purpose of MATLAB is numerical computing, symbolic computing capabilities may also be accessed through an optional toolbox that utilizes the Mu-PAD symbolic engine. Simulink is an extra program that offers model-based design for dynamic and embedded systems as well as graphical multi-domain simulation. Currently, MATLAB has about a million users in both academia and business. These users have a variety of engineering, scientific, and economics backgrounds [6].

Numerous studies addressed this topic; Majid et al. (2013) detailed the benefits of MATLAB as a teaching and learning tool for students studying engineering mathematics. A addition to the conventional classroom teaching and learning approach is the integration of MATLAB. The study's sample consists of first-year Integral Calculus students from the University of Ha'il in Saudi Arabia. Students sent in their work in groups after using the program in small groups. The study's goals were to evaluate how using the program affected students' attitudes and motivation toward using technology to teach and learn engineering mathematics, as well as how that impact affected learning. The study's qualitative and quantitative data sets demonstrated that the software had benefited the pupils. Despite the pupils' limited mathematical proficiency, it was discovered that using the program had improved their conceptual knowledge. Positive attitudes and increased performance in the course have been observed in the pupils [2].

In Wolkite University, Gemechu et al. (2021) carried out a quasi-experiment study to look into how students were motivated to learn Applied Mathematics II and how MATLAB software aided learning. Various methods of instruction: For this reason, the MATLAB assisted collaborative approach and the MATLAB supported traditional lecture technique were developed. Using a straightforward random sampling method, two intact classes-Mechanical engineering groups 1 and 2-were chosen, and each underwent a distinct intervention. At first, there were 30 and 29 pupils participating, respectively. Likert scale items pertaining to pre- and post-motivation were created and given to the participants before to and following therapy, respectively. The study's findings demonstrated that there is no appreciable mean difference between the two groups' students' motivation for learning mathematics. Aside from intrinsic and extrinsic motivation, which needs more investigation, there is no discernible mean difference between the other components of motivation. Several factors were cited as the reason for the non-significant difference, including little experience and low ambition to study mathematics. It should be mentioned that the capacity to control technical software and access is also a key component [7].

The goal of the study by Obradovic et al. (2021), was to explain how educational technologies might be used to encourage interactivity and help learners and students grasp mathematics. It was discovered that students might obtain a fundamental understanding of Matlab's capabilities after using it. Matlab offers "countless" options, such as the autonomous construction of functions, great graphic solutions, simulations, etc., in contrast to many free online math applications that are mostly restricted to the basic needs of pupils. In summary, students may focus on thinking about mathematical concepts and finding easier and more effective ways to solve problems when they use Matlab. It broadens the range of issues that may be explored and enhances the learning of mathematics by giving students the opportunity to investigate and make discoveries. It cannot, however, totally take the place of the conventional portion of the instructional process. It need mathematical knowledge and the ability to recognize difficulties from foundational courses like Mathematics 1 and Mathematics 2 to solve problems. Next is the update using Matlab and

related altos. Matlab heavily relies on programming language training in addition to studies on fundamental mathematics. Compared to students' preferred free math tools, understanding the syntax of Matlab is significantly simpler after mastering a language [8]. The findings of several research on the use of computers in mathematics education were presented by Ulfa et al. in 2021. The research methodology employed is descriptive. The many kinds of software that are utilized and how they affect learning mathematics are the factors that are observed. The study's findings support the notion that using computers in the classroom might improve students' comprehension and visualization of mathematical concepts [9].
The use of MATLAB as a technology tool for mathematics instruction and learning in schools was discussed by Ogan and Ibibo (2015). MATLAB was used to show the application of this program in the teaching of several challenging topics, including vectors and matrices, the distance between two points on a coordinate plane, sine graphs, 3D bars, and simultaneous and quadratic equations. A few suggestions on the use of MATLAB to improve the teaching process were offered [10].

Methodology

The method followed in this study is depending on comparing the time required to get the final solution of the math problem, precision and accuracy or (Degree of confidence of the solution- taken for average student) required to solve five of case studies using manual solution and MATLAB software.
The case-studies taken here are
- Solving a system of linear equations
-Finding the inverse of matrix of order > 3
-Multiplication of two matrices
-Solving Differential Equation
-Drawing some given complex function

Results and Discussion

Case-study #1: Solving a system of linear equations –Figure 1.

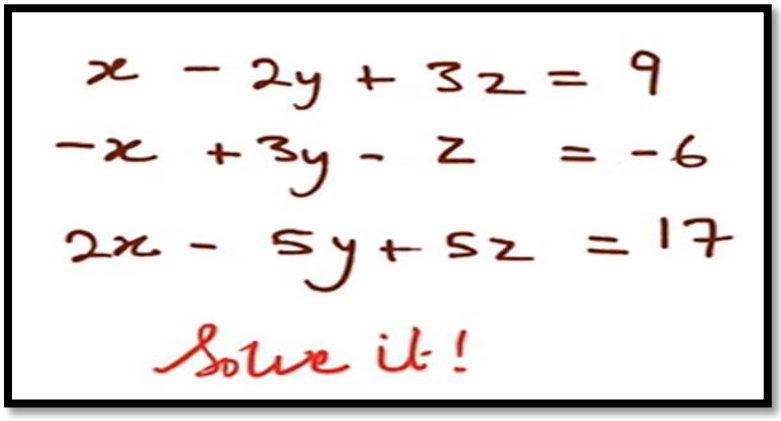

Figure 1. Linear Algebraic Equations

Using MATLAB-Figure 2

```
>> A = [1,1,1;6,4,5;5,2,2]

A =

     1     1     1
     6     4     5
     5     2     2

>> b = [2;31;13]

b =

     2
    31
    13

>> x = inv(A) * b

x =

    3.0000
  -18.0000
   17.0000

>>
```

Figure 2. Solving the linear Algebraic equations using MATLAB

The time needed for manual solution of the system by average student is 15 minutes while using Matlab it is about 6 minutes for beginners.

Case-study #2-Finding the inverse of matrix of order >= 3-Figure 3.

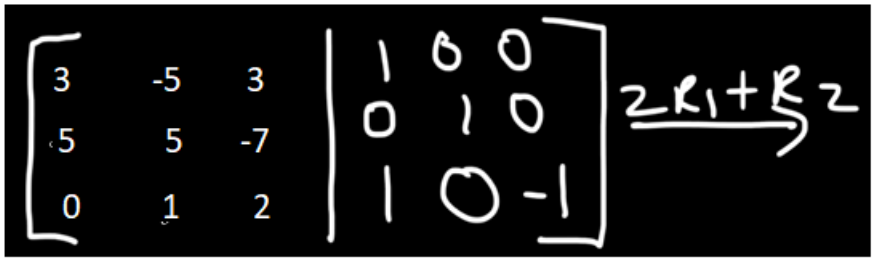

Figure 3. Finding the inverse of matrix of order manually

```
>> A

A =

     3    -5     3
     5     5    -7
     0     1     2

>> inv(A)

ans =

    0.1466    0.1121    0.1724
   -0.0862    0.0517    0.3103
    0.0431   -0.0259    0.3448
```

Figure 4. Finding the inverse of matrix of order via MATLAB

Case-study #3-Multiplication of two matrices

```
EDU>> x = [ 15 18 2; -2 1 0; 3 -2 4]

x =

    15    18     2
    -2     1     0
     3    -2     4

EDU>> y = [ 4 -5 2; 18 12 19]

y =

     4    -5     2
    18    12    19

EDU>> y * x

ans =

    76    63    16
   303   298   112
```

Figure 5. Multiplication of two matrices using MATLAB

Case-study #4-Solving Differential Equation

$$\frac{dy}{dt} = -5y + 20$$

```
syms y(t)
eqn1=diff(y,t)==-5*y+20;
cond1=y(0)==1;
S2=dsolve(eqn1,cond1)
fplot(S2,[0 2])
xlabel('t');
ylabel('y');
```

2nd-order ODE with initial condtion

$$x'' + 5x' + 4x = 1$$

```
syms x(t)
Dx=diff(x);
eqn2=diff(x,t,2)+5*diff(x,t,1)+4*x==1;
cond1=x(0)==0;
cond2=Dx(0)==0;
cond3=[cond1, cond2];
S3=dsolve(eqn2,cond3)
fplot(S3,[0, 2])
```

S3 =

$$\frac{e^{-4t}}{12} - \frac{e^{-t}}{3} + \frac{1}{4}$$

Figure 6. Solving Differential Equation using MATLAB

Case-study #5-Drawing some given complex function

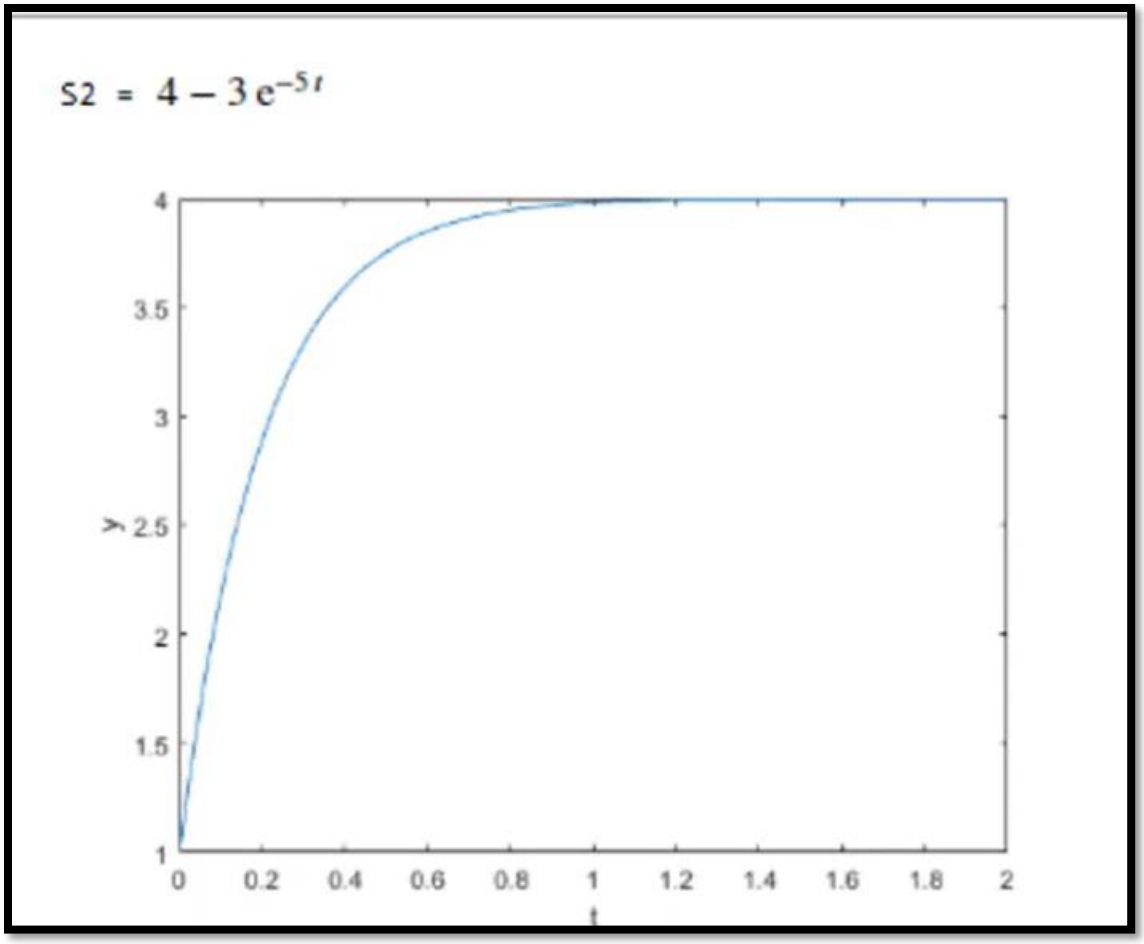

Figure 7. Drawing some given complex function using MATLAB

Table 1 shows a comparison in time for executing the last mathematical operations using manual solution and MATLAB for 10 of average students.

Table 1. Comparison of time for executing the last mathematical operations using manual solution and MATLAB for 10 of average students

Task	Time taken by Manual method (Min)	Time taken by MATLAB (Min)	Degree of confidence of the solution (out of 100%)/Manual	Degree of confidence of the solution (out of 100%)/MATLAB
Solving a system of linear equations	15	6	75%	100%
Finding the inverse of matrix of order >= 3	20	3	65%	95%
Multiplication of two matrices	10	3	80%	100%

Solving Differential Equation	20	6	65%	95%
Drawing some given complex function	8	4	70%	100%

Figure 8 shows the comparison in time for executing the last mathematical operations using manual solution and MATLAB for 10 of average students

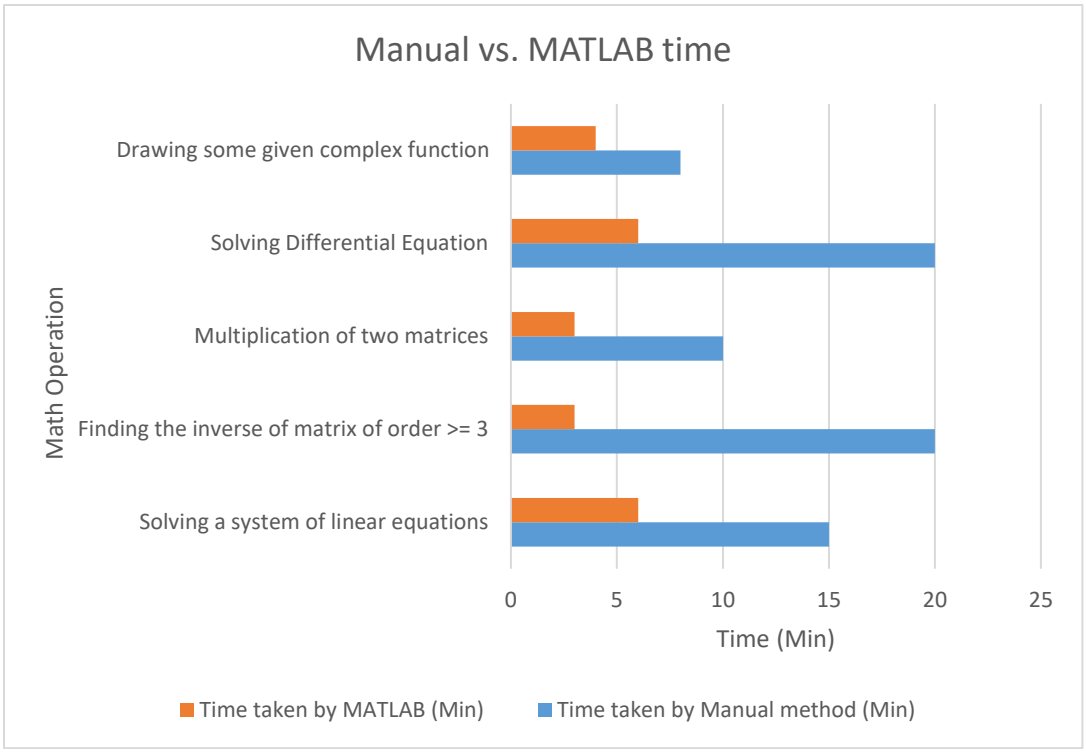

Figure 8. Comparison in time for executing the last mathematical operations using manual solution and MATLAB for 10 of average students

Figure 9 shows the comparison in the degree of final solution confidence for executing the last mathematical operations using manual solution and MATLAB for 10 of average students.

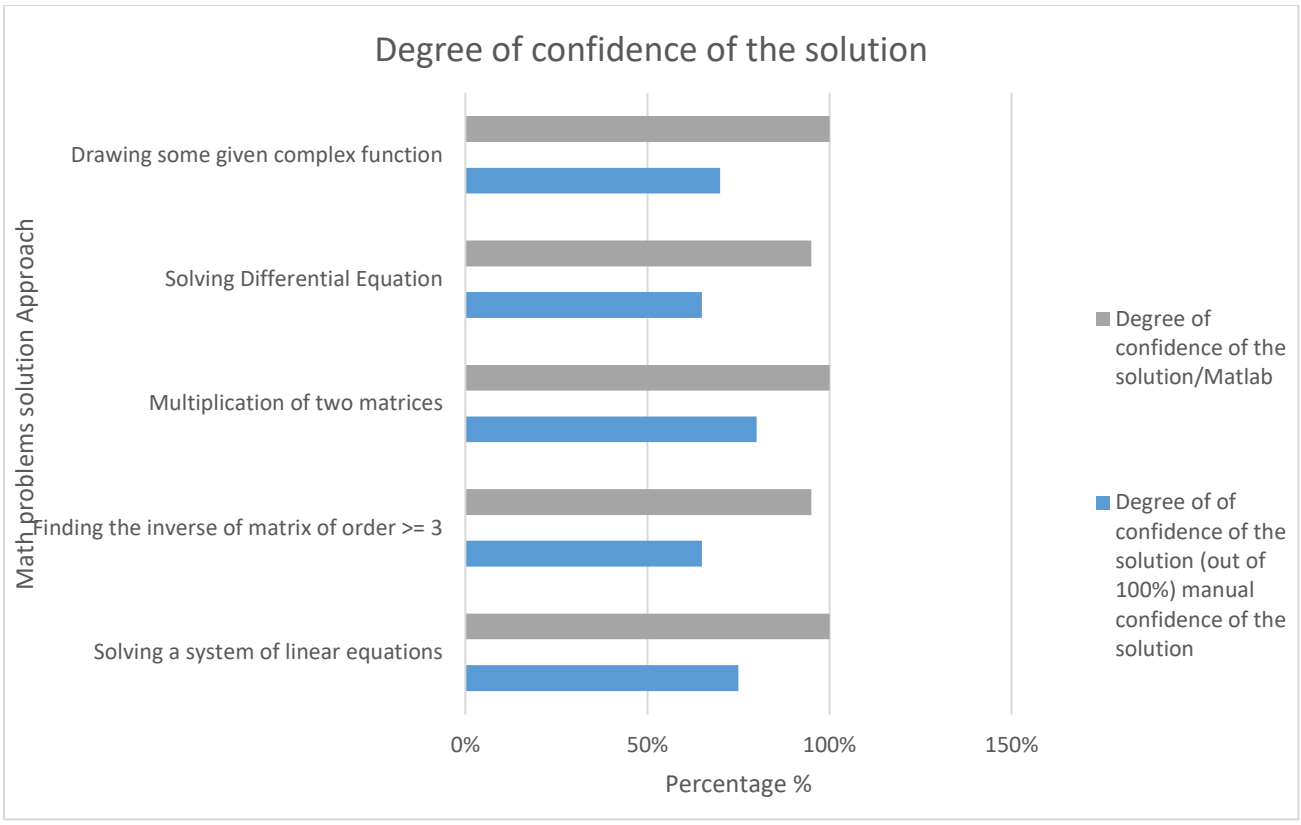

Figure 9. Comparison in the degree of final solution confidence for executing five mathematical operations using manual solution and MATLAB for 10 of average students.

Conclusions

MATLAB software usage is intended to improve the understanding of these difficult topics among the senior secondary school students. The experience of using MATLAB to support the teaching and learning of mathematics topics may have a strong impact on the learning strategies of students. It is therefore possible that with good course design, students and teachers can have some degree of control over what topics, that MATLAB software can be effective for improving performance in mathematics. The results showed that using MATLAB in solving mathematic problems can save about 50-70% of the time taken by manual solutions. The degree of confidence in getting the final solution using Matlab is ranging from 95-100% for a 10 average students under test, while it was 65-80% for the same group.

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