*THINK INDIA JOURNAL*

ISSN:0971-1260

Vol-22-Issue-39-December-2019

# Impact of Digitalization on Mathematics Education

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**ABSTRACT**
*Digitization, less commonly digitalization is the process of converting information in to a digital format, in which the information is organized in to bits, which is represented by an object, image, sound, document or signal by generating a series of numbers that describe a set of points or samples. Impact of digitalization can be seen on Business, Society and Education, especially on Mathematics education. Mathematics education is very important for the society of all ages. Mathematics helps in improving the power of reasoning, creativity, abstract or spatial thinking, critical thinking, problem solving ability and even effective communication skills. Digitalization in education refers to the use of desktop, computers, mobile devices, the internet, software applications and other types of digital technology to teach students of all ages. Mathematical software helps a lot in teaching & learning mathematics. The main idea of this paper is to give introduction of mathematical software its advantages and disadvantages in learning & teaching mathematics. Teachers play very important role to guide the students to make the effective use of available mathematical tool. We also look at some of the reasons due to which Development of mathematical digital technologies help in effective classroom teaching and increase the interest of students towards mathematics.*

## 1. INTRODUCTION

Einstein famously said that "his pencil was more intelligent than he was- meaning, that he could far achieve far more using his pencil as an aid to thinking that he could unaided". There is a need to recognise that mathematical digital technologies are the 'Pencils of today' and that we will fully exploit the benefits of digital technologies in teaching, learning and doing mathematics when it becomes unthinkable for a student to solve a complex mathematical problem without ready access to digital technological tools. Mathematics is a very important tool for improving the memories, mental ability and critical thinking. It was hundred years ago, students are forced to memorise a lot of formulae, rules and theorems in order to solve math problems. But today they can solve the problems using mathematical digital technologies. Digital technologies are a combination of hardware & software to perform a wide range of tasks. Digital technologies have changed the traditional methods of solving mathematical problems. The invention of the calculator was the first step towards digitalization which has had a profound impact on the mathematics education. In the ninth century China developed the first compact calculator called as 'Abacus'. Mr. Blaise Pascal (French mathematician, 1623-1662) invented the first adding machine in 1642. The first solid state electronic calculator was created in the early 1960s. Pocket sized devices became available in the 1970s. After that many more tools and mathematical software were developed by mathematicians to make higher level mathematical activities accessible to students and helps to present content numerically, graphically as well as symbolically.

## 2. OBJECTIVES

- To study the different types of mathematical software available.
- To study the role of mathematical software in computation & solving complex problems.
- To study the impact of digitalization on mathematics education.

## 3. RESEARCH METHODOLOGY

This paper is based on secondary data collected from various sources like Journals, articles, papers, books, website & personal experience.

ISSN:0971-1260

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## 4. REVIEW OF LITERATURE

**Valey F. Ochkov & Elen P. Bogomolora, Moscow, Russia –** states that the advanced mathematical computer programmes allow using a fresh approach to the teaching of mathematics in schools and universities taking in to the attraction of pupils and students to computers. By mean of graphics and animation one can significantly increase the understanding the basic concepts and theorem of mathematics for pupils and students. Modern information & technology can transform and change the traditional solutions of mathematical problems.

**William Stein-** He has written a paper 'Mathematical Software & Me: A Very Personal Recollection' in which he shared his personal experience of learning mathematical software and its applications. He states that if you want to understand the functions and their properties then you should use the mathematical software, it helps you to visualise and understand it in better way. Use of software should include in curriculum at school level.

**Rayon Palo- -** states that software are computer tools which are very easy to understand and useful for both applied and pure mathematics courses.

**The following is the list of open source software for mathematics.**

| Software | Year of Released | Use |
|---|---|---|
| **Computer Algebra Systems** | | |
| Axioms | 2001 | General Purpose CAS |
| Maxima | 1998 | Symbolic Operations |
| Gap | 1986 | Group Theory, Discrete math |
| Cadabra | 2001 | Classical Field theory, Quantum field theory |
| CoCoA | 1995 | Polynomial calculations |
| Xcas | 2000 | Calculus operators & draw graphs |
| PARI/GP | 1985 | Group theory |
| Sympy | 2007 | Calculus, Algebra, DM, Quantum Physics |
| **Numerical Analysis** | | |
| Modelica | 1997 | Numerical computations |
| Octave | 1993 | Numerical computations |
| Scilab | 1994 | Signal Processing, Image enhancement |
| Fremat | 2013 | Programming Language |
| SciPy | 2001 | Scientific Computing |
| Gnuplot | 1986 | Plotting software |
| **Statistics** | | |
| SPSS | 1968 | Statistical Analysis |
| R | 1993 | Statistical problems |
| Demetra+ | 2019 | Statistical problems |
| **Multipurpose Mathematics Software** | | |
| SageMath | 2005 | Algebra & geometry experimentation |

### COMPUTER ALGEBRA SYSTEMS

A computer algebra system is a type of software set that is used in manipulation of mathematical formulae and has the ability to deal with equations symbolically. CAS began to appear in the early 1970s and evolved out of research in to artificial intelligence.

### LATEX

In mathematics, writing an equation, formulae, expression or typesetting is a challenging task. Suppose we want to type the following formula in Microsoft word

ISSN:0971-1260

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$$(x-1)! = \int_0^{\infty} \exp(-s)\, s^{x-1}\, dt$$

Then you have to go to word file → Insert → Symbol → Equation Tools & search for factorial, integral and power operators etc. Searching notation & operators take time so the above task can be done easily by using LATEX software, using the following LATEX

**$$ (x-1)! = \int _\theta^ \infty \exp(-s)\c dot s^{x-1)}\textrm{d}s $$**

LATEX is a very good tool for mathematical typesetting and communication and filled with beautiful formulas. LATEX is also useful in writing a reference book or a history book. Writing in other software needs formatting but LATEX provide a professional looking notes but it takes some time to learn.

**MATLAB**

MATLAB stands for Matrix Laboratory is a high-performance language used for technical computation of engineering mathematical problems. MATLAB gives instant graph of a function and contains other mathematical tools. MATLAB is very easy to use.

Example: The Following value of expression is difficult to compute by using scientific calculator but very simple to solve by MATLAB

$y = e^{-r}\sin(p) + 10\sqrt{q}$ **for** $r = 5, p = 2$ **and** $q = 8$

By using MATLAB

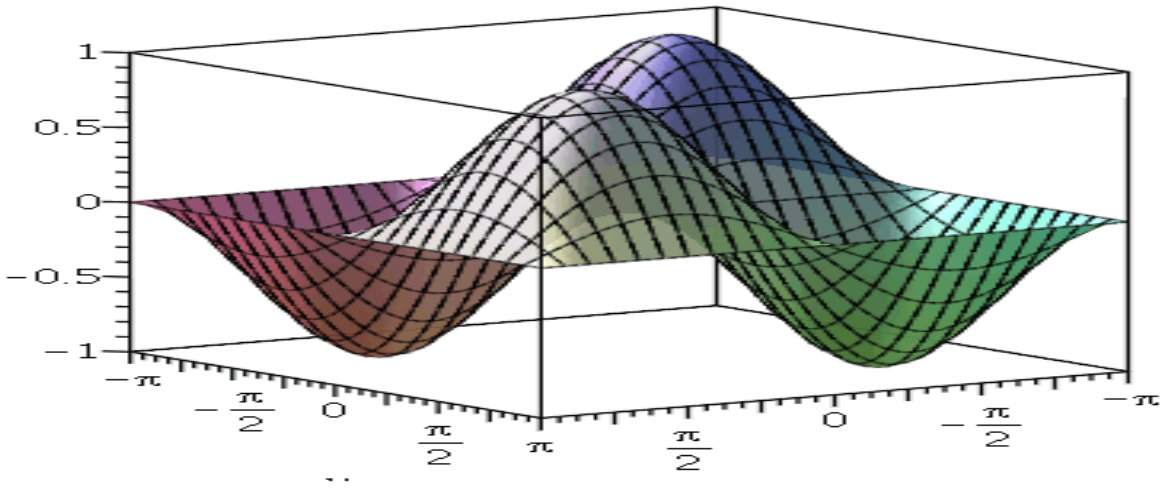
```
>> r = 5; p = 2; q = 8;
>> y = exp(-r) * sin(p) + 10 sqrt(q)
```

Which gives immediate the value $y = 28.290$ .

**MAPLE**

Maple is a mathematical software, very useful for graph plotting in 3-D. The following command generate a 3-D plot of the function $\sin(x)\sin(y)$ over $x$ and $y$ range of $-\pi$ to $\pi$

```
> plot 3d(sin(x) * sin(y), x = Pi..Pi,  y = -Pi..Pi, 'transparency' = 0.2);
```




```
> plot 3d (y,x = -Pi. .Pi, y = 0. .2 * Pi, 'coords' =' cylindrical');
```

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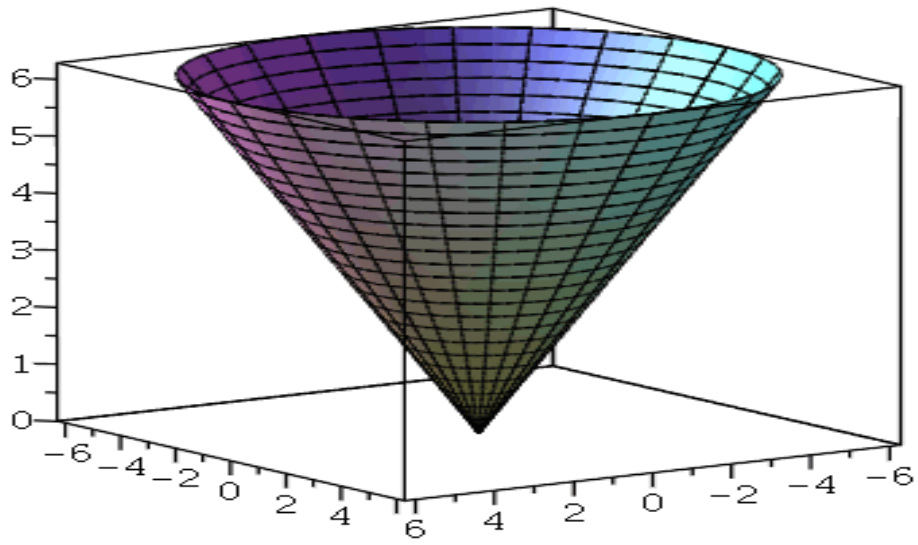


With the help of above 3-D graphs students can better understand the geometry of shapes and their concepts.

**GEOGEBRA**
GEOGEBRA is again powerful mathematical software helps to understand the graph of functions and create variables to change the transformation of a particular function.

**SPSS**
Earlier data analysis was a very challenging part for students, teachers and researchers, but in 1968, the launch of SPSS (Statistical Package for the social sciences) helping teachers and researchers for complex statistical data analysis. It's very popular software used by government entities, researchers of all the fields.

## 5. ANALYSIS & INTERPRAETATION

**Advantages of using Mathematical digital Technologies**

- People having skills in the use of digital technologies with mathematics qualifications have more opportunity for new kind of jobs.
- New mathematical software provides a new platform for teachers and students to understand the complex mathematical problem in a better way.
- The feature of visualization, data interpretation and chart diagram helps in improving the interest of students towards maths subject.
- Instant solution of complex problems helps the students to verify the results which increase their confidence and save time for more practice of the problems.
- Mathematical software is not only for the study of mathematics subject but useful for science, technology and engineering also because their study relies on the collection, analysis and interpretation of data.
- New software takes time to learn and needs proper guidance and training.
- If users have the knowledge of programming language then he can create his own library function and include the formulas which he needs.
- Mathematical software is very useful for researchers, they do not need to spend more time on small calculations which can be done easily by these tools and he can focus more on research part i.e. collection of data, analysis & interpretation.
- It will help teachers to prepare their lectures in more innovative, more graphically and more interesting.

ISSN:0971-1260

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- Modern math programs help to visualize solutions in term of 3D graph and chart diagrams or even animations. It helps to understand the maths concept & theory in better way.

**DRAWBACKS OF USING MATHEMATICAL DIGITAL TECHNOLOGIES**

In spite of so many advantages of mathematical software there are some drawbacks also. Users start using software blindly they do not verify at least once there results and after some time they are least interested to know the concept behind the results. Mathematics needs paper and pen practice which is going to decline after using scientific calculators and programmes. Syntax of each program needs some time to learn which users found unreasonable burden.

## 6. CONCLUSION

Mathematics play very important role in the development of software. The British mathematician developed the encryption which makes mobile communication possible which is a great example for mathematicians to develop more software for the contribution of economic growth. Teaching & learning of mathematical software needs well equipped computer classroom. Use of mathematical software and its application should be included in school and college curriculum. Teacher should be given proper training to use programs and time to time update their skill. Before allowing to use the software, give the users more time to think, analyze and interpret at own then compare with the results of tools which help them to solve complex problems.

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