



## TOOLS OF ICT FOR LEARNING AND TEACHING MATHEMATICS

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### Abstract

*The utilization of Information Communication Technology for learning and teaching is mandatory now a day's for the overall development of the students as well the teachers. Research reveals that ICT is useful in developing higher order skills and increasing student's interest in Mathematics. In this paper, the authors discussed some tools of ICT that are helpful in learning and teaching mathematics and making mathematics an interesting subject for the learners.*

**Keywords:** Mathematical Tools, ICT, Software, Websites, Mobile Apps, Teaching

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### I. Introduction

In order to educate students to be life time learners and successful contributors to the workplace and communities, firstly it is required to replace the traditional teaching learning methods. It is needed to create their interest and infuse spirit of curiosity, reasoning and questioning mind in our youth and must take away past methodology which led to mere memorization and mugging up only.

ICT stands for Information and Communication Technology. ICT includes use of all the devices that can send, receive, store, manipulate, retrieve and exchange information in digital form. Internet plays the most important role in ICT because without internet today these devices are like dump terminals. Today world has been globalized and information about each corner of world is of utmost importance. Internet and electronic devices has made the whole world easily approachable by fast and quick means of communication. The technology can be used for betterment and destructing anything. But whatever science has given to us can be used for the benefit of public at large.

But for effective use of ICT, it must have been adopted from the start of education so that later on students can understand the importance of use of its effectiveness. Technologies make learning environment alive and more attractive. If a teacher wants to play an effective role in international sphere then knowledge of ICT is first and foremost need of the hour. It helps students and the surroundings to get up to date with the events and activities taking place anywhere in the world.

For effective implementation, scenario of the classroom is also required to be changed from the traditional one i.e. from one way communication to two way communication because unless and until there is two way communication, effectiveness of teaching cannot be known and it is possible only with discussion. ICT has enabled presentation of ideas in more understandable and relevant way. It is an effective tool for acquiring, retaining and accessing information so as to encourage the students to look for latest information from multiple sources.

In the present time, students are interested in learning Mathematics if teaching is done by using interactive methods and ICT tools. These methods help in better understanding of concepts because it helps them to visualize mathematical problems. It helps students to understand practical meaning of mathematical tasks. In this paper, some tools of ICT for learning and teaching mathematics are discussed.

## **II. Tools of ICT**

Various ICT tools which are helpful in learning and teaching mathematics are as below:

### **A. Smart Class Rooms**

Smart classrooms are technologically enhanced classrooms that provide opportunities for learning and teaching using technology such as computers, specialized software, networking, audio/visual facilities, projector and screen etc. They provide interactive environment. Teachers can also link online resources with their lectures. It is a great tool of learning using pictures, maps, graphs, audios, videos, Power point presentations, 2D & 3D animations etc. It can be used as most effective method of learning because audio visual aids provide us best way of easy learning and understanding as compared to other methods of learning.

### **B. Social Media**

Technology encourages learning with social media such as Whatsapp, Facebook, Instagram, E-mail etc. Whatsapp messenger allows its users to exchange text messages, images, audios and videos. These can be used as alternative classrooms where students and teachers can do group discussions. Here one can share their views and also can discuss problems. One can get solution at a place without wasting time in visiting any place for getting solution to the problems.

YouTube is very popular among every one and which is within the reach of everybody in present scenario. It is huge collection of videos. It can be used for learning for a child who has to just join the school or who has just joined the school or for the student of any level whether he is of 10<sup>th</sup>, 12<sup>th</sup>, graduation, post graduation, engineering and medical or any other level/ field. This is the platform from where

users can learn anything from our home without visiting anywhere. On YouTube the users have to just subscribe channels they need and the YouTube notifies the users whenever any new video is shared / uploaded by the channel.

There are some other common video sharing sites are Wikiversity, Teacher Tube, TED ed, itunes and vimeo. Slide share, Slide rocket, prezzi are presentation sharing sites. These are the tools for presenting ideas in impressive manner.

### **C. Mathematical Software**

The use of mathematical software in learning and teaching mathematics is increasing. Some of the software are very expensive and beyond the reach of students and teachers individually. The software that are used in learning and teaching mathematics are as follows

- **Matlab:** It is a high performance language used for numerical computing, matrix manipulations, plotting of functions and data analysis. It can interface with programs written in other languages such as C, FORTRAN etc. It makes use of programming languages in order to create scripts to the document and for evaluating the data. This software also provides a toolbox that can be used to calculate functions quickly. The functions can be displayed in the form of 2D, 3D or even 4D graphs.
- **Math CAD:** It is used for data analysis, image processing, signal processing, curve fitting, regression analysis, solving various type of equations, plotting graphs, calculating roots of functions and perform matrix operations etc. It can be used for doing symbolic calculations that requires use of mathematics. 3D graphs can also be plotted using this software that helps to understand dataset that are very complex. It also provides the facility of data sharing as it can be integrated with Microsoft Excel.
- **Mathematica:** It is used for mathematical computation, algebraic manipulation, image computation, number theory, graph computation, geometric computation, visualization and data analysis.
- **Maple:** It is used for technical computing, data analysis, numeric computation, matrix computation etc. It can be used effectively to analyze and solve problems related to mathematics. The results obtained are also very accurate and fast. It can provide solution to all mathematical problems related to different branches such as statistics, linear algebra, calculus, geometry, functions etc.
- **SPSS:** It is a powerful data analysis tool. It helps in performing analysis of quantitative data and provides the facility of reading and writing data from the different databases and packages consisting of statistical data. It also helps to analyze missing values which helps to make decisions by doing estimation of the data.
- **Graphmatica:** It is used for plotting graphs of Cartesian, polar and parametric equations. It is a tool that can be used easily in plotting the graphs of equations, Cartesian functions and also inequalities. It is a very powerful tool as it can show almost 25 numbers of graphs on the screen at a time. It can also be used to plot graph of tangent lines after solving them numerically.
- **Graphing Calculator 3D:** It helps in drawing 3D graphs of mathematical functions. It is a very effective tool for plotting inequalities, parametric, polar and cylindrical equations. It can be used easily because of the user interface that is very

easy to use. It gives result very fast and thus, it is very efficient tool. It does not require any kind of scripting and only equation is required to be written so as to obtain the graph as a result.

But a large number of software's are available free of cost. These mathematical software's are discussed below:

- **Geo Gebra:** It is used for solving problems of vectors, calculus, algebra, complex numbers, statistics, linear programming etc. Also helpful in creation of 2D, 3D geometric figures and graphs. It provides an interface that is easy-to-use and is available in many languages. It makes learning of mathematical concepts easy and more meaningful. It also enhances the conceptual understanding of the topics. The students can also practice by solving different exercises. This can also be used by teachers to create worksheets of topics that can be given to students for solving.
- **Math Mechanix:** It is used for 2D and 3D graphing, single, double and triple differentiation and integration. The 2D and 3D graphs of data and functions can be easily obtained using this software. Also, the facility of data point labeling, zooming and rotating on all axes is also provided. The differentials (first, second and third) of an expression can be easily plotted.
- **Calc 3D Pro:** It is a mathematical graph and charting software for statistics and geometry. It handles function plotting, integration, vectors, matrices, complex numbers, Fourier transformation, volume, area and many more.
- **Compli Calc:** It can be used to solve complex mathematical problems. It provides algebraic calculator that can be used for calculating complex functions like factorial, discount etc. easily in few seconds.
- **Mathematica Player:** It allow user to study lots of available demonstrations on various mathematics topics. It helps students to get better understanding of the concepts.
- **Graph Sketch:** It is used for sketching graphs of various functions such as polar and parametric functions. It also helps in doing mathematical calculations of the functions. Some functions that are already built in the software includes sine, cos, log, tan etc. The color and style of the graph can be chosen by the user.
- **Yenka:** This software provides 3Ds experiments and model for the students. It helps students in creating mathematical models, simulating different experiments of science and designing circuits. The results can be obtained quickly. This tool can be used by the instructors or educators to create interactive lessons for students to make them understand the topic easily.
- **Microsoft Mathematics:** It is used for solving algebraic math problems, drawing 2D and 3D diagrams, solving equations etc. The equations are solved stepwise so as to make students understand the concept in a better way.
- **Math Editor:** It helps in writing mathematical equations. In this, mathematical equations involving square root and other Greek symbols can be created easily and quickly. It allows the facility of not only creating equations but also saving and editing of equations can also be done. The saved equations can be converted into image file and thus can be exported easily on the web. These equations can also be added in any word document or any other document easily.

- **Maxima:** It is used for calculating factorization of a number, factor of a polynomial, simplifying trigonometric expressions, solving equations and systems, 2D and 3D plotting, limits, differentiation, integration etc. It can be used to perform operations on integers, rational and floating numbers. The codes in other languages can be generated very easily.
- **GAP:** It is used for computation group theory. Also useful for topics like vectors, algebra etc. It makes use of programming language and a library including a large number of functions, to implement algorithms of algebra in the GAP language. It is highly interactive as it provides the solution to the problem quickly. The library containing algebraic objects can be accessed using commands. It can be used in research as well as for teaching purpose.
- **Euler Math Toolbox:** It is used for solving mathematical problems like multiplication, addition, and subtraction of functions, algebra, matrices etc. It provides a combination of numeric and symbolic tools that can be easily accessed. It provides a Notebook interface that can be used to display graphics and text. This interface is very simple and provides editing facility using different commands. The complex problems can be solved efficiently. It is a versatile software that allows users to solve any type of mathematical problem.
- **Scilab:** It is useful in numerical computation, 2D & 3D graphing, optimization, simulation etc. It can be used for both engineering and science fields. The different tools are available for data analysis. It makes use of programming language for doing calculations. Some functions are already built inside to perform operations on matrix.
- **Sagemath:** It helps in calculus, cryptography, algebra, advanced number theory etc. It provides real-world experience especially to the graduate students. It makes use of notebook server that allows transparency. It allows interacting with other mathematical software like SciPy, NumPy etc. It assimilates the features of different software packages for a common purpose. It can be used for research as well as education.
- **Axiom:** It is used to create 2D or 3D graphs of functions with the help of “HyperDoc”. It assists the user by providing a library and a commentator.
- **QMentat:** It can be used for learning and practicing mathematical problems without using pen, paper or calculator. Different mathematical functions that can be practiced are addition, subtraction, multiplication, division, power etc.
- **Mental Math:** It is used for enhancing mental math skills. It helps students to learn basic mathematical operations like addition, subtraction, multiplication and division. It allows students to alter the magnitude of operands and thus creating infinite questions for practice. This can help to increase the speed of solving questions and also the accuracy can be improved.
- **TalkingMath:** It supports audio mode. It is useful for children to solve basic mathematical problems like addition, subtraction, multiplication and division. It works in three modes: standard, interactive and timer mode and is touch screen friendly.

- **Braina:** It is a calculator that makes use of voice or audio to solve mathematical problems. The students need to speak the problem that needs to be solved and it provides the answer by speaking back.
- **Gretl:** It is based on C programming language. It offers solution in several international languages. It can be used for econometric analysis. It makes use of scripting language called “hansl” that provides a wide variety of tools of programming and operations of matrix. It also provides independent variables such as logit, tobit etc.
- **Cadabra:** It helps in solving problems related to tensor polynomial simplification and tensor computer algebra including Fierz transformations etc. It can be used for complex problems related to algebra found in the field theory. Both command-line and graphical interface is provided by it. It can be used for abstract computations.
- **xFunc:** This software is based on C# language. It helps to solve complex mathematical equations automatically. It provides an interface that is user-friendly and can be used to solve problems related to arithmetic, trigonometry, etc.
- **SpeQ Mathematics:** This software helps to work out trigonometry related problems. The interface provided is very simple and helps to maintain sheets of the computations done which can be edited later. It helps students to solve complex problems of mathematics and learn new concepts.

#### **D. Mobile Apps**

Mobile apps are programs that are developed for devices that are mobile and wireless in nature like Smartphones. Today everyone has access to mobile phones/tablets and these devices support a number of free apps which are helpful in learning and teaching mathematics. Few of them are as follows:

- **Digits (iOS) and CalcTape (Android):** It is a simple calculator with history backup. Calc Tape can be used for doing calculations regarding tax, percentage. Also, the calculations made can be saved in a file that can be accessed later and can be changed again easily. The results of the calculations done can be printed and can also be shared via e-mail or Airdrop or by any other means. It also helps a user to create its own functions, keypad layouts etc. CalcTape can also be used for tracking budget and expenses anywhere.
- **MyScript Calculator:** Using this app user can perform various basic mathematical functions, trigonometry (inverse) functions, logarithms and constants such as pi and Euler’s numbers etc. It has handwriting recognition system also. It can be used by students to quickly solve mathematical problems.
- **Evernote:** It is a powerful app for preparing notes in electronic form. Using this app user can create the notes by typing or by writing also. It provides the ease of organization, ability to share, easy accessibility and that too without any risk of loss by theft.
- **Kindle:** It is a collection of lakhs of free e-books on various topics. The design of the app is very user-friendly and the navigation through the app becomes very easy with the help of navigation bar provided in the app at the bottom side. Also,



the books containing difficult words can be easily understood by the user with the help of feature “Word Wise” that shows the meaning and definitions of difficult words.

- **Photomath:** It provides step by step solution of lots of mathematical problems by just snapping a picture only. The red frame in this app helps to capture the given equation that needs to be solved. It makes use of OCR (Optical Character Recognition) technology that helps to read the equation and solve it in just a few seconds. It can read the printed text as well as handwritten text very easily from the captured picture of equation. The stepwise solution of equation is then obtained on the screen.
- **Geometry Pad:** It helps in learning geometric concepts. Users can draw geometric shapes also. This app helps to draw or create common shapes of geometry. Not only drawing shapes but also exploring and changing of properties and calculating of metrics can be done using this app. The tools are available for creating medians and altitudes in any triangle. Also, different types of quadrilaterals can be created easily. The images can also be inserted into the document.
- **Coursera:** It provides a collection of study material and practice questions on various topics. It also offers online courses through app. The available courses are taught by the instructors working in top universities and companies. The free courses available allow users to access video lectures and exercises for homework. The paid courses are also available that allow users to access more quizzes available and also provides Certificate upon completion of the course.
- **Maths Formulas Free:** It provides a huge collection of mathematical formulas related to geometry, Matrices, probability, integration, statistics and others. This app can be used effectively by all the students of not only high school but also university and colleges to find different formulas related to mathematics. The tools are available for doing calculations of the geometric shapes and the equations. It also supports sharing of formulas via Facebook, e-mail or messages. The users can also add the formulas and their note in the “favorite” section of the app.
- **SAT Math Trainer:** This app is very easy to use and interactive in nature. It is useful for students in 10<sup>th</sup>, 11<sup>th</sup> and 12<sup>th</sup> class for practicing various problems. The students can practice a large number of questions on different topics and also solve quizzes. The record of the quizzes or test can also be maintained so as to keep track of performance made by students. Also, the correct explanation of the questions can also be seen by students for better understanding.
- **Globaloria:** Students can learn mathematics through games. It helps students to self-learn by creating their own games. This can help students to achieve an improved understanding of the different mathematical concepts. It requires full participation of students in constructing new games which results in meaningful learning of the concepts in an easy way.
- **Dragon Box:** Students can learn algebra with the help of interactive games. The games help the students to learn maths with fun. The games recognized by this app are related to social issues whose outcomes have already been proven. The difficult concepts can be learned very easily with the help of this innovative app. Algebra can be learnt easily by solving equations in a fun manner.

- **Academy of Math:** With the help of videos and assessment tools students can learn various topics of mathematics. It helps to improve the overall understanding of students regarding different mathematical concepts. The assessment can also be done in order to check the learning of the students regarding different topics. It mainly focuses on students who struggle a lot while solving mathematical problems and help the students to get better results.
- **Studygeek:** It is a collection of math vocabulary words, informative videos on geometry and algebra. A different section is provided called Math Vocabulary that helps the students to find the definitions of terms used in mathematics and this dictionary is organized in an alphabetical order. It helps students to improve their mathematical skills by learning different concepts. The games are also provided that helps to test the retention ability of the students regarding the vocabulary words. Thus, students can enjoy and learn at the same time.
- **Math Pentagon:** It provides material on topics ratios, geometry, trigonometry, algebra and statistics. It helps to construct geometric shapes. While constructing the different shapes, points can be moved for the adjustment of size of the shape and the distances so as to see the effect it causes on the shape. The app can be used for constructing difficult and complicated geometric shapes.
- **Apollonius:** It helps to learn concepts of geometry in an interactive manner. It helps to construct geometrical shapes and the different parts of the shape can be moved around with the help of touchscreen of the device.
- **GetTheMath:** Students can relate algebra to the real world with the help of videos and assignment. The professionals have included a lot of videos and lectures related to algebra so as to make students understand and learn the different concepts with the help of real world challenges. The different section of the app shows how maths can be used professionally. After learning a concept, a video series is provided that challenge the students to understand the concept completely.
- **FluidMath:** This platform helps students and teachers to write on the interactive whiteboards. The students solve the problems in their own handwriting. It can be used by students studying in grade 6 to 12. It is very interactive and both teachers and students can engage in solving problems.
- **MathsPlayground:** This tool involves a collection of games related to mathematical concept. The games are separated on the basis of grades and topics. It makes it interesting for the students to learn with the help of games. The different types of games are available such as spelling games, ratio games, addition games etc. that can improve the mathematical skills of students.

#### **E. Websites**

There are millions of websites which are helpful in learning and teaching mathematics. These websites provide a platform for discussion among teachers and students on many issues that arise during general learning and teaching mathematics. Here anyone can share his experience / expertise with lakhs of learners with least cost for both. Most interestingly it made possible to have access to knowledge, experience and expertise of various experts which is not possible for a learner who is thousands of miles away. Many websites helps teacher for planning the irlecture. Some of them

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Madhu Aggarwal et al*



present some wonderful methods to motivate learning mathematics through different games. Few of these web sites are as below:

- **National Council of Teachers of Mathematics:** This website provides various resources which are helpful in mathematics learning and teaching. It also provides details of conferences, professional development programs, Journals, publications, Grants, Scholarship and Awards in mathematics field. The NCTM standards have described set of goals for giving instruction of the mathematical concepts. Some standards represent goals on topics like algebra, geometry, data analysis etc. and some are related to solving problems, reasoning, communication and representation. All these standards help to improve the skills of students.
- **Aplusmath:** It helps mathematics students and teachers in developing logical and creative thinking by providing practice problems of mathematics and logic. The resources provided in the form of worksheets, games, flashcards etc. are very attractive. With the help of worksheets, problems can be solved online and printing of these worksheets can also be done. Flashcards help to test the skills of students in Mathematics subject. Different flashcards of addition, subtraction, multiplication, division and algebra are available that can be used for practice online and can be printed. Games available are MATHO and Hidden Picture that helps to understand the concept in a interactive way.
- **Math Central:** This website provides lots of material for mathematics and statistics learning. It provides many features that can be used to learn different concepts effectively. A resource room is provided that helps educators to share resources. The teachers can send their notes, lesson plans and other resources so that they can be stored in the database on the website and can be accessed by the students. A panel of consultants is also provided who help the students by answering their queries and providing them with the solution.
- **The Math Forum:** This platform provides material on mathematics from elementary school level to graduate level. It is also a source of discussion on mathematics among teachers, researchers, students and parents. It helps to improve the understanding of maths with the help of web learning. The students can learn with the help of puzzles and different problems can be practiced by them to get a better understanding of the concept. It also provides the facility of solving the queries of students with the help of online mentors. The students can work in a team in order to solve difficult problems. In this way, students can learn while having fun at the same time and thus acquire better understanding and learning of new concepts.
- **Simpsonsmath:** This website provides material on many topics of mathematics and presents them in a funny manner. It contains a large number of instances related to mathematics that ranges from simple concepts of arithmetic to difficult geometrical and calculus concepts. This can help to reduce anxiety of students while tackling any mathematical problem and gives motivation to the students in a fun manner.
- **Math Pickle:** This platform is designed for students up to class 12<sup>th</sup>. It includes several games, puzzles and mini-competitions which are helpful in learning mathematical concepts in an interesting way. It can be used as a practical resource by

the teachers. The puzzles and games help the students to get engaged in solving tough problems. These puzzles and games have been organized according to the grade and different subjects. Each puzzle is designed in such a way that it can be solved in 45-60 minutes. Math Pickle is not limited to arithmetical computations. It cannot be considered as a curriculum. In this students are provided with questions that are unsolved. It helps to provide an experience of success to each and every student.

- **Graph Maker:** It is a free tool for designing and sharing online graphs and diagrams like bar graphs, line graphs, pie chart, area chart, Venn diagram etc. it can be used to draw graphs of the raw data in minutes and makes it easy to understand and learn. The user can switch from one chart to another without any loss of data. The graphs drawn with the help of this tool can be embedded in the presentations without any difficulty. The graphs drawn can also be downloaded, shared and published easily.

- **Internet Archive:** It is a digital library. It provides free knowledge on various topics through millions of books, audio recordings, videos, images and software programs. The general members can upload the material in the collection and download the material from the collection digitally. The collected data is in bulk and is automatically generated by the Web Crawler.

- **Mathematics Stack Exchange:** This website provides a platform for discussion of various problems arise during studying mathematics at any level. It allows different users to communicate and discuss not only topics related to Mathematics but also the working, decisions and policies of the website. Meta Mathematics Stack Exchange also provides the facility of voting on the questions asked that shows agreement or disagreement of other users regarding the answers provided. Queries can also be solved easily by discussion method.

- **Brilliant:** This platform is helpful for students and teachers in learning mathematics by solving various interesting mathematical problems on topics such as logic, geometry, calculus, linear algebra, number theory, differential equations, group theory, probability etc. It uses problem-solving approach in order to make students understand the concept of Mathematics.

- **Math Guide:** It helps to learn different concepts of Mathematics such as algebra, geometry, trigonometry and calculus with the help of lessons. The assessment resource is also available which is known as “quiz masters”. It generates problem randomly and then waits for the input to be provided by the students. The student then understands the problem and then solves it and provides the required input. The input is then checked whether it is correct or not and then reported instantly.

- **Math Drills:** It helps students to learn mathematics with the help of thousands of worksheets on different topics such as geometry, algebra, concept of money etc. Sudoku and Dots games of maths are also available which are interactive and makes learning fun.

- **Math Goodies:** This website provides learning of topics such as percentage, probability, geometry, set theory and circle concept. On each topic many interactive lessons are available to understand the concept. After understanding, students can

check their learning by solving the worksheets available. The learning can be done with the help of puzzles and games also.

- **Absurd Math:** This website provides game series that needs to be solved in order to understand a mathematical concept interactively. The game involves a player that goes on a mission in a different strange world that helps to improve mathematical skills of the player. Hidden clues are also available on different pages that help the player while playing the game. The answer keys can be obtained via e-mail at the end of game.

### III. Conclusion

ICT can change role of students and teachers in the process of learning and teaching mathematics. Using ICT tools, users can learn anywhere, anytime and without any need to go anywhere. At present everything which we need is just a click away. Our youth is enjoying electronic devices and had access to these devices. The whole scenario of learning and teaching can be changed by guiding them properly. Because audio visual way of learning helps in understanding and learning of the concepts easily as compared to other ways of learning. Further, on the other side whatever is made by science can be used positively or negatively. Everything has its positive and negative attributes. It depends on how it is used. Today we have access to everything on internet which must not be accessible to our youth because it creates distraction in their mind. They should be made aware about the other side which may cause curse for them. Hence, by proper implementation of ICT the whole system of learning can be changed. One should make efforts to change the process of learning and teaching in order to prepare the students to adjust themselves and go ahead for prosperity and well being of our nation. This is the need of time to create a new learning environment for betterment of the future of the nation.

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