Study of Mathematics Software a New Science Discipline

Anand G Puranik[1]
[1]Assistant Professor, Department of Mathematics
Government Science College, Chitradurga – 577 501

Abstract: The role of mathematics in the design of computers and its software were inevitable. In the same way the role of computing software's cannot be overlooked in Mathematics education. Not only teaching and learning of Mathematics had the hegemony of computing software, but the advanced computing also involves lot of uses. 3D plot, large type of data manipulation, matrix calculations all these involves proper training of man power in Computing software field. As a prime importance, from the inception of computers in Mathematics education, to till date a survey of available software's, with both advantages and disadvantages, were given in this paper. The role of computing software from its inception to its hegemony in Mathematics education has a different pedagogy, so in this paper, an appeal is made to consider hegemony of computers in Mathematics education as a separate paradigm of science.

Key words: Software, CAS, Taxonomy of teaching and learning, Computing Programs. Paradigm

Introduction: Recent development in Mathematics studies mainly depends on the Computers, both for mathematical calculations and Communicating Mathematical works in the form of interactive tutorials, simulations. Most of the software and application packages are of two types. One type is used for typesetting mathematical symbols, fractions, equations etc., insertion of footnotes, bibliographic, images, captions, tables, graphs etc., and design of web pages containing Mathematical symbols and equations. The other type of software were designed to carry out mathematical calculations, like integration, differentiation, solving equations, matrix operations, group operations etc.,. Most of the software are free, Open Source software and some of such software are commercial. it is a better choice to write mathematical programmes, typesetting, footnotes, bibliographic, images, captions, tables, graphs, cross-references power point presentation and else, because it features with a reliable. Microsoft Word also has some or less such similar features but Latex is doing this all in flexible, intelligent, and aesthetically in pleasing manner. Finally Latex is a scientific and dynamic text formatting tool and is also more stable and also optimal for master of PhD thesis. The teaching and learning of mathematical education, incorporating computer software have become key competencies in most institutional curricula and are being addressed worldwide in most countries' educational standards. The young minds of pupil are curious and endeavour to write computing programs in different branches of mathematics, focusing on the use of less electronic resources. However, literature may be scarce on the development of university courses and teacher training workshops for the teaching and learning on the use computer software in Mathematical education. With the advancement in microelectronics industry and computer architecture, the role of computers in Mathematics education is gaining boom, day by day. Since from its inception in 1970's with the use of computers from elementary arithmetic operations to till today up to the use of artificial intelligence, ChatGPT, use of computers in Mathematics education evolved out of research. Technology in Mathematics education has evolved from fourfunction calculators to scientific calculators, to graphing calculators, Chabot and now to computers with computer algebra system software. Those days of Aristotle time of imagining mathematics as a kind of abstract or symbolic logic involving only mental activity, have gone. The theory and practice of Mathematics education, using computers have evolved rapidly and needs to study Computer programming in Mathematics education as a separate scientific discipline, with a clear subject title. The reasons behind the development of computer applications in Mathematics education as a separate discipline (a separate paradigm) may be classified into the followings.

1.**Philosophical causes**: "Interpreted narrowly the philosophy of some activity is its aim or rationale"[Paul][18]. So in this sense the philosophy of computer use in mathematics education concerns the aims or rationale that are distinct from the classical practice of teaching and learning of mathematics. In mathematics trial and error method is not allowed. But most of the computer programing are framed by trial and error method. The error detection and debugging is one of the main aspect in Software creation. Further "Philosophy is about systematic analysis and the critical examination of fundamental problems. It involves the exercise of the mind and intellect, including thought, enquiry, reasoning and its results: judgements, conclusions, beliefs and knowledge. There are many ways in which such processes as well as the substantive theories, concepts and results of past enquiry can be applied", to the use of computers within mathematics

education. Hence the introduction of computers both in learning and teaching of Mathematics plays significant role as the separate study. “A theory in mathematics education is a structured entity shaped by propositions, values and norms about learning mathematics. It consists of a kernel.,[]”, thus computing software or type setting software is not structured not only by propositions or mathematical statements. These software involves different paradigm, characterised by Event driven (center around events, user, actions or interface provider), Logic (concentrated on sequential execution of programs), Functions (both mathematical inbuilt functions or user defined functions) and Object-oriented techniques. Above all, while preparing the software, in the first step is to construct an algorithm or set of instructions which leads to the solution of the problem. In the later stage the source code is prepared in the required programming language. The choice of the programing language or the computer software depends on the Mathematics problem to be solved, in which branch of mathematics it lies, plotting of graphs are required or not etc. Hence the choice of computer software or programing language needs another paradigm, entirely distinct from that of mathematics or computer science. All the mathematical process which can be computerised, from precise, advanced calculations, to processing of large data, keeping and monitoring of students, examination data, scheduling of examination etc., needs a supplementary advanced technology and programing art, that are beyond the scope of teaching and learning of computer science or Mathematics. This needs a separate study with Programming paradigm and educational pedagogy. “Why the philosophy of computing software in Mathematics education? What does it offer? What is the purpose of computer software in Mathematics education? What do we value in use of computer software in Mathematics education, its teaching and learning? Why do we engage in these practices and what do we hope will be achieved? “, These are rationale and aims behind a separate study of computer uses in mathematics education.

2.**Technology development causes**: The applications of computer have covered many fields and their interrelated areas. In all other branches except Mathematics education, computer skill learning and applications gained separate entity. But only in the field of Mathematics education, the computer skills are embedded as a part of mathematics calculations, not giving the separate identity. Unlike other subjects of art, commerce, which have already adapted computer in the teaching and learning process, use of computers in Mathematics has a different view or paradigm. Such type of paradigm relies on an empirical art, logic and thinking pattern, which are different for different individuals. Hence there is a need to look beyond the readymade programming skills only as scientific calculation material, giving prime importance both in programming skills and in publishing technologies

3.**Application causes**: Different algorithms, application packages and programing techniques evolved, having both advantages and disadvantages. The scenario of the actual mathematical calculation process, changed effectively. Constantly developing software field, provides more and more creative, concrete, advanced, generalised, intelligent and comprehensive way to solve; which involves challenging tasks. Hence the processes of choosing appropriate software, programing logic play an increasingly important role in mathematical teaching and learning system. All these virtues establish the principles and heuristics of its practice, specifically of its research practice and theory development, on its own terms

4.**Separate programming paradigms and different taxonomy**: Computer programming for Mathematics education has separate programming paradigm and different learning and teaching taxonomy. The description of programming paradigm is given in the article [2][3] and that of learning and teaching taxonomy in mathematics education is given in the articles [6],[11]. Applying the same thoughts here, one can see that the Computer programming for Mathematics education has separate programming paradigm and different learning and teaching taxonomy or hierarchy. As desired, The hierarchy in teaching of computer software needs to follow the pattern of gradual progress, like teaching of mathematical typesetting using Latex, MS-word, etc., at the preliminary or introductory level, then solving mathematical problems using general Computer Algebraic System (CAS), like scilab, Maxima. FORTRAN etc at the intermediator level, Finally the programming techniques using various programming languages like C, C++, Java, Python and Julia programming must be taught. The programming concepts(programming paradigm) and logic or mathematical methods for solving problems using computers are always distinct from classical mathematics.

5.Simplification of Management of learning systems: Already many government and private organisations have opted learning management systems, for example Learning Management systems of Deepti. But still these systems fall short of advanced automation, appropriate monitoring privileges. The need for continuation and modification of these systems according to the changing technologies and challenging competitive environment is essential. For this there is an urgent need to train both the present faculties and students constantly to upgrade their skills.

6.Promotion of electronically aided Teaching system: In the present and future many companies rush to promote their products, to install in training and teaching systems. The choice of the best products remains always a challenging task. So to give suitable preferences to the required advancement needs prior training. A separate wing for development and maintenance of computer aided teaching and learning system can be established, only when there is a separation of such pedagogy is considered.

The use of software in mathematics initiated by the introduction of Computer algebra systems (CAS) like MACSYMA in around 1960. It evolved over the years in linearly accelerating way. On the other side, the introduction of computers changed the methods of teaching mathematics and also computational methods, contributing significantly to emphasize on

1.practice of critical and creative thinking

2.practice of memory enhancement, with analytical thinking

3.practice of Mathematics methods for problem solving(planning algorithms for solving problems)

4.practice of common interpretation and concessions

5. practice of error detection and removal of errors (debugging)

6.Practice of minimum and valid arguments

7.Retaining of involvement in the subject with common notations

8.Providing support for precise, innovative and deeper approach in the advancement of the subject

9.Assigning substantial ideas to the abstract or conceptual ideas.

The following table (Curtesy:[1] Ajit Kumar, Use of Mathematical Software for Teaching and Learning Mathematics, ICME 11 Proceedings, 2011) lists some of the popular computer software; those are used in Mathematics education and computations. The primary aim of listing software is to urge the consideration of study of computer software for mathematics education, as a separate science discipline at higher education institutes.

Table 1.2

Software	Utility
Mathematica	General purpose CAS
Maple	General purpose CAS
MuPAD	General purpose CAS
MatLab	General purpose CAS
MathCAD	General purpose CAS
SciLab	General purpose CAS
Maxima	General purpose CAS
YACAS	General purpose CAS
In all above software, Mathematica, Scilab, Maxima are used more commonly. These software performs symbolic mathematical operations, along with numerical value operations. Simplify logarithmic, trigonometric expressions, integrate, differentiate, solve differential equations, plot graphs, provide statistical computations.	
Magma	Arithmetic Geometry, Number Theory
SAGE	Algebra and Geometry Experimentation
Macaulay2	Commutative algebra, Algebraic Geometry
GAP	Group theory, Discrete Math
GP/PARI	Number theory
Kash/Kant	Algebraic Number Theory
Octave	Numerical computations
Matlab-like Singular	Commutative Algebra, Algebraic Geometry
CoCoA	Polynomial Calculation
Gnu plot	Plotting software
Dynamic Solver	Differential Equation
R	Statistic
ANASA	Computational Fluid Dynamics Solver
CAPE	Computational Aero science and Mission-critical database. Supports

	CFD solvers like Cart3D, FUN3D, kestrel, OVERFLOW Also provides a combination of database toolkits
COMSOL	General purpose Computational fluid dynamics (CFD)software Multiphysics software to provide simulate designs, devices, and process in all fields of engineering and scientific research
Open FOAM	An open-source CFD software, used for stimulating, modelling, analysing, fluid dynamics scenarios and heat transfer problems.
ANASYS/ ANASYS Fluent	General purpose Computational fluid dynamics (CFD)software
Autodesk® CFD	To create CFD simulations Analyse heat transfer and fluid flow design Enable scripting and automation with APIs
Programming Languages	
Python	Gained lot of popularity in web development, artificial intelligence, big data analytics, scientific computing. A python library “SymPy” proven suitable for algebraic manipulations, calculus and symbolic mathematics.
Prolog	Used for Logic programing in Computational linguistics and Artificial intelligence. Declarative paradigm example.
Answer Set Programing(ASP)	Used for Combinatorial search, planning, reasoning. Declarative paradigm involved.
Datalog	Used in Data base queries, relationship model queries, based on Deductive paradigm.
FORTRAN	The name is combination of two words, FORmula and TRANsfermation. It is used for scientific calculations, even for in these days also. It is simple to use and consistent with simple English language
C,C++,C#	These three are considered as high level structured languages. The Data types, declarations and array statements are convenient for writing Mathematical computations.
Visual C/C++	The Visaul studio IDE provides many advantages for C/C++.This support special type environment for programming in high level structured languages
JAVA	Has wide range of libraries. It provides class, methods and modules which are independent of platform and robust. It is also used for various types of applications of web, mobile apps.
Julia	Used for technical computing and data science applications. It is best suited for mathematical computations, has efficient inbuilt functions in its libraries for numerical computations.
LATEX	Used for producing high quality scientific and mathematical documents. This a Markup language like HTML or XML.
MathType	A window based word processors used for creation of Mathematical equations or text.
Lyx	A user friendly interface for creating mathematical documents, in the front end, but uses LATEX in the background.
Microsoft word containing Equation editor	Like Math-Type this also provides window based mathematical type setting, with various built in equation tools and graphical tools also.
MathJax	Primarily used for displaying mathematical notations on the web=pages with JavaScript

Conclusions: In this paper, the main focused matter address the role and suitable concept of theories, current state of computer software in teaching and learning of mathematics. This paper urges on the need to consider the role of computing software in Mathematical sciences as a separate paradigm of science. Which software is needed in particular consequence, the effectiveness in achieving the goals, advancement in computing etc., must be studied as a separate theory in forth coming days. Another conclusion is, the high potential need for the effective integration and uses of computers in Mathematics education cannot be overlooked. The effective integration and uses of computers in Mathematics education enhance industrial, commercial, economical as well as educational research and development facilities. The design of software and uses of software involves a separate, deep knowledge of programing concepts along with logical, analytical and concrete thinking, apart from mathematical methods to solve problems. Hence Mathematics oriented, computer software design and utility needs separate science discipline status at the higher educational institutes.

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