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The Role of Mathematics in *Make in India*

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Abstract:

Digital technology has become a strategic necessity of our life and its role is sure to increase in the near future. It has deeply affected the education sector. Learning has drastically changed due to the onset of technology. Today, telephones, 4G mobiles, text messages, Email, internet, intranet, video conference, chat- programmes and multi-media devices can be used as an effective way of learning.

The modern smart phones and other portable digital technologies are not just phones. They are multi-purpose computers with well furnished Apps. These Apps have enabled the students to access mathematical information. Pascal‘s and Leibniz‘s mechanical calculating machines, Napier‘s logarithms, Babbage‘s difference engine, Newman‘s Colossus and Turing‘s Bombe for crypto-analysis at Bletchley Park are just a few examples of computational tools which have been fundamental to the evolution of digital technologies to support mathematical developments. In this respect mathematics is, and has always been, a dynamic problem solving activity for which humans have continued to develop and exploit new tools.

Mathematics has opened up new avenues for those with skills in the use of digital technologies. The future generations need to include a variety of mathematical tool modifiers. For this, proper and astute execution is must and it is possible only through adapting the digital technology designed to do a diverse and specified function.

The paper aims to explore the avenues available in Mathematics for digitally empowering Indian human resource.

Keywords: ICT, digital tools, techno- mathematical literacy, empowering human resource.

Digital technology has become a strategic necessity of our life and its role is sure to increase in the near future. It has deeply affected the education sector. Recently, learning has drastically changed due to the onset of technology. Today, telephones, 4G mobiles, text messages, Email, internet, intranet, video conference, chat- programmes and multi-media devices can be used as an effective way of learning. The modern smart phones and other portable digital technologies are not just phones. They are multi-purpose computers with well furnished Apps. These Apps have enabled the students to access mathematical information. This scenario, of course, demands to emphasize the stark contrast between the worlds of past and current Mathematics education at academic arena and the world in which many of our modern students live most of their life.

Digital Technologies refer to a wide range of devices which combine the traditional elements of hardware (processing, memory, input, display, communication, peripherals) and software (operating system and application programs) to perform a wide range of tasks. They include: technical applications; communication applications; consumer applications and educational applications. Einstein famously remarked that his pencil was more intelligent than he was - meaning, that he could achieve far more using his pencil as an aid to thinking than he could unaided. There is a need to recognize that mathematical digital technologies are the pencils of today‘ and that we will only 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.

The point about modern smart phones and other portable digital technologies is that they are not just phones. They are multi-purpose computers with built-in processors, memory, colour display, audio playback, wireless telephone and broadband communications, Global Positioning Systems and accelerometer sensors, still and video camera, touch screen input – and they also run a wide variety of Apps. These Apps ‘short for Applications’ are called computer programs or software. The relevance of this choice of analogy is that the students could quite as easily have been using an Internet browser to access mathematical information, or discussing their maths homework by phone with a friend, or using Google Maps or using a powerful, free, mathematical tool such as *GeoGebra* is a very handy tool/ App to teach, learn and explore mathematical problems an interesting way. Mathematicians have always been engrossed in working on the important practical issues of their times, which have always necessitated both the development of the subject as well enrichment of the tools to support this. Pascal‘s and Leibniz’s mechanical calculating machines, Napier’s logarithms, Babbage’s difference engine, Newman’s Colossus and Turing’s Bombe for crypto-analysis at Bletchley Park are just a few examples of computational tools which have been fundamental to the evolution of digital technologies to support mathematical developments. In this respect Mathematics is, and has always been, a dynamic problem solving activity for which humans have continued to develop and exploit new tools.

Mathematics has channelized new kinds of jobs which are open to people with mathematical qualifications, especially those with skills in the use of digital technologies. It is often argued that the number of mathematical tool users will outweigh many times the number of tool producers, with the implication that only a few experts need to really understand how to produce a mathematical tool. Such dichotomies are unhelpful as the workforce of the future will need to include a large number of mathematical tool modifiers. Video games can be a major source of income for the Indian economy and require advanced skills of mathematics, physics, biomechanics and computer programming to achieve virtual reality Global Positioning Systems. However, for the tool modifier, the central issue becomes the articulation of what the digital technology should do; designing a system to do it, and verifying that it will perform as specified.

There is already a wide range of existing mathematical digital technologies which could readily be used by schools and colleges such as:

- Dynamic graphing tools
- Dynamic geometry tools
- Algorithmic programming languages
- Spreadsheets
- Data handling software and dynamic statistical tools
- Computer algebra systems
- Data loggers, such as motion detectors and GPS
- Simulation software.

India, along with most of the other nations, is looking to strengthen and move ahead with confidence through increased growth and improved international competitiveness of important sectors of the economy. There will always be a need for large scale engineering projects, such as in high-speed railways and more efficient generation of electricity. There is also a need to design and apply new technologies such as genetic-engineering, nanotechnology and smart materials as well as developing ever better medicines, faster communications and more efficient vehicles. India is also a world leader in the software field of digital entertainment through special effects and animations in the media of film, television and video games, including 3D. A key issue facing India is how to inspire and develop the next generation of innovators, creators, scientists, technologists, engineers and mathematicians on which our future well-being and economy depends. The innovative Prime Minister of India Mr. Narendra Modi has launched Make in India campaign to accomplish this vision. Mathematics has to play a very vital role in this direction. This fact has been acknowledged by Hoyles, Noss and Kent their book *Improving Mathematics at Work - The Need for Techno-Mathematical Literacies*, they assert:

> What are the mathematical knowledge and skills that actually matter for the world of work today? Has technology reduced the necessary knowledge to the most basic arithmetic? Or has the era of globalised competition and customer-focus ushered in a new era where novel skills are required? If so, how can they be developed? This book argues that there has been a radical shift in the nature of mathematical skills required for work - a shift which has still not been fully recognised by either the formal education system or by employers and managers. People need mathematical knowledge and skills that are shaped in new ways by information technologies and situated in concrete work situations - what we term techno-mathematical literacies (TmL): for example, the need to be fluent in the language of mathematical inputs and outputs to technologies and to interpret and communicate them, rather than merely to be procedurally competent with calculations. [17]

At various times in the last fifty years or so the specification of subject content has changed to include, or to remove, specific topics such as binary arithmetic, Boolean logic, vectors, matrices,

differential equations, flowcharting, complex numbers, linear programming and critical path analysis as well as applications such as electric circuits, particle kinematics, statistics and decision mathematics. The introduction of a national curriculum, together with regulatory authorities for public examinations and reductions in the number of examination boards, has led to a more stable but arguably less responsive, curriculum. For example, the knowledge and skill required to make use of a protractor to measure angles by hand is carefully specified. There is no equivalent guidance on how to measure an angle using dynamic geometry software.

The need of the hour is that schools and colleges must equip themselves with student-led mathematical modeling, problem solving and computer programming which make use of the powerful mathematical digital technologies that are widely used in society and the workplace. It should be used as a component of computer programming, interpreted in the widest sense of creating and communicating a set of instructions to a computer for a clear purpose. Change to the Mathematics curriculum and its assessment, although necessary, will not be sufficient to develop the classroom practices of teachers, rather there will be a continuing need to update the skills of the teaching workforce, something which the subject associations and teacher education institutions working alongside industry and schools are well-placed to achieve.

To conclude, what is inevitable in colleges is equipping them with problem solving computer programming which makes use of the powerful mathematical digital technologies that are widely used in society and the workplace. Learning in science, technology and engineering in institutions could be greatly enhanced if students were able to use digital technologies to perform mathematical processes, mirroring the types of applications used in STEM-based applications in the workplace. STEM can be very helpful in learning and teaching curriculum based on the idea of educating students in four specific disciplines — science, technology, engineering and mathematics — in a funny and playful way. The benefit of using digital technologies relates both to the processing human resource by the technology. It also enables man power exploring and finding the new opportunities to access real-world data, wh.ich is a store-house of economy. In this way Mathematics can be very handy in developing India where everybody is committed towards- Make in Indian.

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