eContent for Teaching and Learning of Mathematics: Need, Scope and FOSS

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Mathematics Learning & Teaching: Use of Technology

- Mathematics requires abstractions. It is a discipline in which the learners learn to generalise, formulate and prove statements based on logic. In learning to abstract, children would need concrete material, tools for visualisation, experience and known context as scaffolds to help them.

- Children are expected to verify principles or patterns and would also be trying to find out exceptions to these. So, while on the one hand children would be expected to observe patterns and make generalisations, they would also be required to identify and find exceptions to the generalisations, extend patterns to new situations and check their validity.

- Over the last two decades technology has changed the way world works and this change has significantly impacted the way students learn and interact with Mathematics.

- Effective use of technology can enhance student learning by developing understanding, stimulating interest, and increasing student proficiency in mathematics. In addition, strategic use of technology promotes equity by allowing greater access to mathematics by all students.

- Due to the rapid improvement of technology, the world is changing more quickly than ever before, so the future is even more uncertain. The children born from 1980 to about 2000 are known as the Net Generation. They are the most technologically-savvy generational groups. Now many believe that a new generational cohort, Generation-Z, began in about 2000.

- As a result, it is important to equip students with not only academic content knowledge, but also with general skills that will enable students to face any situation with confidence. It is no longer enough for students to be proficient in mathematics, reading, and writing; students need to have more tools at their disposal. These tools generally come in the form of various higher-level thinking and communication skills, often referred to as 21st century skills.

- Information and communication technology (ICT) literacy, media and internet literacy, data interpretation and analysis, computer programming is one of the 21st century skill.

TECHNOLOGY TOOLS

Two types of Technological tools

Content Specific Tools

These include hardware and software such as calculators, computer algebra system, Dynamic and interactive geometry software, applets, and spreadsheets.

Learners can use these tools for computation, construction and representation as they explore problems.

Content Neutral Tools

These include communication and collaboration tools, web-based digital media, presentation software/hardware such as interactive whiteboards and web-based resources.

These tools enhance access to information, improve collaboration among students and teachers, provide opportunities to develop more effective presentations and promote communication with other stakeholders.

- Mathematics should emerge as a subject of exploration and creation rather than an exercise of finding old answers to old and complicated problems. The Mathematics classroom should not expect a blind application of ununderstood algorithm and should encourage children to find many different ways to solve problems.

- For generating proofs in geometry the figures constructed are also models of the ideal dimensionless figure. These diagrams are, however, more abstract than the concrete models required for attempting problems in arithmetic and algebra. Helping children to develop the ability to construct appropriate models by breaking up the problems and evolving their own strategies and analysis of problems is extremely important. This should replace prescriptive algorithms to solve problems.

- Mathematics has to be close to the experience and environment of the child and be abstract at the same time. From the comfort of context and/or models linked to their experience they need to move towards working with ideas. Learning to abstract helps formulate and understand arguments.

- NEP 2020 suggests introduction of a new curricular area of Computational Thinking along with Mathematics Education right from the early years of the school education. Coding is another such area which has been suggested.

- The approach to integrate digital literacy in the early years of Mathematics should be to use ICT as teachers' aid to explain the application or provide the visual context of abstract concepts e.g., converging lines, decimal, mixed fractions, etc. and observe harmony between the practical application and theoretical concepts of mathematics.

- The use of technology also promotes inquiry and contributes to mathematical reflection, problem identification and decision making.

- The use of technology cannot replace an excellent teacher nor ensure the development of conceptual understanding, computational fluency, or problem-solving skills. Teachers need to be decision makers in determining when and how their students can use technology most effectively.

- Technology provides an opportunity for teachers to rethink fundamental pedagogical issues in teaching and learning of Mathematics alongside the approaches to learning that students need to apply in classrooms.

- Teaching is being viewed as a process of facilitating students' learning by creating a learning environment conducive to inquiry. This necessitates the teachers to upgrade and reorient themselves. Though every teacher has her own style, still here comprehensive technology exposures along with how to design digital content resources with pedagogical approaches need to be worked upon.

- There is a need to integrate technology use in mathematics curriculum at school stage in India so that learners can access a better way of learning while connecting to & visualising other concepts and teachers can have a stronger sense of the technology's utility and connection to learning outcomes.

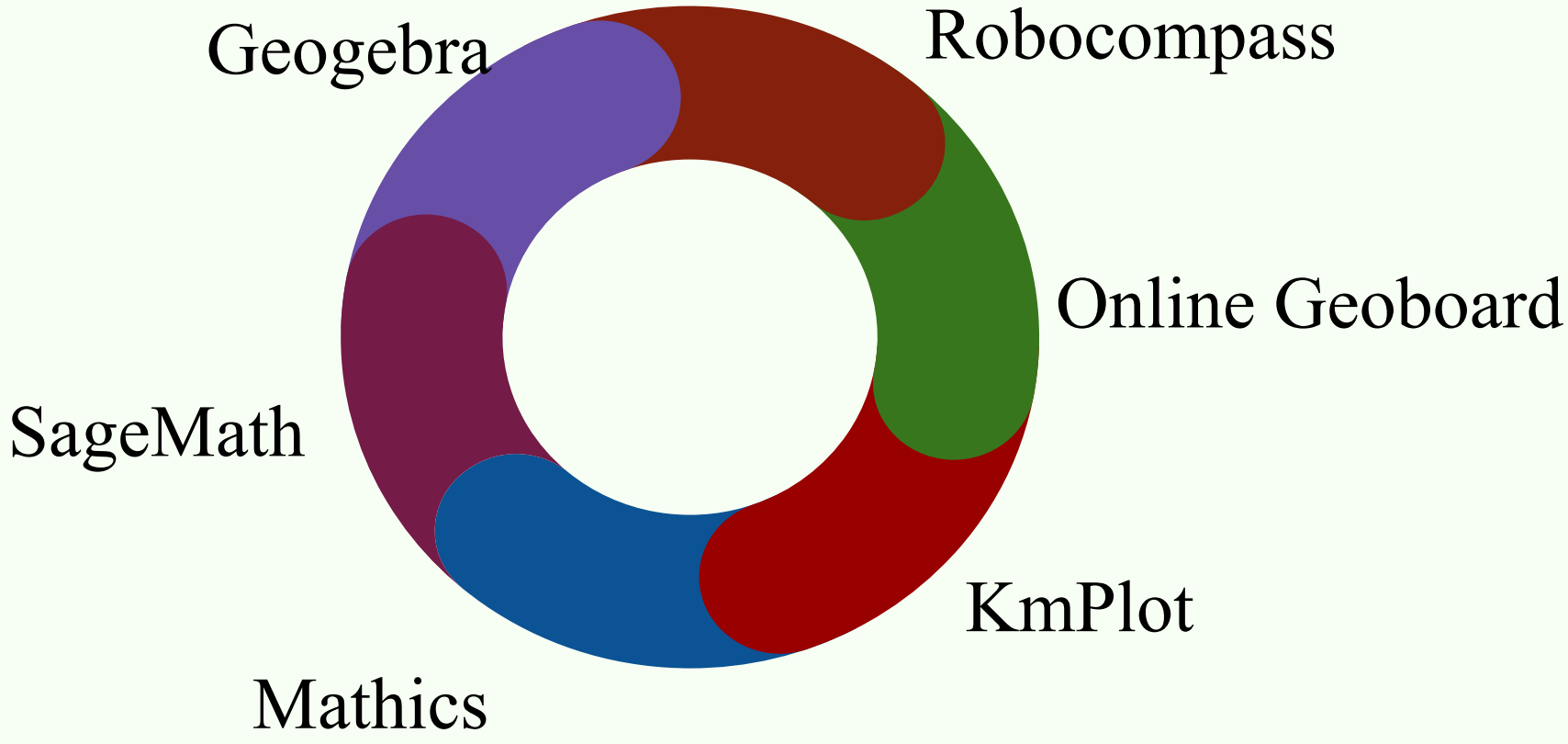
- Appropriate professional development is key to assist teachers not only in the use of new software tools but also introducing a variety of ways by which they could successfully utilize technology in their teaching practices.

- Software applications are resources and it is more important to think about the nature of the user's experiences. Use of software can be invoked in two distinct ways. Sometimes it is appropriate to give the users a ready-made document or file which has been already created and invite them to explore it. At other times, it may be better for users to create their own from a scratch, as they express themselves with contentment by means of a more open application or resource.

Repository for Digital Resource for Mathematics

1. ePathshala
2. Digital Infrastructure for Knowledge Sharing (DIKSHA)
3. Study Webs of Active Learning for Young Active Minds (SWAYAM), Massive Open Online Course (MOOC)
4. SWAYAM PRABHA (a group of 32 DTH channels broadcasting high quality educational contents)
5. https://www.olabs.edu.in/?pg=topMenu&id=58
6. https://virtuallabs.merlot.org/vl_math.html
7. https://phet.colorado.edu/en/simulations/filter?subjects=math&type=html,prototype

Subject Specific Tools for Teaching and Learning of Mathematics



Pedagogical implications of subject specific tools

- The power of software such as GeoGebra lies in the way its users interact directly with geometric figures they have constructed (or that have been pre-constructed for them). This interaction occurs in a continuous and dynamic way, by means of the direct control of one's hand on the mouse.

- For us, the most striking and powerful impact comes when, in pursuit of a mathematical question or goal, students directly explore a geometric realm while interacting with their hands, eyes and focused minds.

- One of the issues in describing the concepts in text is that one necessarily misses the visualisation aspects. Not least among these is the sense of surprise and wonder that animating mathematical diagrams and images can bring, externalizing and setting back in motion images that have been held static within the pages of textbooks. Towards this pedagogical requirement we need to separate out exploratory versus expressive approaches to using GeoGebra.

- In other words, we must confront the decision of offering users preconstructed files to explore *versus* providing students with tasks that require the construction of their own figures. And, as always, there is the general pedagogic question like, what kind of questions and tasks can help students to focus their attention on the mathematically important aspects of the situations presented to them by others or generated by them.

- ICTs are used in education in two general ways: to support existing traditional pedagogical practices (teacher-centric, lecture-based, rote learning) as well as to enable more learner-centric, constructivist learning models. Research suggests that both are useful, but that ICTs are most effective when they help to enable learner-centric pedagogies.

- However, despite the fact that ICTs can enable new types of teaching and learning styles, at present mostly they are being used to support traditional learning practices.

- To bring a change effort should be to empower teacher to develop

  - With an inquiry-based culture.
  - With a community of explorers.
  - Where curiosity, creativity, and questioning are valued.
  - Where resources and opportunities are made readily available.
  - Where students can “work” like scientists engaged in the process of collective sense- making.

- A variety of changes must be implemented to optimize teacher use of ICTs. Shifting pedagogies, redesigning the curriculum and assessment, and providing more autonomy to the schools will help to optimize the use of ICT. With sufficient enabling factors in place, teachers can utilize ICTs in as constructivist a manner as their pedagogical philosophies would permit.

- This is a very exciting time in the development of the educational use of ICT because of recent breakthroughs in technology which are making mobile computing devices ever smaller, powerful, robust, affordable and practicable.

- We need considerable developments in the educational use of ICT to support classroom teaching of mathematics with teachers having access to technological tools, and most also should have used Interactive and Virtual Learning Environment platforms (VLE). Students should have hands-on access to ICT in their normal mathematics lessons when and where needed.