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Utilization of novel digital techniques in mathematics education

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Abstract:

This article discusses the challenges of mathematics education in the age of digital technologies. Education analysis and design, educator roles, and reflection on the difficulties encountered in this area are all of importance. It is also important to investigate the characteristics and elements that contribute to the transformation of educational practices at various levels. Mathematics is a duplex subject: on the one hand, it contains computations and methods; on the other hand, it contains logic and ideas. Throughout the world, Faculty and students rely largely on the incorporation of digital technology into their teaching and learning activities to be effective and efficient. Digital learning enables and enhances students' pedagogical activities. The research inquiry concludes by identifying and providing important success aspects and tools. To illustrate this paradigm, we will present our study's conclusion that these success elements and tools are critical for facilitating mathematics learning using digital technology and some crucial facts.

Keywords: Mathematics learning, Teachers, Digital tools, Novel digital technologies, Crucial factors, mobile, online, students.

1. Introduction

Schools throughout the globe resumed for the final semester of the school year following a two-year closure due to the covid-19 pendemic. Until the conclusion of the 2019/2020 academic year, older students were taught in-person or via a partial attendance approach through many types of software and online classrooms are available to students during the lock down period. In online mode includes Zoom classes, blended blackboard and Google classes, and more.

The PME Group (International Group for the Psychology of Mathematics Education) was established in 1976. Every year since then, the PME Group has gathered in one of the five Continents. It is, in our opinion, the most prominent research forum in mathematics education. PME stands for Psychology of Mathematics Education, (Sinclair, N., & Yerushalmy, M. , 2016) and (Rodríguez, Á. G., & Boero, P., 2006).

The NMC Horizon Project identifies Several developing technologies are expected to have a significant influence on education throughout the world during the next five years. These trends are divided into two categories: fast-moving trends and slower-moving trends that will have an influence in three to five years. Each year, the HR of NMC picks six major features of technology related to education, policy, inquiry and broader aspects of learning. (http://k12.wiki.nmc.org)

The incorporation of the digital environment into the mathematics class-rooms provides researchers, educators, and teachers with many challenges. In a digital mathematical learning environment, the teacher plays a significant role and works as a key variable. Teachers have a dual role in implementing new digital tools in classrooms as guided by departments. Digital technologies supply dynamic tools and resources to process data. These tools help in creating mathematical understanding from different but interlinked perspectives. The educators and learners make use of these tools to find an accurate solution to a problem. This study will present the representational forms of delivering various mathematical meanings. The framework of the study is designed on highlighting the factors associated with learning and tools that are used to express the knowledge. The system to deliver mathematical representations, knowledge, and meanings, over the period has become more fundamental. The digital curriculum i.e: e-books and other digital material are one of the primary resources of students' assessments and knowledge which saves time, enables the teachers and learners to bring transformation into their teaching and learning environments. It is one of the transparent representational media which provides transparency into the pedagogical system (Morales, R. V., Anderson, H., & McGowan, J., 2003). A digital curriculum comprises digital media and resources consisting of e-textbooks, images, audio, videos, and websites. The students can also approach these resources outside classrooms. Digital resources can be created in an individualized and personalized learning environment in the form of interactive media like web resources, video tutorials and whiteboards, charts and diagrams, documents, and e-textbooks. Various scholars have proposed various refined ways to customize and individualize the contents.

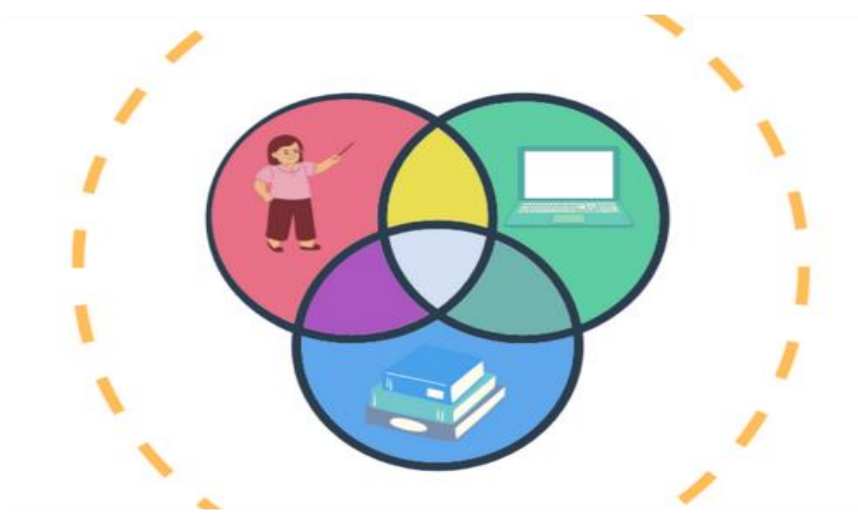
We looked back over the previous decade and identified some distinct trends in technology use:

1. The world of study and learning is at your fingertips with a mobile device.

2. The use of cutting-edge technologies like augmented reality, wearable computing.
3. Combining real and virtual objects through the usage of Personal Web and online networks (cyber network and social networks).

There are various learning platforms like moodle, Edmodo, SAS, cK-12, BrainPOP, Discovery Education, Numberphile Youtube Channel, Khan Academy, Wolfram Mathworld, available online. These apps and websites make learning approachable for different grade students. The major concern is that for some students and sometimes for teachers too, mathematics can bring a real challenge where these online platforms can greatly help them in improving their understanding.

Figure 1. The TPACK model



(www.tpack.org)

The teachers make use of the digital resources to find the accuracy in the solutions to a problem, in building the mathematics curriculum, and to implement a transformed learning environment, while the learners use it to find out the accuracy in solving problems. There is a mass of digital curriculum resources available for the teachers and policymakers, still, a lot of difficulties are being faced in the evaluation of the quality and integration into the teaching system. (see Brousseau, 2006; Balacheff et al. 1997)

The integration of digital curriculum materials into the educational system is significant for mathematical learning. In countries like the United Kingdom, Germany, United States, Netherlands, Australia, France, Asian countries etc. the teachers are motivated to implement such curriculum resources into their pedagogical methods. There are concerns regarding the soundness of the integrated curriculum with the teacher's efficiency which was, earlier, of concern with its accuracy more (Confrey, 2016). In addition to the traditional curriculum resources, several digital curriculum resources are now largely used to transform the system (Remillard, 2005 & Adler, 2000).

The primary nature of mathematics is predominating regardless of the age of the people which focuses on the view that mathematics is a machinery with a set of diversified rules for calculations that learners strive to grasp without actually knowing its purpose or giving a non-mathematical example, When pupils practice scales, it's possible to say that they aren't playing any music at all, or even understanding that they are practicing scales at all, (Hoyles and Noss, 2015).

With the advancement of technologies, the researchers also brought a change in approach to pedagogical methods. In this way, the teachers' approach in teaching mathematics to undergraduate students is also of concern. A report named Shaping the future: New expectations for the undergraduate Education in Science, Mathematics, Engineering, and Technology encourages educators for the exploration of new ways to pedagogical methods of teaching mathematics (National Science Foundation, US, 1996).

Since the exponents that support the digital technological methods bear the ability to evolve learning space into personalized and customized space, the learning spaces like navigation space, the problem space, the workspace, and the presentation space can be narrowed and expanded at the same time. Navigation space is possibly a non-sequential way of learning that students may use for the progression of their learning. The digital presentation space includes the presentation of concepts through videos and animations. A range of media and tools in this method and the topics are presented to students before they reach the problem. In contrast, the workspace has different functions as it provides all the resources and tools for the learners to engage in problem-solving activities. This space is useful because of its connexion, flexibility, and easy access. The digital problem space can be confined as it may provide only one simple answer to the multiple problems and mentions the range of problems and the pathways to the solutions for the learners. Whereas, its role can be extensive with multiple solutions to a single problem. The possible complex nature of problem space can interrupt the potential flow of a lesson with inferences that refer to the sequence of mathematics and prescribed scope (Choppin & Borys, 2017). While on the other hand the flexibility and interconnectedness of the workspace are beneficial as the flexibility provides the choices of tools to the learners and connectedness gives access to how easily a workspace may be shared with learners and educators and potentially collaboratively developed artifacts at the same time, like Google Docs (Pepin et al., 2016). Additionally, the sequence of content and the specified scope may be altered by hyperlinked texts in problem space which alternately alters the logic of jumping from one problem to another.

2. Methodology

The widespread availability of computers, pocket pcs, smartphones, software, and applications for use in mathematics learning have become easier for both teachers and students. Graphing software, computer algebra systems, programming languages, and other tools for the ease of students and teachers are now widely available. Mapping out the integration of this digital system into the framework of our study, the study of the implementation of this system in a mathematical learning environment is a point of concern. The type of digital tools and their functionality are to be addressed. As a result, we use an improved version of the model which has been updated.. The model represents three instructional features of the digital curriculum in mathematics education (Figure 2). These functionalities are: a learning environment for practicing skills, a learning environment for developing concepts, and the doing of mathematics including work outsourcing and work that is done by hand. These tools assist in positioning the technological involvement for the purpose of the study. (see Keefe, 2007; Becher, 2000)

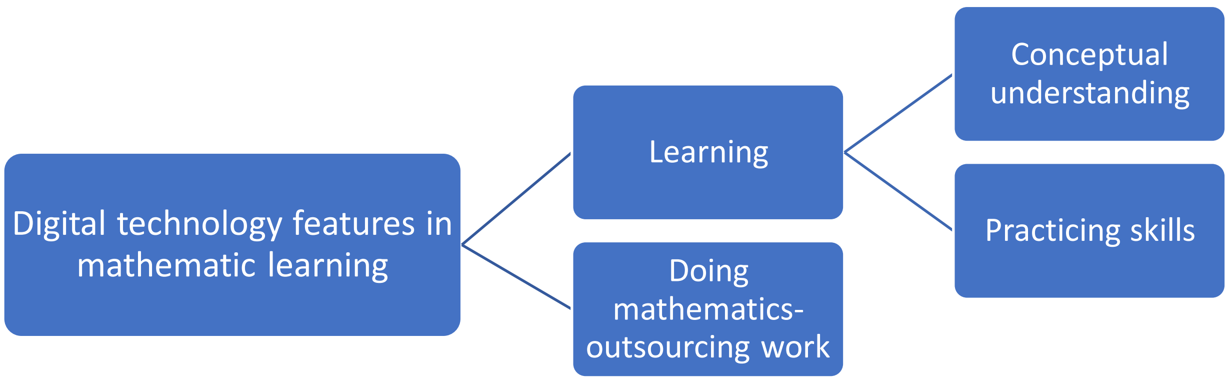


Figure 2: Functionalities of Digital technology in mathematical learning

As we identify the digital tools and design of existing programs, we will address the crucial factors that are making the learning successful.

Use technology to make math lessons that are tailored to your needs

Increased access to technology for math makes it easier for students to learn in a way that fits their needs. This means that kids can use their own devices to look at instructional videos and lessons. This includes tutorials, screencasts, and more. Students who have unique needs can use technology to get content and support that fits their needs better than what is available to everyone else. There are quizzes on the site that users can take to see which concepts they have already learned and which ones they need more practice with. Or, students who learn better by reading can read the transcripts that come with the instructional videos.

Make connections between math principles and their applications in the real world

Teachers may utilize technology to assist students in understanding how things they are learning in the classroom can be applied to their daily lives outside of the classroom. With the help of websites such as Skype in the Classroom and Nepris, teachers may set up live interactive video conversations with experts on a broad range of curricular subjects. Students may communicate with individuals outside of the classroom via the use of technology in the math classroom, which helps them to widen their comprehension of the subject matter.

3. Analysis

Several studies that focus on the digital of digital technologies and digital media in mathematics learning environments indicate that various difficulties and challenges arise while integrating technology into the daily practice of learning. On one side these challenges and difficulties help to identify the complex nature of teaching and learning mathematics and on the other side, it recognizes the delicacy of the application of tools in a learning environment. Here, we will address different classes that the digital tools are grouped into and which fulfills the agenda of our study:

- Outsourcing power tools.
- Graphical tools.
- Tools that offer connectedness.
- Tools that offer new representational infrastructures.
- Tools that provide intelligent support to the teachers.
- and tools that utilize high-bandwidth connectivity.

The tools that include the graphical representation of knowledge and data through visual elements come in the interactive and graphical tools category, (Carifio et al. 2007; Guin et al. , 1998). By using these tools, students can create an error-free design of the solutions. The use of graphing calculators and a computer screen had become intrinsic in the previous time. It is mainly because of the curriculum design and technology-rich activities which made the use of these devices common (Drijvers et al. 2010).

The teachers use sketches of mathematical objects in their curriculum design or may use whiteboard and attractive worksheets. The worksheets are of three types: poll worksheets, helping worksheets, and interactive worksheets Shapes 3D, GeoGebra, Geometry Pad, Desmos, CanFigureIt Geometry, and various other mathematical software programs are available for students learning. These apps and programs make the lessons more interesting and interactive. These apps provide spreadsheets, graphs, calculus, algebra, and other supports in a user-friendly package. However, it is necessary for the students to be fluent with the use of these softwares while the guidance of the teachers is also of importance. In many schools, the use of graphing calculators is still a required standard (Singh, A., 2022; Jasute, & Dagiene, 2012).) for examples of different guided approaches to learning with dynamic sketches. The graphical representation involves the multiple functions of mathematics as well as statistics (Figure 3). A graph defines the data in an organized manner whereas the points represent the relationship between two or more things.

Here, for instance, we can represent the data given below, the type and number of school supplies used by students in a class, on a graph. We begin by counting each supply and representing the data in particular colors in a systematic order in a table.

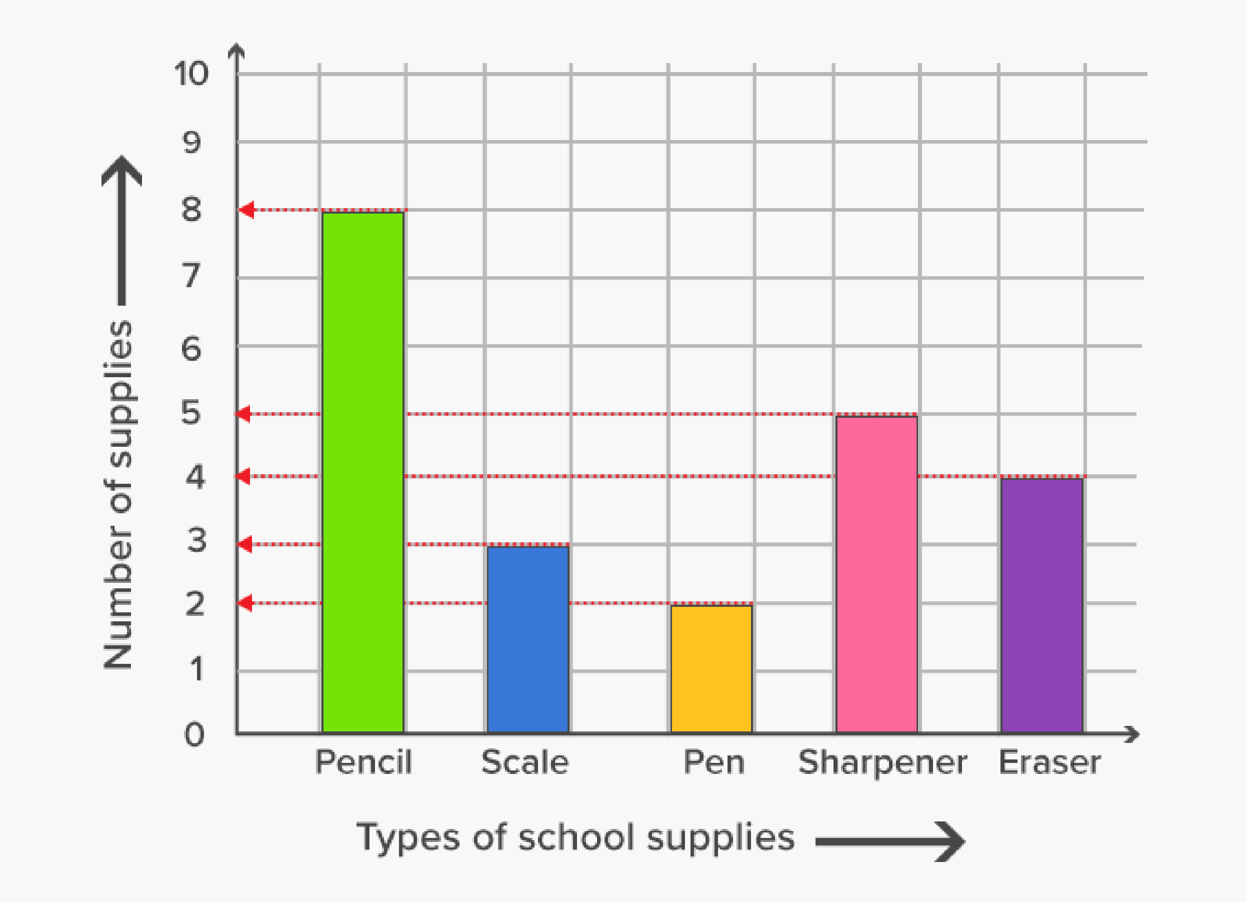


Figure 3 : Pictorial representation of data which uses in study

Figure 3 shows two graphing calculator screens in a school laboratory.

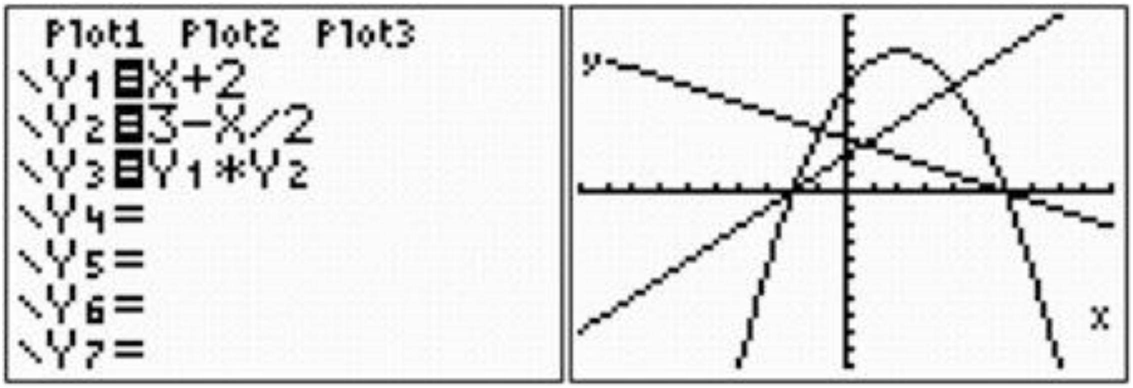


Figure 4 : The graphing calucalator used by the students

The five modes of using these tools is important which are: analysis, data collection, transformation, computation, checking and visualization.

Using digital technology in mathematics is contingent on the educational context and, in particular, mathematical practices in the classroom. In this study, researchers used a handheld computer algebra device as a mathematical tool as well as for conceptual development (Figure 4) to develop the concept of the "super variable" that defines classes of functions and can play many different roles.

A concept of learning was developed named "'Discuss the Screen orchestration'" which was established to discuss the graphing calculator output in a specific format.

A range of tools comprises outsourcing power tools which include devices like simple pocket calculators to computer algebra systems and other apps. The primary goal of the calculator is to provide the student with technical problems so that they can be more focused on problem-solving skills. A researcher proposed that CAS can help teachers in finding solutions with reasonings. This will help balance the relationship between theoretical and pragmatic roles (Heid & Blume, 2008; Artigue, 2002).

The need for dynamic geometry and computer algebra was felt by a few researchers. There is a new way to think about how these practical and theoretical techniques work together. The technique utilized paper-based work, technology, and opinions. A classic study was done on the learning of algebra through pocket personal computer. Students from ninthth grade were working on the concepts in algebra with the help of a computer algebra program.

Using computer algebra to solve parametric equations (Drijvers et al. 2010). The key reason for discussing this research is because detailed examples help provide a realistic and operationalized picture of the instrumental approach's schemes and procedures.

4. Challenge of using safely technology

As technology evolves and spreads, institutions are finding it more difficult to maintain and safeguard the supply chains on which their infrastructure is so heavily reliant. For example, computer shipping shortages may affect computer availability, as well as consumer products, cars, cloud computing, and other things. The blurring of the lines between the obligations of customers and the responsibilities of suppliers is a result of the integration of technology operated in-house and that run by an external provider.

5. Crucial Part of Using Tchnology in learning mathematics

1. For some students, the online experience becomes a distraction from the educational content. People in the whole world who involve in online classes check their smartphones roughly 100 times a day on average. In order to fight this problem, it is necessary to establish clear limits and expectations.
2. Some students are not connected face to face with others students so they feel lonely and they involve ownself in wrong way like taking drug, and others activity.
3. Student can be do cheating easily.
4. Students need to learn how to tell good information from bad information that might be called "fake news." There is a risk that students could be put at a disadvantage when they try to make their own place in society.

6. Conclusions

The first factor is design. The research emphasizes design. This comprises the design of digital technology, associated activities and tasks, lessons and education in general, three design layers that are interrelated. The instrumental genesis model defines appropriate design as enhancing the co-emergence of technical mastery to use digital technology to solve mathematical tasks and mental systems that include conceptual understanding of the mathematics at risk. Our results mirror the challenges to numerous demarcations and models in professional practice and educational theory. We emphasize that digital curriculum resources provide opportunities for transformation in curriculum design and usage, resource quality, and student-teacher engagement with digital materials. Integration of mathematical technology does not negate the function of the educator. This means combining technology-rich assignments with paper-and-pencil skills or other mathematical exercises, teacher must go through a professional development process that involves TPACK model learning, teachers need to be able to think in terms of the TPACK model, or the teacher's own development as well as that of his or her students.

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