Romanian Journal of School Psychology, December 2022
Vol. 15, No. 29-30, pp. 51-57

ACTIVATING MATHEMATICAL SKILLS THROUGH THE USE OF INFORMATION TECHNOLOGIES IN PRIMARY EDUCATION

Emilia Rodica Borșa[1] Adriana Cătaș [2]

University of Oradea *University of Oradea*
Romania *Romania*

Abstract
The optimal development of didactic activities in order to develop mathematical skills in primary education is based on the knowledge of the student's psychology, individual peculiarities as well as the specifics of the formation of mathematical notions at this age. The strategies for stimulating mathematical skills in this period, analyze in the spirit of the logic of modern sciences: the objectives, the contents, the didactic strategies, the means of education, the forms of activity and organization of the children, the ways of evaluating the progress, the bases of the cultivation of some motivational repertoires favorable to learning. In the framework of the educational approach, the use of information technologies allows obtaining better results in the development of mathematical skills. By integrating Information and Communications Technology (ICT) in learning, it is possible to facilitate students' access to scientific knowledge and high-performance technologies, the collection of data for scientific projects and their organization in graphic form, the performance of simulations and the modeling of mathematical processes.

Keywords: mathematical skills; information technology; primary education

Every aspect of community life and education at all levels has been impacted by technology. Therefore, integrating technology into education is something we just must do. It is essential that in school educational system together teachers and students have regular access to technological tools that facility and support mathematical sense making, mathematical communication and problem solving. These technologies meet the needs of students in exploring, understanding and identifying mathematical concepts and relationships. "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning." (*Principle and Standards for School Mathematics*, 2000, p. 873). But, simply having access to technology is not sufficient. The teacher and the curriculum play critical roles in mediating the use of

[1] Lecturer, PhD, Department of Mathematics and Computer Science, University of Oradea, Romania, E-mail: borsa_emilia@yahoo.com
[2] Lecturer, PhD, Department of Mathematics and Computer Science, University of Oradea, Romania, E-mail: acatas@gmail.com

technological tools (Roschelle, et al., 2010; Suh & Moyer, 2010). Teachers and curriculum developers must be knowledgeable decision makers, skilled in determining when and how technology can enhance students' learning appropriately and effectively (International Society for Technology in Education, 2008).

In order to advance the science of education by utilizing new technologies and by examining how various designs of learning environments affect teaching and learning in the technological paradigm (Collins, 1992), design-based (or problem-based) approaches to education emerged in the 1990s from the fields associated with engineering design (Dixon, 1991; Perrenet et al., 2000). Among other things, design thinking in mathematics education involves appreciating technical advancements, critical thinking and learning from mistakes.

Design-based learning activities of posing and solving mathematical problems supported by modern-day digital tools motivate students' interest in evidence of proof, the discovery of novel events, their replication, and application, categorize mathematics unquestionably among the experimental sciences (Montessori, 1917). This, in turn, makes it possible for transformative learning (Avsec, 2021) to occur through continual reflection on a solved problem through the (perhaps) never-ending cycle of "solve-reflect-pose" when one, by "looking at the past... can more wisely design the future" (Freire, 2003, p.84). So, it is possible to think of problem-solving and posing as an iterative learning process that integrates conceptual and procedural knowledge (Rittle-Johnson et al., 2001). As David Hilbert specified, in the keynote address to the 1900 International Congress of Mathematicians, advised the audience, that a mathematical task should be challenging, but not impossible (Hilbert, 1902). Additionally, this counsel serves as a reminder to educators in general that subject matter serves as a useful tool for encouraging discovery. (McEwan & Bull, 1991).

Theoretical framework

Technology gives teachers the ability to expand and enrich their mathematics lessons using technology. Technology provides additional opportunities for learners to see and interact with mathematical concepts. Students can explore and make discoveries with games, simulations and digital tools.

It is worthwhile to "be weaved into existing mathematics courses" so many mathematical ideas, since the history of mathematics offers students intriguing mathematical concepts. Numerous examples of the use of numerical tables as instruments to advance computational concepts can be found in the history of mathematics. As is mentioned in (Abramovich, 2022, p.11) "Ahmes, an ancient (ca. 1500 B.C.) Egyptian scribe, often considered the first mathematician because he was the first one to save and present mathematical results in a written form, is credited with developing a table, representing fractions of the form 2/n as a sum of distinct unit fractions. Michael Stifel, a 16th-century German monk and mathematician, used a table, known as Stifel's triangle, to recursively compute binomial coefficients. In the 17th century, Blaise Pascal, one of the founders of probability theory, came across his famous triangle by recording sample spaces of experiments of tossing coins from where one can determine chances of having a certain result of an experiment. In the 18th century, Élie de Joncourt, a Dutch minister of church and mathematics teacher, used the fact that within a numeric table comprised of triangular numbers, the sum of two consecutive triangular numbers is the square of the rank of the larger number, to compute squares and square roots."

We know from specialized literature the representation of the philosophy of knowledge mathematics as it was initially presented as a triangle, the "didactic triangle" a construct between students, teachers, and mathematics material (Figure 1). Tall (1986) asserts that the didactic triangle shows mathematics as a component of a body of knowledge that is shared by people who first comprehend it, in this case, the teacher. Mathematics is in the mind of the teacher. All content can be found in textbooks. We speak here about a static representation. Mathematics is static in the form of fixed words or images. Only the teacher's verbal explanations and his diagrammed illustrations can result in dynamic representations.

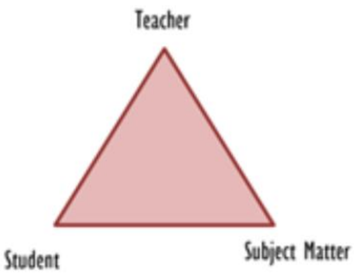

Figure 1. Didactic triangle

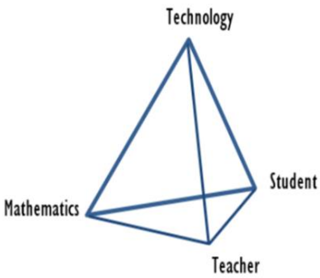

Figure 2. Tetrahedron model of a didactical situation

(Tall, 1986)

As technology develops rapidly, of course, this also impacts the world of education, especially the idea of a didactic situation. The introduction of the computer brings a new dimension into the learning situation. Hence, today's technology (also known as computers or ICT devices) is the fourth component that forms didactic tetrahedrons in the appropriate educational context of learning mathematics, as we can see in Figure 2.

There are three distinguishes main didactical functionalities for digital technology, as are presented in (Drijvers, 2013): (a) the tool function for doing mathematics, which refers to outsourcing work that could also be done by hand; (b) the function of learning environment for practicing skills; and (c) the function of learning environment for fostering the development of conceptual understanding, (see Figure 3).

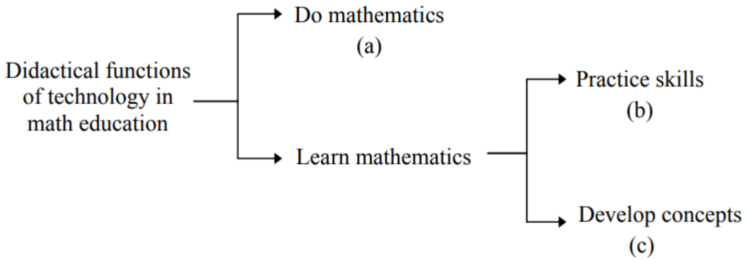

Figure 3. Didactical functions of technology in mathematics education

Activating mathematical skills

More people now have access to math technology, which enables more individualized learning. Technology can offer specific pupils' content and supports that are very helpful to their individual requirements because no two learners are precisely alike. On their own device and at their own pace, children can see classes, tutorials, screencasts, and other educational resources. Therefore, technology can enable each student to take the right next step if one is still having trouble understanding a concept and another is ready for more difficult material. Several studies mention that the use of information technologies in primary education contributes to early childhood development, especially in core areas such as language, literacy, and mathematics (Clements, 2002).

Brain research shows that making math more visually appealing is essential to learning arithmetic in addition to increasing student engagement. There is evidence that visual pathways are engaged even when performing symbolic number computations, according to neuroscientists who are examining how the brain thinks numerically. By adding visual exercises and portraying all mathematical topics visually at all grade levels will considerably benefit students.

Deficiencies in basic math skills in the classroom typically lead to inaccurate computation that created obstacles when problem solving. After a thorough review of the literature, three common probable causes were found to be lack of prior knowledge, negative attitude towards math, varied teaching methods. The teacher researchers narrowed down the range of answers put out by researchers for the problem of students not remembering basic math abilities to four options after reviewing the literature. Early screening, promoting the use of manipulative, cooperative learning, and incorporating technology were some of these potential solution techniques.

The teacher researchers advise all math educators, regardless of grade level, to spend some time reinforcing fundamental mathematical concepts. The teacher researchers advise employing technology such as software programs, PowerPoint, Smart Boards, projectors, calculators, internet pages, You Tube videos and DVDs, and music CDs to reinforce and investigate these themes.

Teachers are much more efficient in the teaching-learning process when they can use and link the three important elements of a learning trajectory—content, levels of thinking, and activities that are catered to their students' thinking levels (Sarama & Clements, 2009).

A learning trajectory is made up of three parts: a goal, a sequence of growth (developmental progression), and instructional activities. To attain a certain competence in a given mathematical topic (the goal), children progress through several levels of thinking (the developmental progression), aided by tasks and experiences (instructional activities) designed to build the mental actions-on-objects that enable mathematical thinking at each level. For instance, we might set a goal for children in primary school to become competent at counting. A developmental progression means that a child might start by learning simple verbal counting, then learn one-to-one correspondence between counting words and objects. After that, the child learns to connect the final number of the counting process to the cardinal quantity of a set (that is, how many elements the set contains). Finally, the child acquires counting strategies for solving arithmetic problems (up to multi-digit problems, for example, 30 + 12: "I counted 30 . . . 40 . . . then 41, 42!"). We can proceed with these stages using a tablet or interactive whiteboard cart in classroom.

ICT tools and materials facilitate the perception of certain mathematical objects because they stimulate students' curiosity through the unique method of presentation or through the playful elements it involves. It also strengthens their motivation to observe or study objects and phenomena by focusing on them, by capturing attention or by getting involved in competitive structures. The first mathematical object with which the child comes into contact in the school stage is the set. ICT tools and materials facilitate contact with mathematical objects represented iconically and symbolically in a contextual diversity that is not found in everyday life or is difficult to reproduce. In this stage, the child globally appreciates the amount of a lot because he does not know numbers or counting (Havârneanu, 2020).

With an endless sea of educational apps to sift through, finding the best apps that effectively build skills, engage students, and boost learning outcomes can be quite difficult. Students can be motivated by using certain software for both paying and learning mathematics. We will list further some of the most interesting used educational software: Prodigy Math

(Prodigy is a curriculum-aligned, fantasy-based math game used by more than a million teachers, three million parents, and 50 million students around the world), Elephant Learning Math Academy, DoodleMaths (Its adaptive learning technology tailors math content based on students' strengths and weaknesses called "7-a-day" activities.), Khan Academy (provides instructional math videos that help students build basic math skills as they walk through common math problems.), Buzzmath, Rocket Math (Complete math missions to build own rockets and launch them into space) and so on.

Conclusions

Teachers can play a variety of roles in facilitating and promoting the integration of technology in children's mathematical education. Similar to other mathematics learning tools like toys, books, blocks, art supplies and task instruments it can be used technology in learning with a mathematical goal. Also, children must be aware that information technology is one of the powerful tools that they can use to record, store, revisit and share what they learn from their math lessons every day. And not the last aspect, when teachers introduce the first primary concept in mathematics, like numbers, sets, geometric figures, they can realize that technology can be an interesting and important tool that helps them convey mathematical notions that are difficult to present directly, such as when showing students 3-dimensional objects. For instance, certain powerful 3D programs enable the manipulation of solid geometrical forms such as cones and cubes, promoting student knowledge. These ICT tools will make it simpler for pupils to understand the material and will motivate them to learn.

References

Abramovich, S. (2022). Technology-Immune/Technology-Enabled Problem Solving as Agency of Design-Based Mathematics Education. *Education Sciences*, *12*(8), 514. https://doi.org/10.3390/educsci12080514

Avsec, S. (2021). Design thinking to enhance transformative learning. *Global Journal of Engineering Education*, *23*, 169-175.

Clements, D. H. (2002). Computers in Early Childhood Mathematics. *Contemporary Issues in Early Childhood*, *3*(2), 160–181. https://doi.org/10.2304/ciec.2002.3.2.2

Collins, A. (1992). Toward a Design Science of Education. In E. Scanlon & T. O'Shea (Eds), *New Directions in Educational Technology. NATO ASI Series* (vol 96, pp. 15-22). Springer.

Dixon, J.R. (1991). The state of education. *Mechanical Engineering*, February, 64-67.

Drijvers, P. (2013). Digital technology in mathematics education: Why it works (or doesn't). *PNA*, *8*(1), 1-20.
Freire, P. (2003). *Pedagogy of the Oppressed*. Continuum.
Havârneanu, G. (2020). *Didactica matematicii și informaticii pentru învățământul primar*. Polirom.
Hilbert, D. (1902). Mathematical problems (Lecture delivered before the International Congress of Mathematicians at Paris in 1990). *Bulletin of the American Mathematical Society*, *8*, 437–479.
International Society for Technology in Education (2008). *National educational technology standards for teachers*. Retrieved from http://www.iste.org/standards/nets-for-teachers.aspx
McEwan, H., & Bull, B. (1991). The pedagogic nature of subject matter knowledge. *American Educational Research Journal*, *28*(2), 316–334. https://doi.org/10.2307/1162943
Montessori, M. (1917). *A Spontaneous Activity in Education*. Frederick A. Stokes Publishers.
Perrenet, J.C., Bouhuijs, P.A.J., & Smits, J.G.M.M. (2000). The suitability of problem-based learning for engineering education: *Theory and practice. Teaching in Higher Education*, *5*(3), 345–358. https://doi.org/10.1080/713699144
Principle and Standards for School Mathematics (2000). NCTM.
Roschelle, J., Shechtman, N., Tatar, D., Hegedus, S., Hopkins, B., Empson, S., Knudsen, J., & Gallagher, L. (2010). Integration of technology, curriculum, and professional development for advancing middle school mathematics: Three large-scale studies. *American Educational Research Journal*, *47*(4), 833–878.
Rittle-Johnson, B., Siegler, R.S., & Alibali, M.W. (2001). Developing conceptual understanding and procedural skill in mathematics: An iterative process. *Journal of Educational Psychology*, *93*(2), 346–362. https://doi.org/10.1037/0022-0663.93.2.346
Sarama, J., & Clements, D. H. (2009). *Early Childhood Mathematics Education Research*. Routledge. https://doi.org/10.4324/9780203883785
Suh J., & Moyer, P. S. (2007). Developing students' representational fluency using virtual and physical algebra balances. *Journal of Computers in Mathematics and Science Teaching, 26*(2), 155–173.
Tall, D. (1986). *Using the computer as an environment for building and testing mathematical concepts: A Tribute to Richard Skemp*. Published in "Papers in Honour of Richard Skemp" (pp. 21–36). Warwick.

Received
October 2022

Accepted
November 2022