


FROM THE POCKET CALCULATOR TO THE SUPERCOMPUTER: THE EVOLUTION OF THE INTELLECTUAL TOOL

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ABSTRACT

The article analyzed the evolution of calculation tools, from rudimentary devices such as the abacus to modern technologies, highlighting their impact on teaching, scientific research, and the democratization of knowledge. The objective was to investigate how the transformation of these tools has influenced educational and scientific practices, as well as the challenges and opportunities associated with their use in school environments. The methodology was based on bibliographic research, according to the guidelines of Zucolotto (2013), with the collection and analysis of data from theoretical works and recent studies on the subject. Initially, the historical context was discussed, addressing the manual and mechanical devices that marked the beginning of calculation tools. Subsequently, technological convergence was explored that integrated advanced calculation functions into modern devices such as smartphones and mobile apps, highlighting the democratization of access to sophisticated technologies. Finally, the study focused on the pedagogical application of these tools, emphasizing the need for educational strategies that use these technologies to enhance learning, while facing challenges related to technological mediation in the classroom. It was concluded that the evolution of calculation tools reflects not only technological advances, but also significant changes in the way knowledge is accessed and applied, making it essential to deepen the discussion on its educational and scientific integration.

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INTRODUCTION

Calculation tools have played an essential role in the evolution of science, technology and education throughout history. From the earliest hand-held devices such as the abacus and slide rule, to modern supercomputers and mobile applications, these technologies have reflected human ingenuity in finding solutions to mathematical and operational problems. The relevance of the theme lies in its ability to demonstrate how the transformation of these tools has accompanied, and in many cases driven, significant changes in teaching methods, scientific research, and accessibility to information.

The objective of the study was to understand and analyze the evolution of calculation tools, from the first mechanical devices to the technological integration in modern devices, with emphasis on their application in the educational environment. The research sought to answer the following question: how has the evolution of calculation tools influenced educational and scientific practice over time, and what are the challenges and opportunities in the use of modern devices in the classroom?

The methodology used was based on bibliographic research, as defined by Zucolotto (2013), exploring works and articles that address the historical context, technological transformations and their educational implications. The analysis technique consisted of identifying and organizing relevant information, allowing the construction of a panorama that dialogues with different perspectives on the subject. The data were collected from recognized academic sources, offering a solid theoretical basis for the analysis.

The development of the work was structured in three main parts, each contributing to a contextualized analysis of the theme. In the first part, the historical trajectory of calculation tools was explored, from the most rudimentary devices, such as the abacus, widely used in ancient civilizations, to the first mechanical machines developed in the modern period. Outstanding were emblematic inventions, such as *Leibniz's Stepped Reckoner and Babbage's Difference Machine, which marked the beginning of a significant transformation in the human ability to handle complex calculations. This section highlighted how these technologies not only solved practical problems, but also created the basis for the development of more advanced computing systems.*

In the second part, the impact of contemporary technologies on the advancement of calculation tools was analyzed, with emphasis on portability and processing power. Devices such as scientific calculators and, more recently, mobile applications and supercomputers, were discussed as technological milestones that expanded the possibilities of solving

mathematical problems in different contexts. Technological convergence, exemplified by the integration of calculation functions into smartphones and online platforms, was highlighted as a phenomenon that democratized access to resources previously restricted to specialized environments. In addition, it was analyzed how these innovations came to play a central role not only in the scientific field, but also in education and daily life.

Finally, the third part focused on the integration of these tools in the educational context, addressing both their potential and the challenges associated with their use. Aspects such as the need to train teachers for the effective use of these technologies, legal and institutional restrictions, such as laws that prohibit the use of cell phones in the classroom, and pedagogical practices that can mitigate these barriers were discussed. The role of calculation tools as mediators of learning was highlighted, promoting interactive activities and the practical application of theoretical concepts. The analysis emphasized the importance of innovative pedagogical strategies that use these technologies to expand access to knowledge and prepare students for an increasingly technological and interconnected world.

Therefore, the analysis presented allowed us to understand not only the evolution of calculation tools, but also their importance as facilitators of learning and research, indicating ways to enhance the use of these technologies in an increasingly connected and dynamic educational scenario.

FROM PORTABILITY TO PROCESSING POWER: THE TRANSFORMATION OF CALCULATION TOOLS

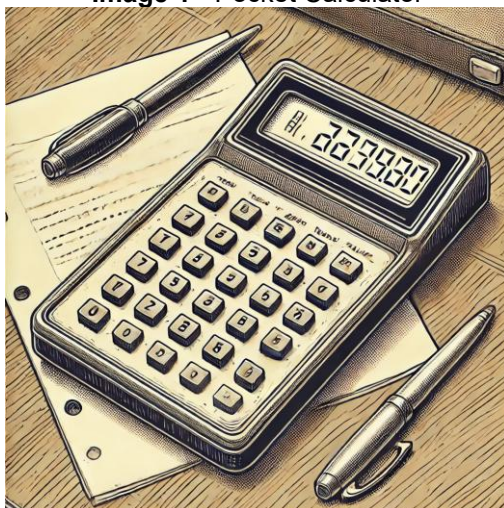
The evolution of calculation tools, from pocket calculators to supercomputers, is a reflection of technological advances that have profoundly transformed the way mathematical operations and complex processing are performed. This historical path shows how innovations in the area of computing have redefined human capabilities, integrating themselves into everyday activities and advanced scientific research.

POCKET CALCULATORS: A TECHNOLOGICAL LEAP

In the early 1970s, the emergence of the first pocket calculators represented a significant milestone in the history of technology. Devices such as the Pocketronic, launched by Canon in 1970, and Sharp's fluorescent display models brought practicality and portability to mathematical operations. In addition, the introduction of the HP-35 by

Hewlett-Packard in 1972, the first scientific calculator equipped with a microprocessor, consolidated a new era for the domestic and professional use of mathematical tools (Santos; Mariotto, 2020).

Image 1 - Pocket Calculator



Source: Image created by AI.

As Santos (2017, p. 13) points out, "the development of calculators is closely linked to the history of Mathematics and Engineering". Thus, these devices not only facilitated basic calculations, but also contributed to the popularization of the use of advanced technology in everyday life. An emblematic example of this advance was the Casio SL-800, considered an innovation as it is thin as a credit card (Santos, 2017, p. 48). These advancements attest to the technology's ability to meet human demands for efficiency and affordability.

SUPERCOMPUTERS: THE HIGH-PERFORMANCE REVOLUTION

While pocket calculators catered to individual use, supercomputers emerged to meet the need to process large volumes of data on unprecedented scales. In the 1960s, models such as the IBM 7030 'Stretch' and the CDC 6600 marked the beginning of this revolution, reaching millions of operations per second. This progress was accelerated by the Cray-1, launched in 1976, which ushered in the era of modern supercomputers, reaching speeds of up to 136 megaflops (Launay, 2019).

Image 2 - IBM 7030 'Stretch' and CDC 6600



Source: Image created by AI.

Currently, machines such as Fugaku, developed in Japan, operate in the range of exaflops, allowing quintillion operations per second. These extraordinary capabilities drive research in climate modeling, genomics, and artificial intelligence, areas that rely on extremely complex calculations to obtain reliable results. According to Launay (2019, p. 225), "the twentieth century saw the triumph of computers, in a proportion that Babbage and Lovelace would never have imagined". This statement reflects the magnitude of the transformations provided by high-performance computing.

TECHNOLOGICAL CONVERGENCE: INTEGRATION AND IMPACTS

The trajectory of technological evolution, from pocket calculators to supercomputers, demonstrates a convergence in the development of intellectual tools that enhance human capacity. While calculators have become accessible instruments for the general public, supercomputers have consolidated themselves as indispensable tools for cutting-edge research. This duality reflects the continued relevance of technological innovation, which ranges from compact devices to highly complex systems.

This convergence evidences not only technical progress, but also the integration of these technologies into contemporary society. As Santos and Mariotto (2020, n.p.) emphasize, "the computer is of paramount importance today and has become a very useful tool, whether at work, for study, or even for leisure". In this sense, it is possible to observe how intellectual tools, regardless of their scale, play complementary roles in a constantly evolving technological landscape.

The evolution of calculation tools reflects the dynamics of human progress in the search for efficiency and innovation. From the introduction of pocket calculators, which revolutionized the accessibility of calculation, to the development of supercomputers capable of performing large-scale operations, these technologies demonstrate how computing has become an extension of human intellectual capacity. With this, the advancement of intellectual tools reaffirms the centrality of technology in everyday life and in science, highlighting its relevance for the challenges of the future.

HISTORICAL CONTEXT AND THE FIRST CALCULATION TOOLS

The development of calculation tools dates back to the distant past, in which humanity sought ways to simplify mathematical operations and deal with complex problems. As Santos and Mariotto (2020, p. 1) point out, "understanding the beginnings of computers, inserted in the historical context of their development and the development of mathematics is important for a greater understanding of the history of science". This perspective reveals that the trajectory of calculation tools is not limited to technique, but dialogues directly with the evolution of science and mathematics.

Initially, the abacus and slide rule represented significant milestones in helping counting and calculation. These manual instruments, although simple, were essential for the advancement of civilizations and for the accomplishment of everyday and commercial tasks. However, as mathematical demands increased, the need for more accurate and agile tools emerged. In this context, mechanical devices such as the *Stepped Reckoner*, developed by Leibniz, were innovative, despite having limitations, such as errors in division and square root operations (Santos, 2017).

In the aftermath, the transition to more sophisticated mechanical machines gained prominence with the contributions of Charles Babbage and his Difference Machine. According to Santos (2017, p. 39), this device was "an important milestone in the history of computing, despite its limitations". These inventions not only demonstrated the possibility of automating calculations but also laid the foundation for modern computing. Babbage's view was shared by other scientists of the time, who began to speculate about the possibility of creating machines capable of performing any type of calculation (Filho, 2007).

Over time, machines have evolved significantly, moving from purely mechanical to electromechanical and, later, electronic devices. Magalhães (1997, p. 45) observes that "the techniques of calculators have evolved: first mechanical, then electromechanical and

finally electronic". This progress not only increased the precision and speed of calculations, but also expanded their application in various areas of knowledge. Oliveira (2011, p. 47) reinforces that "electronic calculators have the advantage of greater precision and speed", highlighting the transformation that these innovations have brought to science, industry and everyday life.

However, it is in the educational context that these tools take on an even more relevant role. According to Santana *et al.* (2024, p. 9), "a diversified scenario regarding the family-school relationship in the Brazilian educational context" reinforces the need for technologies that facilitate learning and make knowledge more accessible. Thus, calculators, in their different forms, have contributed to building bridges between theoretical and practical learning, allowing students to deal with mathematical problems in a more efficient and intuitive way.

Therefore, calculation tools, from the abacus to the first mechanical machines, not only reflect human ingenuity in overcoming limitations, but also pave the way for future innovations. The evolution of these technologies, as the theoretical references point out, exemplifies the intrinsic relationship between science, technology and education, strengthening the ability to deal with the challenges of modernity.

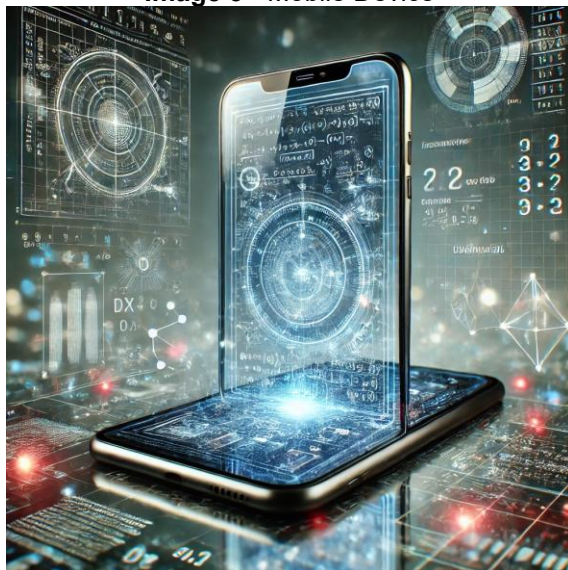
TECHNOLOGICAL CONVERGENCE: CALCULATION TOOLS IN MODERN DEVICES

The integration of calculation functionalities in mobile devices, such as smartphones, is a clear reflection of the technological convergence that marks contemporary society. According to Santos and Souza (2023), the use of cell phones in the classroom, as in the case of the Governador Luís Viana Filho State School, in Nazaré/BA, exemplifies how these tools are increasingly present in school daily life. However, this technological integration presents challenges and opportunities that demand innovative pedagogical practices.

On the one hand, mobile devices offer potential for democratizing access to sophisticated calculation tools. UNESCO (2014) points out that mobile learning has the power to transform education by allowing students from different social backgrounds to access advanced content and resources in a simple and effective way. This includes applications that perform complex calculations, which were previously restricted to specialized calculators or high-cost computers. Thus, technological convergence facilitates educational inclusion, expanding access to intellectual tools.

On the other hand, it is necessary to consider the challenges associated with the use of mobile devices in schools. Recently, a law was sanctioned in São Paulo that prohibits the use of cell phones in the classroom, restricting access to devices with an internet connection during classes and breaks. This restriction, although justified as an attempt to minimize distractions, raises questions about how to balance the pedagogical use of these tools and the risks associated with their inappropriate use. In this sense, Santos and Braga (2023) highlight that, when properly mediated, learning through mobile devices can promote the development of skills, such as critical reading and problem-solving.

Image 3 - Mobile Device



Source: Image created by AI.

Given this scenario, schools need to adopt pedagogical practices that integrate mobile devices in a productive way. One possible approach is to create interdisciplinary projects that use calculus applications or artificial intelligence to solve everyday mathematical problems. These projects can be structured into gamified activities, in which students use their smartphones to simulate real situations, such as planning a budget or analyzing statistical data. In this way, devices are no longer seen only as sources of distraction and become educational tools.

In addition, educational institutions must invest in the continuing education of teachers so that they are able to incorporate these technologies in a strategic way. UNESCO (2014) suggests that public policies should promote the conscious and responsible use of mobile devices, providing clear guidelines for their use in the classroom.

Thus, it would be possible to transform challenges into opportunities, allowing both educators and students to benefit from the potential offered by technological convergence.

Thus, the technological convergence applied to calculation tools on mobile devices represents a fertile field for pedagogical innovations. However, their effective implementation requires addressing the challenges associated with the use of these devices in schools. Through pedagogical practices that encourage critical and creative mediation, educational institutions can fully explore the potential of these tools, contributing to a more inclusive education that is connected to the demands of the 21st century.

In view of this, it is necessary for educational institutions to adopt strategies that promote the conscious and planned integration of these technological tools into the school environment. This includes the continuing education of teachers so that they understand the potentialities and limitations of calculus applications and *software*, as well as the development of public policies that encourage their pedagogical use. In addition, it is essential to create methodologies that take advantage of the interactive capacity of these technologies to make learning more accessible, meaningful, and adapted to the needs of students (Narciso *et al.*, 2024).

Table 1 - Calculation tools on modern devices

Calculation Tool	Description	Classroom Applications
Photomath	Application that solves mathematical equations scanned by the smartphone camera .	<ul style="list-style-type: none"> - Teaching algebra, step-by-step solving of equations. - Error analysis and alternative methods to solve problems.
GeoGebra	<i>Interactive geometry, algebra and calculus</i> software.	<ul style="list-style-type: none"> - Exploration of geometry concepts and mathematical functions. - Creation of simulations for visualization of graphs and shapes.
WolframAlpha	Computational engine to solve complex math and science problems.	<ul style="list-style-type: none"> - Support to scientific research projects. - Advanced problem solving in calculus, statistics, and physics.
Desmos	Online tool to create and explore mathematical graphs.	<ul style="list-style-type: none"> - Teaching of mathematical functions and graphical analysis. - Visualization of transformations in graphs.
Microsoft Math Solver	Application that solves mathematical problems and explains each step.	<ul style="list-style-type: none"> - Help with homework. - Review of concepts in basic and advanced mathematics.
Scientific Calculator on Smartphones	Native or downloaded apps that offer scientific calculator functions.	<ul style="list-style-type: none"> - Trigonometric, logarithmic and exponential calculations in physics and mathematics classes.
Python com SymPy	Programming tool to solve mathematical problems symbolically.	<ul style="list-style-type: none"> - Introduction to programming applied to mathematics. - Symbolic solutions for algebra and calculus.

MatLab Mobile	Platform for numerical calculations and advanced simulations.	<ul style="list-style-type: none"> - Modeling of mathematical systems in interdisciplinary projects. - Data analysis and scientific simulations.
Google Sheets/Excel	Electronic spreadsheets to perform calculations and analyze data.	<ul style="list-style-type: none"> - Construction of data tables and graphs. - Financial and statistical problem solving.
Khan Academy (App)	Educational platform that includes calculation tools and tutorials.	<ul style="list-style-type: none"> - Reinforcement of mathematical concepts through interactive videos. - Personalized exercises for students.

Source: authorship.

The calculation tools available on modern devices represent a significant transformation in the way students interact with mathematical knowledge. Apps like Photomath and GeoGebra, for example, exemplify the potential of technology to facilitate learning by offering interactive and visual solutions. According to Santos and Souza (2023), the use of mobile devices in the classroom can enrich the learning process, as long as it is mediated appropriately. These tools allow you to not only solve problems but also explore different approaches to understanding the underlying concepts, which is key to promoting more meaningful learning.

In addition, more integrative platforms, such as WolframAlpha and MatLab Mobile, have expanded the possibilities of teaching beyond the traditional classroom. These technologies are capable of solving complex problems, such as system modeling or statistical analysis, democratizing access to advanced calculation methods. UNESCO (2014) emphasizes that mobile learning, when well implemented, can transform access to knowledge and provide greater educational equity. In this sense, tools like these not only meet academic demands, but also prepare students for future challenges in the professional and scientific spheres.

However, the use of these tools requires a planned pedagogical approach, especially in the school context. Applications such as Microsoft Math Solver or the use of spreadsheets can be integrated into practical activities to develop applied skills, such as financial calculations or solving everyday problems. According to Santos and Braga (2023), technological mediation in the classroom should be structured to promote the development of specific skills, ensuring that students use the tools as allies in the construction of knowledge. Thus, interactive pedagogical practices aligned with the use of these technologies can minimize the challenges imposed by restrictions or misinformation about the educational potential of mobile devices.

Finally, the tools presented not only enhance individual learning, but also provide opportunities for collaboration and interdisciplinary work. Integrating platforms such as Desmos or Python with SymPy into school projects encourages critical thinking and creativity, while challenging students to apply mathematical knowledge in real-world situations. As Santos and Mariotto (2020) point out, understanding the historical and evolutionary role of technological tools allows for a broader view of their educational relevance. Thus, by dialoguing with the theoretical frameworks, it is possible to perceive that modern calculation tools expand the learning potential by promoting a dynamic interaction between technology and education.

RESULTS AND DISCUSSIONS

The trajectory of calculation tools, from pocket calculators to supercomputers integrated with mobile devices, illustrates the transformative impact of technology on daily life and education. In the 1970s, devices such as the HP-35 introduced portability and accessibility to the field of complex calculations, enabling their application outside of specialized environments. According to Santos (2017), the emergence of portable calculators marked an era of democratization of access to advanced mathematics, while expanding their applications in practical areas, such as engineering and accounting.

In parallel, the development of supercomputers in the 1960s, exemplified by models such as the CDC 6600, brought exponential advances in processing power. These systems, initially restricted to research centers, represented a milestone in technological evolution. According to Launay (2019), these machines were responsible for enabling scientific discoveries that depended on highly complex calculations. Over time, some of this capability has been integrated into mobile devices, making it possible for features previously exclusive to large laboratories to be accessible to anyone with a smartphone.

In addition, the technological convergence evidenced in platforms such as WolframAlpha or Python with SymPy demonstrates the reach of calculation tools in the contemporary context. For Santos and Souza (2023), the integration of these technologies in mobile devices has allowed not only to solve mathematical problems, but also to foster collaborative and interdisciplinary learning, especially in educational environments. Such tools now play a central role in promoting critical thinking and student engagement in practical projects.

Therefore, the evolution of calculation tools is more than a technological chronicle; It is a testimony of human ingenuity and its quest to broaden the horizons of knowledge. As Santos and Mariotto (2020) emphasize, understanding the historical and technological evolution of these tools is essential to recognize their educational and social relevance. Thus, these technologies, which began as rudimentary devices, have become indispensable tools, capable of integrating technology and education in order to prepare future generations for the challenges of the contemporary world.

CONCLUSION

This article sought to investigate the evolution of calculation tools, from their most rudimentary forms to modern technologies, highlighting their impact on educational and scientific practices. Throughout the work, the proposed objectives were fully met, offering an analysis of the technological transformations that occurred over time and the opportunities that these innovations provide in the educational environment. In addition, the challenges inherent to the incorporation of these technologies were addressed, especially in the school context, where pedagogical mediation plays a fundamental role in their effective use.

Initially, the study presented a historical overview of calculation tools, exploring the relevance of manual and mechanical devices in the advancement of science and mathematics. This trajectory has shown that, since ancient times, human beings have demonstrated creativity and ingenuity to overcome the limitations imposed by manual calculations, resulting in inventions that revolutionized the way of solving mathematical problems. The analysis highlighted that these tools not only met practical demands, but also served as precursors for the development of more advanced technologies, connecting past and present in a consistent way.

Subsequently, the analysis focused on the transformation of calculation tools with the advent of contemporary technologies. The integration of functionalities in mobile devices and digital platforms, for example, was identified as a milestone in the democratization of access to advanced calculation tools. In addition, technological convergence proved to be a determining factor to expand the applicability of these tools in various areas of knowledge, including education, scientific research and everyday life. Despite the restrictions and challenges faced, such as the inappropriate use of devices in the classroom, it was

concluded that the planned adoption of these technologies can enhance learning and promote greater educational equity.

Finally, the article addressed the pedagogical application of these tools, emphasizing the need for educational practices that integrate technology strategically. The continuing education of teachers and the development of public policies aimed at technological inclusion were highlighted as indispensable elements for the success of this integration. It was recognized that, although there are structural and cultural challenges, there is a vast field for pedagogical innovation, enabling calculation tools to contribute to the construction of a more interactive, meaningful teaching aligned with the demands of the twenty-first century.

Thus, it is encouraged that more research be done on this subject, deepening the analysis of the impacts of these tools on academic performance and educational practices. Future studies could investigate more effective strategies for technological incorporation in diverse school contexts, as well as explore the potential of emerging tools, such as quantum computing and artificial intelligence, in education. Thus, it is expected that the results of this work will inspire new discussions and practices, strengthening the relationship between technology, science and education for the benefit of a society more prepared for the challenges of the future.

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