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MICROSOFT EXCEL AND MATHEMATICAL PRECISION: REFLECTIONS ON EMPOWERMENT, EDUCATIONAL CHALLENGES AND POSSIBILITIES FOR INNOVATION

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ABSTRACT

The article analyzes the mathematical limitations of Excel, highlighting how multiple power inaccuracies present in the tool can influence global education. The analysis focuses on how these failures in the treatment of data and calculations can affect the quality of learning and the training of professionals, mitigating the impact on academic and scientific decisions. The research investigates the main recurring inconsistencies in the software, such as limitations in the calculation of large numbers and inaccuracy in the manipulation of exponential variables, proposing solutions to mitigate these problems. **Objective:** To investigate the mathematical limitations of Excel, especially power aspects that present inconsistencies, and how these problems affect global education, proposing alternatives to improve the reliability of the tools used in teaching and research institutions. **Methodology:** The study uses a literature review and technical analysis of mathematical inconsistencies found in Excel, comparing it with other calculation tools. The qualitative approach examines the application of Excel in different educational areas and the implications of these errors, in addition to analyzing the technical and scientific literature on the subject. **Expected Results:** Identify how power inaccuracies in Excel affect the accuracy of calculations in educational and research settings, highlighting the impacts on academic decisions, research projects, and scientific publications. It is also expected to highlight the effects of these errors on the training of professionals and the dissemination of erroneous data. **Conclusion:** It is concluded that, although Excel is widely recognized for its importance in global education, it is necessary to be aware of its limitations in mathematical calculations, such as the inaccuracies related to potentiation. To address these issues constructively, it is essential to promote greater awareness on the topic, invest in user training, and encourage the development of complementary solutions. Thus, it is possible to continue using this tool effectively, ensuring reliable results and reinforcing its role in learning and academic practice.

Keywords: Mathematical limitations. Excel. Power inconsistencies. Global education. Data reliability.

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INTRODUCTION

Potentiation is one of the fundamental concepts of Mathematics teaching, often introduced from the 6th grade of Elementary School. This topic is extremely important, as it not only serves as a basis for understanding more complex mathematical concepts, but also plays a crucial role in the development of students' logical reasoning. When addressing powers, students are challenged to think more abstractly and understand the relationship between numbers in a deeper way.

The teaching of Potentiation at the basic level of education is essential for the formation of a solid foundation, as it is directly related to several other mathematical contents that will be explored at more advanced levels, such as algebra, geometry and even in areas of exact and applied sciences. Concepts such as radiciation, exponential equations and geometric progressions, for example, have their understanding strongly supported by the understanding of Power.

In addition, Potentiation offers students the opportunity to improve cognitive skills that go beyond simply performing calculations. It encourages the development of logical reasoning, the ability to solve problems, and the analysis of numerical patterns, which contributes to the formation of a critical and analytical mindset. Therefore, teaching Empowerment properly in Basic Education is not only teaching a mathematical concept, but also providing the necessary tools for the academic and professional advancement of students, in addition to preparing them to solve everyday issues that require more refined quantitative thinking.

However, it is critical to recognize that despite its importance, Potentiation is also an often challenging concept for students, especially when it comes to manipulating powers of large numbers or understanding their applications in various situations. Therefore, effective teaching of this topic requires an approach that combines theory, practice, and contextualization, aiming to build solid and lasting learning.

THEORETICAL FOUNDATION

INCONSISTENCY IN CALCULATING POWERS IN MICROSOFT EXCEL: A GLOBAL EDUCATIONAL CHALLENGE

Microsoft Excel, one of the most widely used tools globally for data calculations and analysis, has a significant inconsistency in calculating powers involving negative numbers. According to the universal mathematical properties of operator precedence, the power

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(exponentiation) must be calculated before the application of the negative sign. Therefore, the expression **-2^2** should be interpreted as **−(2^2)**, resulting in **−4**. However, Excel performs the calculation as **(−2)^2**, returning **4**, which is in disagreement with the established mathematical conventions (DE MEDEIROS; GONÇALVES, 2023).

This discrepancy forces users to manually enter parentheses to ensure the correct result, as in **-(2^2).** This limitation can lead to misinterpretation, especially in educational settings, where Excel is often used to teach fundamental math concepts. The lack of conformity with universal mathematical rules can cause confusion among students and professionals, compromising the accuracy of calculations and the understanding of mathematical principles (DE MEDEIROS; GONÇALVES, 2023).

Note 1 – Power: sign, base and exponent – no parentheses

A2 | =-2^2

	A	B	C	D	E
1	Fórmula Excel	Fórmula Texto Excel	Resultado Excel	Resultado Matemático	Parecer
2	4	=-2^2	4	-4	**Errado**. Apenas o número dois está elevado ao quadrado

The widespread adoption of Excel in educational institutions around the world highlights the relevance of addressing these inconsistencies carefully. Teachers and students may unintentionally rely on inaccurate results, which can lead to inadequate understanding of concepts. To minimize these challenges, it is essential to:

1. **Include parentheses explicitly** (e.g., **-(2^2)** instead of **-2^2**).
2. **Make users aware** of this particularity of Excel.
3. **Propose to Microsoft** an urgent update in Excel to correct exponential calculations and avoid errors in global education.
4. **Consider alternatives**, such as software that strictly follows standard mathematical rules (DE MEDEIROS; GONÇALVES, 2023).

Correcting this behavior in Excel, or at least including a clear warning about this particularity, would be beneficial to ensure mathematical accuracy and contribute positively to learning.

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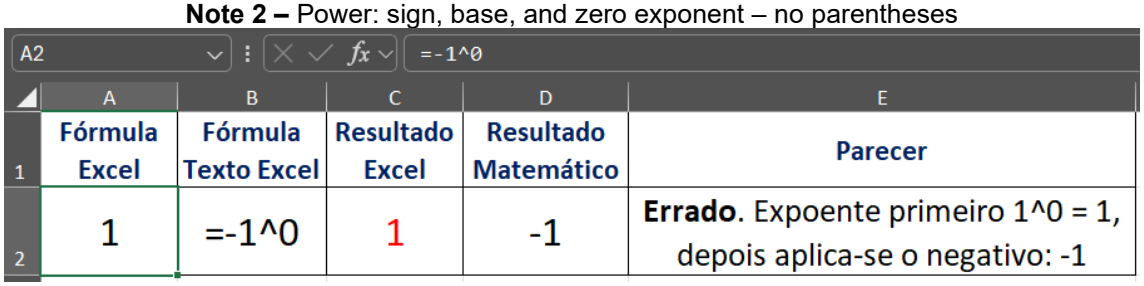
Note 2 – Power: sign, base, and zero exponent – no parentheses



	A	B	C	D	E
1	Fórmula Excel	Fórmula Texto Excel	Resultado Excel	Resultado Matemático	Parecer
2	1	=-1^0	1	-1	**Errado**. Expoente primeiro 1^0 = 1, depois aplica-se o negativo: -1

Microsoft Excel, widely used in scientific and educational calculations, also has an important limitation in the interpretation of mathematical expressions involving powers and negative numbers. An emblematic example occurs in the evaluation of the expression **−1^0**. According to the universal mathematical conventions of operator precedence, exponentiation must be solved before the negative sign can be applied. Therefore, the correct calculation would be **−(1^0) = −1**, because any number (natural greater than or equal to 1) raised to zero results in 1, and later the negative sign is applied (GONÇALVES, 2024).

However, Excel interprets this operation as **(−1)^0**, which results in a value **of 1**. This interpretation diverges from mathematical principles established before the development of the software, and can lead to inconsistent results in academic and professional analyses (GONÇALVES, 2024).

This inconsistency gains relevance in the educational context, where Excel is often used as a tool for teaching basic mathematical concepts. The imprecise interpretation of expressions such as −1^0 can negatively influence students' understanding of the precedence of operators and properties of powers (GONÇALVES, 2024).

In addition, in scientific and engineering applications, where numerical precision plays a key role, this limitation can lead to inconsistencies in calculations, especially in more complex formulas that involve multiple operations with exponents and negative signs.

Solutions and Recommendations

To mitigate these issues, it is recommended to:

1. **Explicit use of parentheses** (e.g., **−(1^0)** instead of **−1^0**).
2. **Awareness of users** about this particularity of Excel.
3. **Validation of results** in alternative software that strictly follows mathematical conventions.
4. **Inclusion of warnings** in Excel itself about this limitation.

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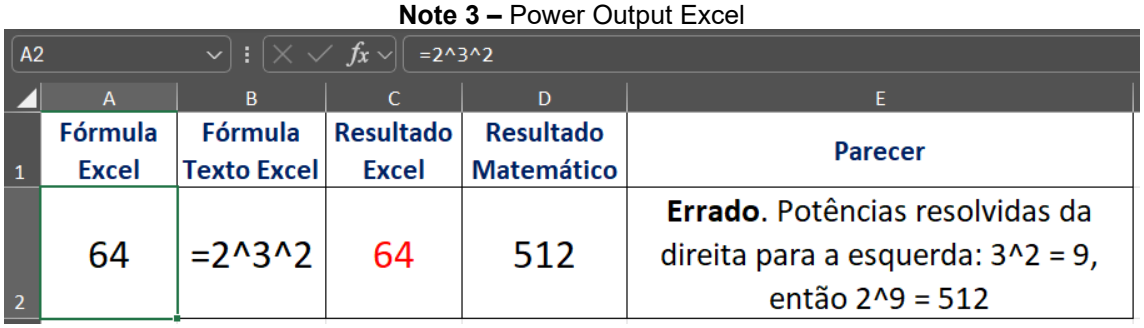
The correction of this behavior by Microsoft, or at least the inclusion of clear documentation on this characteristic, would be a valuable step to ensure the reliability of calculations in educational and professional contexts (GONÇALVES, 2024).

Note 3 – Power Output Excel



	A	B	C	D	E
1	Fórmula Excel	Fórmula Texto Excel	Resultado Excel	Resultado Matemático	Parecer
2	64	=2^3^2	64	512	**Errado**. Potências resolvidas da direita para a esquerda: 3^2 = 9, então 2^9 = 512

Failure to Calculate Chained Powers in Microsoft Excel and Their Impacts

Microsoft Excel has a limitation in the calculation of chained powers, as in the expression 2^3^2, which can impact its reliability in contexts that require mathematical precision. According to the universal norms of operator precedence, potentiation should be evaluated from right to left (right-hand associativity), which means that 2^3^2 should be calculated as 2^(3^2) = 2^9 = 512. However, Excel interprets this expression as (2^3)^2, returning the incorrect value 64 (DE MEDEIROS; GONÇALVES, 2020). This difference becomes even clearer when compared to the performance of Google Sheet, which performs the calculation correctly, providing the expected result of 512.

This discrepancy goes beyond a mathematical curiosity, posing a real challenge for users who rely on Excel for accurate calculations. In educational settings, where software is widely used to teach mathematical concepts, this interpretation can lead students to inadequate understandings about operator precedence. Similarly, in scientific and professional contexts that require accuracy in calculations, such as engineering, physics, and data analysis, this particularity can result in inconsistencies that go unnoticed.

The persistence of this limitation in one of the most widely used spreadsheet tools in the world deserves attention. While workarounds such as Google Sheets correctly apply mathematical rules, Excel introduces this behavior, encouraging users to adopt practices such as the explicit use of parentheses to ensure the correct order of operations, writing 2^(3^2) instead of 2^3^2. However, this approach does not address the broader aspect, which is the implementation of operator precedence in software.

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It is recommended that Excel users be aware of this characteristic and, when necessary, validate their calculations on other platforms, especially when working with complex formulas involving multiple powers. In the short term, it would be desirable for Microsoft to consider adjusting this behavior in Excel, bringing it in line with standard mathematical conventions and the functioning of other similar tools. Meanwhile, awareness of this particularity of Excel remains essential to prevent inconsistencies in critical applications.

Google Power Up

A2 =2^3^2

	A	B	C	D	E
1	Fórmula Google	Fórmula Texto Google	Resultado Google	Resultado Matemático	Parecer
2	512	=2^3^2	512	512	Certo. Potências resolvidas da direita para a esquerda: 3^2 = 9, então 2^9 = 512

A comparative analysis between spreadsheet tools reveals a fundamental difference in the treatment of basic mathematical operations. While Google Sheets, available for free, correctly calculates the expression 2^3^2 as 512 - strictly following the mathematical conventions of right-to-left associativity (right-to-left potentiation) -, Microsoft Excel presents a different interpretation by returning the incorrect value 64, interpreting the expression as (2^3)^2 (DE MEDEIROS; GONÇALVES, 2020).

This inconsistency goes beyond a simple implementation difference and raises concerns regarding one of the most widely used software globally for educational purposes. Excel, by presenting results that diverge from the fundamental rules of arithmetic, can compromise its reliability as a tool for teaching basic mathematics. Accuracy in educational tools is essential to ensure that mathematical concepts are conveyed correctly and effectively.

The impact of this difference is amplified considering:

1. The ubiquity of Excel in educational institutions.
2. The importance of potentiation as a fundamental operation.
3. The trust placed by educators in technological tools.

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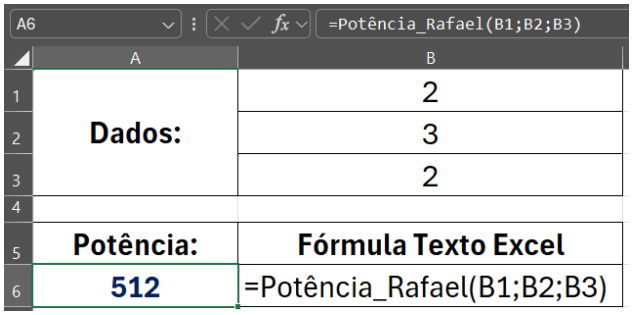
4. The contrast with free solutions that correctly implement the rules (DE MEDEIROS; GONÇALVES, 2020).

The persistence of this limitation in a paid and widespread tool like Excel deserves attention, especially when compared to the consistent performance of free alternatives like Google Sheets. This characteristic raises reflections on the adequacy of Excel as a pedagogical tool for teaching basic mathematical concepts (DE MEDEIROS; GONÇALVES, 2020).

Excel Power Output – Author



	A	B
1	Dados:	2
2		3
3		2
4		
5	Potência:	Fórmula Texto Excel
6	512	=Potência_Rafael(B1;B2;B3)

The author developed a program in Visual Basic for Applications (VBA) that respects this important mathematical property, demonstrating through simulations that it is possible to correct this inconsistency identified in Microsoft Excel.

```
Function Potência_Rafael(base As Double, _
                         expoente1 As Double, _
                         expoente2 As Double) As Variant

     If expoente1 = 0 And expoente2 = 0 Then
        Potência_Rafael = "Indeterminado"
        Exit Function
    End If

    If base = 0 And (expoente1 = 0 Or expoente2 = 0) Then
        Potência_Rafael = "Indeterminado"
        Exit Function
    End If

    Dim resultado As Double
    On Error GoTo ErroDeCálculo

    If base < 0 Then
        resultado = (-1) * (Abs(base) ^ (expoente1 ^ expoente2))
    Else
        resultado = base ^ (expoente1 ^ expoente2)
    End If

    Potência_Rafael = resultado
    Exit Function

ErroDeCálculo:
    Potência_Rafael = "Erro no cálculo"
End Function
```

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As presented by the professor, by demonstrating the potentiation operation through Excel, an innovative program in VBA was developed that strictly respects the fundamental mathematical principles. This system, the result of careful analysis and a continuous development process, ensures greater accuracy in calculations, simultaneously promoting computer security and student engagement in the learning process.

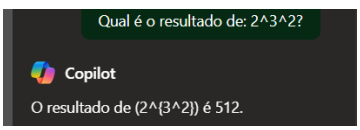
Program contributions and benefits:

1. The work carried out goes beyond the simple validation of expressions such as (−2)^0^0, using LaTeX notation for clarity.
2. The practical application of the program highlights its potential in educational contexts, offering teachers a pedagogical tool that not only corrects inconsistencies in calculations, but also enriches the learning of the student by aligning universal mathematical conventions.
3. In addition, the development of this program encourages the adoption of good computational practices and awakens in students the interest in programming and understanding how systems work. This also contributes to a broader education, which combines mathematical precision with indispensable technological skills.

The students' experience when using this program is unique, since it enables the construction of knowledge from solid concepts. However, Microsoft Excel, despite its widespread global use, still presents challenges in implementing these fundamental operations. The maintenance of these inconsistencies can impact both the accuracy of results and the effectiveness of teaching, especially in the context of universal concepts of mathematics.

Considering that Excel is a platform widely used in educational and professional contexts around the world — with an interface accessible to users of different languages — it is important that Microsoft evaluates the possibility of revising and improving its mathematical functions. Correcting these inconsistencies could not only represent a technical improvement, but also contribute significantly to the reliability of the tool and the quality of global teaching, especially in educational settings.

Copilot: Overcoming Excel Challenges



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Although it was released years after Microsoft Excel, the free Google Sheets spreadsheet demonstrates advances in mathematical accuracy by correcting inconsistencies seen in the market-leading software. Excel, despite being a widely consolidated and commercialized tool over the decades, presents challenges in the processing of basic mathematical operations, such as potentiation, which can impact its reliability in some contexts.

The recent integration of Copilot into the Excel platform, although it represents a technological advance, ends up further highlighting the structural limitations of the software. The fact that such inconsistencies are addressed with the aid of artificial intelligence suggests an opportunity for the development of native and robust solutions in the future.

Given this scenario, it is important to consider a review of Excel's functional architecture, focusing on the implementation of fundamental mathematical operations. Users of a platform widely recognized in the market value accuracy and excellence as essential characteristics. Addressing these discrepancies would contribute to further strengthening the relevance and credibility of Excel in academic, scientific, and corporate settings.

The current scenario highlights a relevant issue: while researchers develop precise solutions in VBA to improve the mathematical operations of Excel — as demonstrated in recent scientific publications — Microsoft continues to distribute worldwide a tool that presents challenges in fundamental operations. This situation goes beyond a technical detail, highlighting the importance of improving the tool in educational and professional contexts.

The problem manifests itself especially significantly in three emblematic operations: when it calculates 2^3^2 and returns 64 instead of the correct value 512; by evaluating -2^0^0 as 1, ignoring that it should be indeterminate, and when presenting -3^0^5 as 1, when the mathematically accurate result would be -1. These inconsistencies are not exceptions, but symptoms of an implementation that does not align with basic mathematical rules.

The impact on education is significant. Considering that Excel is present in the vast majority of schools around the world, these inconsistencies can lead to the teaching of mistaken mathematical concepts to many students. The consequences extend across four important dimensions of learning: understanding operator precedence, mastery of

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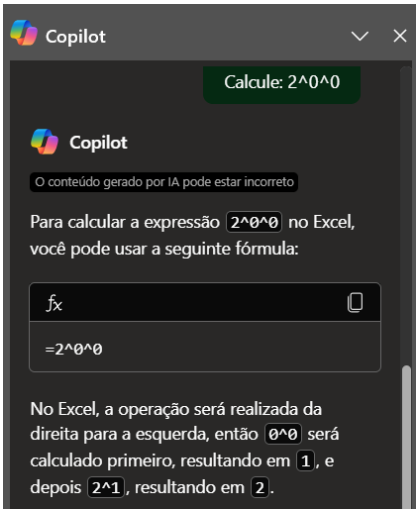
potentiation properties, understanding mathematical limits, and recognizing situations of indeterminacy.

The paradox becomes more evident when comparing with free alternatives such as Google Sheets, which performs the 2^3^2 calculation according to mathematical conventions. This difference raises reflections about the cost of Excel licenses, considering challenges in basic operations that other tools solve correctly. Integration with Copilot, by correcting some of these inconsistencies, highlights the opportunity to further enhance the mathematical foundation of the software

The situation demands immediate attention. It would be important for Microsoft to recognize these historical limitations; implement improvements in the next update; develop an educational module with revised calculations; and consider ways to support educational institutions that have used its tool. As a leader in the spreadsheet market, Microsoft plays a key role in advancing global education. Each day without progress represents students being exposed to possible inconsistencies in mathematical concepts — something that can negatively impact scientific education. Mathematical precision is essential, as it supports logical thinking and critical training in all areas of knowledge.

Copilot & Excel: Challenges in Building Global Trust



Challenge in Power Calculation in Excel and Its Reflection on Mathematics Education

A detailed analysis indicates that Microsoft Excel presents challenges in calculating exponential expressions, which may impact its effectiveness as a tool for teaching and applying mathematics. When evaluating the expression "2^0^0", we identified two

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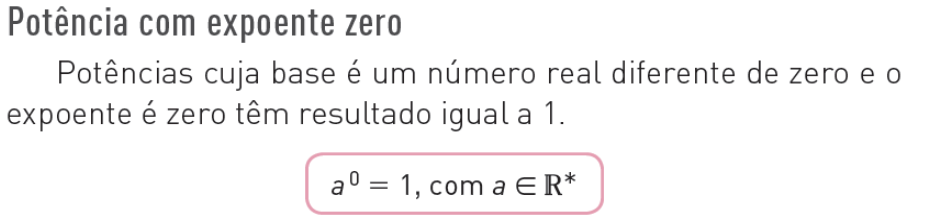
inconsistencies: first, Excel does not adopt the standard mathematical convention of solving powers from right to left; second, it treats the expression 0^0 as defined, although it is considered indeterminate in certain mathematical contexts.

These inconsistencies go beyond mere technical details, and can impact the integrity of mathematical education. Excel, widely used in classrooms and professional settings around the world, can inadvertently present inaccurate concepts to millions of users. When students and professionals rely on the results of the software without analyzing its mathematical foundations, there is a potential impact on learning and the quality of teaching.

The situation becomes even more worrying when compared to other tools. While workarounds correctly implement the mathematical rules, Excel persists with these basic errors, despite being a paid and widespread software. This discrepancy calls into question the reliability of one of the most widely used calculation tools globally.

The impacts of this mathematical imprecision can be broad and relevant. Students who learn from these imprecise concepts can carry these inconsistencies into their professional careers, influencing important areas such as engineering, economics, and the exact sciences. In addition, a lack of consistency in basic mathematical rules can reduce trust in digital learning tools. (DE MEDEIROS; GONÇALVES, 2020, p. 72).

It is important that Microsoft consider recognizing and correcting these inconsistencies. The educational community benefits from tools that reinforce the correct mathematical principles, promoting confidence and excellence in teaching. While these improvements are not implemented, educators can address existing limitations by supplementing teaching with explanations of the correct mathematical conventions and ensuring that students develop a critical and accurate understanding of fundamental concepts.



Source: (Alfha Mathematics Generation, 2022)

Given its prominent position and global reach, it is important for Microsoft to evaluate and implement improvements to address this gap in its tools. The persistence of elementary

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mathematical inconsistencies suggests an opportunity to improve the platform's validation and development processes. Considering feedback from your user base can reinforce your company's priorities and contribute to confidence in your solutions.

This scenario can generate challenges for education on a global scale, highlighting the importance of ensuring the reliability of software that is widely used in academic and professional contexts. Addressing these inconsistencies should not only be seen as a functional improvement, but also as an opportunity to reinforce ethical principles. Aligning tools with the standards of accuracy and quality required by education and science contributes directly to the advancement of teaching and scientific practices. (DE MEDEIROS; GONÇALVES, 2020, p. 72).

Note 4 – Power & Square Root

A2 | =-4^(1/2)

	A	B	C	D	E
1	Fórmula Excel	Fórmula Texto Excel	Resultado Excel	Resultado Matemático	Parecer
2	#NÚM!	=-4^(1/2)	#NÚM!	-2	**Errad**o. Expoente primeiro-4^(1/2) = 2, depois aplica-se o negativo: -2

Microsoft Excel has another inconsistency in its mathematical implementation when interpreting the expression -4^(1/2). According to universal mathematical properties, this operation is equivalent to -√4, where only the number 4 is subjected to radiciation, resulting in -2. However, Excel considers the basis as negative, interpreting the expression as (-4)^(1/2), which generates a complex result that is inappropriate in the context of real calculations (GONÇALVES, 2024, p. 477).

This limitation is not just a technical issue, but indicates an opportunity to improve the system and strengthen the reliability of software that:

1. It has been marketed for decades as a professional tool.
2. It is widely used in educational institutions.
3. It serves as a reference for millions of users.
4. The need to acquire licenses that can be expensive.

The educational impact of this limitation deserves attention. As highlighted in the analysis "Decades of Inefficiencies and Empty Updates in Excel: Rootedness and its Implications", the software can introduce inaccurate mathematical concepts to students

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(GONÇALVES, 2024, p. 477). Teachers who rely on Excel as a pedagogical tool are unknowingly transmitting notions that need correction:

1. The precedence of operators.
2. The treatment of negative signs in exponential expressions.
3. The difference between unary and binary operations.

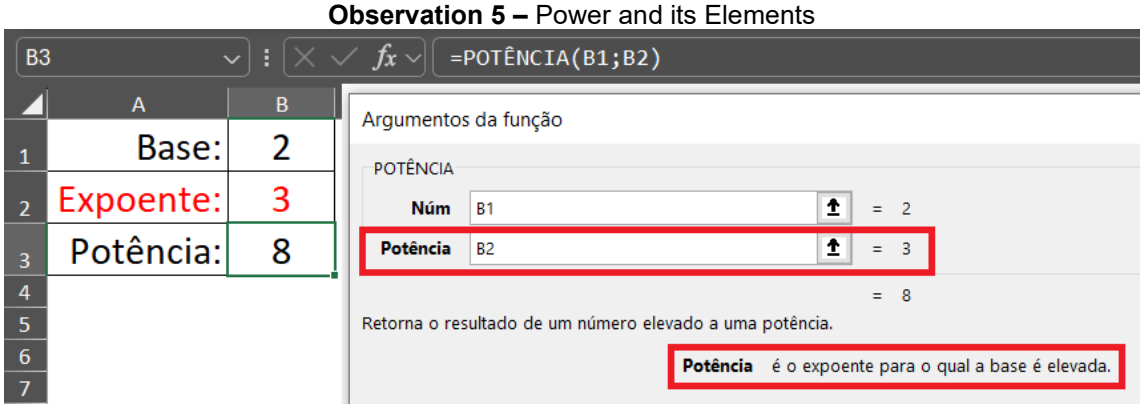
The continuation of this limitation over so many years of development and updates brings to light important reflections on Microsoft's commitment to:

1. Mathematical precision.
2. Educational quality.
3. The reliability of your tools.
4. Global scientific advancement.

While smartphone solutions and scientific calculators correctly implement these basic operations, Excel presents challenges in implementing one of the fundamental principles of mathematics. This situation draws attention, especially considering the technological and financial resources available to a company the size of Microsoft.

The solution to this issue does not require complex technological advances, but rather:1. Recognition of the problem.2. The willingness to correct historical implementations.3. Respect for established mathematical principles.4. The commitment to quality education (GONÇALVES, 2024, p. 477).

Observation 5 – Power and its Elements



The concept of empowerment, introduced in the initial grades of basic education, is an essential content that accompanies students throughout their school education. Due to its importance in areas such as financial mathematics, engineering, and exact sciences, it is crucial that computational tools are designed in a way that facilitates learning. However, in

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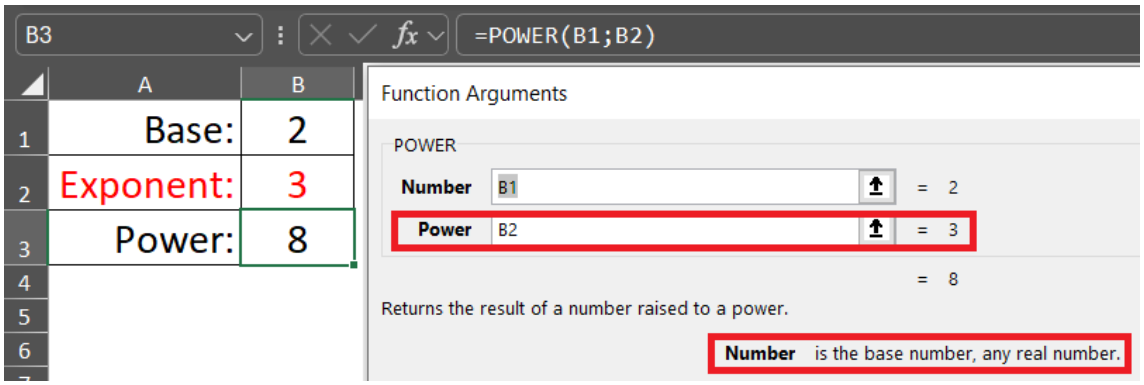
the Microsoft Excel power function, the field destined to the exponent value can be confusing, because many users, conceptually, expect to insert the result of the operation in this location. This detail can make it difficult to understand the elements involved in the calculation. (GONÇALVES, 2024, p. 155).

While this conceptual inconsistency has been pointed out in previous reviews, there is still room for Microsoft to consider major adjustments. Although it seems simple, the issue can impact the teaching of mathematics on a global scale. This scenario highlights the relevance of large corporations promoting educational tools that are aligned with mathematical fundamentals. Facing limitations like this can contribute to widely used software supporting even more the learning of essential mathematical concepts. (GONÇALVES, 2024, p. 155).

Power in Excel – Challenge in Reference to the Exponent



Studies indicate that this conceptual limitation in Excel is not restricted to the Portuguese version. The equivalent function in English, called POWER, also presents the same challenge, suggesting that it is a structural issue in the design of the function and not just a translation problem. Introduced in 1985 for Mac and in 1987 for Windows, the powering function has been widely used for decades. Given the simplicity of the fix and the positive impact it could have for millions of licensed users, it is relevant to reflect on the importance of reviewing aspects like this. Improvements in this regard can strengthen Microsoft's role in developing tools that support math education and contribute positively to global education. (GONÇALVES, 2024, p. 155).

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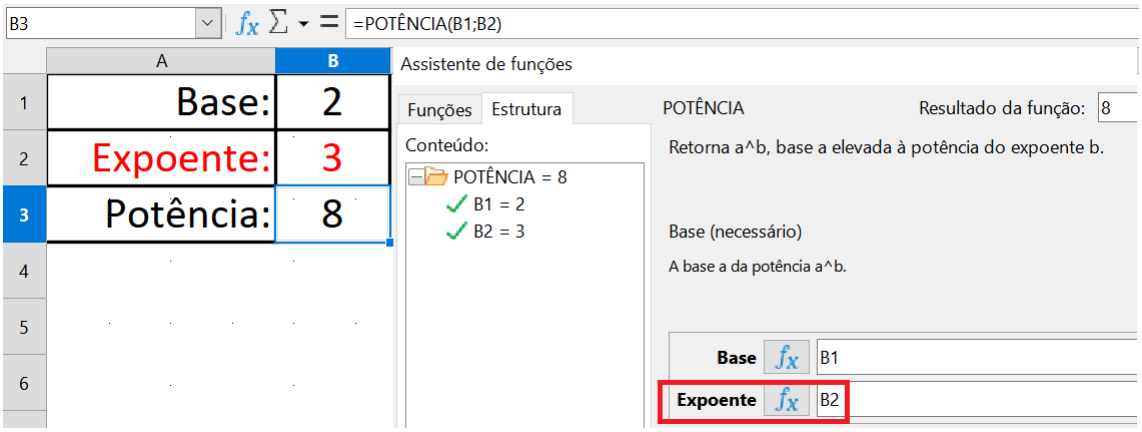
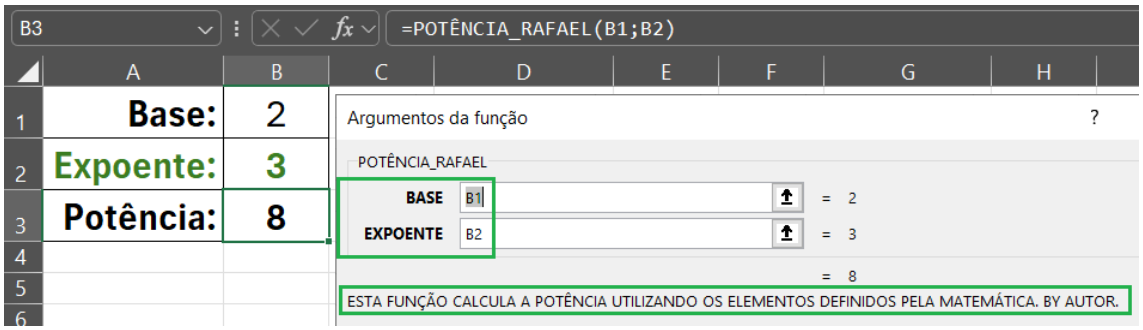
Calc – Correct Exponent



An additional relevant point is the comparison with Calc, an open-source spreadsheet software with a free license, which performs the calculation of power in line with mathematical principles. It is interesting to note that a free tool offers clear and pedagogical instructions for students and users in general, while Excel, a widely used commercial solution, presents a misconception that can hinder learning. In addition, Excel uses the nomenclature 'Num' in the Portuguese version and 'Number' in the English version to indicate the power base, which may cause doubts about the specific meaning of the term. This contrast highlights the importance of prioritizing conceptual clarity in the development of educational software, in order to ensure that widely used tools contribute positively to the education of millions of people. (GONÇALVES, 2024, p. 155).

Author – Correct Excel – Exponent



As already pointed out, correcting this limitation in Excel would not impact existing spreadsheets, which certainly represent a significant number. However, its correction could bring significant benefits to teaching and learning, contributing to a more accurate understanding of the concept of potentiation. Making this adjustment would be an important

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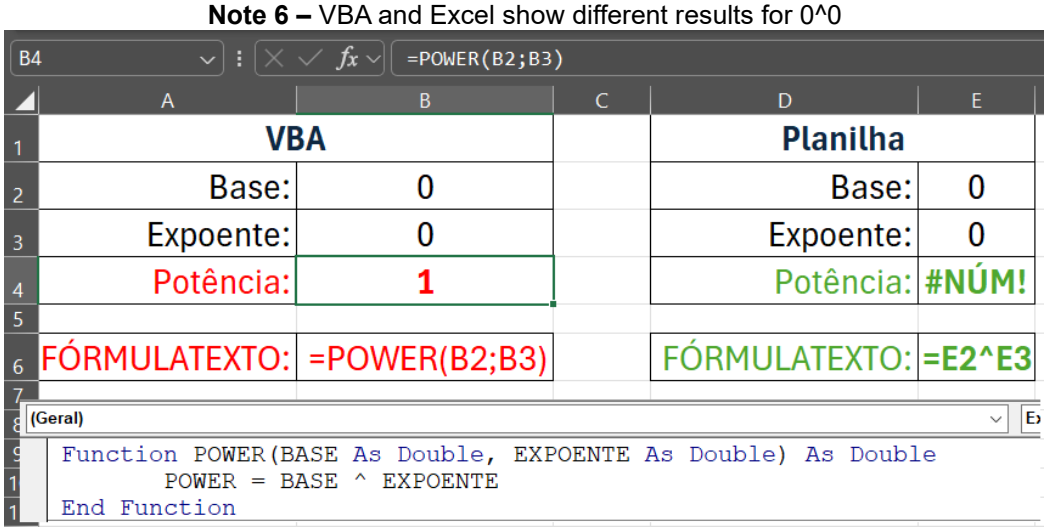
opportunity to reinforce the quality and accuracy of mathematical knowledge disseminated on a global scale. (GONÇALVES, 2024, p. 155).

Note 6 – VBA and Excel show different results for 0^0



It is mathematically established that the expression 0⁰ (zero to the power of zero) is an indeterminate form. This indeterminacy stems from conflicting limits in mathematical analysis: while lim_(x→0⁺) x⁰ = 1, we have to lim_(x→0⁺) 0x = 0. Therefore, 0⁰ does not have a definite value in pure mathematics. However, serious inconsistencies are identified in the implementation of this concept in Microsoft Excel and its VBA:

1. In the VBA environment, the expression 0^0 returns 1, following a convention adopted in some areas of discrete mathematics. However, this approach may not be the most suitable for general calculation tools.
2. In the Excel spreadsheet, the same expression 0^0 returns the error #NÚM!, reflecting a different approach, more aligned with analytical mathematical principles.

This difference between Excel environments deserves attention, because:

1. VBA is widely recognized as an advanced environment within the Excel environment.
2. Divergence is related to a fundamental mathematical concept.
3. It can lead to significant conceptual misconceptions, especially in educational contexts.

It should also be noted that:

1. The 0/0 division is also undefined in mathematics.
2. Ideally, computational tools could clearly signal these uncertainties.

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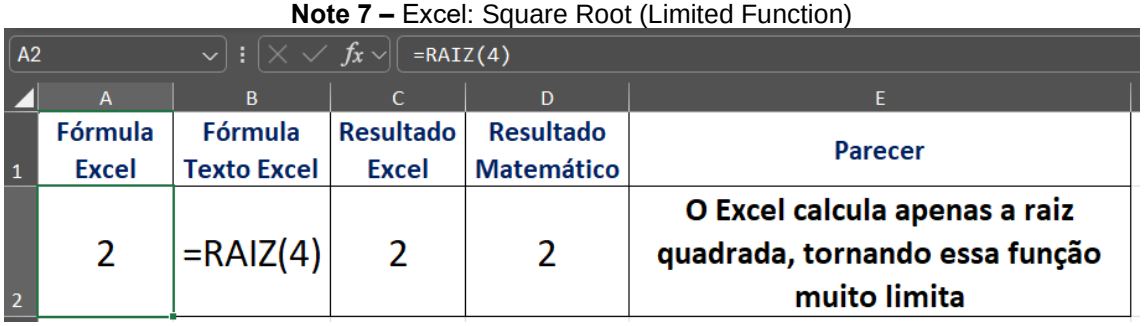
3. For rigorous calculations, it is recommended to use specialized systems such as Wolfram Alpha or Python with symbolic mathematics libraries.

This case demonstrates how some computational implementations can inadvertently generate inconsistencies in fundamental mathematical concepts, with possible negative impacts on the teaching and practical application of mathematics. Excel, widely used as a pedagogical resource in various contexts around the world, can face challenges in this regard, making learning difficult by presenting certain conceptual inconsistencies.

Note 7 – Excel: Square Root (Limited Function)



	A	B	C	D	E
1	Fórmula Excel	Fórmula Texto Excel	Resultado Excel	Resultado Matemático	Parecer
2	2	=RAIZ(4)	2	2	**O Excel calcula apenas a raiz quadrada, tornando essa função muito limita**

The square root function in Excel has certain limitations, as observed by Gonçalves and Rodrigues in the work *Technological literacy in the early grades* (2023), in the chapter entitled 'What is the purpose of the square root function in Excel?'. The authors discuss the pedagogical challenges of this functionality and suggest possible advances that can expand its educational applicability, especially considering the investment associated with the annual license of the software.

It is an important function for the training of students, with applications in various areas of knowledge, such as finance, statistics, engineering and computing. However, as observed by Gonçalves and Rodrigues (2023, p. 148), Excel could broaden its approach to the rooting process, including elements such as the index, the rooting and the root itself. Improvements in this regard could strengthen its effectiveness as a tool to support mathematical teaching and learning.

The square root function in Excel has some limitations that can impact its effectiveness. As illustrated in the image below, the function requests the rootand, but uses the term 'Num', which is generic and may not make it clear which parameter should be entered. This less specific nomenclature can generate doubts for users, making it difficult to fully understand the functionality.

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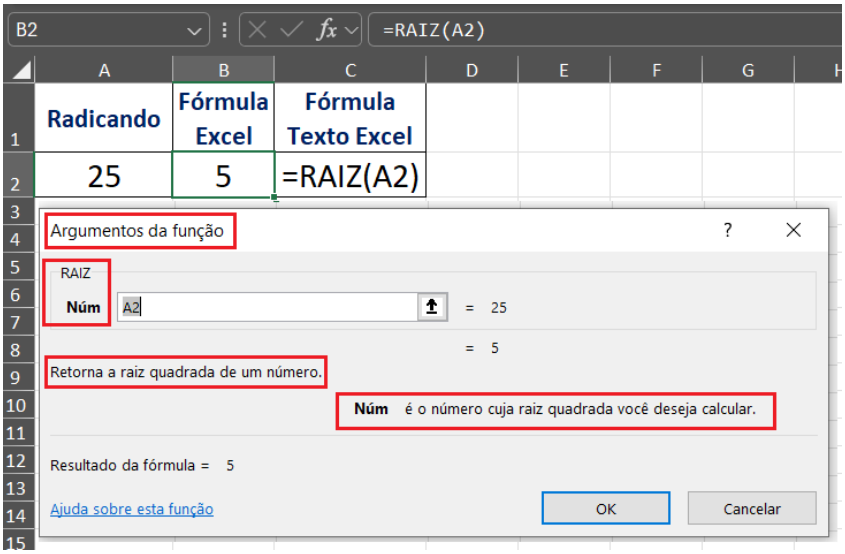
In addition, the use of the term 'arguments' may generate doubts. Although Excel refers to the function as if it accepts multiple arguments, in practice, the square root function requires only a single input: the rootand. This terminological choice can lead to misinterpretations, suggesting that the function could operate with more than one value, which does not reflect its actual functionality.

These conceptual limitations influence the clarity and usability of the square root function, making it less intuitive and reducing its effectiveness as a tool for accurate mathematical calculations. In an educational context, where accuracy in terminology and clarity of tools are critical to learning, these issues can pose significant challenges.

Excel: Limitation and Adjustments in Grammatical Agreement



Excel: Square Root (Unlimited Function in Dollars) – Author

Excel offers VBA, allowing users to customize functionality and expand spreadsheet limits. However, it would not be ideal for teachers to need to develop solutions to circumvent technical issues of the software. As mentioned in the chapter, several limitations have been identified, reinforcing the importance of Microsoft considering revisions to improve the program, especially given the significant impact of these issues on the educational context.

The suggestion of correction for the square root function, although simple, can bring significant improvements, especially in the context of mathematics classes. The inclusion of elements such as the index and the radicando expands the functionality of the tool, allowing

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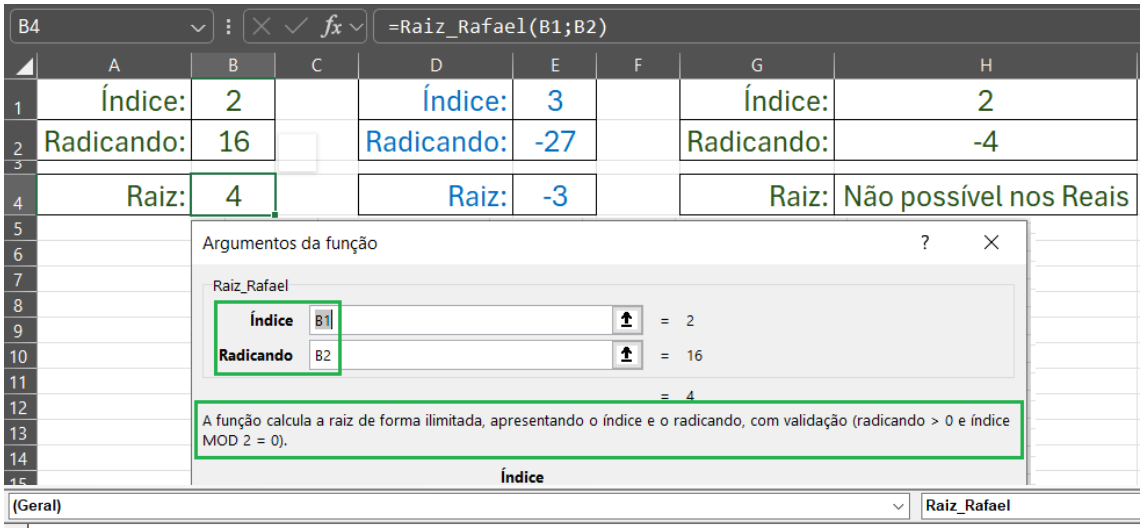
for more flexible and accurate simulations. This contributes to facilitating learning and promoting experimentation on the part of students.

Another relevant aspect of this correction proposal is the guidance offered by the function, especially in the field of validations. In addition to informing the student about the impossibility of calculating the set of real numbers, the function can also introduce concepts that prepare the student for the study of the set of imaginary numbers. As noted by Gonçalves and Rodrigues (2023, p. 148), this approach not only solves immediate doubts, but also enriches classes by connecting practical content with mathematical theory that will be explored in future stages.




```
Function Raiz_Rafael(Índice As Double, Radicando As Double) As Variant
    Dim resultado As Variant

    If Radicando > 0 And Índice Mod 2 = 0 Then
        resultado = Radicando ^ (1 / Índice)
    ElseIf Radicando < 0 And Índice Mod 2 = 0 Then
        resultado = "Não possível nos Reais"
    ElseIf Radicando < 0 And Índice Mod 2 <> 0 Then
        resultado = -((-Radicando) ^ (1 / Índice))
    Else
        resultado = Radicando ^ (1 / Índice)
    End If

    Raiz_Rafael = resultado
End Function
```

The code calculates the power of n forms, validating correctly with radicando > 0 and MOD index 2 = 0, avoiding the expression #NÚM!.

The square root function in Excel is designed to provide a quick solution in basic numerical calculations, catering to both professional and academic contexts. However, as Gonçalves and Rodrigues (2023, p. 148) note, its current implementation can be improved

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to better meet educational needs. Although Excel's SQRT function adequately performs its computational role by providing the numerical value of the square root, there is room to evolve as a pedagogical tool, broadening its approach and contextualizing the conceptual elements of the mathematical operation.

This limitation becomes especially relevant in the educational context, where function could play a more significant role in connecting mathematical theory with its practical application. However, as mentioned by Gonçalves and Rodrigues (2023, p. 148), the current implementation presents challenges that could be addressed to enhance this potential:

1. Simplify the mathematical operation, prioritizing the numerical result to the detriment of its broader meanings.
2. Not including fundamental components of radiciation, such as index, root, and root, in the function presentation
3. Failing to take advantage of opportunities to support the teaching of essential mathematical concepts and enhance practical understanding
4. Using the term "Num" instead of "rooting," which can cause terminological doubts and reduce clarity in the interpretation of the function.

Although it has a significant educational purpose, the function could be more widely used if it integrated more complete explanations directly into the tool, without relying on complementation by teachers. This scenario, where software widely used in classrooms faces challenges to fully meet the demands of teaching, highlights an important opportunity to improve its contribution to the education of students, especially in mathematics.

Note 8 – Exact function: a precise inconsistency

A2 | =EXATO(2^3^2;512)

	A	B	C	D	E
1	Fórmula Excel	Fórmula Texto Excel	Resultado Excel	Resultado Matemático	Parecer
2	FALSO	=EXATO(2^3^2;512)	FALSO	512	A função EXATO no Excel interpreta **errado** EXATO(2^3^2;512)

The EXACT Boolean function in Excel brings to light some inconsistencies in the software that can affect the educational context in a significant way. These points reinforce the importance of Microsoft considering adjustments to address the issues highlighted in order to improve the quality of teaching and the effectiveness of the pedagogical tools available.

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Note 9 – Inconsistency in Excel's Boolean Function: -3^2<> 3^2

A2 =-3^2=3^2

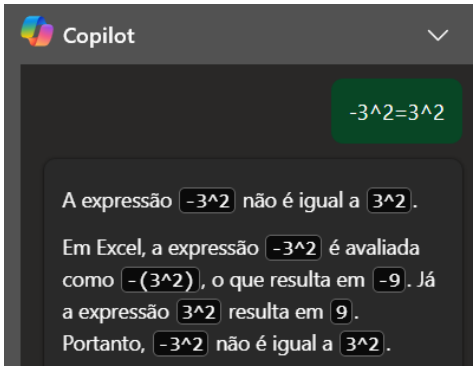
	A	B	C	D	E
1	Fórmula Excel	Fórmula Texto Excel	Resultado Excel	Resultado Matemático	Parecer
2	TRUE	=-3^2=3^2	TRUE	FALSE	O Excel **erra** ao calcular -3^2, resultando em 9, quando o correto é -9

It is interesting to note that when using the comparison sign in the expression −3^2 = 3^2, Excel returns the value **TRUE.** This behavior highlights a discrepancy in the way Excel interprets mathematical operations, considering the rules of precedence. According to mathematical principles, the correct calculation would be −3^2 = 9 should be -3^2 = -9, while for 3^2 the result is 9. This misinterpretation, which is not related to language or location, represents a universal challenge, with a potential impact on learning in different educational contexts.

In addition, it is worth mentioning that the points mentioned in the chapter were identified in the latest version of the software, the licensed Office 365. This demonstrates that even after years of developing and perfecting Excel functions, there is still room for improvement. Considering the significant educational impact these functions can have, it would be a valuable opportunity for Microsoft to invest in adjustments that better meet the needs of education.

These aspects can pose significant challenges for global education, given that Excel is widely used as a teaching tool in schools and universities. Such limitations can influence the learning of essential mathematical concepts. Investing in tweaks and improvements could strengthen the software's role as a valuable educational resource, ensuring greater mathematical accuracy and support for learning.

Copilot and Excel: Reflections on the Mathematical Paradox



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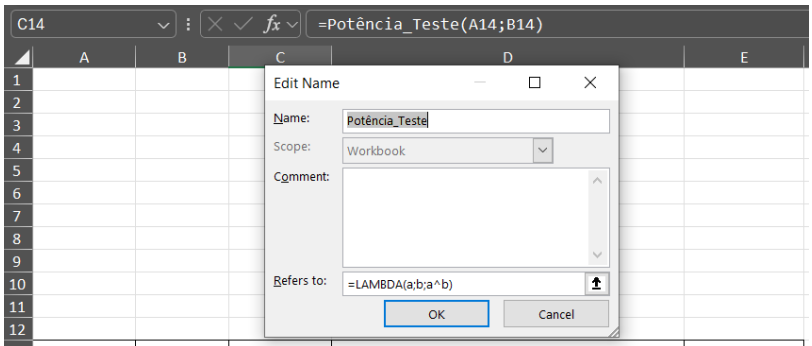
It is curious to note that, while the Copilot available in Excel provides the correct answer for expressions such as −3^2 = -9 and = 3^2 = 9, the Excel spreadsheet itself still has inconsistencies in the interpretation of these operations. This situation highlights an opportunity for software improvement, especially considering its extensive use in mathematical calculations and analysis. With these improvements, Excel could further cement its role as an effective and reliable tool for both professional and educational contexts.

This contrast between the analysis performed by Copilot and the incorrect behavior of Excel highlights the urgency of revisions and corrections in the software. The discrepancy shows that, while the artificial intelligence integrated into Excel can perform the analysis properly, the basic software does not keep up with this level of accuracy, which can have profound impacts on the educational process. This flaw, being persistent in such a widely used tool, raises questions about Microsoft's responsibility to ensure the quality and accuracy of its educational tools, so as to prevent errors like this from harming the learning of students around the world.

Note 10 – LAMBDA Function Error: -7^0 = 1



Base	Expoente	Resultado Excel (LAMBDA)	Fórmula Texto Excel	Resultado Matemático
-7	0	1	=Potência_Teste(A14;B14)	-1

The **LAMBDA** function introduced in Office 365 Excel in 2020 brought an important innovation by allowing users to create custom functions using the native Excel language. This functionality improves the efficiency and readability of spreadsheets by turning repetitive formulas into named functions. Despite the advantages, the points of improvement highlighted in the chapter indicate opportunities to further enhance the software, especially considering the investment associated with its licenses and its wide global use.

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The author, with his experience as a teacher, has pointed out for more than a decade the challenges that some Excel features can bring to the learning of fundamental concepts. As education is essential for the progress of several areas, these issues can impact important sectors, such as healthcare, industries, and the military. This situation underscores the importance for Microsoft to consider adjustments to the software in order to strengthen both the educational process and its application in meaningful professional contexts.

Gonçalves (2023) points out that the mathematical errors observed in Excel can pose significant challenges for education and professional applications, especially in areas that require high accuracy in calculations. While the LAMBDA function has introduced important advancements for spreadsheet customization, there are still opportunities for improvement in the way the software handles basic operations like potentiation and splitting. According to the author, it is essential that Microsoft considers these points, along with a broader awareness among users and educational institutions about the limitations of the tool.

FINAL CONSIDERATIONS

Microsoft Excel, widely used in educational and professional contexts, presents opportunities for improvement that can strengthen its role as a learning tool, especially in basic and technical education. Despite its great reach and functionality, points of improvement were identified related to calculations such as potentiation, arithmetic operations and data validation. These aspects can impact the educational use of the program, highlighting the relevance of future adjustments. A greater commitment to technical improvement could benefit users around the world by broadening their contribution to teaching and professional practice.

The results obtained in this research are important for society and for academia, as they highlight the urgent need to review the use of Excel in educational practices. The academic community and educators should be aware of the limitations of this tool and seek alternatives that ensure more accurate and effective learning for students. In addition, by presenting these flaws, this study seeks to alert to the importance of a more critical and technical approach in the choice of educational tools, especially in areas that require mathematical precision, such as Potentiation. Recognizing these inconsistencies will allow educational institutions to adapt their curricula and adopt more efficient methods for

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teaching mathematical concepts, in addition to stimulating the adoption of more reliable and robust software.

While this study has provided a comprehensive overview of Excel's flaws and its impact on education, it does have some limitations. First, the research focused on documented cases of Excel failures, without exploring in a deeper way the individual and contextual variables that can contribute to the indiscriminate adoption of this tool in different educational contexts. In addition, the data analyzed is limited to secondary sources, such as previous studies and user reports, which could be complemented with more detailed empirical analysis, such as interviews with educators or a broader assessment of the impact on classrooms.

For future investigations, it is recommended that a more in-depth analysis of Excel mathematical errors be carried out, with specific case studies involving educational practice and real-time data analysis. It would also be interesting to carry out a comparative research between Excel and other calculation tools, in order to identify more accurate and appropriate alternatives to the educational environment. In addition, studies on the training of educators in the use of digital tools, considering their limitations and potentialities, can contribute to a better implementation of technologies in mathematics teaching. The review of curricula and the proposal of specific training for the use of tools such as Excel in schools are also important points to ensure that educators can prepare their students more effectively, promoting quality mathematics education free of harmful errors.

In summary, although Excel is a widely used tool, there are still opportunities for improvement to ensure greater mathematical accuracy, especially in the educational context. It is relevant that society, academia and educational institutions evaluate complementary alternatives and promote a more reflective approach in the teaching of mathematical concepts, strengthening learning with resources that better meet educational needs.

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