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MICROSOFT EXCEL AND CONCEPTUAL SILENCING: CHALLENGES FOR STATISTICAL LITERACY IN THE DIGITAL AGE

MICROSOFT EXCEL E O SILENCIAMENTO CONCEITUAL: DESAFIOS PARA A ALFABETIZAÇÃO ESTATÍSTICA NA ERA DIGITAL

MICROSOFT EXCEL Y EL SILENCIAMIENTO CONCEPTUAL: DESAFÍOS PARA LA ALFABETIZACIÓN ESTADÍSTICA EN LA ERA DIGITAL

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ABSTRACT

This article examines the lack of conceptual clarity in Excel's Statistical Summary, with emphasis on the omission of the definition of the type of standard deviation being calculated—sample or population. This ambiguity undermines conceptual accuracy and may lead to confusion in the teaching and learning of Statistics, especially in educational contexts where Excel is used as a didactic tool. Teaching with Excel is different from calculating with Excel—a fundamental distinction that this study seeks to highlight by analyzing how the software's interface and features influence users' conceptual understanding. The research adopts a qualitative approach, grounded in a literature review, analysis of technical manuals, and observations in school environments. Examples are presented to demonstrate how this inconsistency affects the statistical education of students and teachers on a global scale. In contrast, the article discusses the pedagogical approach adopted by Copilot in Excel, which offers greater clarity in distinguishing between types of standard deviation, emphasizing the role of artificial intelligence in promoting more accessible statistical foundations. Finally, the article proposes a redesigned Statistical Summary model with a didactic focus, incorporating graphical elements, conceptual explanations, and interpretations in natural language, aiming to make the teaching of Statistics more contextualized, intuitive, and aligned with best educational practices.

Keywords: Excel. Statistics. Standard Deviation. Statistics Education. Copilot. Educational Technologies.

RESUMO

Este artigo analisa a ausência de clareza conceitual no Resumo Estatístico do Excel, com ênfase na omissão da definição do tipo de desvio padrão calculado — amostral ou populacional. Essa ambiguidade compromete a precisão conceitual e pode gerar confusão no ensino e aprendizagem da Estatística, sobretudo em contextos educacionais que utilizam o Excel como ferramenta didática. Ensinar com Excel é diferente de calcular com Excel — uma distinção fundamental que este estudo busca evidenciar ao analisar como a interface e os recursos do software influenciam a compreensão conceitual dos usuários. A pesquisa adota uma abordagem qualitativa, fundamentada em revisão bibliográfica, análise de manuais técnicos e observações em ambientes escolares. São apresentados exemplos que

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evidenciam como essa inconsistência afeta a formação estatística de estudantes e professores em escala global. Em contraponto, o artigo discute a abordagem pedagógica adotada pelo Copilot no Excel, que apresenta maior clareza na distinção entre os tipos de desvio padrão, destacando o papel da inteligência artificial na promoção de fundamentos estatísticos mais acessíveis. Propõe-se, por fim, um modelo reformulado de Resumo Estatístico, com foco didático, que incorpora elementos gráficos, explicações conceituais e interpretações em linguagem natural, visando tornar o ensino da Estatística mais contextualizado, intuitivo e alinhado às boas práticas educacionais.

Palavras-chave: Excel. Estatística. Desvio Padrão. Ensino de Estatística. Copilot. Tecnologias Educacionais.

RESUMEN

Este artículo analiza la falta de claridad conceptual en el Resumen Estadístico de Excel, haciendo hincapié en la omisión de una definición del tipo de desviación estándar calculada (muestra o población). Esta ambigüedad compromete la precisión conceptual y puede generar confusión en la enseñanza y el aprendizaje de la estadística, especialmente en contextos educativos que utilizan Excel como herramienta didáctica. Enseñar con Excel es diferente a calcular con Excel, una distinción fundamental que este estudio busca destacar mediante el análisis de cómo la interfaz y las características del software influyen en la comprensión conceptual de los usuarios. La investigación adopta un enfoque cualitativo, basado en una revisión bibliográfica, el análisis de manuales técnicos y observaciones en entornos escolares. Se presentan ejemplos que demuestran cómo esta inconsistencia afecta la formación estadística de estudiantes y docentes a escala global. En contraste, el artículo analiza el enfoque pedagógico adoptado por Copilot en Excel, que proporciona mayor claridad para distinguir entre los tipos de desviación estándar, destacando el papel de la inteligencia artificial en la promoción de fundamentos estadísticos más accesibles. Finalmente, se propone un modelo de Resumen Estadístico reformulado, con enfoque didáctico, que incorpora elementos gráficos, explicaciones conceptuales e interpretaciones en lenguaje natural, buscando hacer la enseñanza de la Estadística más contextualizada, intuitiva y alineada con las buenas prácticas educativas.

Palabras clave: Excel. Estadística. Desviación Estándar. Estadística Docente. Copilot. Tecnologías Educativas.

1 INTRODUCTION

The teaching of Statistics plays a fundamental role in the formation of critical citizens, capable of interpreting data, making informed decisions and understanding social, economic and scientific phenomena. Among the core concepts in this area, standard deviation stands out—a measure of dispersion that is essential for analyzing variability in data sets. However, the way this concept is presented in widely used technological tools, such as Microsoft Excel, can compromise its proper understanding, especially in the educational context.

Excel is one of the most used platforms in the teaching and practice of Statistics, both in schools and universities. Its Statistical Summary feature, easily accessed by students and faculty, provides a synthesis of descriptive measures such as mean, median, mode, and standard deviation. However, a critical limitation of this feature is the lack of clarity regarding the type of standard deviation calculated — whether sample or population. This conceptual omission can generate misinterpretations, hindering learning and compromising the statistical training of students on a global scale.

The lack of conceptual precision in Excel's Statistical Summary is not only a technical flaw, but a pedagogical obstacle. In a learning environment, where clarity and rigor are essential, uncertainty about which formula is being applied can lead to the consolidation of misunderstandings. This is especially worrying in a scenario where the use of digital technologies intensifies in classrooms, and Excel is often adopted as a didactic support tool.

This article aims to investigate this conceptual inconsistency in the Excel Statistical Summary, analyzing its implications for the teaching of Statistics. The research adopts a qualitative approach, based on literature review, analysis of technical manuals and practical observations in educational contexts. In addition, it will be presented how Copilot, an artificial intelligence tool integrated with Excel, treats the calculation of standard deviation in a more transparent and pedagogical way, highlighting the need for revision in the design of traditional software. Finally, a reformulated Statistical Summary model is proposed, with a didactic focus, which aims to make the teaching of Statistics clearer, more precise and aligned with the conceptual foundations of the discipline.

It is noteworthy that the analyses and comparisons carried out in this study are exclusively technical and academic in nature, with the purpose of fostering reflections on the use of digital technologies in mathematics teaching. It is not intended, under any circumstances, to disqualify trademarks or attribute inappropriate conduct to their respective developers.

2 THEORETICAL FOUNDATION

2.1 THE SERIOUS IMPLICATIONS OF THE LACK OF CLARITY IN THE EXCEL STATISTICAL SUMMARY: WHEN THE UNDEFINED STANDARD DEVIATION COMPROMISES GLOBAL EDUCATION

Excel, one of the most powerful and widely used tools in various industries — including education, healthcare, finance, and industry — is recognized for its ability to perform statistical calculations quickly and efficiently. However, even such a consolidated and reliable platform is not without conceptual limitations.

Statistical summarization is a key step in data analysis, as it allows complex information to be synthesized into representative measures that facilitate interpretation and decision-making. According to Triola (2019), "descriptive statistics involves methods to organize, present, and summarize data", with the statistical summary being one of its central tools.

Statistical summary measures are traditionally classified into groups as measures of central tendency (mean, median, mode), dispersion (**standard deviation of sample or population**, variance, amplitude), position, and shape, each with a different purpose in data analysis.

According to Bussab and Morettin (2017), "measures of central tendency indicate the point around which data cluster, while measures of dispersion reveal the degree of variability of the data." These measures are widely used in various areas, such as economics, health, education, and engineering. Montgomery and Runger (2016) highlight that "statistics are essential for quality control and for making decisions based on reliable data".

A particularly worrying example occurs in the Statistical Summary, a resource widely used by educators and students to interpret data quickly. In this context, a critical omission is observed: Excel presents the standard deviation without specifying whether the calculation corresponds to the sample or population formula.

This lack of definition compromises conceptual clarity and can lead to misinterpretations, especially in educational settings, where the distinction between the two types of standard deviation is critical for adequate statistical understanding. The lack of transparency at this point not only hinders the teaching and learning process, but can also compromise analyses in professional contexts, where decisions are made based on statistical data.

This type of flaw, although subtle at first glance, reveals a deeper structural problem: the disconnect between the tool's interface and the theoretical foundations of Statistics. Identifying and discussing these inconsistencies is essential to ensure that widely used technologies, such as Excel, effectively contribute to statistical training and informed decision-making, and do not perpetuate conceptual confusions that compromise the quality of teaching and professional practice.

Figure 1

Ambiguous Statistical Summary: The Standard Deviation not specified in Excel

A1 | fx | 2

	A	B	C	D
1	2		*Coluna1*	
2	4			
3	6		Média	6
4	8		Erro padrão	1,414
5	10		Mediana	6
6			Modo	#N/D
7			**Desvio padrão**	**3,162**
8			Variância da amostra	10
9			Curtose	-1,2
10			Assimetria	0
11			Intervalo	8
12			Mínimo	2
13			Máximo	10
14			Soma	30
15			Contagem	5

Source: (the author 2025).

In Statistics, the distinction between sample and population standard deviation is fundamental for the correct interpretation of data. The standard deviation is one of the most widely used measures of dispersion in statistics, as it expresses the degree of variation or dispersion of the data in relation to the mean.

It can be calculated for both a population and a sample, and this distinction is essential to ensure the accuracy of statistical analyses.

According to Triola (2019), "the standard deviation is a measure that shows how dispersed the values are in relation to the mean; the higher the standard deviation, the greater the variability of the data."

- **Population standard deviation (σ):** Used when there is access to all elements of the population. The formula considers the total number of elements (N) and is less susceptible to sample variations.
- **Sample standard deviation(s):** Applied when working with a population sample. The formula uses (n − 1) in the denominator, known as Bessel's correction, to compensate for bias in the estimation of population variability.

According to Bussab and Morettin (2017), "the use of n − 1 in the calculation of the sample standard deviation is necessary to obtain a non-biased estimate of population variance".

Standard deviation is widely used in fields such as quality control, finance, psychology, and social sciences. Montgomery and Runger (2016) highlight that "variability analysis is essential to understand the behavior of processes and make informed decisions". Additionally, understanding the difference between the two types of standard deviation is crucial to avoid methodological errors, especially in inferential studies.

However, Excel, when presenting the standard deviation in its Statistical Summary, completely omits this information, limiting itself to displaying only the generic term "Standard Deviation". This lack of conceptual clarity compromises user understanding, especially in educational settings, where terminological accuracy is essential for adequate statistical training.

The teaching of Statistics in the contemporary educational context faces several challenges, among which technological mediation stands out. Tools such as Microsoft Excel are widely used in classrooms and academic settings to facilitate data processing and results visualization. However, the absence of conceptual clarity in functionalities such as the "Statistical Summary" can represent a significant obstacle to meaningful student learning.

According to Lopes and Nascimento (2014), "the use of statistical software in teaching can both enhance and limit the understanding of concepts, depending on the way they are presented and explored". Excel, although accessible and widespread, has pedagogical limitations when its resources are used without a critical and conceptual approach.

Excel's "Statistical Summary" feature offers a series of descriptive measures, such as mean, median, mode, standard deviation, variance, among others. However, these measures are presented in an automated way, without conceptual explanations or distinctions between sample and population contexts. This can lead to confusion among students, especially those in the early stages of training.

As Cazorla et al. (2011) point out, "the understanding of statistical concepts requires more than the mechanical application of formulas; it requires the construction of meanings from real contexts and critical interpretations". By using Excel without adequate mediation, there is a risk of transforming the teaching of Statistics into a merely operational practice, devoid of conceptual reflection.

The lack of conceptual clarity in the Excel Statistical Summary compromises the formation of essential statistical skills, such as the interpretation of variability, the distinction between sample and population measures, and the critical analysis of data. Many students, when faced with automatically generated results, are unable to understand the meaning of the measures or their methodological implications.

Triola (2019) reinforces that "Statistics is not just a set of techniques, but a language to understand the world through data". When this language is presented in an obscure or superficial way, as occurs in some Excel resources, the learning process is impaired.

In addition, Bussab and Morettin (2017) warn that "the correct interpretation of statistical measures depends on understanding the assumptions that underlie them". Excel, by not clearly differentiating between sample and population standard deviation, for example, can induce conceptual errors that are perpetuated in the academic and professional practice of students.

To overcome this obstacle, it is necessary for educators to adopt a critical and reflective approach in the use of technological tools. Excel should be used as a support, and not as a substitute for conceptual construction. Teacher mediation is essential to contextualize the results, discuss the meanings of the measures and promote the understanding of the statistical foundations.

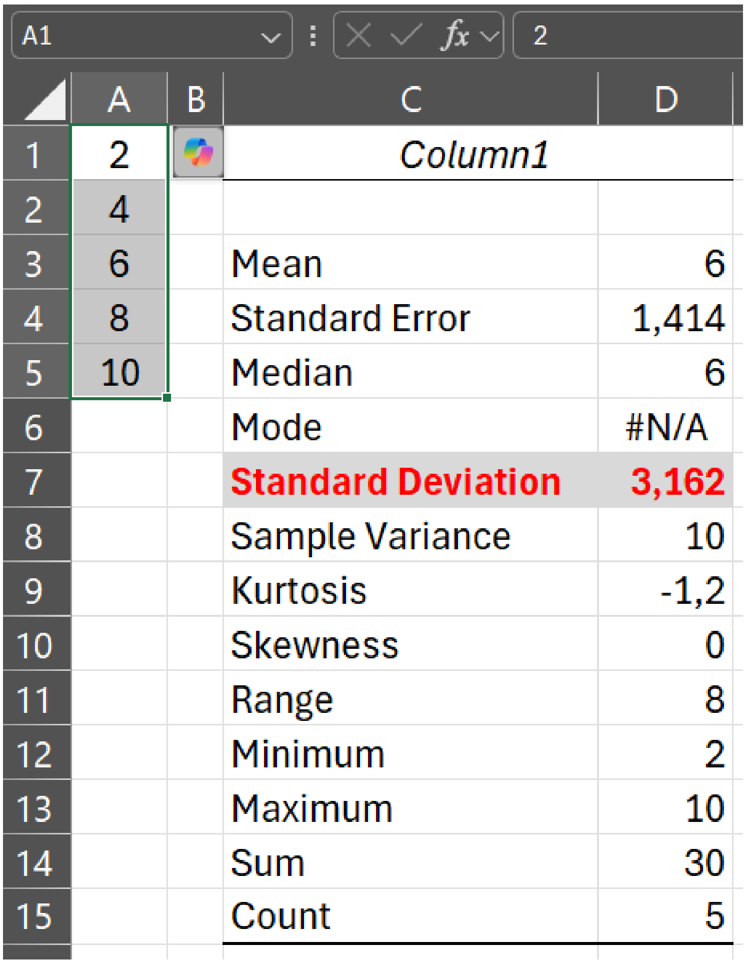
According to Ponte et al. (2003), "technology should be integrated into the curriculum in order to promote active learning, problem solving and the development of statistical thinking". This implies rethinking the use of Excel in the classroom, prioritizing activities that encourage critical analysis of data and interpretation of results.

Thus, the lack of conceptual clarity in the Excel Statistical Summary represents a relevant obstacle to the teaching of Statistics, especially in educational contexts that depend heavily on technological resources. Overcoming this challenge requires a conscious pedagogical performance, which values the construction of meanings, the contextualization of concepts and the critical use of digital tools.

Figure 2 illustrates this flaw, showing that even in the English version of Excel, the inconsistency persists—the software still does not indicate which **standard** deviation is being applied. This ambiguity represents a significant pedagogical risk, as it can lead students and teachers to misinterpretations, perpetuating conceptual errors on a global scale.

Figure 2

Ambiguous statistical summary: The Standard Deviation not specified in Excel, including its English version


A1 | 2

	A	B	C	D
1	2		*Column1*	
2	4			
3	6		Mean	6
4	8		Standard Error	1,414
5	10		Median	6
6			Mode	#N/A
7			**Standard Deviation**	**3,162**
8			Sample Variance	10
9			Kurtosis	-1,2
10			Skewness	0
11			Range	8
12			Minimum	2
13			Maximum	10
14			Sum	30
15			Count	5

Source: (the author 2025).

In the educational context, the absence of conceptual clarity in the Excel Statistical Summary represents a significant obstacle to the teaching of Statistics. Excel is widely used in schools and universities around the world as a tool to support the learning of fundamental statistical concepts.

Statistics, as a tool for understanding data variability, requires precision not only in calculations, but also in the communication of concepts. Excel, widely used as an instrument for statistical analysis, offers in its Statistical Summary a measure called "Standard Deviation", without explaining which definition is being used — whether population or sample. This apparently technical omission reveals a conceptual gap that can compromise interpretations and decisions based on data.

According to Triola (2017), "the standard deviation is a measure of the dispersion of the data around the mean, and its interpretation depends on the context: whether the data represent a population or a sample." The distinction between the population standard deviation (σ) and the sample size (s) is not merely formal; It changes the numerical value of the measure and, consequently, the statistical inference.

Excel, when presenting the standard deviation in the Statistical Summary, uses the sampling formula by default (dividing by the amount of data minus one), but does not inform the user of this. This lack of clarity can be misleading, especially in academic, scientific, or business contexts where the distinction is critical.

For Benjamini and Hochberg (1995), "transparency in the presentation of statistical data is essential for the reproducibility and reliability of the results." The lack of specification in Excel compromises this transparency, as the user may incorrectly assume that they are dealing with a population measure, leading to misinterpretations about the variability of the data.

Moreover, this conceptual gap reflects a broader problem: the oversimplification of digital statistical tools. As Taleb (2007) warns, "the illusion of understanding generated by user-friendly interfaces can mask fundamental complexities." Excel, by hiding the nature of the calculation, contributes to this illusion, distancing the user from the critical understanding of statistical fundamentals.

However, when students and teachers use the Statistical Summary and are faced with the presentation of the standard deviation without any indication of which formula is being applied — sample or population — this can generate confusion and compromise the conceptual formation of the students. The internalization of an inaccurate statistical concept can affect not only individual performance, but also collective understanding in the classroom, perpetuating errors that propagate between classes and institutions.

In professional settings, this ambiguity can also have serious consequences. In sectors such as healthcare, where statistical analysis is used to interpret clinical data, define protocols, and calculate indicators, the lack of precision in identifying the type of standard deviation can compromise critical decisions. The incorrect choice between sample and population deviation can distort the interpretation of data, directly affecting patient safety and treatment efficacy.

In the financial and business sector, the impact is no less. Excel is widely employed for risk analysis, market projections, and investment evaluation. The use of an unspecified standard deviation can lead to misinterpretations about the variability of the data, resulting in ill-founded strategic decisions. This can compromise the profitability of projects, mislead managers, and affect the credibility of quantitative analyses.

In summary, the omission of the nature of the standard deviation in the Excel Statistical Summary is not only a technical flaw, but a conceptual gap with profound implications. This ambiguity compromises the quality of teaching, safety in professional environments, and the reliability of analyses in different sectors. Awareness of this limitation is essential to promote the critical and responsible use of educational and analytical technologies, ensuring that widely used tools are aligned with the fundamental principles of Statistics.

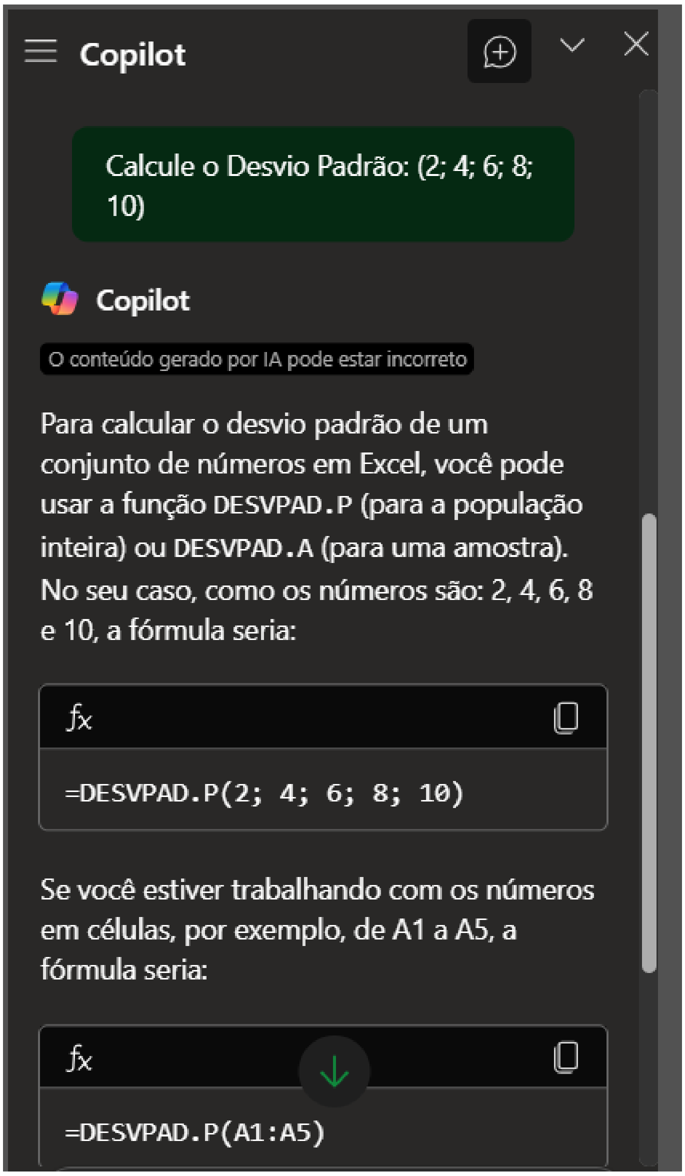
2.2 DECADES OF AMBIGUITY: EXCEL STILL HIDES THE STANDARD DEVIATION TYPE, WHILE COPILOT BRINGS DIDACTIC CLARITY

Figure 3 illustrates a crucial distinction between two approaches to using Excel. While the software's traditional Statistical Summary presents the standard deviation in a generic way, without indicating whether the calculation is based on the sample or population formula, Copilot — an artificial intelligence tool integrated into Excel — provides clear and conceptually correct guidance. By explicitly suggesting the use of the DEVPAD functions. P (for population) and DESVPAD. A (for example), Copilot fixes a historical gap in Excel, which for decades maintained this ambiguity even after several updates and versions.

This difference has significant implications in the educational context. The absence of specification in the Statistical Summary can lead students and teachers to misinterpretations, compromising the understanding of one of the most fundamental concepts of Statistics: the distinction between population and sample variability. By presenting the correct formulas based on the context of the data, Copilot contributes to more accurate learning that is aligned with statistical fundamentals, reinforcing the importance of technological tools that not only perform calculations, but also promote conceptual clarity in the teaching-learning process.

Figure 3

Unlabeled Standard Deviation: Excel hides, Copilot explains



Source: (the author 2025).

2.3 IMPROVING DIDACTICS IN EXCEL: A VBA SOLUTION FOR STANDARD DEVIATION AMBIGUITY AND COMPLETE MODE IDENTIFICATION

In the educational context, conceptual clarity is an essential pillar for the effective teaching of Statistics. Technological tools such as Microsoft Excel, widely used in educational institutions around the world, have the potential to facilitate the learning of fundamental statistical concepts. However, the way Excel presents certain measures in the Statistical Summary can compromise this process, especially when it omits crucial information about the calculations performed.

One of the most recurrent failures is the lack of specification on the type of standard deviation displayed — whether sample or population. This conceptual ambiguity, already discussed in previous publications in the work Information and Communication Technologies: Challenges and Perspectives in Academic and Market Integration, organized by Medeiros and Gonçalves (2020), compromises students' understanding and can lead to the consolidation of misinterpretations.

In learning environments, where the distinction between sample and population variability is key, the lack of clarity about which formula is being applied represents a significant pedagogical obstacle. To overcome this ambiguity, it is necessary to promote a culture of statistical literacy that values understanding of the concepts behind formulas.

Rumsey (2002) argues that "statistics are not just a matter of calculation, but of conscious and contextualized interpretation of data." This entails not only teaching the difference between STDEV. S and STDEV. P, but also to foster critical thinking about when and why each measure should be used.

In short, unambiguous standard deviation is more than a matter of technical precision—it's a commitment to the integrity of statistical analysis. Tools such as Excel should be improved to make these distinctions explicit, and users should be trained to correctly understand and apply the concepts involved. Statistics, after all, is not just about numbers, as Moore (1997) reminds us, "but about thinking clearly about the world."

Another critical point identified refers to the way Excel presents the fashion in the Statistical Summary. In situations where the data is, for example, (1; 2; 2; 1), the software returns the value 1 as a mode, ignoring the fact that the set is bimodal. This limitation, also addressed in one of the publications mentioned, highlights the need for a more rigorous and didactic treatment of measures of central tendency. The absence of an indication such as "amodal", "bimodal" or "multimodal" compromises conceptual precision and hinders the development of a solid statistical understanding by students.

In view of these limitations, an alternative model of Statistical Summary was developed, with the support of an algorithm in Visual Basic for Applications (VBA), which reorganizes and explains the main statistical calculations: mean, mode (with identification of amodality), sample standard deviation, population standard deviation, sampling standard error and population standard error. This reformulation aims to make the learning environment more transparent, promoting a pedagogical experience more aligned with the fundamentals of Statistics.

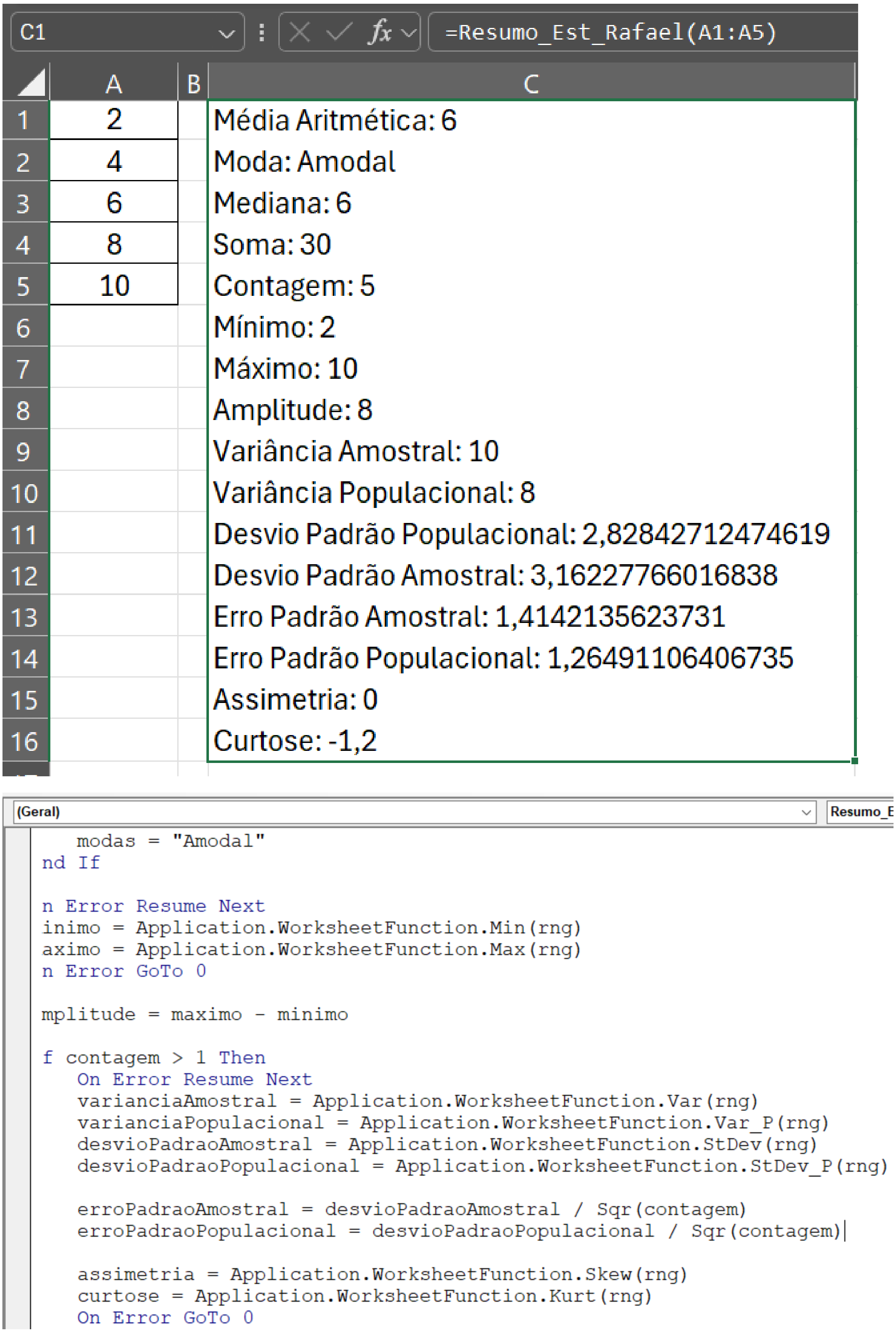
Although the complete VBA code is extensive, this article presents a representative part of the solution, sufficient to demonstrate its applicability and transformative potential in teaching. The proposal aims to improve Excel pedagogically, offering educators and students a clearer, more precise and conceptually aligned tool.

By making explicit the distinctions between the different types of statistical calculations, this solution contributes to the formation of a more solid conceptual basis, reducing the spread of misconceptions and strengthening the teaching of Statistics on a global scale. This is an important step towards a more critical, accurate and technologically aware education.

To solve the aforementioned limitation, the author developed an algorithm in **VBA (Visual Basic for Applications),** a programming language integrated into Excel. This algorithm allows you to devise custom solutions and automate tasks, recognizing, for example, situations where the divisor results in a null value to display that the calculation is undefined. The implemented functionality and some of the VBA code are detailed in Figure 4.

Figure 4

Unambiguous Standard Deviation: Excel that teaches with precision



Source: (the author 2025).

3 METHODOLOGY

This study aimed to investigate the inconsistencies in the presentation of the sample standard deviation in Excel and its impacts on the educational process, especially in the teaching of Statistics. For this, a methodological approach was adopted that integrates qualitative and quantitative analyses, in order to understand the effects of this ambiguity on students' learning and propose strategies for its correction.

The research was based on a comprehensive literature review, with scientific articles, academic reviews and relevant documents on the use of Excel in teaching and its implications in statistical calculation. The literature search was carried out in specialized databases, such as Scopus, Google Scholar and other scientific sources, using key terms such as "Excel", "sample standard deviation", "statistical errors", "educational impact" and "teaching of Statistics".

According to Lakatos and Marconi (2003), "bibliographic research is developed based on material already prepared, consisting mainly of books and scientific articles". This approach allows the researcher to understand the state of the art on a given topic, identify gaps and build a solid theoretical framework.

Gil (2008) reinforces this idea by stating that "bibliographic research is that which is carried out from material that has already been published, mainly books and articles from scientific journals". For him, this type of research is fundamental for the formulation of hypotheses and delimitation of the study problem.

In addition, Severino (2007) points out that "bibliographic research is an intellectual activity that requires the researcher to have a critical and selective capacity in the face of the vast existing production". In other words, it is not enough to gather sources: it is necessary **to evaluate the relevance, reliability, and timeliness** of the materials consulted.

As Wellington Aquino (2025) points out, "citing reliable sources increases the credibility of the work and inserts the author into a broader academic dialogue".

The selection of documents will follow specific criteria, prioritizing studies that directly investigated the flaws in the presentation of the standard deviation in Excel and its consequences on the learning process, as well as reports of educational experiences and practical examples.

The bibliographic research is developed based on books, scientific articles and practical experiences that show the need for a critical and pedagogical approach in the use of digital tools such as Excel.

4 RESULTS AND DISCUSSION OF THE RESEARCH

The impact of conceptual inconsistencies in the calculation of the sample standard deviation in Excel goes beyond a simple technical failure. This is a critical gap that compromises the reliability of one of the most used technological tools in the teaching of Statistics. The absence of specification in the Statistical Summary about which formula is being applied — whether sample or population — raises relevant questions about the conceptual clarity offered by the software and its effects on the learning process.

The research revealed that this ambiguity can lead students and teachers to misinterpretations, especially when Excel only presents the generic term "standard deviation", without any methodological distinction. In an educational environment, where conceptual precision is essential, this omission compromises the statistical training of students and can lead to the consolidation of incorrect understandings.

In educational settings, conceptual accuracy is a key element in ensuring the quality of learning. In the field of statistics, this requirement becomes even more critical, as poorly defined or misunderstood concepts can lead to the consolidation of mistaken understandings, compromising the education of students and their ability to apply knowledge appropriately.

According to Cazorla et al. (2003), "school statistics should be taught based on contextualized situations and with conceptual clarity, so that students develop interpretative and critical skills". The absence of this clarity can lead to confusion between concepts such as mean, median, and mode, or between correlation and causation, which compromises data analysis and decision-making.

For Campos and Wodewotzki (2006), "statistical training requires not only technical mastery, but also deep conceptual understanding, because it is from it that the student constructs meanings and develops intellectual autonomy". The omission of rigorous definitions and well-structured examples can lead students to reproduce formulas without understanding their purpose, which weakens the teaching-learning process.

In addition, Lorenzato (2006) points out that "the teaching of mathematics — and by extension statistics — must be based on the problematization and collective construction of knowledge, which requires precision in the language and concepts worked on in the classroom". The lack of conceptual precision is not only a didactic failure, but an epistemological barrier that prevents the development of statistical thinking.

In this sense, the responsibility of the educator is twofold: to provide that the concepts are presented clearly and to promote an environment of critical reflection. As Skovsmose

(2000) states, "mathematics education must prepare students to interpret and intervene in the world, and this is only possible with a solid and contextualized conceptual basis".

As discussed in previous publications by the author in the work Information and Communication Technologies: Challenges and Perspectives in Academic and Market Integration, excessive reliance on automated solutions, without proper pedagogical monitoring, can hinder the construction of a solid foundation in Statistics.

The results also indicate that the dependence on tools such as Excel, when not accompanied by critical training, can generate a false sense of accuracy. The lack of clarity about the type of standard deviation calculated is not easily noticeable by users in training, which makes the error even more dangerous from an educational point of view. This conceptual flaw, when disseminated in the classroom, can compromise not only individual but also collective performance, creating a confusing and technically fragile learning environment.

The research reinforces the need for educators to explicitly address these limitations in their pedagogical practices, encouraging students to question the results presented by digital tools. In addition, the importance of continuous teacher training in the critical and conceptually rigorous use of software such as Excel is highlighted. Technology, in this context, should be understood as a resource to support statistical reasoning — and not as a substitute for conceptual understanding.

Finally, the data analyzed suggest that Excel, despite its wide acceptance and functionality, needs to evolve in terms of conceptual accuracy. The implementation of improvements that make explicit the distinction between sample and population standard deviation in the Statistical Summary would be a significant advance for the teaching of Statistics. This change would contribute to the formation of students who are more critical, aware and prepared to deal with data in an ethical, accurate and reasoned way.

5 FINAL CONSIDERATIONS

Microsoft Excel is widely recognized as a powerful and accessible tool for teaching and applying statistical concepts. Its intuitive interface, combined with the ability to perform calculations, generate graphs, and organize data, makes it a popular pedagogical resource in educational environments.

However, the data analyzed in several surveys suggest that, despite its acceptance and functionality, Excel still has significant limitations when it comes to conceptual accuracy.

According to Francisco et al. (2020), the use of Excel in the teaching of statistics contributes to streamlining classes and facilitating learning, especially through the construction of graphs and attendance tables. However, the authors warn that the effectiveness of the software depends directly on the teacher's training and the conceptual clarity with which the contents are approached. The absence of rigorous explanation of statistical concepts can lead students to use formulas and functions in a mechanical way, without understanding the theoretical foundations behind the calculations.

Pinto (2024) reinforces this concern by stating that "the simple introduction of digital technologies in the classroom does not guarantee learning; It is essential that teachers know how to use these resources in order to maximize their educational potential". Excel, for example, allows you to easily calculate measures of central tendency, but does not by default offer conceptual explanations of when and why to use each measure. This gap can compromise the statistical training of students, consolidating incorrect or superficial understandings.

In addition, Pontes and Guimarães (2021) highlight that the use of Excel in elementary school evidenced the need to explain all the elements that make up a table or graph, such as scales, units, and titles. The omission of these aspects, often neglected by the software's automated interface, can generate misinterpretations of the data.

This study analyzed the inconsistencies in the presentation of the standard deviation in the Excel Statistical Summary, highlighting the pedagogical impacts of this conceptual omission. The absence of an explicit definition of the type of standard deviation calculated — sample or population — compromises the clarity of the results and makes it difficult for students to understand the statistical foundations.

Excessive reliance on automated tools, without adequate pedagogical support, can lead to the internalization of mistaken concepts, as already discussed in previous works by the author.

The research offers a detailed analysis of the inconsistencies in the Excel Statistical Summary, with suggestions for practical solutions, such as the implementation of algorithms in VBA that make explicit the nature of the statistical calculation performed, as well as improvements in teacher training and the pedagogical use of the tool.

The study also aims to promote greater awareness of the importance of the proper use of technologies in the educational context, contributing to the improvement of statistical learning and the reduction of conceptual errors.

The need for critical training for teachers and students in the use of educational technologies was evidenced. The improvement of the Excel interface, with greater transparency in calculations and more precise nomenclatures, is essential to ensure conceptual rigor in the teaching of statistics. In addition, the development of complementary algorithms can make the results more didactic.

While Excel is a valuable tool, the data suggests that it needs to evolve in terms of conceptual accuracy. This implies not only improvements in the interface and explanatory functionalities of the software, but also a more critical and reflective pedagogical approach on the part of educators. The continuous training of teachers and the conscious integration of technology are essential to ensure that the use of Excel effectively contributes to the development of statistical thinking.

The study reinforces that technology should support — and not replace — theoretical understanding, and conceptual clarity is indispensable to train students capable of accurately interpreting data and making decisions based on reliable evidence.

The present study sought to critically analyze the use of Microsoft Excel as a tool to support the teaching of statistics, highlighting its potentialities and limitations in the educational context. In addition to contributing to the debate on pedagogical practices mediated by technologies, the work aims to promote greater awareness about the importance of the appropriate use of these resources, especially with regard to conceptual precision and the development of statistical thinking.

The data analyzed show that, although Excel is widely accepted and functional, its indiscriminate use can lead to the consolidation of conceptual errors, especially when there is no qualified pedagogical mediation. The automation of calculations and the absence of conceptual explanations embedded in the software can compromise the deep understanding of statistical contents, making the teacher's role as a critical mediator in the teaching-learning process essential.

Some limitations must be recognized. First, the study focused on a qualitative approach, based on a literature review and analysis of teaching practices, which restricts the generalization of the results.

In addition, comparative analyses with other statistical software were not included, which could broaden the understanding of the relative advantages and disadvantages of Excel. The absence of empirical data from classroom observations or interviews with students also limits the depth of the analysis of the tool's direct impact on learning.

To deepen the discussion, it is recommended that future research: carry out empirical studies with practical application of Excel at different levels of education, evaluating student performance and the occurrence of conceptual errors; Compare Excel with other statistical tools (such as R, GeoGebra, SPSS, or Jamovi), considering aspects such as accessibility, conceptual accuracy, and pedagogical potential; Investigate teacher training focused on the critical use of technologies in the teaching of statistics, identifying gaps and proposing training strategies. Develop didactic proposals that integrate Excel with active methodologies, such as project-based learning and problem solving, aiming at greater engagement and conceptual understanding.

In summary, the study reinforces the need for a conscious and critical pedagogical approach in the use of educational technologies. Excel can be a valuable ally in the teaching of statistics, as long as it is used with intentionality, conceptual clarity and adequate didactic support.

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