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Educational technologies: The unthinkable use of spreadsheets

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ABSTRACT
This expanded abstract is an excerpt from the studies carried out by the authors regarding the consequences in the adoption of computerized systems in the academic environment (face-to-face and distance) in order to be a driver of student development and a facilitator of teaching obligations regarding the teaching of mathematics at different educational levels. However, when evaluating the impact of a set of virtual/digital tools directed to the calculation of mathematical expressions critically, it is common to find users of different academic levels who resort to different technological tools for simple mathematical operations, and because of this no longer resort to their own reasoning, thus losing the foundations of simple mathematical operations. Therefore, continuity was given in the investigative procedures which revealed the permanence of logical inconsistencies (arithmetic) throughout several updates of the available systems and added to the other fragilities can, to a certain degree, collaborate for considerable crises which will be explored in the course of this cut, which is characterized by being a report of teaching experiences in the critical-reflective teaching of educational technologies and a continuum linked directly to the authors' work both at the academic level and at the market level (MEDEIROS and GONÇALVES, 2018).

Keywords: Electronic Spreadsheets, Work and Teacher Training, Information and Communication Technologies.

1 INTRODUCTION

When approaching information technology, it is common for academics and even market professionals to have the habit of referring to systems as endowed with intelligence, whether they are computerized (as is the case with some software) or not. This is a common misconception, since computational systems are based on logical principles, that is, they are based on mathematical calculations. However, these so-called intelligent systems, however complex and automata they may seem, only mathematically simulate what is known as intelligence.

> These contributions are indispensable to the understanding and analysis of the contemporary use of mathematics in its various means and applications, especially when taking into account that technology itself has become a driving force for the generation of more technology, which has dramatically expanded the development of new technological resources and concepts. Which have become part of contemporary daily life [...] (GONÇALVES and MEDEIROS, 2015, p. 34303).

From this brief understanding of complex systems, we begin to glimpse the importance of reliable calculations and projections, ranging from their simplified daily use, to their application in large economic-financial markets or even in military and strategic applications for governments and security entities.

These applications in various segments reinforce the need for reliability in the results, not only for planning issues or measurement of concepts, but mainly because the consequences of an erroneous projection can cause impacts on all modern society, which depends heavily on technological resources.

A more recent example involving the current processing capacity of computerized systems, coupled with a large volume of data is the prediction of viral outbreaks based on the analysis of research on their symptoms on the internet. An example of this type of application is cited as a report by Osterath (2014, Web) which states that:

> Tools like Google Maps allow you to map Ebola cases and plot the chronology of the epidemic, showing the spread of the virus. This technology is used, for example, by HealthMap professionals – a team of epidemiologist researchers and software developers. Its interactive map illustrates, through a timeline, how the epidemic spread from Guinea...
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> Probability calculations. Starting from this principle, physicists Dirk Brockmann of Humboldt University in Berlin and Dirk Helbing of the Technical University of Zurich have created a mathematical model that calculates how a virus or bacterium can propagate geographically and in which city it is likely to arrive first.
>
> The model has already been used to simulate the spread of the H1N1 swine flu virus, E.coli bacteria (EHEC) and severe acute respiratory syndrome (SARS). Now the team has adapted the simulation for the recent Ebola outbreak.

This type of statistical prediction favors the use of efforts, mainly logistical, in the allocation of medicines, human and financial resources to combat infections before they become true pandemics in their respective places of origin. If this type of information is processed erroneously, it will cause an inaccurate result, and all preventive planning will be affected and, consequently, will eventually bring negative results to the whole society.

Thus, questions arise such as: Are we providing our students with the basis and criticality necessary to work with technologies? Or are we just indoctrinating into the use of computerized tools? Are we prepared to question and measure the results of mathematical and logical equations from computerized systems?

2 METHODOLOGY ADOPTED

The present case study emerged during the preparation and construction of the didactic materials that were used in the classroom in professional and technological education (face-to-face and distance learning - EaD), in the disciplines of knowledge management, financial mathematics and statistics, as well as in the orientation of works and research from the academics, it was possible to

verify the existence of errors in the mathematical results from simple applications which significantly interfered in the results of the analysis of the data obtained in Electronic Spreadsheets of Calculation of different brands and developers.

These errors motivated a theoretical deepening on the subject through an exploratory research that came to support the construction of a case study along the lines proposed by Yin (2010, p. 39) when he defines that:

> "The case study is an empirical investigation that investigates a contemporary phenomenon in depth and in its real-life context, especially when the boundaries between the phenomenon and the context are not clearly evident."

This identified "case" brings together different inconsistencies and errors of logical and mathematical concept, which could be identified and cataloged for future measurement.

It is noteworthy that, based on ethical parameters in academic research, after the identification of the errors and inconsistencies pointed out in the study and before the publication of the results, due science was given to the respective companies that develop the spreadsheet software with a focus on promoting updates and corrections. However, we did not obtain the fruitful return for solving the problems of mathematical and logical structure.

3 RESULTS AND DISCUSSIONS

As already seen, during the preparation and construction of the didactic materials it was possible to verify the existence of errors in the mathematical results from simple applications, based on logics and formulas of notorious use over the centuries in classrooms around the world.

Many of the calculations involving sets, expressions such as fashion and modal, as well as in the translation of simple mathematical models to the expressions adopted in electronic spreadsheets, have been shown to be inconsistent, thus generating wrong results, or rather, false results compared to the expected. These results may seem insignificant, or simple, but if observed on larger scales, such as applications of mathematical models of stock exchanges around the world, they could provoke real economic collapses, condemning society to a colossal setback, such as the great depression of the 1920s in the United States of America, the housing bubble of 2008 in Europe, events that still have their consequences currently experienced in Brazil.

In order to exemplify these mathematical inconsistencies, we highlight the treatment of "Power with negative basis (-22 and (-2)2)" in which several spreadsheets of calculation promote the treatment of different mathematical expressions as if they were equal. Thus, the present inconsistency is observed in the application of the expression "-22" which is different in essence from the expression "(-2)2" and that, therefore, have different results, and the non-conformity occurs in the question that both expressions are identified and treated in the same way by the electronic spreadsheets.

To better understand this inconsistency in practice, it is necessary to observe the principle demonstrated in Tables 1 and 2, which deal with the content of "Power with negative basis in parentheses":

Tabela 1 – Entendendo o princípio

Observação	Expressão Matemática
Vamos considerar as potências:	-2^2 e (-2^2)
Pela definição, temos que:	$-2^2 = -(2.2) = -4$ e $(-2)^2 = (-2) . (-2) = +4$
Logo:	$-2^2 \neq (-2)^2$

Fonte: Giovanni (2012, p. 33)

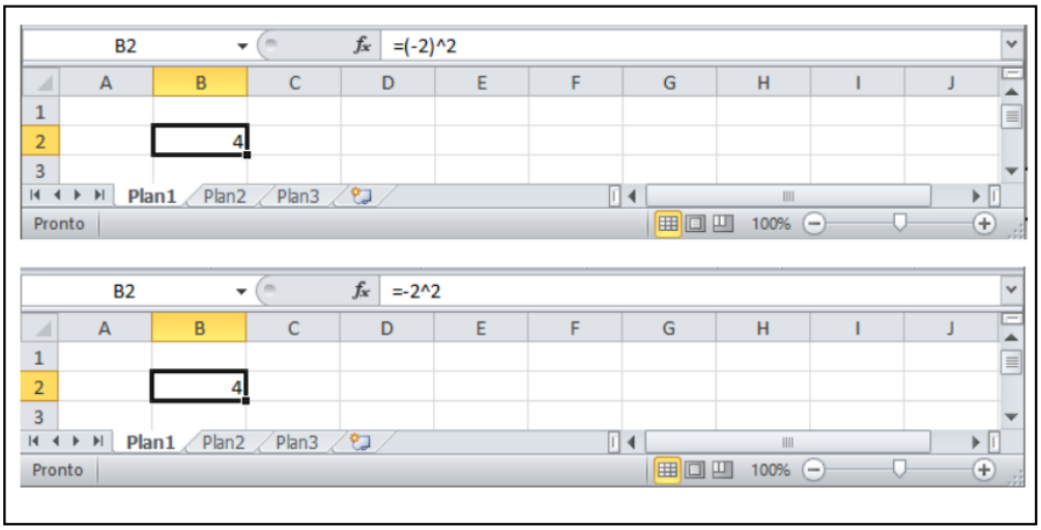
Therefore, it was identified that in the construction of mathematical models, different expressions can be interpreted in the same way, this is usually due to the fact that programmers and analysts only create the tools based on the rules analyzed by third parties, not having the prior knowledge in volume to deepen necessary to the construction of useful and safe applications in their results, as exemplified in Table 2 and Figure 01 that expose the difference in the way the spreadsheets solve this mathematical expression, generating incorrect result:

Tabela 2 – Análise

Expressão matemática	Comando na planilha eletrônica	Interpretação pela planilha eletrônica	Resultado na planilha eletrônica	Resultado correto
$= (-2)^2$	= (-2) ^ 2	(-2) * (-2)	4	4
$= -2^2$	= -2 ^ 2	(-2) * (-2)	4	- 4

Fonte: Gonçalves e Medeiros (2015, p. 34307)

Figura 1 - Planilha Eletrônica de Cálculo (aplicativo para computador)



However, following the example, it is identified that the expressions -2^2 and $(-2)^2$, when submitted in another application of the same company that develops the respective Electronic Spreadsheet of Calculation (computer application) used in Figure 01, does not support the same error, as can be seen in Figure 02 that uses a Graphing Calculator (computer application). It should be noted that both tools are made available in the market by the same company and that, however, they have different mathematical treatments for the same logical expressions.

Figura 2 - Calculadora Gráfica (aplicativo para computador)

4 FINAL CONSIDERATIONS

The present case focused on the use of electronic spreadsheets as part of the educational technological tools, evoking a critical look at the teaching practices adopted for civic-scientific training, which should not take place without the necessary foundation for the construction of knowledge, since it is the role of the teacher to subsidize the student's ability to prove the world around him.

Consequently, the question arises as authors if these errors identified in the study are not purposeful, since inconsistencies and nonconformities, when identified by the developer should be corrected in new versions of the same software. However, tools such as spreadsheets, adopted in academic and professional circles, are updated and improved to remain competitive, but the logical flaws still remain, opening the market for more robust applications from the same developers.

Finally, it is worth noting that the teaching of mathematics in a context such as that of contemporary Brazil is a great challenge. The intellectual potential of academics is proportional to the cultural, social and family bases that nourished them in their training (PINTO, 2005) which is fertile ground for the dependence on technological tools that take away the freedom and autonomy of students and teachers, when they are not able to prove the veracity of the data they receive, remaining only to believe that they are real and true (MEDEIROS, 2017).

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