



# The use of technological resources in teacher training as a contribution to teaching statistics, probability and combinatorial analysis at the National Meeting of Mathematical Education in Brazil

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**ABSTRACT:** To assess the evolution of research aimed at the use of technological resources in the initial and continuing education of teachers from 1987 to 2019 in the teaching of statistics and probability, a systematic literature review was carried out to determine the trend of scientific production through the analysis of annals the National Meeting of Mathematical Education (ENEM), the main event in the area of Mathematical Education in Brazil. When analyzing publications in the annals of ENEM regarding learning proposals involving the teaching of Statistics, Probability and Combinatorial Analysis mediated by technological resources aimed at teacher training, we group them according to the following criteria: (1) Researched content; (2) Initiated training or continuing training; (3) Teaching cycle of the proposal; (4) Authors and institutions that publish the most; (5) Groups of technologies used (Learning objects; Software; Virtual Learning Environments; Programming languages; Google Drive). Of the 294 papers identified with a focus on teaching Statistics, Probability or Combinatorics, we found 15 (5.1%) who used digital educational technologies for initial and continuing teacher education, in favor of teaching learning-learning in the classroom. The works are mostly focused on the continuing education of teachers in Basic and Higher Education, presenting strategies for the use of different technological resources. We believe that more work should be developed and that focus on the use of technological resources to support teacher training, enabling explorations that favor the understanding of concepts and skills in this area of knowledge.

**KEYWORDS:** Initial and Continuing Teacher Training, Technological Resources, Teaching

Statistics, Probability and Combinatorial Analysis, ENEM.

## I. INTRODUCTION

The realization of the present work is due to the growing scientific production aimed at teaching Statistics, Probability or Combinatorial Analysis recorded in the proceedings of several events in recent years in Brazil.

We also consider that the rapid advancement of technologies and especially the internet bring a range of resources for teaching and learning from Early Childhood Education to Higher Education. In [1], as well as in [2], mention is made of the urgency to modify the way of teaching Statistics, Probability or Combinatorics from Basic Education to Higher Education.

In addition, today we have access to video classes, texts, software, and among other diverse resources from the most diverse disciplines and, in many cases, free of charge and available on the internet.

In addition, these resources are increasing at an accelerated pace and keeping up with each new thing is practically an impossible task. In the educational context, it can even be said that we live in an era in which there is an abundance of educational tools, particularly for teaching Statistics, Probability or Combinatorics.

However, what can be said about this subject is that despite the evolution of technology associated with teaching, the technological infrastructure of several Brazilian schools, still have deficiencies when compared with other schools, worldwide. Thus, it is clear that although educational tools have evolved considerably over time, we have the hypothesis that the way of



teaching Statistics, Probability and Combinatorics did not follow the same trend.

Therefore, the objective of this work was to develop a Systematic Literature Review - RSL on the use of technological resources in the initial and continuing training of teachers regarding the teaching of Statistics, Probability or Combinatorics, starting in 1987, based on the published literature in the proceedings of the National Meeting of Mathematical Education - ENEM, the largest event in this area in Brazil.

## II. TECHNOLOGICAL RESOURCES AS A CONTRIBUTION TO THE TRAINING OF TEACHERS IN THE TEACHING OF STATISTICS, PROBABILITY OR COMBINATORY ANALYSIS

We believe that understanding how teachers' training dynamics take place and what aspects influence them is essential for the conception of a change in their formative process, so, according to [3], it is important to emphasize that teacher training is a fundamental point for change educational, especially when it comes, for example, to statistics, probability and combinatorial analysis.

Regarding the teaching of Statistics, Probability or Combinatorics, Degrees in Mathematics courses contribute little to the formation of the teacher, since they present only the discipline of Descriptive Statistics, emphasizing the procedures and techniques to be developed, forgetting to structure this discipline in a pedagogical [4].

We also highlight that the inclusion of statistics and probability and combinatorics teaching in Brazilian curricula is recent, justifying that many teachers did not have systematic learning in this subject in their school and professional life ([5] and [6]).

Teachers, both educators and graduates in mathematics, are not prepared for teaching these because, according to [7], they did not have adequate pedagogical training. Teachers end up acquiring an operationalization of content that does not fit with a context of scientific or social research at the school level [8].

Despite this, it is still evident that the initial and continuing training of teachers does not contribute significantly to the construction of a repertoire of knowledge that allows them to act safely in their school routine about the teaching of statistics and probability [9].

Continuing education is shielded from a permanent need for teacher professional development. It is necessary to deal with the integration of Information and Communication Technologies - ICT in the school to coordinate the

languages and characteristics of digital technologies with the particularities of didactic-pedagogical practices under the mediation of the teacher [10].

According to [10] it is necessary to introduce a critical and reflective dialogue on the theoretical and methodological foundations of the use of technological resources in schools, as educating with new technologies is a major challenge that needs to be faced.

In addition to these factors, there is a divergence between what is taught in initial training and what should be taught in Basic Education. The training on the subjects in the degree has a content character detached from contexts, due to this, it is observed that the degrees that use statistics end up having more adherence to Basic Education than the degree in mathematics itself [8].

According to [11], some courses highlight theoretical knowledge in class, while others choose to carry out pedagogical activities in the classroom. Therefore, it is noted that teacher training courses need to break with the current dichotomy and coordinate different knowledge to be exposed in real teaching and learning environments, favoring the development of professional knowledge [12].

In [13] it is highlighted that characteristics such as receiving diverse information quickly and performing several tasks at the same time are inherent to digital natives. Therefore, teachers need to be aware of these characteristics present in their students and use them as something favorable to the learning of their discipline. It also emphasizes that teachers need to learn to communicate with students through new ways of teaching. In the same perspective, [14] warns that the contents of the past with tools from the past cannot prepare today's students for the world of tomorrow.

For [15], the enthusiasm, speed and increase in the amount of software, which make it possible to examine all aspects of data processing, justify the acceptability of digital technologies in the work with Probability and Statistics.

Finally, in [16], attention is drawn to the fact that the use of technology requires careful planning, innovation and enthusiasm. The choice of a technological resource must be based on ease of use and interactivity, and appropriate choices can benefit the relationship between students and the teacher.

## III. MATERIAL AND METHODS

This is a Systematic Literature Review (RSL). RSL is a form of secondary study using a well-defined methodology to identify, analyze and interpret all evidence related to a research question [17]. To complement the systematic mapping with the RSL technique, which is characterized by



offering a wide review of preliminary studies on a specific topic, with the objective of identifying the available evidence for the use of technological resources, from Early Childhood Education to Higher Education in Brazil.

Thus, we seek to carry out a bibliographic search on the Teaching of Statistics, Probability and Combinatory Analysis aimed at the use of technological resources, aimed at initial and continuing education, from Early Childhood Education to Higher Education, seeking to identify and describe the works published in the annals of the National Meeting of Mathematical Education - ENEM in Brazil, since its first realization in 1987 until the last realized in 2019.

ENEM has been carried out since 1987 by the Brazilian Society of Mathematical Education (SBEM). This event has been the locus where teachers publish their research and show their work in the most diverse modalities, in this perspective, it serves not only teachers (from the basic network and higher education), but students (from undergraduate, graduate), as well such as researchers working in the field of scientific research with a focus on initial and continuing education.

Therefore, we seek to verify and discuss the general characteristics and trends of the works presented in ENEM that contribute to the formation

of teachers that is restricted to a certain thematic field, school level, area of knowledge, methodological approach, etc.

Publications from the last thirty-two years, that is, from 1987 to 2019, were taken for the data recovery period. The consulted records are those made available on the Brazilian Society of Mathematical Education - SBEM's website (<http://www.sbembrasil.org.br/sbembrasil/index.php/anais/enem>), which has published research papers on the Teaching of Statistics, Probability and Combinatory Analysis, from Early Childhood Education to Higher Education.

Therefore, the consultation was carried out online in the annals of ENEM, on the SBEM website. We justify the choice of this event because it is the main event held in Brazil in Mathematics Education promoted by SBEM, which brings together researchers in Mathematics Education and, specifically, WG 12 - Teaching Probability and Statistics.

SBEM held the event, from II to IV ENEM, until 1992, biannually and after that date, it became tri annually. The table 1 presents the description of all ENEMs, carried out from 1987 to 2019, in different regions in Brazil.

Year	Event title	Event's place
1987	I ENEM (There was no specific theme)	Pontifical Catholic University of São Paulo - São Paulo, Brazil
1988	II ENEM (There was no specific theme)	State University of Maringá - Paraná, Brazil
1990	III ENEM (Mathematical Education and Sciences, Technology and Society)	Federal University of Rio Grande do Norte - Rio Grande do Norte, Brazil
1992	IV ENEM (There was no specific theme)	Regional University of Blumenau - Santa Catarina, Brazil
1995	V ENEM (There was no specific theme)	Federal University of Sergipe - Sergipe, Brazil
1998	VI ENEM (There was no specific theme)	University of Rio dos Sinos Valley - Rio Grande do Sul, Brazil
2001	VII ENEM (There was no specific theme)	Federal University of Rio de Janeiro - Rio de Janeiro, Brazil
2004	VIII ENEM - "Mathematical Education: a social commitment"	Federal University of Pernambuco - Pernambuco, Brazil
2007	IX ENEM - "Dialogues between research and educational practice" "	Belo Horizonte University - Minas Gerais, Brazil
2010	X ENEM- "Mathematical Education - Culture and Diversity"	Federal University of Bahia - Bahia, Brazil
2013	XI ENEM - "Retrospectives and Perspectives of Mathematical Education in Brazil"	Pontifical Catholic University of Paraná - Paraná, Brazil
2016	XII ENEM - "Contemporary Mathematical Education: challenges and possibilities"	Cruzeiro do Sul University - São Paulo, Brazil
2019	XIII ENEM - "Importance of the Basic Education school in the scope of Mathematical Education"	Pantanal Arena - Mato Grosso, Brazil

TABLE 1: YEAR, TITLE AND PLACE OF EVENTS FROM THE YEAR 1987



Thus, the objective of this work is to develop an RSL on the teaching of Statistics, Probability and Combinatorial Analysis, focused on the use of technological resources as a contribution to the initial and continuing education of teachers, starting in 1987 based on the literature published in the annals of ENEM. And as specific objectives: (1) Search for available literature on the Teaching of Statistics, Probability and Combinatorial Analysis, aimed at the use of technological resources for the initial and continuing education of teachers, starting in 1987; (2) Indicate studies on the Teaching of Statistics, Probability and Combinatorial Analysis, aimed at the use of technological resources for the initial and continuing education of teachers, starting in 1987.

It is intended to list works carried out in Brazil based on the literature published in the annals of ENEM since 1987, in order to know the production and understand about the knowledge produced, in the search for consolidation of the field and identification of advances and gaps thematic.

The research problem refers directly to covering a range of phenomena in a much wider way than those that could be known directly, making it possible to have contact with the production developed in different higher education institutions, in the different regions that make up the vast Brazilian territory and even outside it, which is not the case of this research.

Thus, we identified the key words or terms to find aspects related to this research are: (1) Teaching Statistics; (2) Teaching Probability; (3) Combinatorial Teaching; (4) Teaching of Stochastics; (5) Technological resources; (6) Technological tools; (7) Software; (8) Virtual Learning Environment (VLE).

The search carried out associate's terms or keywords since together they converge towards the objective of the work using the following clippings: (1) Temporal - from 1987 on, works published in ENEM; (2) Linguistic - in Portuguese.

Abstracts of works published in the ENEM annals were read and/or the full article was read. Each work was analyzed and classified according to eight criteria: (1) Year of publication; (2) Researched content; (3) Investigated participant; (4) Level of education focused on the work; (5) Educational institutions that are references from the works published in ENEM; (6) Groups of technologies used for the development of the work published in the annals of ENEM (Learning objects; Software; Virtual Learning Environments - AVA; Programming languages; Google Drive).

### **III. TEACHING STATISTICS, PROBABILITY AND COMBINATORY ANALYSIS AND THE USE OF TECHNOLOGICAL RESOURCES FOR INITIAL AND CONTINUING TEACHER TRAINING IN ENEM FROM 1987 TO 2019**

The following are aspects of the systematic review of the literature regarding the teaching of Statistics, Probability and Combinatorics aimed at the use of technological resources aimed at the use of technological resources for the initial and continuing education of teachers at ENEM, in which the reading was carried out of abstracts and/or full articles referring to scientific productions contained in the annals of ENEM in the period from 1987 to 2019.

As a result of this search, we identified 15 works that will be presented below, in chronological order of publication and linked to the events in which it was published. Thus, to facilitate the study, we created a code, the first column being composed of the letter E, indicating that it is a work published in ENEM, and an order number from 1 to 15. This code was used to associate, later, each work with the thematic axes that will be analyzed.

The ENEM, held periodically every three years, according to SBEM (2017), is an event organized by the National Executive Directorate of SBEM and coordinated by the proposing regional directorate that brings together the various segments involved with Mathematics Education as Basic Education teachers, teachers and undergraduate students in Mathematics and Pedagogy, graduate students and researchers, aiming to provide spaces for discussions on Mathematics Education, its multiple and complex activities, new methodological trends and research that support the field.

During the research carried out at ENEM, works that used technological resources aimed at initial and continuing teacher education were selected, among the different modalities, that is, scientific communication, experience reports, short courses, workshops, posters, round table and lecture.

The ENEM is the largest event organized by SBEM, focusing on the teacher who teaches mathematics and represents an important factor in the growth of SBEM and in the organization of the Mathematics Education community. It is a privileged space for exchanges between professors and researchers, so that advances in the scientific field are disseminated in classrooms, as well as the experiences of teachers are shared by the scientific and school community.

It has been taking place in the last 32 years, with thirteen meetings taking place, characterized by



a vast program of scientific and pedagogical nature, in which new knowledge productions in the area are presented, major themes are debated and research and the challenges that emanate from schools in the process of teaching and learning mathematics.

From the identification of 15 (fifteen) works focused on the teaching of Statistics, Probability and Combinatory Analysis and aimed at the use of technological resources for the initial and

continuing training of teachers, we present them in table 2.

Work	Identification	ENEM (Year)	Type	Title	Author(s)
E1	E9	IX ENEM (2007)	Experience Report	Learning by doing: how to take advantage of the computer to improve the learning of Statistics.	Lori Viali (PUCRS/UFRGS)
E2	E11	IX ENEM (2007)	Experience Report	Statistics applied to education in virtual environments: evaluating processes.	Suely Scherer (UFPR/UNERJ)
E3	E12	IX ENEM (2007)	Experience Report	Continuing education of teachers and mathematics: planning and collective development of a workshop using the electronic data spreadsheet to learn statistics.	Teresinha Fumi Kawasaki (UFMG) Patrícia D. Magalhães (PUC/MG)
E4	E15	X ENEM (2010)	Scientific Communication	Inserting computer use in rural schools: an experience of interpreting graphics by teachers.	Andreika Asseker (UFPE) Carlos Eduardo F. Monteiro (UFPE) Iranete Lima (UFPE)
E5	E19	X ENEM (2010)	Short Course	Water planet: a sequence to teach Mathematics, Statistics and Citizenship.	Anaildes Moreira Andrade (UESC) Irene M. Cazoria (UESC) Alexandre V. dos S. Cruz (Colégio Amélia Amado/Itabuna-BA)
E6	E20	X ENEM (2010)	Short Course	Treatment and Analysis of Information with the aid of software.	Douglas da Silva Tinti (UNICID) Bárbara Cristina M. S. Nakayama (UFSCAR) Gilberto Januário (PUC-SP)
E7	E24	XI ENEM (2013)	Scientific Communication	Different resources for Teaching Statistics.	Wesley Marcos de A. (PUC/PR) Mirian C. C. Guebert (PUC/PR)
E8	E25	XI ENEM (2013)	Scientific Communication	"Forget those drawings, let's use numbers": an initial study focused on solving a combinatorial problem by Pedagogy students in a virtual environment.	Aline Terra Salles (UFRRJ) Marcelo A. Bairral (UFRRJ)
E9	E27	XI ENEM (2013)	Scientific Communication	Statistical Education in front of technologies.	Rosiane de Jesus Santos (UFJF)
E10	E32	XII ENEM (2016)	Short Course	Learning Statistics with Software R.	Lisandro Bitencourt Machado (IFSC) Ednei Luís Becher (IFRS)
E11	E33	XII ENEM (2016)	Short Course	Teaching Statistics for the initial / final years of Basic Education using active methodology and the computer program R.	Alexandre Sousa da Silva (UNIRIO) Maria Tereza S. Barbosa (UNIRIO)
E12	E35	XIII ENEM (2019)	Scientific Communication	BNCC of High School and Statistics: analysis and construction of Box Plot and diagram of Branches and Leaves using Geogebra applets	Alan Júnior Severo (UNESP)
E13	E36	XIII ENEM (2019)	Scientific Communication	Statistical Activity - Lowest Bid Auction	Ana Olívia R. P. Justo (USP) Marcos Nascimento Magalhães (USP)
E14	E38	XIII ENEM (2019)	Short Course	Use of technological tools in the Teaching of Statistics	Juliano T. Alves da Silva (IFMT/UFMT) Patrícia do S. da S. R. Castro (IFMT)

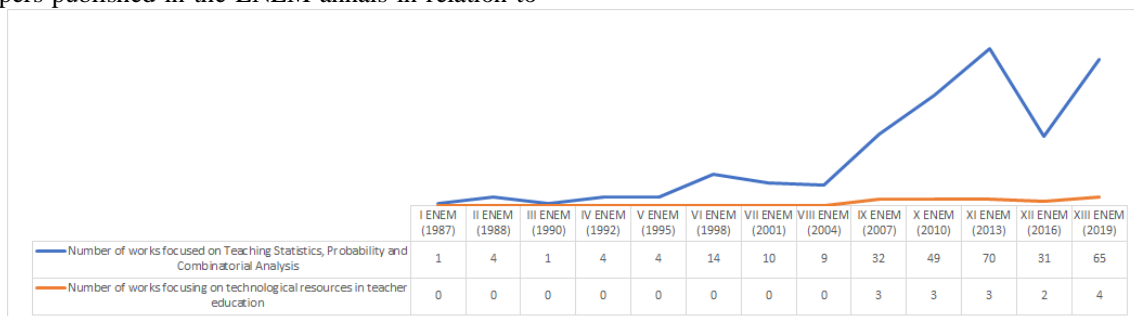


					Gilberto F. Araújo (IFMT)
E15	E41	XIII ENEM (2019)	Short Course	Teaching Statistics for the final years of Elementary School using Active methodology and the Computer Program R	Luciane Velasque (UNIRIO) Alexandre Sousa da Silva (UNIRIO)

**TABLE 2: WORKS PUBLISHED IN ENEM RELATED TO THE TEACHING OF STATISTICS, PROBABILITY OR COMBINATORY THAT ADDRESSED ASPECTS REGARDING THE USE OF TECHNOLOGICAL RESOURCES FOR INITIAL AND CONTINUED TRAINING OF TEACHERS**

the teaching of Statistics, Probability or Combinatorics, and in parallel those that addressed the use of technological resources from 1987 to 2019.

Figure 1 shows the trend in the number of papers published in the ENEM annals in relation to



**FIGURE 1: NUMBER OF PAPERS PUBLISHED ON THE TEACHING OF STATISTICS, PROBABILITY OR COMBINATORY AND THE HIGHLIGHT OF THOSE WHO ADDRESSED THE USE OF TECHNOLOGICAL RESOURCES FOR THE INITIAL AND CONTINUED TRAINING OF TEACHERS IN ENEM FROM 1987 TO 2019**

From a total of 294 (two hundred and ninety-four) works that were published in the annals of ENEM from 1987 to 2019 addressing the teaching of Statistics, Probability or Combinatorics, we observed 15 (fifteen) focused on the use of technological resources and aimed at initial training and continuing education of teachers, that is, it corresponds to 5.1% of the total work.

It can be observed that only after the IX ENEM in 2007 did we observe studies aimed at teaching Statistics, Probability or Combinatorics with a focus on technological resources and aimed at the initial and continuing education of teachers, which may indicate the concern of researchers to incorporate these resources in the educational process in Brazilian schools and which still faces many challenges, ranging from the elaboration and execution of projects and public policies that guarantee a minimum of infrastructure to the institutions, to the critical training of teachers for the choice, evaluation and coherent use of technologies.

Considering the fourteen institutions that published works at ENEM in the period from 1987 to 2019, focused on the use of technological resources with a focus on teacher training in the teaching of Statistics, Probability or Combinatorics,

we can observe that there is no institution that has research focused in the use of technological resources and the training of teachers, except at the Federal University of the State of Rio de Janeiro (UNIRIO) which presents two works I try to support for this production the Research Group Teaching-learning and evaluation in the teaching of Statistics, Probability or Combinatorial registered with CNPq, and the researchers are linked to the SBEM WT-12 (Statistical Education).

Table 3 shows the researched content and directed to the teaching of Statistics, Probability or Combinatorics and focused on the use of technological resources in the training of teachers in the works published in ENEM.

Searched content	Identification	n	%
Statistic	E1, E2, E3, E4, E5, E6, E7, E9, E11, E12, E14	11	73,33
Statistics and probability	E10, E13, E15	3	20,00
Combinatory	E8	1	6,67

**TABLE 3: PUBLISHED PAPERS ADDRESSING THE USE OF TECHNOLOGICAL RESOURCES FOR CONTINUED TRAINING IN THE TEACHING OF STATISTICS, PROBABILITY OR COMBINATORY IN THE ANNUALS OF ENEM**



As we can see in Table 1, most of the published works were developed in the Statistics area with 11 (73.33%) works, corresponding to more than two thirds of the published works, shows us the interest in Statistics as an object of study.

Some authors believe that the teaching of Statistics, combined with technology, makes it easier to understand the logic of data representations and also a significant time gain, which can be better used with reflections on the information collected and about possible actions in view of the conclusions reached ([18], [19] and [20]).

In [21] it is emphasized that, in order to have a better use of technological resources for the teaching of Combinatorics, various symbolic representations must be made feasible, in addition to important issues to be considered such as: feedback compatible with the type of invariant to be mobilized and assistance to the user that allows the reflection on the situation to be solved and allows the reformulation of resolution strategies.

For [22] technological resources can be useful for the construction of new knowledge in Statistics, Probability and Stochastic, and the activities using these resources must be related to practical problems, requiring constant teacher intervention.

Complementing these ideas, [23] consider that the true incorporation of Information and Communication Technology - ICT in the teaching process requires specific knowledge from the teacher, in which the dimensions of content knowledge, pedagogical practice and technology are intertwined. It is understood that teachers need both technical and pedagogical preparation to be able to integrate technologies in their classes.

Table 4 shows the distribution of works published in ENEM that address the teaching of Statistics, Probability or Combinatorics and are focused on the use of technological resources with a focus on initial and continuing teacher education.

	Training	Identification	n	%
Initial	Pedagogy	E2 e E8	3	20
	Mathematics	E13		
Continued	Early years Elementary School	E11	9	60
	Final years Elementary School	E9 e E15		
	High school	E3		
	Basic education	E4, E5, E7 e E14		
	University education	E1		
Initial (Mathematics) and Continued	Basic education	E6 e E12	3	20
	High school	E10		

**TABLE 4: PAPERS PUBLISHED ACCORDING TO PARTICIPANTS FOCUS OF RESEARCH AND THE USE OF TECHNOLOGICAL RESOURCES IN THE ANNALS OF ENEM**

The main focus on the works identified in ENEM is mostly (two thirds of the total) focused only on the continuing education of teachers of Basic and Higher Education, presenting strategies to indicate strategies on how to use technological resources in Statistics, Probability or Combinatory classes.

Focused on the continuing education of teachers, we consider it necessary to propose strategies for teachers or evaluate their pedagogical posture regarding the use of technologies, as well as the style of teaching, just as the student has his own way of learning, that is, of developing his cognitive behavior.

When it comes to the use of technological resources in the classroom, the educator has a number of options as the tools available are so many and so varied, that it is essential to research these alternatives and evaluate not only their effectiveness, but their adequacy students' objectives and level of development.

We should also not forget that technology can make life easier for educators, allowing them to automate some of their tasks, optimizing both the time used to prepare classes and the didactic action itself.

For [24] there are several ways to improve the transmission of knowledge in schools, one of which is the use of technological resources (computer, multimedia resources, educational software, etc.), which help both the teacher and the student during the process of learning, providing conditions, to the teacher, to teach classes in a more creative way, following the transformations and changes that occur when the student starts to exercise his independence in the search and selection of information and in solving problems, thus becoming the actor in building your knowledge.

We consider what they say [25], that is, that the presence of technology in education is not seen in the same way by students and teachers, because while for students they seem to face them



naturally, for teachers, despite using them in daily life, they do not always do so in pedagogical practice.

In this context, we also indicate that [26] affirm that since the teacher is unprepared for the use of technological resources in his practice, the computer, for example, by itself, has no effect on the school's computer room, considering that a large part of educators is born and were trained before the digital generation.

The authors still consider that, the reality is that the technologies are inserted in all the spaces of the daily life, however, many educators still place it as something exceptional and external to the pedagogical context.

We believe that technology has an increasingly relevant role in society, having been applied to different daily activities and, therefore, has played an important role from a personal and professional point of view. Therefore, we consider that it is not possible to think about the formation of a citizen who is not prepared to deal with these tools, who has mastery of their use and, above all, who knows how to critically analyze their applications and implications.

According to [27], young people in a world in which personal computers are popularized and the internet is created, comprise a segment of users of Information and Communication Technologies that not only make current use of them, but also anticipate what lies ahead. come, it is important to understand that it is important that education also adapts to technology, and bring it to the reality of students, who are already "born" inserted in it.

When analyzing the publications present in the annals of ENEM in the period from 1987 to 2019, it is observed that the learning proposals that involve the teaching of Statistics, Probability or Combinatorics mediated by the use of technological resources in the training of teachers are present in five types of technologies:

- (1) Learning Objects - are resources that have reusability as a characteristic, that is, the object must explain its pedagogical objectives and be structured in such a way that it is self-contained (with regard to the content covered), allowing it to be reused, as: videos, hypertexts and interactive games [28];
- (2) Softwares - they are stored electronic instructions, known as programs and that this software is the component that gives life to the machine [29];
- (3) Virtual Learning Environments (VLE) - it is a means of communication that has been used to intermediate the teaching and learning process, especially in distance learning. Chats and discussion forums are communication tools that are part of the VLE and through these instruments, teachers and students can interact with each other, since it is possible to socialize productions and information [30];
- (4) Programming Languages - when it comes to Statistics, we highlight the "R" which is an object-oriented language created in 1996 by Ross Ihaka and Robert Gentleman that, together with an integrated environment, allows data manipulation, calculations and graph generation [31];
- (5) Google Drive - is an application package that is completely online and has the following features: text editor, presentation editor, forms editor and a spreadsheet editor [28].

Considering the 15 works of ENEM that involve digital technologies associated with the teaching of Statistics, Probability or Combinatorics for teacher training, we divided them into the five subgroups mentioned above, as shown in Table 5. Some works feature more than one type of technology.

Technology Group	Description of technologies	Technologies used	Work published in ENEM
Learning Objects	Lowest Bid Auction Game (Portal AtivEstat)	1	E13
Software	Excel (spreadsheet)	3	E1, E6 e E7
	BrOffice.org Calc. (spreadsheet)	2	E3 e E9
	SPSS (Statistical Package for Social Sciences)	2	E7 e E13
	GeoGebra	1	E12
	Minitab	1	E7
	Tinkerplots	1	E4
	Statistics	1	E7
Virtual Learning Environments	Virtual Environment to Support Statistical Literacy - AVALE	1	E5
	Virtual Online Environment: VMT-Chat VMT =	1	E8





	Virtual Math Team		
	Virtual Environment (general)	1	E2
	Kahoot	1	E14
Programming languages	Language R	3	E10, E11 e E15
Google Drive	Google Forms	1	E14

**TABLE 5: GROUP OF TECHNOLOGIES USED IN WORKS PUBLISHED IN ENEM FROM 1987 TO 2019**

We will present in more detail below, the works that made use of some digital technology through software for teacher training and which were indicated in table 3.

Indicated as the use of a learning object, in E13, XIII ENEM, the use of activities in the teaching of Statistics is discussed through the game of the lowest bid. The game Auction of the lowest bid helps in the interpretation of the concepts of average and median and has a version for the classroom present in the AtivEstat of the Institute of Mathematics and Statistics of the University of São Paulo - IME-USP. A digital version was developed, presenting suggestions that help the teacher in the implementation and application of the game. Based on the observed results, the game can contribute to students' statistical literacy, which consists of the ability to understand basic statistics concepts such as the mean and median.

Highlighted in this work as the use of software, we believe that the electronic spreadsheet has several purposes that can be highlighted, among others: it makes it possible to format a numerical representation in a graph; facilitates understanding of the data; develops and encourages the interpretation of graphic data, among others. For [32] electronic spreadsheets make it possible to perform calculations, quickly, from informed data that facilitate the visualization of information.

Thus, in E3 experience reports are brought to the IX ENEM, in a workshop of continuing education for mathematics teachers given in November 2006 for two classes of students from EJA, from High School. The experiences have moments of experimenting with didactic material in parallel with classroom activities, seeking, whenever possible, to contextualize and assign meanings to classes, promoting to the maximum, autonomy in the construction of knowledge.

In work E9, XI ENEM, an interview was conducted with mathematics teachers from elementary school to verify how they work on the content of statistics through technological resources, among other issues. The results indicate the need to develop pedagogical practice that will integrate statistics, education, technology and society, and it is necessary to reflect on education in an attempt to seek training, didactic resources to

support the teacher in the classroom, in order to promote education quality statistics.

In work E1, IX ENEM, the teaching of Descriptive Statistics was considered considering a computational resource in which one learns by doing. This approach has been used in the teaching of students from different university courses, among several courses, Mathematics and Pedagogy. It is considered that such an approach presents greater motivation and less fear in relation to statistics, creating a view of the discipline and bringing more disposition in its professional use.

In E6, X ENEM, the need to create training spaces where the use of new technologies is considered, learned and (shared) is emphasized, highlighting the potential of the technology-teaching articulation. And the motivating elements for thinking about a workshop that provides a reflection on the Teaching of Statistics, at different levels of learning, aiming at valuing the analysis of information, applicability and understanding of the features of Descriptive Statistics with the help of software, specifically the Excel spreadsheet.

In the work identified as E7, in X ENEM, they consider that Excel® can provide faster resolution of statistical problems, and with this tool, it is estimated that teachers obtain with their students, in statistics classes, permanent goals such as learning, retain and transfer the studied concepts. According to the authors, the mini-course was designed in order to present some of the functions available in Excel® for statistical analysis such as: graphical representation of data; absolute frequency and relative frequency; frequency tables; counting class elements; bar diagram; histograms; circular diagram; arithmetic average; median; fashion; variance; standard deviation.

Distance Learning (DE) has assumed an important role in the teaching and learning process due to advances in digital technologies, information and communication systems. A distance learning course to be well developed, in addition to careful didactic planning and good technological resources, requires the help of a Virtual Learning Environment (VLE), which by definition is a system designed to assist in the development of distance learning courses.

In E5, at X ENEM, the short course aimed



to socialize the teaching sequence “Water planet” made available by the “Virtual Environment to Support Statistical Literacy - AVALE”. Based on the need for conscious and rational use of water, this activity probes the profile of the household in relation to water, “measures” the level of awareness of water use and analyzes the profile of water consumption of the students' families. In addition to focusing on the specificities of time-dependent variables (time series), it also presents the use of tables, graphs, measures of central tendency and dispersion. This sequence was experienced in several courses and in a public school, with students from the 6th year of elementary school. According to the authors, the results are promising, because despite the difficulties with the quantitative aspects, students have great ease with the computer and are able to give meaning to the content addressed next.

In E8, XI ENEM, focused on learning in virtual environments that can signal that the analysis of online interactions enables the teacher to build discursive strategies to contribute to the continuity of the collaborative debate. The learning environment used was VMT-Chat, a space where students solved introductory combinatorial activities. The virtual sessions were held in three classes of a Pedagogy Degree course. The analysis focused on finding aspects of the discourse that show the development of mathematical reasoning and the resolution strategies adopted by the participants. The results identified two heuristics used by the learners in the online resolution of a combinatorial activity: the tree and the list of possibilities.

In E2, IX ENEM, a communication and learning process was evaluated in a virtual learning space in the discipline of statistics applied to education, in a Pedagogy course. The proposal for a bimodal education of the discipline was discussed based on the analysis of the records left by the students in the virtual environment throughout the process and at the end, identifying movements that can favor the students' learning in virtual environments, imbricated to the movements present in a room classroom.

In work E14, XIII ENEM, a short course was offered using technological tools that the teacher can use to awaken the student's interest and participation in the teaching and learning process of Statistics, aiming at understanding: data collection, representation of research data expressed in tables and graphs, calculations of central measures and dispersion. Google Forms was presented for data collection; Microsoft Excel for data treatment and

analysis and Kahoot as a learning assessment tool.

Regarding the use of “R” or “R” software, we emphasize that it is a language and, at the same time, a computational environment that allows the performance of calculations, simulations and the development of statistical models; in addition to allowing the realization of a wide variety of mathematical calculations and the construction of graphs.

In E10, at the XII ENEM in 2016, the mini-course was given with the objective of presenting the software R, RStudio development environment, demonstrating some possibilities of didactic-pedagogical use. The mini-course had an introductory character and was developed through the proposition of a sequence of activities that would enable participants to know and learn to use the software to simulate and solve statistical or probabilistic problems commonly dealt with in the teaching of Statistics in High School, without requiring previous knowledge. about the software.

In E11, at XII ENEM, assuming that Statistics was effectively included in the Common National Curricular Base (BNCC) of Mathematics for Basic Education and that, mathematics teachers are not always comfortable teaching statistical concepts in the early years of the basic cycle, a short course was offered presenting and discussing activities that will allow working on these concepts using teaching and active learning methodologies and computer programs available on the internet. In particular, the R program will be used, with the Rcmdr interface, as it is free, open source and has a large number of discussion forums, blogs and pages designed to facilitate the use of this program.

At XIII ENEM, in E15, a mini course was offered where activities were presented that allow the collection of information to be worked through a questionnaire and data analysis with the elaboration of graphics and calculation of descriptive measures using active teaching / learning methodologies and computer programs available on the internet. In particular, the R program was used, with the Rcmdr interface, as it is free, open source and has discussion forums, blogs and pages designed to facilitate the use of this program.

TinkerPlots [33] is an educational data analysis application, developed for working with students in the early years of elementary school. According to its authors, this software is a complex statistic teaching tool that motivates students to perform activities inside and outside the classroom [34]. TinkerPlots is a program that constitutes a dynamic, interactive and easy to manipulate



environment that encourages students to work with them.

In 2010, at X ENEM, in work E4, they investigated the use of the Tinkerplots software by two rural school teachers. The activity was carried out from a database arranged in the software, where the teachers manipulated the tools contained in the software to help the interpretation of the data from questions suggested by the researchers. From the data obtained, it can be concluded that the use of TinkerPlots by teachers was a rich moment of reflections and interaction with new technologies. They interacted with the proposed tools, performed the commands shown by the researcher and went further, with autonomy, they sought new representations from different uses of the tools available in the software, demonstrating a high level of acceptance and availability for work in computational environments even with little experience using the computer.

GeoGebra (<http://www.geogebra.org/>) is free software for teaching and learning Mathematics and Statistics at various levels of education (from elementary to university) that brings together numerical, graphic, symbolic and programming resources in Geometry, Arithmetic, Algebra, Statistics, Probability and Logic. The software is available for desktop computers (Windows, Linux and Mac OS), tablets and smartphones (Windows, Android and iOS).

According to [3], GeoGebra provides three different fields for mathematical objects: The Graphical Zone, the Algebraic (or numerical) Zone and the Spreadsheet. They allow you to show mathematical objects in three different representations: graphically (for example, points, function graphs), algebraically (for example, point coordinates, equations) and in the cells of the spreadsheet. Thus, all representations of the same object are dynamically linked and automatically adapt to changes made in any one of them, regardless of how these objects were initially created.

In E12, XIII ENEM, in Cuiabá, from the thinking of new possibilities offered by the BNCC of High School approved in December 2018 for the work of statistics in the classroom, activities were presented to work with box plot and graphs diagrams of branches and leaves through applets available on the Geogebra website. In order to carry out this work, an analysis was performed on the skills and competences related to statistics within the area of Mathematics and its technologies and the selection and adaptation of activities

seeking a better adjustment to these skills and competences.

#### IV. CONCLUSION

Undoubtedly, teacher education needs attention. It is essential that the opportunity for this knowledge is made possible. Guidelines and guidelines need to be arranged so that this teacher can understand the importance of teaching Statistics, Probability or Combinatorics in the daily lives of students and himself, so that, throughout his reflections and work, he can mediate knowledge at respect to the theme.

We consider that it is still incipient to present works developed with technological support at ENEM having as support the software that can be used and/or classified as educational (Excel, BrOffice Calc, "R", SPSS, among others) indicating that it can be given more prominence in future research.

We believe that digital technologies can be characterized as a powerful support tool for the teaching of Statistics, Probability or Combinatorics, since their characteristics can favor the awareness and understanding of certain statistical and also probabilistic concepts. In addition, they are resources that enable and streamline the research and data analysis processes.

We suggest that technological resources should enter the classes as an alternative to prioritize reasoning, understanding the data analysis processes and the concepts that permeate them, while pointing to a devaluation of algebraic calculations and repetition of procedures. Perhaps this is the great differential of technological resources, when compared with didactic alternatives and that justifies its relevance to the teaching of Statistics, Probability or Combinatorics.

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