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Learning of Statistics, Measures of Central Tendency through the Use of ICT

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ABSTRACT

Different pedagogical experiences of teaching statistics, particularly measures of central tendency, in a traditional way, have led to unsatisfactory learning. As a consequence, low school performance. Traditional strategies do not motivate the learner for deep learning, but demonstrate the importance of orienting education to practice and the promotion of critical thinking. That is why this study aims to re-signify the teaching of statistics from a techno-pedagogical unit design that links the use of digital tools, in order to adapt the teaching and that students manage to appropriate statistical knowledge. A mixed method has been used, by means of a quantitative study for a pretest and posttest comparative analysis of the techno-pedagogical intervention, and at the same time a qualitative approach has been integrated to obtain opinions on school performance. The results show on the one hand that traditional pedagogical practices limit learning and on the other hand, the techno-pedagogical intervention has favored school performance, that is to say, this study highlights the importance of the insertion of ICT in the teaching process to innovate didactics and overcome the deficiencies produced by traditional pedagogical practices.

Keywords: Statistics, Measures of Central Tendency, ICT

Introduction

The teaching of statistics, specifically of measures of central tendency, has had to face the problems to which it is subjected when it is approached through traditional methods. In the context of the Pablo VI Educational Institution, which is located in the municipality of Cubará, Boyacá, these methods are not able to motivate ninth grade students, so that the result obtained is a superficial understanding and low school performance. Deslauriers et al., (2019) indicate that traditional methods do not actively bind students, even many of them are passive to learning. Seta bah et al., (2019) points out that the teaching of statistics should not only resort to the memorization of formulas, but should take into account the importance of creating strategies that generate critical thinking and the practical use of knowledge.

The framework that defines the research topic refers to transforming the teaching of statistics with ICT, since some authors defend the help that ICT can provide in education. Thus, Sripavithra et al. (2022) emphasize that technological tools can change learning, making it more interactive for the learner. On the other hand, De La Hoz Ruiz and Hijón-Neira (2023) argue that the use of ICT in the teaching of statistics not only facilitates the understanding of concepts, but at the same time increases motivation and development on the part of the learner.

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The framework of this research is established in order to re-signify the teaching of statistics through the implementation of ICT. This is due to the fact that for some authors the integration of ICT in the educational process would make its advantages materialize. For Wibowo et al., (2023), the technological endowment understood as technological tools can change the way of learning, making it more active and interesting, which is what is needed in the student. Likewise, Toma et al., (2023) consider that the use of ICT in statistics education not only makes understanding more efficient, but also promotes students' participative attitude.

During the last years, different studies have been developed that provide a justification for innovation in the teaching of statistics, Burckhardt et al. (2020) refer that virtual learning environments can help the understanding of concepts, because they allow the visualization and manipulation of data in real time. On the other hand, Lekka et al. (2017) state that educational platforms that integrate simulations and interactive games can make the learning of statistics more engaging and meaningful for students.

The purpose of this research is to re-signify the teaching of statistics with ninth grade students of the Pablo VI Educational Institution, through the development and implementation of a techno-pedagogical unit that integrates various technological tools, with the intention of transforming the learning process into a more meaningful knowledge of the measures of central tendency. The research has a mixed approach, since it integrates the use of quantitative and qualitative methods to verify the impact produced by the techno-pedagogical intervention in terms of improved academic performance and students' perception of their own learning process.

According to Timans et al., (2019), the use of a mixed approach allows obtaining a broader and more integrated perspective from the studied phenomenon, where quantitative assessment allows measuring the progression of students' academic assessment before and after the intervention and where qualitative research allows capturing in detail students' opinions and experiences, which provides a global understanding of the educational process. Swatzell and Jennings (2007) support the idea that a descriptive type of research done in conjunction with the action research method (Kemmis and McTaggart, 1988) allows for constant reflection that will result in adjustments during the implementation of such intervention so that it is effective and serves the interests of the students.

The results of the study show that traditional teaching practices considerably limit student learning. It has been shown that traditional methods limit students' active participation and hinder the application of statistical concepts. However, the techno-pedagogical intervention has shown significant improvements in academic performance and in the understanding of measures of central tendency, thus supporting the use of ICT in education.

Globally, the implementation of techno-pedagogical strategies not only enriches the educational process, but also stimulates students and improves their academic performance, becoming a transforming mechanism that allows palliating the shortcomings of traditional pedagogies. In this way, it seeks to promote a more meaningful and profitable learning in the field of teaching-learning of statistics, since, if students are authors of their training process, they will have the possibility of building critical skills, applicable to the future that awaits them, both academically and professionally.

Measures of central tendency in secondary education

Measures of central tendency: mean, median and mode, are important in secondary education as a means of teaching students to summarize and analyze data sets. Their understanding is fundamental in the development of critical thinking and statistical literacy, basic skills in contemporary societies. Rojas Sandoval et al. (2020) argue that statistics can be taught through projects from the first grades of elementary school, significantly improving students' learning and motivation towards this discipline.

The teaching of measures of central tendency in secondary education presents obstacles such as the absence of specific training for teachers and the use of unattractive teaching methodologies. In Catalonia, for example, it has been evidenced that the lack of mathematics teachers produces undesirable academic results in students (El País, 2024), in addition to the fact that the traditional teaching of statistics has become accustomed

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to considering it as a boring discipline and, therefore, one that does not facilitate learning in students (Rojas Sandoval et al., 2020).

In order to address these difficulties, alternative methodologies have been introduced in which measures of central tendency are applied in one or another context more appropriate and relevant to students. To illustrate, Rendón Vasco (2023) carried out a study in the rural area of Támesis (Colombia), using measures of central tendency with the objective of addressing financial education oriented to productive projects, an activity that increased financial skills and stimulated the design of projects within the framework of teaching.

The implementation of statistical projects in the classroom dealing with problems of a community nature has been equally effective. Garibot et al. (2020) offered a proposal for teaching statistics in secondary school that was based on the treatment of problems of a community nature and allowed students to pose statistical concepts, confronting them with problems in their daily environment, which led to their improved understanding and appreciation of these proposals. These strategies favor an active and contextualized learning and allow the treatment for the understanding and application of the concepts of measures of central tendency on the students' daily situations.

ICT in statistics learning

The incorporation of Information and Communication Technologies in the teaching of statistics in secondary education has proven to be an effective strategy to improve student understanding and interest. A study in Peru on the use of ICT in the teaching of descriptive statistics in higher education shows that ICT has indeed influenced the learning process in a positive way, and that it has helped the understanding of complex concepts and a more active participation of students (Núñez et al., 2023).

A review of the systematic literature also highlights the importance of ICT in learning in secondary education, indicating that the correct arrangement of its use can enrich the educational experience and improve academic results (Peralta Roncal et al, 2023). In the same way, technological materials in the classroom can put students in contact with the data of reality and with the analysis of statistics in a more dynamic way. For its part, a study conducted in Chilean universities showed that the use of ICT in the statistics class allows students to understand the content and have an interest in actively participating in their learning process (Toledo San Martín, and Vicencio, 2021).

Likewise, the possibility of finding resources with digital support and the preparation mediated through specific training of teachers who use these technologies are general conditions for their application to provide good results in formal education (UNESCO, 2020). With the arrival of the COVID-19 pandemic, the use of ICT for formal education intensified, a clear sign of its importance for the development of the educational process. However, their application cannot be achieved without good planning and training of teachers and students to provide effective support (Oliveira et al., 2021).

In this sense, educational institutions have to provide all the technological resources available and favor the creation of digital competencies to enhance the advantages provided by ICT in the teaching of statistics (Reddy and Reddy, 2022); despite the benefits that their use promotes, it is also necessary to take into account problems or risks associated with their implementation in the educational context, for example, the use of gamified apps for the teaching of mathematics has generated controversy regarding their impact on students and the need for more extensive studies on their effectiveness.

Therefore, it is necessary that the integration of ICT in the teaching of statistics be balanced, taking into account the opportunities as well as the possible limitations, and always with the objective of enhancing the quality of student learning.

Methodology

One of the main objectives of this research was to validate the use of ICT in the learning of measures of central tendency. For this purpose, statistical thinking was considered as a dependent variable and specifically, the knowledge of measures of central tendency, as well as the use of different quantitative techniques and

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instruments. In the case of the independent variable, the use of ICT was evaluated based on the referents and the opinion of the participating subjects in the sample.

Considering the analysis of variables, the present study has opted for a mixed approach. From the quantitative paradigm, the dependent variable has been taken in two moments of the learning process measured by means of pre-test and post-test. Since this is an educational research that actively involves the participants in the pedagogical process, the qualitative paradigm has been incorporated to collect their opinions and reflections on the use of ICT as a learning tool on the measures of central tendency.

The combination of these approaches made it possible to integrate the study within the framework of a mixed methodology, which, as mentioned by Hernández et al. (2006), allows for a deeper understanding of the object of study; that is, not only to be able to make a quantitative interpretation of the variables, but also to incorporate the qualitative references provided by the participants in the research process, thus showing that both paradigms are complementary and not mutually exclusive.

In terms of scope, the study is framed within the descriptive method, which is used to describe all the dimensions observed in each of the stages of the research process. As Ander Egg (1995) argues, the descriptive methodology makes it possible to describe the characteristics and features of the study phenomenon as it appears in the research setting.

The research design is based on the pre-experimental or hypothesis-testing method, whose objective is to determine the influence that the independent variable (ICT use) could have on the learning of measures of central tendency in two learning moments: before and after the didactic intervention. Following Campbell and Stanley (1978), this type of study attempts to determine the relationship between the variables under investigation, trying to demonstrate in this case the way in which the use of ICT could influence the learning of measures of central tendency by the students belonging to the sample population.

Population and Sample

The present study consisted of a total of 60 ninth grade students from the Pablo VI Educational Institution, in the municipality of Cubará, Boyacá. A sample of 22 students was chosen from the total population, responding to the convenience sampling. Table 1 describes the explanatory criteria that supported the selection of the students who participated in the sample.

Table 1

Convenience criteria in sample selection

Selected sample	Criterios de selección muestral
Of the 60 students in the ninth grade of elementary school, a representative sample of 22 students was selected to be included in the research process.	The sample, composed of 22 students out of the 60 students that make up the ninth grade population, was selected based on the following criteria: - Be an active student in the SIMAT academic registration system. - Present low school performance in the area of mathematics, specifically in measures of central tendency. - Have the informed consent of their guardians or legal representatives to participate in the study. - Possess basic knowledge in the use of ICT, a necessary requirement for their inclusion in the techno-pedagogical strategy implemented.

Note: The table summarizes the criteria used to form the representative sample.

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The students who participated in the research showed a high inclination towards the implementation of ICTs, due to their liking for the interaction that this type of tool allows. Most of the students belong to socioeconomic strata 1 and 2. Table 2 presents some relevant characteristics of the sample subjects.

Table 2

Demographic and contextual characteristics of the sampled subjects

Item	**Detail**
School level	Ninth grade of basic education
Genre	Women: 12 Men: 10
Age range	13 to 15 years
Context	Urban
Socioeconomic Level	1, 2 y 3
Opportunity to use ICTs	Good; all of the sample students have an adequate level of digital skills and are familiar with the use of ICTs.

Note: The table presents the demographic and contextual characteristics of the students included in the study.

Variables and hypotheses

The research, with a mixed approach, includes both quantitative and qualitative methods. From a quantitative approach, the dependent variable has been established as a function of academic performance in the context, in particular, of the area of mathematics, in the field of knowledge of calculations of measures of central tendency. Similarly, independent and intervening variables are integrated. Table 3 shows details concerning the operationalization of the variables analyzed in this research.

Table 3

Operationalization of variables

VARIABLES	**INDICATORS**	**QUESTIONS**	**COLLECTION TECHNIQUE AND INSTRUMENTS**
Dependent Variable: School performance in the area of mathematics (knowledge measures of central tendency).	Estimation of the level of students' knowledge in the area of mathematics (knowledge in the calculation and interpretation of measures of central tendency).	At what level of performance is the school performance of the sample students in the topic measures of central tendency?	Technique: pre and post knowledge test. Instrument: structured questionnaire
Independent Variable: Digital educational resources.	Students' behavior towards the integration of ICT in the learning of measures of central tendency.	How do the sample students act when faced with the integration of ICT in the appropriation of knowledge inherent to measures of central tendency?	Technique: Observation Participant Instrument: Field Diary

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Interviewer: Didactic Strategy	Students' perception of the educational experience.	How do the sample subjects interpret the techno-pedagogical strategy focused on learning measures of central tendency?	Technique: Post didactic intervention opinion survey. Instrument: structured questionnaire with open-ended questions.

Note: The table presents the operationalization of the variables considered in the study.

In relation to the qualitative approach, the arguments, opinions and reflections of the students after having applied the didactic strategy are evaluated. For this purpose, an opinion questionnaire with open-ended questions was used to assess the perceptions and experiences of the participants.

With respect to the hypothesis in this research design, the following assumptions are proposed to be tested:

- **Null Hypothesis (Ho):** The average school performance in mathematics, specifically in knowledge of measures of central tendency, is equal when teaching is done through ICT compared to the traditional teaching method.

This approach must be refuted to validate the alternative hypothesis.

- **Alternative Hypothesis (Ha):** The average school performance in mathematics, specifically in knowledge of measures of central tendency, is different when teaching is done through ICT compared to the traditional teaching method.

Phases of the Research Process

The research process is structured in four main phases, aligned with the methods and specific objectives proposed. These phases are described below.

First stage

The initial stage of the study focused on the first objective: to characterize the knowledge of the sample students about measures of central tendency. This objective was achieved by means of a pretest of knowledge that allowed us to assess the level of school performance of the students. The results obtained in this stage are presented in the results section.

Second Phase

After the diagnostic phase, it was identified that the students' performance in the topic of measures of central tendency was low, which led to the adoption of pedagogical measures to address this problem. In order to achieve the second objective of the study, which was to create an educational environment that would redefine mathematics methods and didactics, a techno-pedagogical strategy focused on the integration of ICT was designed. This strategy was developed in collaboration between the researcher and the mathematics teacher.

Third Phase

The third phase involved the implementation of the techno-pedagogical didactic strategy, focused on fulfilling the third objective of the study: to analyze the behavior of students when using ICTs as a learning tool. During this stage, students' reactions and attitudes were systematically observed and documented throughout the different moments of the techno-pedagogical unit, using field diaries to record these observations.

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Fourth Phase

The final phase of the study was aimed at comparing the results obtained in the pretest and posttest of knowledge in the area of mathematics, with a particular focus on the measures of central tendency. This comparison was aimed at reflecting on the incidence of ICT integration in the learning of such content, thus addressing the fourth objective of the research. Additionally, an opinion survey was conducted to capture students' reflections, opinions and arguments regarding the educational experience. The results of this last phase are detailed in the results section.

Results

The results presented below are related to the objectives formulated in the research and account for the development achieved in the different phases that make up the research process. At the same time, each of the phases of the study was carefully elaborated to account for the research questions that helped to reveal the learning dynamics of students in mathematics, fundamentally in relation to the measures of central tendency, together with the effects of ICT in this process. These results provide a comprehensive and coherent view of the progress achieved and the educational challenges that the application of the ICT-mediated pedagogical strategy entailed.

- **Results of the First Phase: Diagnosis**

The results of this phase are aligned with the first objective of the study: to characterize the level of knowledge of students on the topic of measures of central tendency. For this purpose, a pretest composed of 15 items designed to evaluate aspects related to the calculation and interpretation of measures of central tendency in grouped and ungrouped data was applied. It is important to note that the pretest was administered face-to-face, as illustrated in Figure 1.

Figure 1

Ninth grade students taking the diagnostic pretest on measures of central tendency.

Note: Figure 1 shows students participating in the diagnostic test focused on the topic of measures of central tendency applied in the classroom to ninth grade students of the Pablo VI Educational Institution.

The pretest evaluation was carried out using the rating scale adopted by the Pablo VI Educational Institution, where the study took place, which ranges from 1.0 to 5.0, as detailed in Table 4.

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Table 4

Evaluation Scale - Pablo VI Educational Institution

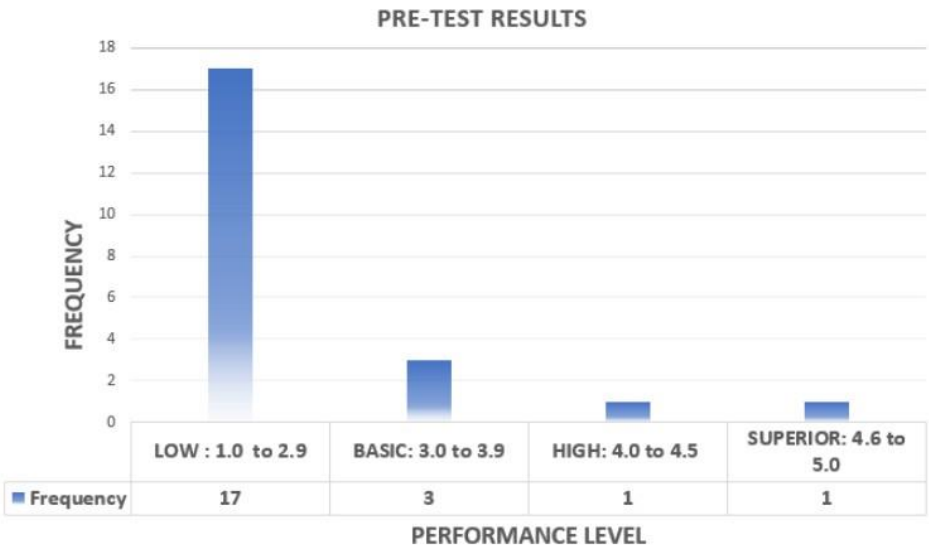
Qualitative performance	Quantitative performance
Low	1.0 a 2.9
Basic	3.0 a 3.9
High	4.0 a 4.5
Superior	4.6 a 5.0

Note: The table shows the grading parameters used to evaluate academic performance at the institution.

The pretest results revealed that the students' performance in mathematics, specifically in measures of central tendency, is predominantly at a low level. Figure 2 presents the detailed results of the test applied to the 22 students who participated in the study.

Figure 2

Pretest results on knowledge of measures of central tendency.



Note: The graph illustrates the results obtained by the students in the pretest on measures of central tendency.

The data analysis shows that 77.2% of the students have achieved a score within the limits of 1.0 and 2.9, thus placing them in the low performance category according to the institution's assessment scale; in addition, 13.6% (3 students) have achieved ratings between 3.0 and 3.9, placing them at a basic performance level; finally, only 9% (2 students) have achieved ratings within a scale of 4.0 to 5.0, placing them at high and superior performance levels.

Table 5 presents the key descriptive statistics derived from the pretest application.

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Table 5

Basic statistics derived from the pretest on knowledge of measures of central tendency.

Pre-test Knowledge of measures of central tendency	
Validated Data	22
Missing information	0
Average performance	2.045
Standard Deviation	1.090
Minimum Qualification	0.66
Maximum Qualification	4.66

Note: The table presents the essential descriptive statistics resulting from the pretest quantitative assessment.

According to the basic statistical data, the school evaluation mean corresponding to the measures of central tendency is 2.04, which indicates that the degree of knowledge that the students have in this subject is low; being the value of the maximum grade reached of 4.66 in relation to the minimum grade of 0.66, which gives an overall mean of 2.53, which reaffirms the low level of learning. Therefore, it is necessary to resort to educational strategies where both the knowledge and the application of the measures of central tendency are worked on. It is fundamental that the practical point of view does not leave aside the theoretical part, since this favors the fulfillment of the learning objectives.

In addition to the pretest, an opinion survey was administered to the 22 students in the sample. The purpose of this survey was to know the students' opinions on the causes of their low performance in mathematics, specifically on the topic of measures of central tendency. The results showed that most of the students attributed their low performance to the existence of traditional teaching methods. Specifically, they indicated that the pedagogical approach focuses on memorization and verbal repetition of formulas and algorithms, which prevents them from understanding and applying knowledge in real situations.

Another element found in the students' responses was the fact that the didactics used during mathematics classes are insufficient to achieve an adequate and fundamental understanding of measures of central tendency. The students indicated that far from favoring critical and contextualized learning of the topics addressed, the mathematics classes were an occasion to perform mathematical procedures in a very mechanical way. This didactic approach led to a mismatch between the concepts and their practice, which in turn limited the development of analytical skills in the disciplinary area.

Finally, students indicated that the teaching of measures of central tendency was considered to be framed in an isolated and abstract way, separated from situations and problems of everyday life, which made it difficult for them to link useful concepts in real life situations, thus reaffirming the idea that learning meant learning for exams rather than for appropriating knowledge of a meaningful and applicable nature. These data point to the need to review and reformulate the pedagogical strategies that could be useful for teaching measures of central tendency so that they can favor a deeper and more situated understanding in the teaching-learning context of mathematics.

- **Results of the Second Phase: Didactic Design**

After detecting the deficiencies in the level of knowledge of the students on the topic of measures of central tendency, the design of a techno-pedagogical strategy was carried out, oriented to address the detected problem in order to try to improve it. The improvement strategy focused specifically on strengthening skills in the calculation, application and interpretation of measures of central tendency, integrating the use of Information and Communication Technologies (ICT) as a fundamental part of teaching.

This didactic strategy was designed taking into account the use of different digital educational resources that have a high degree of interactivity and contextualization with the teaching content. For the design of the intervention, resources such as online educational platforms like GeoGebra and Khan Academy were used, which

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corroborate the mathematical teaching in a more dynamic and explanatory way through visual tools and interactive exercises. In turn, other types of resources used were educational videos or simulations, which showed in a more visual way the contents and how to apply them in real situations. Excel software was also used for data analysis, so that students were able to manipulate real data sets and make observations on how to calculate and interpret means of central tendency in different situations.

The strategy was oriented towards a comprehensive teaching of the three measures of central tendency, which are the mean, median and mode. For each measure, activities were carried out that contained, among other aspects, practical exercises of manual and computational calculation, as well as interpretative exercises on results in applicable situations. From this point of view, the strategy not only had to prepare the student to calculate the mean, median or mode, but also to understand the meaning of the results, as well as their usefulness in making informed decisions based on data, which represents a component of data analysis techniques. Thus, the design phase of the strategy was developed in a constructivist approach through which students were guided in a process of discovery in order to understand how statistics can be applied to correctly summarize and analyze data sets.

- **Results of the third Phase: Didactic Intervention**

The implementation of the didactic intervention phase, carried out in the fourth period of the academic year 2024, made it possible to investigate the effect of the implementation of information and communication technologies on learning about measures of central tendency. In this sense, in 12 sessions, totaling 24 school hours, we worked on some of the thematic blocks in which the intervention was framed: the calculation, application and interpretation of measures of central tendency. The use of digital educational resources played a key role in facilitating the understanding and use of the mathematical knowledge covered.

One of the most notable results observed at this stage was the improvement in student learning. Thanks to educational technology, students showed considerable progress in their ability to understand and use measures of central tendency. The use of digital tools helped students to be much more active in interacting with information. ICT helped to transcend the traditional limitations of school performance; it not only allowed better visualization of mathematical concepts, but also fostered active and participatory learning, where learners were able to explore and play with practical examples.

The personalization and adaptability of educational technology led to improved student learning (see Figure 3). The digital resources allowed all students to progress at their own pace, receive feedback imminently, and adapt their own work in the learning process according to their needs; and not only did these features increase students' understanding of measures of central tendency, but they also reinforced the confidence students were gaining in developing exercises on measures of central tendency.

Figure 3

Students developing the techno-pedagogical intervention strategy.

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Similarly, the mathematics teacher experienced a favorable change in the way she carried out her teaching practice thanks to the use of ICT. The availability of diverse resources and digital tools enriched the teaching methodology, since it allowed the diversification of didactic strategies to the extent that it facilitated more successfully the exposition of abstract ideas. Educational technology not only improved the effectiveness of the exposition, but at the same time helped the teacher to better grasp the particular needs of her students, reformulating the lessons according to the progress made.

The didactic intervention phase shows that the integration of ICT in the teaching of measures of central tendency not only increases student performance, but also transforms the educational experience, benefiting both the learner and the teacher. The didactic intervention phase highlights the importance of ICT in the modernization of teaching and the fact that the appropriate use of these technologies can significantly improve the quality of learning.

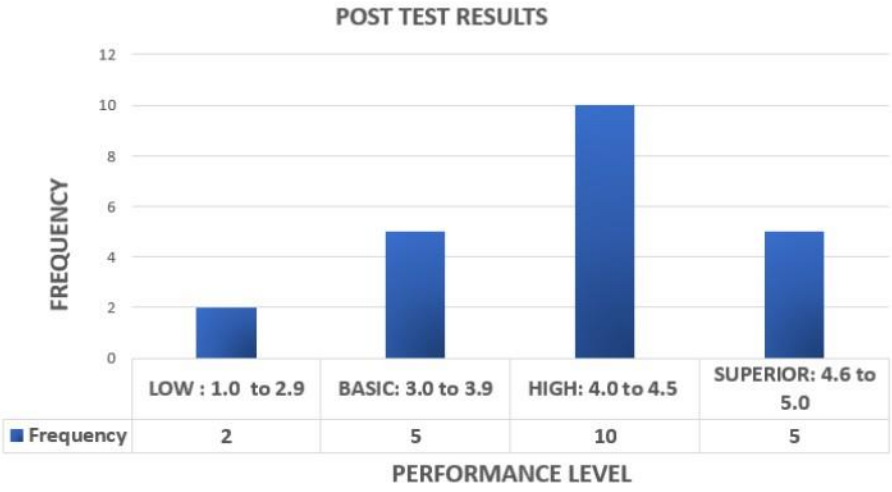
- **Results of the fourth Phase: Pre-test / Post-test contrasts**

In this stage of the research the incidence produced by the didactic intervention in the acquisition of knowledge on the measures of central tendency was considered and for this purpose a post-test was applied after the intervention and inferential statistics were used to compare and contrast the means of the scores obtained in the initial test with those of the final test.

The post-intervention test consisted of 20 items that evaluated mastery in the application, calculation, and interpretation of measures of central tendency, the results of which can be seen in Figure 4, which reflects the level of performance obtained by the students after carrying out the intervention through the techno-pedagogical strategy.

Figure 4

Post-test evaluation results - measures of central tendency



Note: The figure details the level of school performance achieved by students in the post-test.

The analysis of the results presented shows that there has been a significant improvement in the level of academic performance of the students, since 45.4% reached the high performance level in a range of scores from 4.0 to 4.5. Likewise, 22.7% of the students have a superior performance, in the range of 4.6 to 5.0; on the other hand, 22.7% of the students demonstrated a basic performance, in the range of 3.0 to 3.9; and only 9.09%, corresponding to two students, are those who continue at a low level of academic performance.

Table 6 specifies the baseline statistics of the quantitative assessment of the post-test applied to the students. These data indicate that the mean value of the students' performance was at a high level, namely a mean

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of 4.216 points and a standard deviation of 0.642. While the minimum score was 2.75 points, the maximum score reached 5.0 points.

Table 6

Basic statistics post-test knowledge test - measures of central tendency

Pre-test Knowledge of measures of central tendency	
Validated Data	22
Missing information	0
Average performance	4.216
Standard Deviation	0.642
Minimum Qualification	2.75
Maximum Qualification	5.00

Note: The basic statistics derived from the quantitative evaluation of the pretest are detailed below.

The results obtained suggest that the didactic intervention strategy that was implemented had a positive effect on the students' academic performance. Some 68.1% (15 students) were placed at a high or higher performance level according to the institutional academic rating scale, that is, there was a notable improvement in the acquisition of knowledge inherent in the measures of central tendency.

To carry out the comparison of means with respect to academic performance before and after the intervention, the Shapiro-Wilk normality test was applied to the scores reflecting the results of the pre- and post-test. This test was chosen because of the sample size, which is equal to or greater than 0 and less than 31 sample subjects. The results of the normality test are shown in Table 7, which provides the statistical basis from which to provide insight into the effect of the didactic intervention on the students' knowledge.

Table 7

Normality test (Shapiro-Wilk)

		W	**p**
PRE TEST - POST TEST		0.894	0.062
2.045	4.216		

Note: The results suggest that the pre-test and post-test scores have a normal distribution.

In agreement with the results of the normality test (Shapiro-Wilk), the pretest scores on the statistical measures of central tendency as well as those of the posttest show normality from the statistical point of view, since the p value is greater than 0.05, as can be seen in the table.

With the normality of the pretest and posttest scores and given that the sample has been evaluated at both moments of the learning process, it has been decided to apply the parametric Student's t-test to perform the corresponding statistical contrast. Under these circumstances, the hypotheses formulated in the study are taken up again to make the corresponding analysis.

- **Null Hypothesis (Ho):** The average school performance in mathematics, specifically in knowledge of measures of central tendency, is equal when teaching is done through ICT compared to the traditional teaching method.

This approach must be refuted to validate the alternative hypothesis.

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- **Alternative Hypothesis (Ha):** The average school performance in mathematics, specifically in knowledge of measures of central tendency, is different when teaching is done through ICT compared to the traditional teaching method.

Once the study hypotheses were taken up again, we proceeded to apply the inferential statistics test, the results of which are shown in Table 8.

Table 8

Test statistics

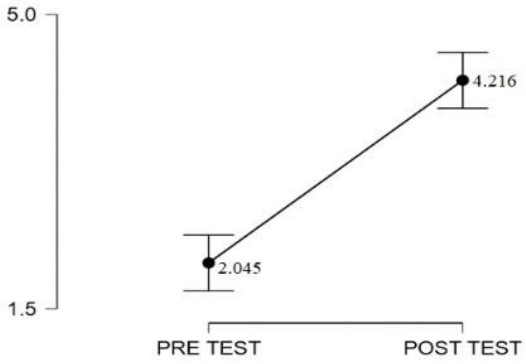
Paired samples Student's t-test						
Sample 1		**Sample 2**	**t**	**df**	**Mean Difference**	**p**
PRE TEST	-	POST TEST	-9.614	21	2.171	< .001
2.045		4.216				

Note: The table shows the mean difference of the dependent variable scores.

Conclusion: With a confidence level of 95% and a margin of error of 5%, it can be affirmed that the results provide sufficient statistical evidence to conclude that there are relevant differences in the mean performance observed between the pretest and the posttest on measures of central tendency, after implementing the didactic intervention strategy. The differences obtained are shown in Figure 5.

Figure 5

Comparison of means between pretest and posttest on knowledge of measures of central tendency.



Note: The figure illustrates the variation in the means obtained in the pretest and posttest administered to the sample students.

The analysis indicates that the pretest mean score on measures of central tendency showed an average of 2.045 points, considering a score scale from 1.0 to 5.0. The application of the didactic intervention program, the mean score in the posttest showed 4.216 points, i.e., an improvement in the students' academic performance is observed. The mean difference was 2,171 points, thus, the participants' performance increased by 106%, which allows validating the alternative hypothesis raised in the research.

Alternative Hypothesis (Ha): The average school performance in mathematics, specifically in knowledge of measures of central tendency, is different when teaching is done through ICT compared to the traditional teaching method.

Discusión

From the emerging results in this research, it is important to reflect on the need to re-signify pedagogical practices in the teaching of measures of central tendency, since, as previously expressed, didactics in mathematics

has traditionally been rigid, based on memorization and the application of formulas, which may not allow students to apprehend the disciplinary knowledge; as Li et al, (2023) the teaching and learning of mathematics should not remain in the transmission of algorithmic procedures, but provide a meaningful understanding that allows students, in this case, to be able to apply the concepts in real contexts. This study has shown that the resignification of the pedagogical practice, from a didactic intervention mediated by ICT, can significantly transform students' learning, since it not only allows them to remember, but also to understand and apply knowledge in an autonomous way.

Likewise, the need to bring innovations to the way statistical knowledge is taught is evident. Statistics and, above all, measures of central tendency have direct applications in everyday life and in the contexts of data analysis that students will encounter in the course of their academic training. Therefore, Rodríguez-Muñiz et al. (2022) emphasize that the traditional way of teaching statistics is disconnected from the applied contexts, limiting the students' ability to see the meaning of what they learn. This study shows that by implementing strategies that combine real problems and technological tools it is possible to make statistical concepts more accessible and useful, thus linking theory and practice.

The integration of educational technologies in teaching, as this research shows, is increasingly necessary in order to be able to adapt to the demands of the contemporary world of education. For Deepthi (2021), educational technology should be considered in the context of the teaching-learning process, more than just an educational resource with great synergy with other resources; it should also be understood as a resource that, properly used, can enrich the learning process itself. The use of digital educational resources, as could be verified in this study, made it possible for students to act with the concepts referred to the measures of central tendency in new and dynamic ways, which could favor to a certain extent an increase in the level of understanding of the disciplinary knowledge, as well as in the degree of motivation for learning statistics.

On the other hand, it is important to consider that education centered on the students' reality, in addition to increasing the learning potential, allows students to feel better able to face the problems of today's world directly: which, as Poeck and Östman (2020) indicate, should be the reason for the educational act, since it should be an act of liberation around personal knowledge about reality and the possibility of transforming it. In the case of statistics education, a pedagogy that articulates abstract concepts with a number of situations from the realm of everyday life not only serves to increase the relevance of statistical content for students, but also gives them the opportunity to use the content learned for decision making in their daily lives.

Conclusions

Throughout the research, the need to redefine the pedagogical practices related to the teaching of measures of central tendency has become evident. The results that emerge from the study point out that, if traditional classroom practices focused on formulas and algorithms continue to be used, this does not allow students to achieve significant learning; rather, learning is distant from reality. Teachers should not only bring statistical knowledge to the classroom, but should also contribute to the learning and use of this knowledge in everyday contexts, only then will the learning that students will achieve necessarily link a meaningful applicability beyond the classroom setting.

In the same way, this study shows the importance of integrating educational technology as a fundamental resource to re-signify the teaching of statistics. The implementation of a techno-pedagogical strategy allowed the academic performance of students to be much better, in addition to promoting interest in learning this discipline from the active interaction of the student in the teaching-learning process. In this way, educational technology offers the teacher new possibilities to personalize teaching, satisfy the different needs of the learner and prepare him/her to face the demands of today's world.

Finally, the results allow us to conclude that the transformation in pedagogical practice must be accompanied by a necessary transformation in the field of teacher training, in which the development of innovative didactic competencies and the use of technological tools for teaching must be prioritized. Only through an education that is in tune with current demands, it can allow to enhance the ability to develop critical and analytical

skills in students, giving them the necessary knowledge to understand and apply the concepts of statistics in their daily lives and their professional training, but also to develop argumentation skills in the face of uncertain situations.

References

[1] Ander-Egg,E.(1995). Técnicas de Investigación Social. 24. Edición. Editor. Lumen, Buenos Aires.

[2] Burckhardt, P., Nugent, R., and Genovese, C. (2020). Teaching Statistical Concepts and Modern Data Analysis With a Computing-Integrated Learning Environment. Journal of Statistics and Data Science Education, 29, S61 - S73. https://doi.org/10.1080/10691898.2020.1854637

[3] Campbell, D. y Stanley, J. (1 978). Diseños experimentales y cuasiexperimentales en la Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.). SAGE Publications.

[4] Deepthi, T. (2021). A Paradigm Shift through Digital Technology in Teaching and Learning Process., 100-103. https://doi.org/10.48175/IJARSCT-V2-I3-317.

[5] De La Hoz Ruiz, A., and Hijón-Neira, R. (2023). Educational Video Game "Statistical Scratch" for teaching Statistics. 2023 International Symposium on Computers in Education (SIIE), 1-6. https://doi.org/10.1109/SIIE59826.2023.10423713

[6] Deslauriers, L., McCarty, L., Miller, K., Callaghan, K., and Kestin, G. (2019). Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. Proceedings of the National Academy of Sciences of the United States of America, 116, 19251 - 19257. https://doi.org/10.1073/pnas.1821936116

[7] El País. (2024). El problema de los malos resultados de los alumnos catalanes: "Hay maestros que han huido de las matemáticas y acaban enseñándolas". https://elpais.com/espana/catalunya/2024-12-15/el-problema-de-los-malos-resultados-de-los-alumnos-catalanes-hay-maestros-que-han-huido-de-las-matematicas-y-acaban-ensenandolas.html

[8] Garibot, G., Zacharías, D., Treuque, J., Guardamagni, A., Huaylla, C., Vega, R., Miori, G., Viozzi, G. (2020). Una propuesta de enseñanza de estadístca en la escuela secundaria mediante el abordaje de problemas comunitarios. Contextos de Educación 28 (20). 1-14. https://www.academia.edu/106305504

[9] Hernández, R., Fernández, C. y Baptista, L. (2006). Metodología de la Investigación. (5ª. ed.).

[10] investigación social. Amorrortu Editores.

[11] Kemmis, S., y McTaggart, R. (1988). The Action Research Planner. Deakin University Press.

[12] Lekka, A., Toki, E., Tsolakidis, C., and Pange, J. (2017). Literature review on educational games for learning statistics. 2017 IEEE Global Engineering Education Conference (EDUCON), 844-847. https://doi.org/10.1109/EDUCON.2017.7942945

[13] Li, Y., Xu, W., Xu, Y., and Liu, B. (2023). Mathematics learning and teaching directed to process construction: reflection on the application of mathematical induction. Annals of Mathematical Modeling. https://doi.org/10.33292/amm.v2i2.23

[14] Núñez, M., Yarasca, U., Carpio, C., Córdova, A., y Montes, L. (2023). TICS en la enseñanza aprendizaje de estadística descriptiva en educación superior tecnológica en Perú. Llimpi. 3. 53-66. 10.54943/lree.v3i2.398.

[15] Oliveira, G., Teixeira, J., Torres, A., y Morais, C. (2021). An exploratory study on the emergency remote education experience of higher education students and teachers during the COVID-19 pandemic. British Journal of Educational Technology, 52, 1357 - 1376. https://doi.org/10.1111/bjet.13112

[16] Poeck, K., & Östman, L. (2020). The Risk and Potentiality of Engaging with Sustainability Problems in Education—A Pragmatist Teaching Approach. Journal of Philosophy of Education. https://doi.org/10.1111/1467-9752.12467

[17] Rendón Vasco, J. (2023). Aplicación de medidas de tendencia central en la enseñanza de la educación financiera para el diseño de proyectos productivos a estudiantes de Pos-primaria 9°, 10° Y 11° En la zona rural de Támesis. [Tesis de pregrado. Universidad Católica de Manizales.Colombia]. https://repositorio.ucm.edu.co/jspui/handle/10839/4311

[18] Reddy, P., and Reddy, Y. (2022). The Impact of ICTs on Teaching, Learning and Progressing. International Journal of Advanced Research in Science, Communication and Technology. https://doi.org/10.48175/ijarsct-4986

[19] Rodríguez-Muñiz, L., Muñiz-Rodríguez, L., García-Alonso, I., López-Serentill, P., Vásquez, C., and Alsina, Á. (2022). Navigating between abstraction and context in secondary school statistics education (Nadando entre dos orillas: abstracción y contexto en educación estadística en Secundaria). Culture and Education, 34, 689 - 725.

[20] https://doi.org/10.1080/11356405.2022.2058794

[21] Rojas Sandoval, A., Díaz Quintanilla, C. L., y García Valero, M. D. los Ángeles. (2020). La enseñanza de la estadística en cuarto grado de primaria a partir de proyectos. Mendive. Revista De Educación, 18(4), 759–776.
[22] https://mendive.upr.edu.cu/index.php/MendiveUPR/article/view/1975
[23] Setambah, M., Tajudin, N., Yaakob, M., and Saad, M. (2019). Adventure Learning in Basics Statistics: Impact on Students Critical Thinking. International Journal of Instruction. https://doi.org/10.29333/IJI.2019.12310A
[24] Sripavithra, C., Kirubanand, V., and Paulose, J. (2022). Role of Information Tools in Teaching and Learning. SHS Web of Conferences. https://doi.org/10.1051/shsconf/202213903003
[25] Swatzell, K. L., y Jennings, S. (2007). Descriptive research design. In Handbook of Research on Science Education (pp. 378-394). Routledge.
[26] Timans, R., Wouters, P., y Heilbron, J. (2019). Investigación de métodos mixtos: qué es y qué podría ser. Theory and Society , 48, 193-216. https://doi.org/10.1007/s11186-019-09345-5
[27] Toledo San Martín, A y Vicencio, I. (2021). El uso de TIC para el aprendizaje de la estadística: un estudio en universidades chilenas. Educação e Ensino na Era da Informação. https://www.researchgate.net/publication/350956948_el_uso_de_tic_para_el_aprendizaje_de_la_estadistica_un_estudio_en_universidades_chilenas
[28] Toma, F., Ardelean, A., Grădinaru, C., Nedelea, A., and Diaconu, D. (2023). Effects of ICT Integration in Teaching Using Learning Activities. Sustainability. https://doi.org/10.3390/su15086885
[29] UNESCO. (2020). Guía Práctica para la Implementación de Encuestas sobre el Uso de TIC en Escuelas de Enseñanza Primaria y Secundaria. [Archivo PDF]
[30] https://uis.unesco.org/sites/default/files/documents/pratical_esp_-_web_1.pdf
[31] Wibowo, G., Karim, A., Hasan, S., and Ruhimat, M. (2023). Use of Technology in Active Learning: Increasing Student Interaction and Engagement. Al-Hijr: Journal of Adulearn World. https://doi.org/10.55849/alhijr.v2i4.539