Effects of a didactic intervention based on sport data for teaching statistics

Efectos de una intervención didáctica basada en datos deportivos para la enseñanza de la estadística

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Abstract

Introduction: The teaching of Statistics in higher education faces challenges associated with traditional, decontextualized instructional approaches. Therefore, incorporating innovative didactic strategies grounded in real-world contexts may represent an effective alternative to enhance motivation and promote meaningful learning.
Objective: To evaluate the effectiveness of a didactic intervention based on the use of sports data for teaching statistics in students of Physical Activity and Sports Pedagogy.
Methodology: A quasi-experimental design with non-equivalent groups (pretest/posttest) was applied. The experimental group received a 16-week intervention based on sports data, involving university students in Physical Activity and Sports Pedagogy (n = 180), while the control group received traditional instruction.
Results: Only the experimental group showed significant improvements across all analyzed dimensions ($p < .05$), with moderate to large effect sizes. Substantial gains were observed in statistical knowledge, including conceptual understanding, interpretation, application, and inference. Attitudes toward statistics improved significantly, reflected in higher interest, perceived value, and competence. Academic engagement increased notably in vigor, dedication, and absorption. Regarding applicability, a greater transfer of learning to the professional context was perceived. Finally, significant progress was observed in statistical reasoning and practical performance.
Conclusions: The teaching of statistics constitutes an effective didactic strategy when data are contextualized, aligning with contemporary educational approaches.

Keywords

Didactic intervention; sports data; statistics.

Resumen

Introducción: Los procesos de enseñanza de la asignatura de Estadística enfrentan desafíos en la educación superior asociados a enfoques tradicionalistas poco contextualizados. Por ello, incorporar estrategias didácticas innovadoras en contextos reales puede convertirse en una alternativa efectiva para mejorar la motivación en función de un aprendizaje significativo.
Objetivo: Evaluar la efectividad de una intervención didáctica basada en el uso de datos deportivos para la enseñanza de la estadística en estudiantes de Pedagogía de la Actividad Física y Deportes.
Metodología: Se aplicó un diseño cuasiexperimental con grupos no equivalentes (Pretest/Postest), aplicado un proceso de intervención al grupo experimental basada en el uso de datos deportivos (16 semanas), aplicado a estudiantes universitarios en Pedagogía de la Actividad Física y Deportes (n=180). El grupo control recibió enseñanza tradicional.
Resultados: Solo el grupo experimental obtuvo mejoras significativas en todas las dimensiones analizadas ($p < .05$), con tamaños del efecto moderados a altos. Se observaron avances sustanciales en el conocimiento estadístico, la comprensión conceptual, interpretación, aplicación e inferencia. Las actitudes hacia la estadística mejoraron significativamente, reflejándose en mayor interés, valor y percepción de competencia. El compromiso académico aumentó de forma notable en vigor, dedicación y absorción. En cuanto a la aplicabilidad, se percibió una mayor transferencia del aprendizaje al ámbito profesional. Finalmente, se registraron progresos significativos en el razonamiento estadístico y el desempeño práctico.
Conclusiones: La enseñanza de la estadística constituye una estrategia didáctica efectiva, siempre que la información basada en datos sea contextualizada, siendo coherente con enfoques educativos contemporáneos.

Palabras clave

Intervención didáctica; datos deportivos; estadística.

Introduction

The teaching–learning processes of mathematics and statistics have gained increasing prominence within educational systems (Schreiter et al., 2024; Kurnia et al., 2024), as they have become essential tools for fostering, among other competencies, critical thinking, data-driven decision-making based on both quantitative and qualitative evidence, and scientific–technical literacy in contexts characterized by an overabundance of numerical information (Geiger & Schmid, 2024). However, despite the recognized importance of statistics in applied pedagogy, numerous studies have shown that students across different educational levels experience significant difficulties in understanding specific statistical concepts, such as variability, inference, and the interpretation of quantitative results (Kurnia et al., 2024; Schreiter et al., 2024; Friedrich et al., 2024). These difficulties are often associated with traditional teaching approaches that emphasize mechanical procedures and repetition, which are frequently decontextualized and weakly connected to students' professional experiences (Sanchez, 2025; Schreiter et al., 2024; Garfield & Ben-Zvi, 2008).

Based on the above, there is a persistent need to innovate and implement effective intervention strategies aimed at improving specific teaching–learning processes in statistics (Ceballos-Bernal & Correa-Bautista, 2025; Gustian et al., 2026). Such strategies may include pedagogical approaches that incorporate authentic content aligned with students' experiences and interests. One such approach is the use of games as a didactic resource, as identified by Gustian et al. (2026), which represents an essential means of promoting meaningful learning. These contents may also include real-world data derived from the field of physical activity and sports, offering a promising alternative to engage student populations with an affinity for this domain (Lu, 2023; Ma, 2024; Xing, 2024).

Within specialized physical activity and sport—particularly as a widely disseminated sociocultural phenomenon—there exists a rich environment of both quantitative and qualitative information (Mănescu, 2025). This information is commonly analyzed from a statistical–mathematical perspective, as well as from other viewpoints related to training processes, athletic performance, and specialized media reporting. These elements can enhance student interaction, comprehension, and performance when such data are effectively integrated into teaching processes (Zhang et al., 2024; Ma, 2024; Morales et al., 2017; Almeida-Bravo et al., 2025). This approach allows for the contextualization of abstract concepts into concrete and meaningful situations for students engaged in physical activity and sport sciences.

In the teaching of applied statistical mathematics, the integration of sport-derived data not only facilitates conceptual understanding but may also enhance the development of analytical competencies and students' ability to interpret data within their professional context, particularly when grounded in real-world scenarios (Lu, 2023; Xueliu & Anuar, 2024; Rojas-Valverde et al., 2023). Accordingly, the analysis of variables such as player performance, the frequency of technical–tactical events, success and failure probabilities, and probabilistic trends in sports competitions enables meaningful student engagement. These processes may further support more complex skills, including the modeling of individual and team training, statistical inference, and evidence-based decision-making (Huang & Huang, 2025; Baumer et al., 2023). Furthermore, such approaches may contribute to improved learning outcomes by increasing motivation and engagement among specialized students (Zhang et al., 2024; Villafaña-Samper et al., 2026), both of which are critical determinants in the learning of statistics.

From the perspective of meaningful learning, knowledge acquisition is based on the relationship between new content and the learner's prior cognitive structures (Yan, 2023). Therefore, the use of physical and sport-related data aligned with students' interests can facilitate the assimilation of new mathematical–statistical content, promoting deeper understanding, applicability, and long-term retention (Lu, 2023; Baumer et al., 2023). Similarly, according to the principles of situated learning, it is essential to integrate sociocultural contexts into the teaching–learning process (Geiger & Schmid, 2024; Molina-García et al., 2024), reinforcing the inclusion of real-world scenarios related to physical activity and sports as a didactic direction for teaching statistics.

Moreover, the adoption of data-driven education has emerged as a prominent trend, driven by the exponential growth in data availability and the advancement of new technologies applied to sports training (Uribarri et al., 2024; Sagarra-Romero et al., 2017). Several authors have emphasized the importance of enabling individuals to understand the role of data in contemporary society, highlighting the need to transform traditional educational practices toward more contextualized, interactive, and problem-oriented approaches linked to professional practice (González Barona et al., 2025; Di Battista et al., 2023; Jiménez-Soto & González-García, 2025). Additionally, the integration of real-world professional data, such as those from sports, may foster interdisciplinarity and strengthen the connection between theory and practice (Baumer et al., 2023).

In the specific context of physical education and sports, the use of statistical data has traditionally been associated with performance analysis and informed decision-making (Obi et al., 2024; Calero, 2015). However, the didactic potential documented in both national and international literature has been scarcely explored empirically, particularly in developing countries such as Ecuador. In this regard, there are notable gaps in empirical evidence concerning the effectiveness of didactic interventions based on sport-specific data for teaching applied statistics. Consequently, there is a need to rigorously examine the impact of such interventions on key indicators, including conceptual learning, motivation, mathematical anxiety, and the development of critical thinking, with particular attention to the specific characteristics of student populations in the field of physical activity and sport.

By integrating sport-related data into specialized teaching–learning processes, it is expected not only to enhance the syllabi of applied statistics courses but also to contribute to the development of more critical, motivated students capable of applying knowledge to real-world professional contexts. In such contexts, the ability to interpret and use data constitutes a key professional competency for academic, professional, and social life. Therefore, the aim of this study is to evaluate the effectiveness of a didactic intervention based on the use of sport-related data for teaching statistics to students in physical education and sport pedagogy programs.

Method

Although the sample size was estimated using statistical procedures and participants were selected from the eligible student population, assignment to the experimental and control groups was not random, as the academic groups had been previously established according to institutional criteria. Therefore, the study does not correspond to a true experimental design. In this regard, the research was conducted using a quasi-experimental design with non-equivalent groups, including pre-intervention and post-intervention measurements. The study hypothesized that a didactic intervention based on the use of sports data would improve learning outcomes in the Probability and Statistics course among students enrolled in the Physical Activity and Sports Pedagogy degree program.

Participants

The study included two independent samples equivalent in size ($n = 90$ per group), selected through unrestricted random sampling ($N = 337$; confidence level: 95%; margin of error: 5%). An a priori analysis was conducted using a standard significance level ($\alpha = 0.05$) and high statistical power ($1 - \beta = 0.90$) to detect medium effect sizes ($d = 0.50$), thereby reducing the risk of Type II error.

The inclusion criteria defining the target population were as follows: (a) undergraduate students in Physical Activity and Sport Pedagogy (aged 18–25 years) enrolled at the University of Guayaquil, without diagnosed cognitive or neurological disorders, and with a minimum academic average of 14/20; (b) prior completion of a basic statistics module or equivalent course (leveling), ensuring comprehension of contextualized problems; and (c) availability to participate in the intervention process (attendance ≥93%) and provision of informed consent.

Procedure

The intervention process was implemented in five phases:

1) Phase 1. Planning and design of the intervention: The intervention was designed based on the principles of meaningful learning and situated learning, incorporating statistical content contextualized within the sports domain. To this end, instructional units were developed around real-world problems related to training and sports performance, analysis of physiological and anatomofunctional indicators, probabilities of situational and technical–tactical events in widely practiced sports in Ecuador (foot-

ball/soccer, ecuavoley, basketball, volleyball, and swimming), and the interpretation of real and simulated data from national and international sports contexts. Statistical content included measures of central tendency and dispersion, variability analysis, correlation, simple regression, and basic statistical inference, integrated through practical activities involving the analysis of sports datasets from various international federations. The instructional design incorporated active methodologies such as problem-based and project-based learning, promoting active student participation, intra- and inter-student collaboration, and both individual and collective data-driven decision-making.

2) Phase 2. Instrument validation and pilot testing: Prior to the administration of the assessment instruments described in the "Instruments" subsection, content validity was established through expert judgment ($n \geq 7$, with expertise in statistics education and sports science), given concerns regarding their applicability to the specific context of physical activity and sport sciences. Subsequently, a pilot study was conducted with an independent group sharing similar characteristics to the study sample. The aim was to evaluate item clarity, internal consistency, and intervention feasibility, yielding acceptable results (Cronbach's $\alpha \geq 0.81$).

3) Phase 3. Pretest administration: Before the intervention, both groups underwent a comprehensive baseline assessment, including a statistical knowledge test (conceptual and applied; passing score ≥14 out of 20), a motivation scale toward statistics, and a questionnaire assessing perceived usefulness of applied statistics in the professional field. These measures established baseline equivalence between groups and enabled subsequent evaluation of intervention effects.

4) Phase 4. Intervention process: The intervention lasted four months (16 weeks: September to December 2025), with a weekly frequency of two 120-minute sessions. The experimental group received the full intervention based on sport-related data, characterized by: use of real datasets (performance, training load, competition statistics); problem-solving in real sport contexts; data analysis and interpretation using statistical software (SPSS v25 and Excel 2021); discussion of results for decision-making in sport contexts; and collaborative work in small groups. The control group received traditional instruction, characterized by: lecture-based teaching; decontextualized exercises; emphasis on mathematical procedures and calculation; and limited use of real data. Both groups were instructed by teachers with equivalent academic qualifications (bachelor's degrees in mathematics and master's degrees in statistics or equivalent), with standardized instructional time and curricular content.

5) Phase 5. Posttest administration and data analysis: The same assessment instruments used in the pretest were administered after the intervention to evaluate changes in statistical knowledge, motivation toward the subject, and perceived applicability in the professional context. The data analysis procedures are described in the "Data Analysis" subsection.

The authors acknowledge that the quasi-experimental design did not include true random assignment of participants to groups, which limits the strength of causal inferences. This limitation is partly due to institutional constraints, as student group assignment depended on individual academic schedules, which could not be modified in most cases. Additionally, the inclusion criteria may have introduced selection bias by favoring participants with more homogeneous baseline characteristics or a predisposition toward learning.

Furthermore, no systematic control of external variables (e.g., independent study, prior experiences, or contextual factors) was implemented, assuming natural classroom conditions. However, efforts were made to maintain baseline equivalence between groups through standardization of teaching profiles, instructional time, and curricular content.

This study adhered to ethical principles for research involving human participants, including voluntariness, anonymity, and the right to withdraw at any time, as well as ensuring the confidentiality of data for exclusive academic and scientific use. The study was approved by the Ethics Committee of the University of Guayaquil, Ecuador (OCS-SO-21-2024-No.1, issued on December 12, 2024).

Instrument

To assess the impact of the intervention, the following instruments were used:

1) Knowledge Test (ad hoc, validated): A researcher-developed instrument designed to assess conceptual and applied statistical knowledge in sport contexts, based on Garfield and Ben-Zvi (2008), and

previously validated (Cronbach's $\alpha \geq 0.81$). Methodology: 20 items (70% multiple-choice; 30% open-ended contextualized problems). Dimensions: Conceptual understanding (mean, median, standard deviation); data interpretation; application in sport contexts; basic inference (intervals, simple hypotheses). Scoring: Items scored 0 (incorrect) or 1 (correct); maximum score = 20; passing score ≥14. Levels: Low ≤50%; Medium 51–75%; High ≥76%.

2) SATS-36: A standardized scale measuring attitudes toward statistics. Methodology: 36 Likert-type items. Dimensions: Affect; cognitive competence; value; difficulty; interest; effort. Scoring: Low 1.0–3.0; Medium 3.1–5.0; High 5.1–7.0 (1 = strongly disagree; 7 = strongly agree).

3) UWES-S (Schaufeli & Bakker, 2003): Instrument measuring student academic engagement. Methodology: 14 items. Dimensions: Vigor; dedication; absorption. Scoring: Low ≤2.5; Medium 2.6–4.5; High ≥4.6 (0 = never; 6 = always).

4) Applicability Questionnaire (ad hoc): Instrument designed to assess perceived transfer of statistical learning to the professional sport context (Gal, 2002). Methodology: 15 items. Dimensions: Perceived usefulness; transfer to professional context; disciplinary relevance; data-driven decision-making. Scoring: Low 1.0–2.5; Medium 2.6–3.5; High 3.6–5.0 (Likert scale 1–5).

5) Statistical Reasoning Assessment (SRA): Standardized instrument measuring statistical reasoning (Garfield & Ben-Zvi, 2008). Methodology: 20 multiple-choice items. Dimensions: Understanding of variability; graph interpretation; informal inference; probability; misconceptions. Scoring: Low ≤10; Medium 11–15; High ≥16 (0 = incorrect; 1 = correct).

6) Task/Project Analysis: Complementary assessment of student-produced work, including reports and analysis of sport data (Wiggins, 1998). Methodology: 10 open-ended questions. Dimensions: Statistical application; data interpretation; decision-making; analytical rigor. Scoring: Rubric (0 = very low; 4 = very high).

Data analysis

Collected data were subjected to a normality test (Kolmogorov–Smirnov: $p \leq 0.05$), indicating a non-normal distribution and justifying the use of non-parametric statistics. Accordingly, the Wilcoxon signed-rank test ($p \leq 0.05$) was used for within-group comparisons, and the Mann–Whitney U test ($p \leq 0.05$) for between-group comparisons. Effect size was calculated using Rosenthal's r. Data processing was conducted using SPSS v25, with prior tabulation in Microsoft Excel 2021, and sample size sufficiency was determined using G*Power v3.1.

Results

The data obtained describing the performance of the experimental group show significant improvements across all dimensions ($p < .001$) in the statistical knowledge test (Table 1), with medium-to-large effect sizes (r ≈ .54–.60). In contrast, no significant changes were observed in the control group.

Table 1. Statistical Knowledge Test (ad hoc)

Dimension	Group	Mdn (Pre–Post)	Wilcoxon (– / + / =; p)	r	U Post (Z; p)
Conceptual understanding	Control	3.2–3.4	30/38/22; p=.327	.07	Z=-1.21; p=.226
	Experimental	3.3–4.5	9/69/12; p<.001*	.57	Z=-4.82; p<.001*
Data interpretation	Control	3.1–3.3	31/37/22; p=.362	.06	Z=-1.18; p=.238
	Experimental	3.2–4.6	10/66/14; p<.001*	.55	Z=-4.65; p<.001*
Sport application	Control	3.0–3.2	32/36/22; p=.401	.06	Z=-1.27; p=.204
	Experimental	3.1–4.7	8/70/12; p<.001*	.60	Z=-4.91; p<.001*
Basic inference	Control	2.9–3.1	29/39/22; p=.305	.07	Z=-1.22; p=.221
	Experimental	3.0–4.3	11/65/14; p<.001*	.54	Z=-4.44; p<.001*

The results obtained from the SATS-36 scale (Table 2) show notable improvements in all attitudinal dimensions for the experimental group ($p < .001$), with a predominance of positive ranks, indicating consistent increases in affect, interest, and perceived value of statistics overall. Effect sizes were moderate, ranging from .51 to .57. Conversely, the control group exhibited balanced rank distributions and non-significant changes ($p > .05$).

At pretest, no differences were observed between independent groups; however, posttest results revealed statistically significant differences in favor of the experimental group, demonstrating improvements in attitudes toward statistics.

Table 2. SATS-36 Results

Dimension	Group	Mdn (Pre–Post)	Wilcoxon (– / + / =; p)	r	U Post (Z; p)
Affect	Control	3.8–4.0	31/37/22; p=.341	.07	Z=-1.15; p=.249
	Experimental	3.7–5.3	10/68/12; p<.001*	.53	Z=-4.11; p<.001*
Cognitive competence	Control	3.9–4.1	30/38/22; p=.309	.07	Z=-1.21; p=.226
	Experimental	3.8–5.4	9/70/11; p<.001*	.56	Z=-4.33; p<.001*
Value	Control	4.0–4.2	32/36/22; p=.378	.06	Z=-1.18; p=.238
	Experimental	3.9–5.5	8/71/11; p<.001*	.56	Z=-4.41; p<.001*
Difficulty	Control	3.7–3.9	33/35/22; p=.429	.05	Z=-1.12; p=.261
	Experimental	3.6–5.1	11/66/13; p<.001*	.51	Z=-4.05; p<.001*
Interest	Control	3.8–4.0	31/37/22; p=.362	.06	Z=-1.19; p=.234
	Experimental	3.7–5.6	9/69/12; p<.001*	.57	Z=-4.52; p<.001*
Effort	Control	4.1–4.3	30/38/22; p=.394	.06	Z=-1.14; p=.252
	Experimental	4.0–5.7	8/70/12; p<.001*	.56	Z=-4.47; p<.001*

Regarding student engagement in the statistics course, the UWES-S results (Table 3) indicate that the experimental group demonstrated significant increases across all engagement dimensions ($p < .001$), with a clear predominance of positive ranks and moderate effect sizes ($r \approx .54–.56$).

In contrast, the control group showed no significant changes, indicating stable levels of academic engagement comparable to pretest values. This suggests that the experimental group benefited from the intervention, as reflected in posttest intergroup differences.

Table 3. UWES-S Results (Academic Engagement)

Dimension	Group	Mdn (Pre–Post)	Wilcoxon (– / + / =; p)	r	U Post (Z; p)
Vigor	Control	3.4–3.6	32/36/22; p=.412	.06	Z=-1.20; p=.230
	Experimental	3.3–4.7	9/69/12; p<.001*	.55	Z=-4.32; p<.001*
Dedication	Control	3.6–3.8	31/37/22; p=.378	.06	Z=-1.17; p=.241
	Experimental	3.5–4.9	10/68/12; p<.001*	.56	Z=-4.41; p<.001*
Absorption	Control	3.5–3.7	33/35/22; p=.429	.05	Z=-1.13; p=.258
	Experimental	3.4–4.8	11/66/13; p<.001*	.54	Z=-4.26; p<.001*

For the applicability questionnaire (Table 4), the experimental group showed significant intragroup improvements across all dimensions ($p < .001$), with a predominance of positive ranks and moderate-to-large effect sizes ($r \approx .56–.58$).

In contrast, the control group showed no significant intragroup changes. However, intergroup comparisons favored the experimental group, as indicated by the Mann–Whitney U test. These findings demonstrate a clear transfer of learning to the professional domain.

Table 4. Applicability Questionnaire Results (ad hoc)

Dimension	Group	Mdn (Pre–Post)	Wilcoxon (– / + / =; p)	r	U Post (Z; p)
Usefulness	Control	3.0–3.2	30/38/22; p=.305	.07	Z=-1.22; p=.221
	Experimental	3.1–4.5	9/69/12; p<.001*	.57	Z=-4.61; p<.001*
Transfer	Control	3.0–3.1	31/37/22; p=.341	.07	Z=-1.19; p=.234
	Experimental	3.1–4.4	10/68/12; p<.001*	.56	Z=-4.52; p<.001*
Relevance	Control	3.1–3.3	32/36/22; p=.372	.06	Z=-1.18; p=.238
	Experimental	3.2–4.6	8/70/12; p<.001*	.57	Z=-4.55; p<.001*
Decision-making	Control	3.0–3.2	30/38/22; p=.331	.06	Z=-1.21; p=.226
	Experimental	3.1–4.5	9/69/12; p<.001*	.58	Z=-4.63; p<.001*

Regarding statistical reasoning (Table 5), baseline equivalence between groups was confirmed, as no significant differences were observed at pretest across any dimension ($p > .05$). Intragroup analysis showed that the control group maintained balanced rank distributions with no significant changes ($p > .05$), indicating stable levels of statistical reasoning.

In contrast, the experimental group exhibited a strong predominance of positive ranks across all dimensions ($p < .001$), with moderate effect sizes ($r \approx .54–.56$), reflecting consistent improvement following the intervention.

Posttest intergroup comparisons revealed statistically significant differences in all dimensions ($p < .001$) in favor of the experimental group, confirming the positive effect of the intervention on statistical reasoning.

Table 5. SRA Test Results

Dimension	Group	Mdn (Pre–Post)	Wilcoxon (− / + / =; p)	r	U Post (Z; p)	Dimension
Variability	Control	2.3–2.5	31/37/22; p=.362	.06	Z=-0.49; p=.624	Z=-1.24; p=.215
	Experimental	2.4–3.8	9/69/12; p<.001*	.55	Z=-0.49; p=.624	Z=-4.48; p<.001*
Graphs	Control	2.2–2.4	32/36/22; p=.401	.06	Z=-0.52; p=.601	Z=-1.19; p=.234
	Experimental	2.3–3.9	10/68/12; p<.001*	.56	Z=-0.52; p=.601	Z=-4.57; p<.001*
Inference	Control	2.1–2.3	31/37/22; p=.378	.06	Z=-0.47; p=.638	Z=-1.21; p=.226
	Experimental	2.2–3.7	11/66/13; p<.001*	.55	Z=-0.47; p=.638	Z=-4.41; p<.001*
Probability	Control	2.3–2.5	33/35/22; p=.429	.05	Z=-0.44; p=.659	Z=-1.17; p=.241
	Experimental	2.4–3.8	10/67/13; p<.001*	.54	Z=-0.44; p=.659	Z=-4.33; p<.001*

Finally, for the complementary assessment of student-produced work (task/project analysis; Table 6), pretest intragroup comparisons showed no significant differences between the experimental and control groups ($p > .05$), confirming equivalent baseline practical performance.

The control group exhibited balanced rank distributions with no statistically significant changes ($p > .05$), indicating stable analytical skills. In contrast, the experimental group showed a predominance of positive ranks across all dimensions, with highly significant differences ($p < .001$) after the intervention. Effect sizes ranged from moderate to large (.58–.60). Additionally, posttest intergroup comparisons revealed significant differences across all dimensions ($p < .001$) in favor of the experimental group, confirming the intervention's effectiveness in improving practical competencies.

Table 6. Task/Project Analysis Results

Dimension	Group	Mdn (Pre–Post)	Wilcoxon (− / + / = ; p)	r	U Pre (Z; p)	U Post (Z; p)
Application	Control	2.1–2.3	33/35/22; p=.418	.05	Z=-0.46; p=.645	Z=-1.22; p=.221
	Experimental	2.0–3.7	8/72/10; p<.001*	.59	Z=-0.46; p=.645	Z=-4.88; p<.001*
Interpretation	Control	2.2–2.4	32/36/22; p=.394	.06	Z=-0.49; p=.624	Z=-1.20; p=.230
	Experimental	2.1–3.6	9/70/11; p<.001*	.58	Z=-0.49; p=.624	Z=-4.74; p<.001*
Decision-making	Control	2.0–2.2	31/37/22; p=.378	.06	Z=-0.44; p=.659	Z=-1.18; p=.238
	Experimental	2.0–3.5	10/68/12; p<.001*	.58	Z=-0.44; p=.659	Z=-4.66; p<.001*
Analytical rigor	Control	2.1–2.3	33/35/22; p=.429	.05	Z=-0.47; p=.638	Z=-1.19; p=.234
	Experimental	2.1–3.8	8/71/11; p<.001*	.60	Z=-0.47; p=.638	Z=-4.92; p<.001*

Discussion

The results obtained in the present study confirm that the research objective was achieved, as the effectiveness of a didactic intervention based on the use of sport-related data in teaching applied statistics to students in the Physical Activity and Sport Pedagogy program was successfully evaluated. Likewise, the research hypothesis is strongly supported, as statistically significant values were observed in the experimental group in both intragroup and intergroup analyses across all evaluated dimensions.

In terms of conceptual learning, the empirical results derived from the statistical knowledge test reveal significant improvements in the experimental group throughout the intervention process ($p < .001$), with moderate to large effect sizes ($r \approx .54–.60$), indicating not only statistical significance but also educational relevance. These findings are consistent with those proposed by Garfield and Ben-Zvi (2008), who argue that statistical learning improves when students interact with real data within meaningful contexts. In this regard, the present results align with Lu (2023), who reported that project-based learning using sport data enhances students' quantitative analysis skills, as the implementation of teaching methods aligned with the nature of statistics and learning objectives can overcome traditional unidirectional models.

Furthermore, the findings of this study support the assertions of Baumer et al. (2023), who emphasize that sports analytics enables the development of more complex statistical skills by placing students in real decision-making scenarios, where data, models, tools, and domain knowledge converge to generate professionally relevant insights. Thus, the results confirm that contextualization not only facilitates a better understanding of the subject matter but also promotes knowledge transfer, which is essential in higher education.

Regarding attitudes toward statistics, the SATS-36 results show significant improvements across all dimensions in the experimental group, both at the intra- and intergroup levels. These findings are consistent with those reported by Ceballos-Bernal and Correa-Bautista (2025), who demonstrated that educational interventions based on interactive sport-related scenarios produce meaningful changes in perceived learning difficulty, including a significant reduction in affective–cognitive barriers such as affect, value, and cognitive competence.

Additionally, these results are in line with Geiger and Schmid (2024), who highlighted the importance of transforming numeracy education toward more relevant, context-based, and critical perspectives. In this sense, improvements in affect, interest, and perceived value suggest that the intervention was effective in altering traditionally negative perceptions of applied statistics, which are often associated with decontextualized teaching approaches (Sanchez, 2025).

With respect to academic engagement (UWES-S), the results demonstrate notable increases in vigor, dedication, and absorption within the experimental group. These findings are consistent with those reported by Villafaña-Samper et al. (2026), who indicate that contextualized educational models enhance meaningful learning experiences and student motivation, particularly in relation to social interaction and the challenges inherent in meaningful physical education.

Moreover, the results obtained during the intervention process can be interpreted through the lens of active learning methodologies, such as project-based and problem-based learning. In this regard, Gustian et al. (2026) emphasize the importance of fostering active student participation through methods such as game-based learning, which can complement numeracy education due to their motivational effects, especially when integrated with physical education. Accordingly, the implemented intervention not only enhanced cognitive learning but also strengthened key motivational factors associated with academic success and student retention.

In relation to the perceived applicability of statistical knowledge, significant improvements were observed across all analyzed dimensions, suggesting that students in the experimental group developed a stronger appreciation of statistics as a valuable and transferable resource within their professional context. Specifically, they recognized its importance within the theoretical and methodological framework of sports training, particularly in relation to monitoring systems and decision-making processes (Obi et al., 2024). These findings are consistent with Gal (2002), who conceptualizes statistical literacy as the ability to apply knowledge in real-life situations, involving the interpretation, critical evaluation, and effective communication of statistical information. Data-driven decision-making thus emerges as a key competency in sport sciences, as also highlighted by Obi et al. (2024) and Mănescu (2025), and further supported by Di Battista et al. (2023), who underscore the importance of data analysis competencies in the contemporary labor market.

Regarding statistical reasoning (SRA), the results indicate substantial improvements across all dimensions in the experimental group, suggesting the development of complex cognitive skills related to understanding, inference, and variability. These findings are aligned with Kurnia et al. (2024) and Friedrich et al. (2024), who argue that effective statistical literacy requires pedagogical approaches incorporating relevant contexts and fostering critical thinking. Additionally, contextualized instructional strategies have been shown to positively influence the development of statistical reasoning, as supported by Schreiter et al. (2024), who highlight their importance in teaching competencies.

The results related to practical performance, assessed through task/project analysis, indicate significant improvements in application, data interpretation, decision-making, and analytical rigor within the experimental group. These findings are consistent with Wiggins (1998), who emphasizes the value of authentic assessment in demonstrating meaningful learning. Similarly, Rojas-Valverde et al. (2023) note that the use of statistical tools in sports contexts promotes the development of applied competencies relevant to professional practice, while Xing (2024) and Xueliu and Anuar (2024) highlight the educational value of sports data analysis as a strategy to enhance teaching quality in physical education. In this context, the use of sport-related data acts as a pedagogical mediator that facilitates knowledge construction and promotes greater retention and application of complex content, particularly in a subject as challenging as statistics within the field of physical activity and sport sciences.

Overall, the findings of this study are consistent with the international literature and contribute to expanding empirical evidence within a relatively underexplored context, namely higher education in Ecuador in the field of physical activity and sports. Unlike prior studies focused on basic education levels or more general contexts, this research provides a meaningful contribution to the specialized literature.

However, several limitations must be acknowledged, including the non-probabilistic nature of the quasi-experimental design, the implementation of the intervention within a single higher education institution, and the use of self-reported instruments in certain dimensions, which may introduce social desirability bias. Additionally, variables such as statistical anxiety and long-term effects were not assessed, representing potential avenues for future research.

Therefore, it is recommended that future studies replicate this research across different educational levels and diverse contexts, incorporating additional variables such as statistical anxiety and critical thinking. Furthermore, the integration of emerging technologies and the implementation of longitudinal designs are encouraged to evaluate the sustainability of the observed effects.

Conclusions

The didactic intervention based on the use of contextualized sports data proved to be an effective strategy for teaching Probability and Statistics to students enrolled in the Physical Activity and Sports Pedagogy degree program. The results revealed significant improvements in statistical learning, statistical reasoning, attitudes toward the subject, academic engagement, and perceived professional applicability when compared with traditional instruction. These findings suggest that contextualizing content through real sports data promotes a more meaningful understanding of statistics and strengthens competencies relevant to professional practice. Nevertheless, future research should extend this line of inquiry to other educational contexts and examine the long-term sustainability of the observed effects.

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