Pedagogía y Sociedad
UNIVERSIDAD DE SANCTI SPÍRITUS José Martí Pérez
ISSN: 1608-3784 RNPS: 1903

Recibido: 17/6/2023, Aceptado: 17/10/2023, Publicado: 10/1/2024
Volumen 27| Número 69| Enero-Abril, 2024|

[Translated article]

Contextualization of biostatistics to biological situations for the initial training of Biology teachers

Contextualización de la bioestadística a situaciones biológicas para la formación inicial de profesores de Biología

Yusimí Guerra Véliz[1]
E-mail: yusimig@uclv.cu
https://orcid.org/0000-0002-1711-5686
Julio Leyva Haza[1]
E-mail: haza@uclv.cu
https://orcid.org/0000-0002-1711-5686
Yasmani Alonso Rojas[1]
E-mail: yaarojas@uclv.cu
https://orcid.org/0000-0003-1947-7442

[1] Universidad Central "Marta Abreu" de las Villas. Villa Clara, Cuba.

How to cite this article (APA, Seventh Edition)
Guerra Véliz, Y., Leyva Haza, J. y Alonso Rojas, Y. (2023). Contextualización de la bioestadística a situaciones biológicas para la formación inicial de profesores de Biología. *Pedagogía y Sociedad, 27*(69), 92-109. https://revistas.uniss.edu.cu/index.php/pedagogia-y-sociedad/article/view/1689

ABSTRACT

Introduction: Due to the value of statistics for the analysis of biological phenomena, in the training of biology teachers teaching should be contextualized and related to professional problems. The inclusion of biostatistics in the curriculum is aimed at achieving this connection, but it requires a change in the didactic treatment of the content so that future teachers can apply this knowledge when solving biological problems.

Objective: To determine the results of comparing the learning of future biology teachers in a biostatistics course, based on two approaches to solving learning tasks: active contextualization and artificial contextualization.

Methods: A longitudinal experimental design with a quantitative approach was used to measure students' learning by means of the grades given in both types of tasks and the Wilcoxon signed-rank test to compare learning.

Results: The best learning results were achieved for active contextualization with a significance of 95%.

Conclusion: It is recommended that the subject biostatistics in biology teacher training focus on solving active contextualization tasks to connect biological phenomena and statistical models.

Keywords: biostatistics; contextualization; didactics of statistics; teacher training

RESUMEN

Introducción: La estadística es muy importante para analizar fenómenos biológicos, por esta razón es necesaria su enseñanza de manera contextualizada y relacionada con los problemas profesionales, en la formación de profesores de biología. La inclusión de la bioestadística en el currículo se encamina a lograr esta conexión, pero se requiere un cambio en el tratamiento didáctico del contenido para que los futuros profesores puedan aplicar estos conocimientos en la solución de problemas biológicos.

Objetivo: Determinar los resultados de comparar el aprendizaje de futuros profesores de biología en un curso de bioestadística, a partir de dos enfoques en la solución de tareas de aprendizaje: la contextualización activa y la contextualización artificial.

Métodos: Se utilizó un diseño experimental longitudinal con enfoque cuantitativo para medir el aprendizaje de los estudiantes mediante las calificaciones otorgadas en ambos tipos de tareas y la prueba de rangos con signos de Wilcoxon para comparar los aprendizajes.

Resultados: Los mejores resultados en el aprendizaje se alcanzaron para la contextualización activa con una significatividad del 95%.

Conclusiones: Se concluye que la asignatura de bioestadística en la formación de profesores de biología se centre en la solución de tareas de contextualización activa para conectar los fenómenos biológicos y los modelos estadísticos.

Palabras clave: bioestadística; biología; enseñanza superior; estadística; formación de docentes

Introduction

Statistics is considered a fundamental tool in the training of biology teachers to understand and analyze the data generated in the study of biological phenomena that are random in nature.

As mentioned by Moreno et al. (2014), "in relation to the training of future Biology teachers, the understanding of randomness is necessary for the interpretation of numerous natural phenomena" (p. 199).

However, it is not enough to include statistics in the curriculum; rather, its teaching in initial training must be closely linked to the problems and challenges that future biology teachers will face. As Walz (2015) states, it is crucial to provide an "adequate teaching of applied statistics" (p.18), starting from the principle that "statistical data come from a context and the model and its interpretation has to be immersed in that context" (Kuntze et al., 2017 as cited by Del-Callejo-Canal et al., 2020, p. 199).

An attempt to achieve statistics linked to the context in the training of biology teachers can be seen in its inclusion in the curriculum under the name of biostatistics. But this solves the problem only at the formal level. In essence, a change is required in the didactic treatment of the content, so that a close link between the statistical model and its usefulness in explaining biological phenomena is achieved, which allows future teachers to apply these contents in the solution of problems that require the interpretation and analysis of biological data.

The objective of this article is to determine the learning outcomes of future biology teachers in a biostatistics course, through the comparison of two approaches in the solution of learning tasks: active contextualization and artificial contextualization. The aim is to determine which of these methodologies is more effective for learning biostatistics and its application in solving biological problems.

Theoretical framework or conceptual references

Contextualization in teaching consists of connecting knowledge with the real life and daily experiences of students. As stated by Chibás-Creagh and Navarro-García (2020), “when dealing with contextualized learning, it is necessary to consider the environment, the context and the socio-historical and cultural environment” (p. 84).

This didactic approach is made concrete by approaching the content, starting from practical situations and using it to solve problems where the abstract content of a branch of knowledge is applied to concrete situations of reality. Thus, contextualized learning becomes a tool to develop useful skills in the student's future performance.

Hence the need to achieve contextualized teaching as a distinctive feature of current didactic models. In agreement with Torres Salas (2010), “teaching science in a contextualized way and related to everyday life is one of the most puzzling challenges of this era” (p. 135).

Teaching statistics from a contextualized approach refers to the application of statistical content to real situations. Statistical data are meaningless without a context. “Statistics is a tool that makes it possible to endow the world with meaning where context provides meaning” (Zapata-Cardona and González Gómez, 2017, p. 64).

As Contreras and Molina-Portillo (2019) asserted, “the consideration of context is fundamental to understand statistical thinking or reasoning, and any teaching of statistics must incorporate this aspect” (p. 6).

In particular, the contextualization of statistics to the biological sciences refers to establishing a bridge between statistical theory and its application in the analysis and resolution of problems related to biological phenomena.

On this basis, the authors agree with Ortega-García (2016), when stated that: "(...) the educational process must respond to a contextualized analysis, rather than to a knowledge presented in foreign formulas that ignore the different problems" (p. 138). Then, according to Tauber et al. (2019), it is needed to "design and develop proposals that present statistics as a tool for the specific professional field" (p. 202), which in this particular case refers to the training of biology teachers.

When referring to teacher training, the teaching of statistics acquires another value, since it allows "(...) teachers to inquire into their context and make scientifically based decisions to transform it" (Guerra Véliz et al., 2023, p. 111).

In the contextualization of statistics "(...) it is not a matter of making students become experts in this subject, but of making them see it with interest and desire to apply it to the reality around them" (Quiroz Guzmán, 2023, p. 87).

According to Amú Casarán and Pérez Padrón (2019), in contextualized teaching, each concrete situation is more or less influenced by the context. Specifically, in a biostatistics learning situation aimed at the training of biology teachers, two elements will be identified: the context referred to some biological or educational phenomenon and the statistical model.

This paper agrees with Gómez Ferragud et al. (2013) who state that the context is made up of the "set of perceivable features in a real-world problematic situation, involving objects and facts in concrete (i.e., not abstract) terms" (p.136), which in this case refers to biological or pedagogical contexts.

On the other hand, the statistical model refers to the "equations, rules or laws, etc." (Gómez Ferragud et al., 2013, p. 136), which constitute abstract entities and allow a problem to be posed in statistical terms.

At least two types of contextualization are addressed in the scientific literature: Artificial contextualization and active contextualization (Chavarría-Arroyo and Albanese, 2021; and León Gómez, 2021).

In the former, the context is used to make sense of the statistical model, but knowledge of the context is not necessary to solve the problem itself or, rather, to operate with the statistical model and provide information about the context from it. According to León Gómez (2021), in artificial contextualization "the approach is internal to statistics, the type of thinking corresponding to the linking of statistics and context is not present here, nor is the recognition of the need for data" (p. 241).

In the second, the context is necessary to solve the task in the sense that the context is necessary to obtain information about the data and interpret the results in correspondence with the situation in which they are presented. It occurs when the question "is the context necessary to perform the task?" is answered positively (Ruiz, 2017, as cited by Chavarría-Arroyo and Albanese, 2021, p. 43).

In contrast to artificial contextualization, it can be said that in active contextualization the approach is to the internal of the context and the role of statistics is the simplification of the context, through the statistical model, to better understand it.

The value of active contextualization is recognized in order to achieve that students have a significant learning of the content by recognizing its application to deepen their knowledge of reality.

Considering that the teaching-learning process takes place through the performance of learning tasks, it is considered appropriate to address the characteristics of biostatistics learning tasks that involve active contextualization.

In the active contextualization referred to the teaching of biostatistics in the initial training of biology teachers, the conditions of the task are concretized in a situation that deals with a biological phenomenon that has a random behavior and in that sense is modeled by statistics. With this, the bridge between the biological phenomenon (context) and the statistical model is established.

As for the requirement of the task, it should be directed to obtaining some information about the biological phenomenon addressed in the conditions and for which it is necessary to use the statistical model that acquires a strict meaning in the context of the task. This ensures that the solution (fulfillment of the requirement) is made from the establishment of close cognitive links between the biological phenomenon and the statistical model used.

Methodology

The modeling method allowed the design of the biostatistics course in which two types of learning tasks were included: non-contextualized or artificially contextualized statistics tasks and tasks with active contextualization.

The design was implemented in the stage from January to June 2023, to a sample of 19 students enrolled in the Bachelor's Degree in Education, specialty Biology, at the Central University “Marta Abreu” of Las Villas, Cuba. Of these, 11 were enrolled in the regular daytime course and 8 in the part-time course. The sample was chosen intentionally, because it constituted the totality of students following the course in both modalities in the period in which the intervention was carried out.

The subject is part of the tailored curriculum and is located in the 6th semester of the regular modality and in the 8th semester of the part-time course. At this time, in both cases, the students had taken several subjects of the specialty (biological sciences), an aspect that enabled them to understand the context of the biological phenomena addressed in the tasks.

As for previous knowledge of mathematics or statistics, only those received in pre-university were considered, since Biostatistics is the only subject of the branches of mathematics included in the curriculum of the degree program.

The course was structured in two topics (probability and descriptive statistics) distributed in 32 face-to-face hours in the regular course and 22 in the part-time course. The course included the same number of both types of assignments to avoid the number of assignments influencing the learning outcomes.

A descriptive and longitudinal experimental design based on the quantitative approach was followed. To measure students' learning (dependent variable), data referring to the grades of both types of tasks during the whole course were collected. The data were classified into groups. The first group included the grades given on the non-contextualized (or artificial contextualization) tasks and the second group included the grades given on the active contextualization tasks. The course had no final exam or partial evaluations, so the final evaluation was given considering only frequent evaluations.

Nine evaluations of each type were carried out, so that, at the end of the course, each student had 18 evaluations. Table 1 provides the context and model addressed in each task assessed in topic 1 and indicates whether they correspond to an active contextualization or artificial contextualization task. Five tasks of each type were included in this topic.

Table 2 shows the same information for the tasks evaluated in item 2. Four tasks of each type were included.

It should be noted that the same context can be used as active contextualization or artificial contextualization, it is not the context itself that gives this character to the contextualization but the way in which the task requirement is phrased.

For example, the wording of task 1 states: Phenylketonuria is an inherited disease caused by a recessive allele. If a woman and a man, both healthy carriers have a child. Determine the sample space for the genotype of this child.

To answer this task you have to apply knowledge of genetics referring to the fact that in the genetic composition of each child there are two alleles for the same character, one coming from the father and the other from the mother. You have to know how to make genetic crosses using the information that both parents are healthy carriers, i.e. they have a dominant gene and a recessive gene that is responsible for the disease. From this, using a Punnett square (or a binary tree) the sample space for the genotype can be determined.

If in this same task the statement were: Phenylketonuria is an inherited disease caused by a recessive allele. A sex cell consists of only one allele for this disease, which can be denoted as (F) for the dominant allele and (f) for the recessive allele. In a healthy carrier person the sex cells are two types with respect to this gene (F) or (f). During fertilization a female sex cell is joined with a male sex cell so that in the cells of the offspring there can be any combination of (F) and (f), so that each different combination determines the genotype. If a female and a male, both healthy carriers have a child. Determine the sample space for the genotype of this child.

In this task the contextualization is artificial because the student only has to make the combinations of (F) and (f), using a binary tree as if it were a coin toss.

Of course, it is not appropriate to put the same situation in the two tasks, since this introduces biases as both solutions are almost similar. For this reason, in the artificial contextualization tasks other contexts were used, not related to biology, and even dispensed with the context whenever possible.

Table 1

Context and statistical model in active contextualization and artificial contextualization tasks in the probability topic.

Topic 1		
Task	Context	Statistical Model
Task 1 Active C.	Phenylketonuria as a hereditary disease caused by a recessive allele.	Sample space. Generalized multiplication theorem.
Task 1 Artificial C.	Dice throwing.	Sample space. Generalized multiplication theorem.
Task 2 Active C.	Presence of Aedes Aegypti larvae in urban reservoirs.	Relationships and operations with random events.
Task 2 Artificial C.	Toss of a coin and a die.	Relationships and operations with random events.
Task 3 Activa C.	Interaction between the gene for the coloration of the fur of a mouse and the epistatic gene that encodes its color.	Sample space and classical probability and frequency probability.
Task 3 Artificial C.	Toss of a coin.	Sample space and classical probability and frequency probability.
Task 4 Active C.	Cystic fibrosis as an autosomal recessive disease.	Binomial distribution.
Task 4 Artificial C.	Red and white balls.	Binomial distribution.
Task 5 Active C.	Population structure of the bombona palm according to age categories.	Poisson distribution.
Task 5	Errors in a typed page.	Poisson distribution.

Artificial C.		
Task 5 Active C.	Life of a population of reasons from a protein-rich diet.	Normal distribution.
Task 5 Artificial C.	Area of the normal curve.	Normal distribution.

Table 2

Context and statistical model in the active contextualization and artificial contextualization tasks in the descriptive statistics topic.

Topic 1		
Task	Context	Statistical model
Task 6 Active C.	Collection of insects in a field practice.	Data collection, types of variables and scales.
Task 6 Artificial C.	Scores on college entrance exams.	Data collection, types of variables and scales.
Task 7 Active C.	Height and weight of adolescents (males and females).	Numerical indices, construction of graphs.
Task 7 Artificial C.	Table of primary data without indicating the context.	Numerical indices, construction of graphs.
Task 8 Active C.	Incidence of breast cancer in Cuba.	Graph interpretation
Task 8 Artificial C.	Graphs without context.	Graph interpretation
Task 9 Active C.	Comorbidities in Covid-19 patients.	Posing informal hypotheses from data.
Task 9 Artificial C.	Examination grades.	Posing informal hypotheses from data.

With the students' scores for each task, the median was calculated for each group of evaluations. Finally, each student was compared with him/herself considering the median. The contrast statistic was the Wilcoxon signed-rank test.

The assumption that the absence of contextualization or that the type of contextualization does not influence student learning would be evidenced by the fact that there would be no significant differences between the two groups of evaluations. Conversely, if there were significant differences between the two groups of ratings, it would indicate that the type of contextualization or its absence does influence student learning.

Both assumptions gave rise to the statistical hypotheses:

H0: There are no significant differences between the ratings obtained in the assessments from non-contextualized tasks (or with artificial contextualization) and the ratings obtained in the assessments coming from tasks with active contextualization.

H1: There are significant differences between the scores obtained in the evaluations of non-contextualized tasks (or with artificial contextualization) and the scores obtained in the evaluations of tasks with active contextualization.

Finally, if significant differences were obtained, it would be evaluated which of the types of tasks produced better results, thus, a descriptive analysis of the data would complete the test.

Results and Discussion

The course went as planned. Tasks 2, 4, 5 and 7 were oriented for independent study. In each of these tasks, the same statement was kept for all students and the requirement was set differently for each one, but considering that it responded to the same objective. The rest of the tasks were applied in the classroom in the form of a written question.

With the medians per student for each type of assessment, the box plot in Figure 1 was constructed.

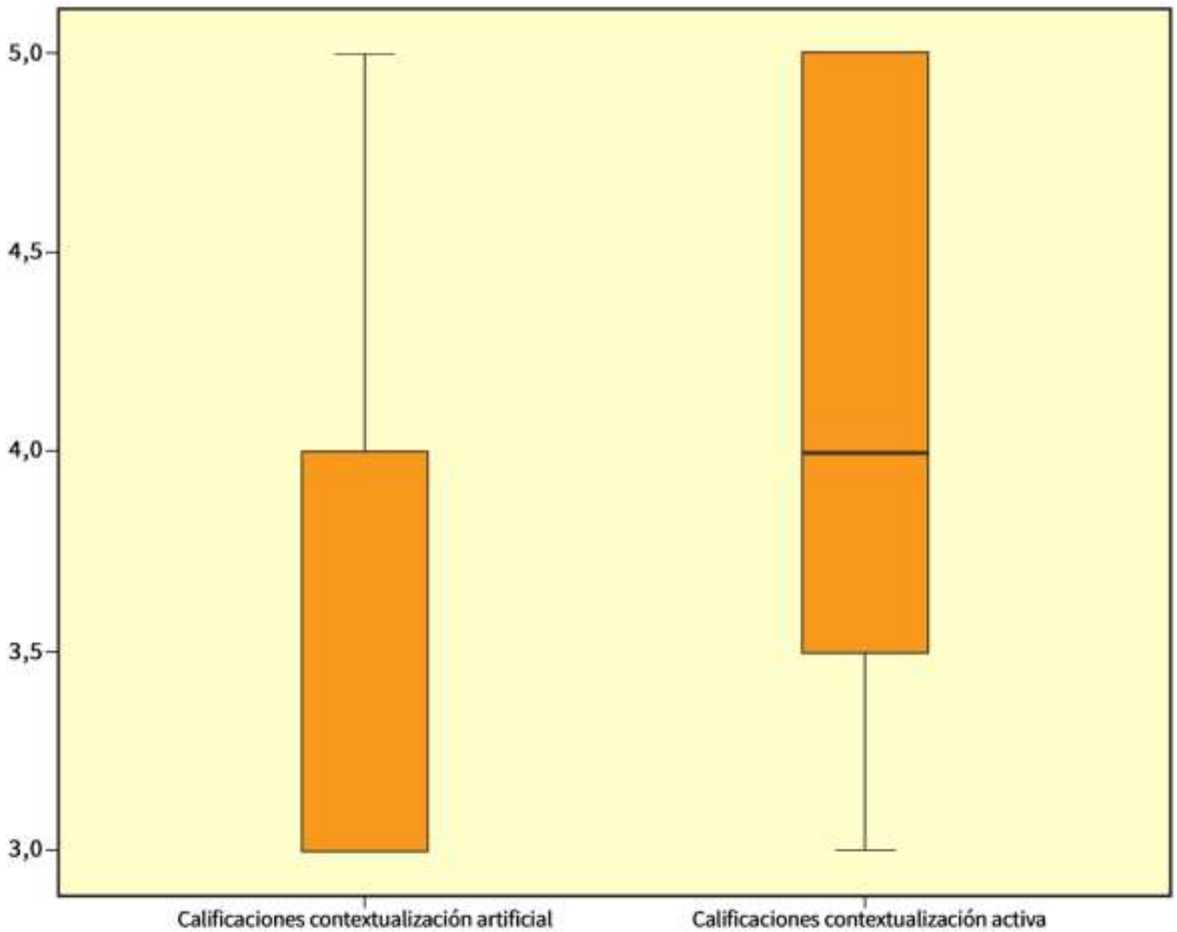
The results shown in the graphs in Figure 1 suggest that there are differences between the two types of assessments, and better scores were observed in the active contextualization tasks. Note that, although for both tasks the range of scores is the same from 3 to 5 points, in the active contextualization tasks the median reaches the value of 4 points, while in the artificial contextualization tasks the median value is 3, which coincides with the minimum. Moreover, the interquartile range for the active contextualization tasks is located between 3.5 and

5 points, while for the artificial contextualization tasks it is slightly shifted downwards between 3 and 4.

Finally, in the active contextualization tasks, the extreme values are located in the first quartile, unlike the artificial contextualization tasks, for which the extreme values are in the fourth quartile, indicating that obtaining high scores in this type of tasks is a rare case.

Figure 1

Student scores according to task type



As for the results of the Wilcoxon signed-rank test, only one negative rank was obtained, indicating that, for one student, the score in the active contextualization tasks was lower than in the artificial or non-contextualized tasks. Eight ties, which means that for eight students the scores in the ratings, for both types of tasks, were the same. Finally, ten positive ranks were recorded; this is evidence that an equal number of students scored better in the active contextualization tasks than in the other group of tasks.

Table 3

Wilcoxon Signed Ranks Test

		N	Average rank	Sum of ranks
Active contextualization scores - Artificial contextualization scores	Negative ranks	1[a]	6,00	6,00
	Positive rankings	10[b]	6,00	60,00
	Ties	8[c]		
	Total	19		

a. Active contextualization scores < Artificial contextualization scores

b. Active contextualization scores > Artificial contextualization scores

c. Active contextualization scores = Artificial contextualization scores

As for the contrast statistic, the bilateral asymptotic significance yielded a value of 0.007, which is much lower than 0.05, so the null hypothesis was rejected. This shows significant differences between both types of scores and how the descriptive results were higher in the scores of the tasks with active contextualization than in the tasks with artificial contextualization. It was possible to affirm with 95% confidence that the learning of statistics was superior in the solution of the tasks with active contextualization.

Although no articles were found that compared students' learning in statistics when solving tasks with active contextualization with those achieved when solving tasks with artificial contextualization, it was possible to confirm that when a systematic treatment of active contextualization is carried out in the teaching-learning process, positive results are achieved.

In this sense, the favorable results achieved in the active contextualization tasks offered in the present study agree with those presented by Sánchez Numa et al. (2019), in a study on the contextualization of statistical content in the Bachelor's degree programs in Tourism and Civil Engineering. These authors found “through the review of final tasks oriented to the resolution of professional problems, that students achieved better results in the resolution of statistical professional problems” (p.348).

These results are also in line with those obtained by other authors who have addressed active contextualization in statistics tasks at other levels of education, such as Guerra Véliz et al. (2020).

Conclusion

From the theoretical analysis carried out, the tendency to include active contextualization in the teaching-learning process of statistics with a professional approach was evidenced, an aspect that contributes to the development of future teachers for their performance.

In particular, it is recognized that the subject of biostatistics in the initial training of biology teachers should be oriented towards an active contextualization that establishes a bridge between biological phenomena of a random nature and the statistical models that make their study possible.

Based on the methodology used, it was possible to measure student learning in two types of statistical tasks: active contextualization and artificial contextualization. The comparison of learning evidenced in the solution of both types of tasks revealed better results in the active contextualization, an aspect that constitutes an argument in favor of the validity of this type of tasks.

References

Amú Casarán, M. S. & Pérez Padrón, M. C. (2019). La habilidad comprender y las tipologías textuales en la Educación Básica Primaria, tercer grado. *Universidad y Sociedad*, *11*(4), 7-12. http://scielo.sld.cu/pdf/rus/v11n4/2218-3620-rus-11-04-7.pdf

Chavarría-Arroyo, G. & Albanese, V. (2021). Problemas matemáticos en el caso de un currículo: Análisis con base en el contexto y en la contextualización. *ATEM: Avances de Investigación en Educación Matemática*, (19), 39–54. https://dialnet.unirioja.es/servlet/articulo?codigo=8010656

Chibás-Creagh, M. & Navarro-García, G. (2020). El aprendizaje contextualizado de la Biología 1 de Secundaria Básica. *LUZ*, *19*(3), 81-90. https://luz.uho.edu.cu/index.php/luz/article/view/1054.

Contreras, J. M. & Molina-Portillo, E. (2019). *Elementos clave de la cultura estadística en el análisis de la información basada en datos*. Universidad de Granadas. https://digibug.ugr.es/bitstream/handle/10481/55035/contreras.pdf?sequence=1&isAllowed=y

Del-Callejo-Canal, D., Canal-Martínez, M. & Rubiette Hákim-Krayem, M. (2020). Desarrollo del pensamiento estadístico en estudiantes de nivel superior a través de una Experiencia Educativa. *Educación Matemática, 32*(2), 194-216. https://www.scielo.org.mx/pdf/edumat/v32n2/1665-5826-ed-32-02-194.pdf

Gómez Ferragud, C., Solaz Portolés, J. J. & Sanjosé López, V. (2013). Efectos de la similitud superficial y estructural sobre la transferencia a partir de análogos en problemas de alta y baja familiaridad: primeros resultados. *Enseñanza de las Ciencias*: *Revista de investigación y experiencias didácticas, 31*(1), 135-151. https://ensciencias.uab.cat/article/view/v31-n1-gomez-solaz-sanjose/782-pdf-es

Guerra Véliz, Y., Aguilar García, A. & Leyva Haza, J., (2020). Aprendizaje de la estadística descriptiva en secundaria básica con datos provenientes del consumo de energía. *Horizonte de La Ciencia*, *11*(21), 201–215. https://revistas.uncp.edu.pe/index.php/horizontedelaciencia/article/view/906/1102

Guerra Véliz, Y., Leyva Haza, J. & Soler Rodríguez, G. (2023). Estadística mediante problemas y proyectos para la formación investigativa del Máster en Educación. *Universidad y Sociedad, 15*(S1), 110-120. https://rus.ucf.edu.cu/index.php/rus/article/view/3690/3628

León Gómez, N. A. (2021). Enseñanza de la Estadística con sentido y en contexto a través de la resolución de problemas. *Realidad y Reflexión*, *21*(53), 228-253. http://ri.ufg.edu.sv/jspui/bitstream/11592/9674/1/Ense%C3%B1anza%20de%20la%20Estad%C3%ADstica%20con%20sentido%20y%20en%20contexto.pdf

Moreno, A., Cardeñoso Domingo, J. M. & González García, F. (2014). La aleatoriedad en profesores de biología y de matemática en formación: análisis y contraste de significados. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias, 11*(2), 198-215. https://www.redalyc.org/pdf/920/92030461006.pdf

Ortega-García, C. A. (2016). Para qué un aprendizaje contextualizado y coherente en la escuela. *Revista Praxis, 12*(1), 135-144. https://www.readcube.com/articles/10.21676/23897856.1855

Quiroz Guzmán, F. J. (2023). Pedagogía por proyectos como modelo para el proceso de pensamiento estadístico. *Revista Boletín Redipe*, *12*(5), 84-96. https://revista.redipe.org/index.php/1/article/view/1966/1953

Sánchez Numa, A., Numa Rodríguez, M. de la C. & Rodríguez Moya, O. S. (2019). Estrategia didáctica para la contextualización del contenido estadístico en las carreras de Licenciatura en Turismo e Ingeniería civil. *Mendive: Revista de Educación*, *17*(3), 346-356. https://mendive.upr.edu.cu/index.php/MendiveUPR/article/view/1584/pdf

Tauber, L., Redondo, Y. & Santellán, S., (2019). Construcción del sentido estadístico en estudiantes universitarios de ciencias naturales. *Acta Latinoamericana de Matemática Educativa, 32*(1), 200-209. http://funes.uniandes.edu.co/14031/1/Tauber2019Construccion.pdf

Torres Salas, M. I. (2010). La enseñanza tradicional de las ciencias versus las nuevas tendencias educativas. *Revista Electrónica Educare, 14*(1), 131-142. https://www.redalyc.org/pdf/1941/194114419012.pdf

Walz, M. F. (2015). Programa de Estadística aplicada a la Biología: una propuesta. *Números: Revista de didática de las matemáticas, 88,* 17-29. https://redined.educacion.gob.es/xmlui/bitstream/handle/11162/228785/Walz.pdf?sequence=1

Zapata-Cardona, L. & González Gómez, D. (2017). Imágenes de los profesores sobre la estadística y su enseñanza. *Educación Matemática*, *29*(1), 61-89. https://www.scielo.org.mx/pdf/edumat/v29n1/1665-5826-ed-29-01-00061.pdf

Conflict of interest

The authors declare that they have no conflicts of interest.

Contribución de los autores

Y.G.V.: Conceptualization, supervision, Formal analysis, Methodology, Data curation and statistical processing, Draft and original writing, Data processing, Writing (proofreading and editing).

J.L.H.: Conceptualization, Methodology, Draft and original writing, Formal analysis, Writing (proofreading and editing).

Y.A.R.: Practical application, data collection, writing, resources.