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Mobile devices as didactic mediators in the teaching of statistics

Los dispositivos móviles como mediadores didácticos en la enseñanza de la estadística

Dispositivos móveis como mediadores didáticos no ensino de estatística

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ABSTRACT
The use of didactic mediators was of vital importance to optimize work in classes and in this way, guarantee learning in Higher Education students. In the case of Statistics, to easily operate these didactic mediators using mobile devices since their applications provide a good opportunity to show students their usefulness by quickly working on application exercises for the different contents, which is why this article was intended the objective is to present and socialize a methodological procedure for teaching Statistics through the use of mobile devices as didactic mediators. Theoretical level methods such as synthetic analytical, historical and logical methods were used. At the empirical level, document review, interviews, performance observation, pedagogical testing and expert consultation were used. As a sample, students from the Agricultural Engineering program at the University of Ciego de Ávila were part of this research. This result can be generalized to other university courses. With the application of this methodological procedure, it was possible to improve student learning in the contents of this discipline.

Keywords: learning; statistics; didactic mediators; technology.

RESUMEN
El empleo de mediadores didácticos resultó de vital importancia para optimizar el trabajo en las clases y, de esta manera, garantizar el aprendizaje en los estudiantes de la Educación Superior. En el caso de la Estadística, para operar fácilmente estos mediadores didácticos utilizando los dispositivos móviles, puesto que sus aplicaciones proporcionan una buena oportunidad para mostrar a los estudiantes su utilidad al trabajar con rapidez ejercicios de aplicaciones para los diferentes contenidos. Por ello, este artículo tuvo como objetivo presentar y socializar un procedimiento metodológico para la enseñanza de la Estadística, a partir de la utilización de dispositivos móviles como mediadores didácticos. Se utilizaron

métodos del nivel teórico como: el analítico-sintético, histórico-lógico. Del nivel empírico se empleó la revisión de documentos, entrevistas, la observación del desempeño, la prueba pedagógica y la consulta a expertos. Como muestra formaron parte de esta investigación los estudiantes de la carrera Ingeniería Agrónoma de la Universidad de Ciego de Ávila. Este resultado puede generalizarse para otras carreras de la universidad. Con la aplicación de este procedimiento metodológico se logró perfeccionar el aprendizaje de los estudiantes en los contenidos de esta disciplina.

Palabras clave: aprendizaje; estadística; mediadores didácticos; tecnología.

RESUMO
A utilização de mediadores didáticos foi de vital importância para otimizar o trabalho nas aulas e, desta forma, garantir a aprendizagem dos alunos do Ensino Superior. No caso da Estatística, operar facilmente estes mediadores didáticos através de dispositivos móveis, uma vez que as suas aplicações proporcionam uma boa oportunidade para mostrar aos alunos a sua utilidade, trabalhando rapidamente em exercícios de aplicação para diferentes conteúdos. Portanto, este artigo teve como objetivo apresentar e socializar um procedimento metodológico para o ensino de Estatística, baseado na utilização de dispositivos móveis como mediadores didáticos. Foram utilizados métodos de nível teórico como: analítico-sintético, histórico-lógico. No nível empírico, foram utilizadas revisão documental, entrevistas, observação de desempenho, testes pedagógicos e consulta a especialistas. Como amostra, fizeram parte desta pesquisa alunos do curso de Engenharia Agronômica da Universidade de Ciego de Ávila. Este resultado pode ser generalizado para outros cursos universitários. Com a aplicação deste procedimento metodológico foi possível melhorar o aprendizado dos alunos nos conteúdos desta disciplina.
Palavras-chave: aprendizagem; Estatisticas; mediadores didáticos; tecnologia**.**

INTRODUCTION

The use of mobile devices as didactic mediators in the development of Education makes it possible to create the foundations so that new generations can understand technological advances. For this, it is essential to update academic programs and improve teaching-learning strategies.

Mobile devices as didactic mediators offer valuable contributions to the teaching-learning process of different subjects at different levels of education. In the specific case of Higher Education, research has been carried out in this regard, such as that of Rodríguez *et al.* (2019), who explore the perceptions of the use of information technologies and mobile devices for teaching at the university. Its advantages and disadvantages are analyzed and the main applications used in the field of Higher Education are classified.

This pedagogical modality, according to Sánchez (2019), supports student-centered learning. He participates directly and actively in the construction of his own learning, being able to create and share content through the use of his mobile devices.

According to Kim and Park (2019), the use of mobile devices such as the smartphone is effective in improving students' position in learning; In addition, it has a positive impact on obtaining knowledge and skills.

In the specific case of Statistics, a topic addressed in this article, important research has been carried out on the use of mobile devices, such as that of Rangel *et al.* (2019), where the relevance of the use of information technologies and the smartphone as a mobile device is discussed using an application in obtaining data,

understanding and interpreting descriptive statistics.

The use of mobile applications as a teaching resource in Statistics, as proposed by Castillo (2020), is a form of innovation that becomes important because it constitutes a novel implementation that expands the study possibilities of students.

The incorporation of mobile devices in current teaching processes, according to Osorio (2021), is essential, given the increase in their use worldwide. These devices allow portability and immediacy, allowing teaching anywhere and anytime.

The preparation of man in the use of statistics and new technologies is today's main challenge, which cannot be renounced, concludes Rojas (2023).

The review of the literature shows interest in using mobile devices as educational mediators in Higher Education classes, and especially in subjects with statistical content, using applications that provide a good opportunity to show students their usefulness when working with quick exercises for the different contents to be covered in the classroom or outside of it.

Mobile devices (Laptops, Tablets, Smartphones), intelligent tools, have useful applications in all areas, especially for education. Every technological tool has programs or applications that allow the level of performance to be developed, both professionally and academically. All these applications allow you to perform different functions; That is, it allows you to browse, play, investigate, socialize, send emails, create figures, etc.

In the specific case of university courses such as Agricultural Engineering, the use of these statistical applications is of vital importance and they have been identified as teaching aids, didactic media or didactic mediators and have had various classifications. The most significant thing in all this analysis is that, regardless of the classification, the most important function of these is to promote the teaching-learning process.

In the case of statistics, it is vitally important to use applications to work with some content that requires data processing in order to interpret certain studies. In this case, these applications are considered statistical applications and are very useful in the teaching-learning process.

Based on the previous background, it is considered that statistical applications and their usefulness in the teaching-learning process in students of the Agricultural Engineering career allow for the conscious preparation of future graduates; In addition, it provides the knowledge and skills required in the field of statistical techniques, providing the student with the necessary knowledge for the management and analysis of statistical data that allows the solution of problems related to their professional profile.

In this degree program at the University of Ciego de Ávila, the learning of statistics does not achieve satisfactory results and proposals for solutions to this problem are recognized, including statistical applications on mobile devices as didactic mediators.

Therefore, this article highlights the fundamental elements to develop the learning of Statistics with mobile devices, with the objective of presenting and socializing a methodological procedure for teaching Statistics, based on the use of mobile devices as didactic mediators. ; This is a relevant and current topic, and the results constitute a starting point for subsequent studies in the teaching-learning process.

MATERIALS AND METHODS

Theoretical level methods such as analytical-synthetic and historical-logical methods were used. At the empirical level, document review, interviews, performance

observation, pedagogical testing and expert consultation were used.

Analytical-synthetic: it was used in the analysis of the content of bibliographic sources related to student learning in the contents of statistics, based on the use of mobile devices as didactic mediators for working with different statistical applications, to express the essence of the same that will be referential to develop the methodological procedure. It was also used to identify diagnostic regularities.

Historical-logical: it was used to assess how students' learning in statistics content has behaved from the use of mobile devices as didactic mediators for working with different applications, according to criteria of different authors and researchers on the subject. object of study.

Documents were reviewed, which allowed us to delve deeper into the foundation of the topic and class systems, methodological guidelines, subject programs, master's and doctoral theses were developed.

Interview with students: it allowed us to verify the insufficiencies and strengths in learning, based on the use of mobile devices as didactic mediators for work with different statistical applications in students of the Agricultural Engineering career.

Interview with teachers: made it possible to assess the experience that teachers have to direct learning, based on the use of mobile devices as didactic mediators for working with different statistical applications.

Performance observation: it was used to diagnose the level reached in learning from the use of mobile devices as didactic mediators for work with different statistical applications in the students of the Agricultural Engineering career at the University of Ciego de Ávila "Máximo Gómez Báez "; It also allowed recording the changes that occurred in their performance during the beginning, execution and completion of the investigation.

The pedagogical test to determine the regularities and trends of the current state achieved in learning by students of the Agricultural Engineering career from the use of mobile devices as didactic mediators for working with different statistical applications and to evaluate the implementation of the methodological procedure.

In addition, a workshop was held to validate the methodological procedure with experts who work on the subject of Statistics for professional reflection, analysis of results and decision making.

The sample was made up of 28 students from the Agricultural Engineering degree at the University of Ciego de Ávila and was selected through simple random sampling.

Indicators were established to assess the learning of the students of the Agricultural Engineering career at the University of Ciego de Ávila "Máximo Gómez Báez", based on the interpretation of the results obtained in the processing of information.

For its evaluation, the following indicators were determined based on the assumed foundations:

1. Interpretation of statisticians or statistical parameters.

2. Selection of statistical tools for information processing.

3. Application of statistical tools for information processing.

4. Independence shown by students in the application of statistical tools for information processing.

5. Interpretation of the results obtained in information processing.

To evaluate the level reached in the learning of the students of the Agricultural Engineering career at the University of Ciego de Ávila, the results of the pedagogical test developed were taken into account. For this purpose, a qualification key was developed where an analysis and tabulation of the results can be carried out.

The pedagogical test had five questions and each of them was given a score of 20 points.

The final grade was awarded as follows:

Less than 60 points: M
Between 61 and 80 points: R
Between 81 and 90 points: B
Between 91 and 100 points: E

RESULTS

From the instruments applied and the pedagogical test, it was found that there are difficulties in the learning of the students of the Agricultural Engineering career at the University of Ciego de Ávila "Máximo Gómez Báez", based on the interpretation of the results obtained in the information processing.

In this regard, the following regularities are revealed:

1. Limitations in the interpretation of statisticians or statistical parameters in a given problematic situation. They manage, in a limited way, to identify in a presented situation the statistician and statistical parameter to be treated in the exercise and do not correctly argue each of the logical steps to follow in it.

2. Insufficiencies in the selection of statistical tools for information processing, since the analysis and understanding carried out by the student is insufficient when selecting the statistical tool to be used, depending on the situation presented, where to do so they must also know what this tool provides you to carry out the exercise or problem in question.

3. Deficiencies in the application of statistical tools for information processing.

4. Insufficiencies in the independence shown by students in the application of statistical tools for information processing, applying methods and techniques of descriptive and inferential statistical analysis.

5. Limitations in the interpretation of the results obtained in the processing of information. The student performs insufficiently the interpretation of the results obtained in the processing of information.

Besides:

1. A methodological conception prevails that does not always satisfactorily put the student in a position to seek the information necessary to solve the problem posed.

2. The methodological procedures adopted for the organization of the teaching-learning process of Statistics still do not contribute correctly to students applying the content of the subject independently to achieve an adequate interpretation of the information processing, depending on the process. investigative.

3. Insufficiencies in the didactic orientation of the teaching-learning process of Statistics using mobile devices as didactic mediators for working with different applications that provide information processing and thus dedicate more time to the statistical analysis and interpretation of the data. results obtained.

4. In the texts of the subjects that deal with statistical content, there are limitations in the use of these technologies as didactic mediators.

5. The conditions do not exist in the computer laboratories of the University of Ciego de Ávila for working with students.

There is a dialectical relationship between methods and procedures, which means that at a given moment a procedure can become a method and vice versa. In pedagogical literature, multiple definitions of procedures are evident. However, despite being a frequently used term, the methodological and pedagogical theory on methodological procedures is limited.

According to Coll (1991), a learning procedure is a set of ordered and finalized actions, that is, aimed at achieving a goal.

These definitions specify that procedures are composed of actions carried out by teachers and students based on the achievement of a specific objective.

Silvestre (2000) considers methodological procedures as a complement to teaching methods; They constitute tools that allow the teacher to implement the achievement of objectives through the creation of activities, based on the characteristics of the content, which allow them to guide and direct the student's activity in class and in the study.

These supports allow us to specify the methodological procedures as actions of the activity of planning, execution and evaluation of the teaching-learning process of Mathematics and each action or procedure is made up of a system of operations that are constituted by the methodological steps to be fulfilled to develop each procedure.

Next, a methodological procedure is presented to implement the use of didactic mediators for the teaching of Statistics in Higher Education, which guarantees that the student is prepared to solve the exercises and carry out the corresponding statistical analysis.

Methodological procedure

1 0. Explore the students' prior knowledge before applying these didactic mediators, in order to know the level at which each of the students is and to be able to give them differentiated attention.

1. Read the proposed exercise or problem carefully.

2. Reproduce the content in your own words.

3. Separate what is given from what is sought.

4. Analysis of the meaning of each of the data requested by the exercise.

20 . Structure the exercise system with the use of these applications for the active search for knowledge and that simultaneously promote independent research activity.

1. Select the contents and activities in which learning with mobile devices will be applied.

2. Choose the applications that will be taken into account to solve the proposed exercises and problems.

3. Verify that students know how to use these applications in the proposed exercises.

3 0. Stimulate, with the use of these applications, the logical development of thought.

1. Carefully read the exercise to be solved to select the statistical application.

2. Select the statistical tool to be used.

3. Compare and interpret the results obtained in the exercises solved with and without the application of mobile devices.

4. Assess the advantages of using mobile devices.

4 0. Conceive problematic activities for the solution of which the use of these applications as didactic mediators in working with subjects that present statistical content is essential.

5 O. Ensure that both the solutions to the problem tasks and the consolidation tasks are developed within a framework of collective cooperation among all students.

6 0. For students who have achieved a high level of learning, other exercises of greater complexity should be designed and proposed, where these didactic mediators are used.

To assess the relevance and feasibility of the proposal, the pedagogical test was carried out on the 28 students of the Agricultural Engineering career at the University of Ciego de Ávila, but with the difference that in this case mobile devices were used as didactic mediators in teaching. of statistics.

The final grade achieved by the students, before and after the use of mobile devices as didactic mediators, is presented as follows:

Qualification	Evil	Regular	Good	Excellent
Before	10	8	8	2
After	3	4	12	9

Comparing these results obtained after the use of mobile devices shows that students, already at 89.28%, are able to interpret statistical parameters in a given problematic situation, correctly argue the logical steps to follow, show independence in the application of statistical tools and adequately interpret the results obtained in the processing of information.

After applying the proposed methodological procedure, the following results are obtained:

1. The level of learning by the students rose upwards, managing to solve all the proposed exercises.

2. The orientation and execution of these didactic mediators in the classes of subjects that present statistical content, from all the methodological components, with a developmental function.

3. The students were able to identify errors in the exercises, achieving greater mastery of the procedure to use in each case.

The use of didactic mediators for teaching Statistics has the advantages that:

1. Contributes to the statistical knowledge that students should have.

2. Contributes to the development of logical thinking.

3. It has differentiating exercises that allow it to work in practice.

4. Employs didactic mediators who promote the development of learning by students.

5. Promotes cognitive independence in solving the exercises.

6. Didactic mediators are used that allow the active participation of the student in the search and reflective analysis of mathematical knowledge.

The application of the methodological procedure by the teachers determined, based on evaluations such as: written and oral questions, control work and tests, that there was a change in the learning of the students of the Agricultural Engineering career at the "Máximo Gómez" university. Baez"; Furthermore, it responded to the needs and expectations, since the students' learning of the content was effective, and they were able to solve all the proposed exercises.

DISCUSSION

In the validation workshop carried out by experts who work in the Statistics discipline, the proposed methodological procedure has been considered successful, since it focuses on the incorporation of mobile devices as didactic mediators for the correct interpretation of the results obtained in the processing of information. . The impact that this procedure has on the training of the university student is recognized.

In studies carried out on this topic, for example, in the article referring to the use of applications on mobile devices, carried out by Rangel, M. and Santoyo, F. (2019) and other research referring to didactic mediators carried out by Camilo, E. and Izquierdo, J. (2018) *discussed* the relevance of the use of Information and Communications Technologies and m-learning, using an application in obtaining data, understanding and interpretation of descriptive statistics. In the second, the different classifications of teaching media were presented, delving into the advantages of their use and highlighting the possibilities offered by cutting-edge teaching mediators, but a methodological procedure for teachers to work with mobile devices was not revealed. as didactic mediators, since it was not its objective.

In this regard, Giler (2020) conceived that it was necessary to assess different procedures for teaching statistics that could be used in the training of future professionals, in which essential elements of the teaching-learning process were revealed; Furthermore, he admitted that each teacher should consider these elements when teaching classes in Higher Education.

Chérrez *et al.* (2021) showed that one of the most current and innovative resources in teaching is mobile devices; However, they are not being widely used in the teaching-learning processes of Higher Mathematics.

In other research carried out by Dávila *et al.* (2022) and Terán *et al.* (2019) the relationship between the use of smartphones and learning strategies in undergraduate students was determined. In addition, work was done on the impact of mobile devices in education, an aspect of vital importance to devise a way to work with these devices in classes in a way that improves learning in university students.

On the other hand, the work of Santana *et al.* (2022) detailed that the use of mobile devices in modern life is essential due to the advantages they provide, which confirms that new procedures can be offered in the teaching-learning process.

The analysis and incorporation of information and communications technologies, according to López (2022), in the education process, generated the need to create new ways of educating and moving from traditional education to new forms that have the purpose of building a learning environment, which allows anyone to learn anywhere and at any time through the use of these technologies.

Another measurement criterion are the results of the interviews with students and teachers, which made it possible to verify that 95% agree with the use of these devices as didactic mediators, significantly influencing the better interpretation of the results obtained.

The results obtained in the research showed the current state of learning in statistics content in the students of the University of Ciego de Ávila. In turn, they expressed the need to incorporate the use of mobile devices as didactic mediators in exercises and problems that work on these contents and, in this way, dedicate more time to the analysis and statistical interpretation of the results obtained.

The analysis of the main difficulties detected in the research allowed us to assert that the learning of statistics in the Agricultural Engineering degree at the University of Ciego de Ávila has deficiencies.

For this reason, in this article a methodological procedure is socialized, based on the use of mobile devices as didactic mediators, for the correct interpretation of the results obtained in the processing of information.

The ideas expressed in the article have been implemented for the Agricultural Engineering career of the Faculty of Agricultural Sciences of the University of Ciego de Ávila since the 2022 academic year. Based on interviews with students and teachers, frequent, partial and final evaluations, it was verified a favorable change in the learning of students related to Statistics. The students solved statistical problems using mobile devices as didactic mediators, achieving the correct interpretation of the results obtained in the processing of information.

The work carried out allowed us to reveal important elements about the use of didactic mediators in the teaching of Statistics in the teaching-learning process in Higher Education; However, they are not yet widely used by teachers and students, and essential aspects of the process must continue to be evaluated to make the most of their potential, among which the following stand out:

Take advantage of students' mobile devices as innovative and motivating elements to promote certain aspects of the teaching-learning process.

The activities and ways of using these resources must keep in mind that they are nothing more than a means to achieve the objectives of the teaching-learning process.

Methodological changes are required that direct teachers to new practices that include technology in their teaching methodology to improve their students' learning and be truly meaningful. It is intended that with the use of mobile devices as didactic mediators, new skills are acquired, resulting in flexible teaching for the student, where they are provided with many means to help them make decisions in their learning.

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The author participated in the design and writing of the article, in the search and analysis of the information contained in the consulted bibliography.

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