WEBSITE «MARINE MOLLUSKS IN CIENFUEGOS»: A TEACHING-LEARNING TOOL FOR THE DEVELOPMENT OF MALACOLOGICAL STUDIES

SITIO WEB «MOLUSCOS MARINOS EN CIENFUEGOS»: UN MEDIO DE ENSEÑANZA APRENDIZAJE PARA EL DESARROLLO DE ESTUDIOS MALACOLÓGICOS

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ABSTRACT

The integration of Information and Communication Technologies (ICTs) as teaching-learning tools has become increasingly necessary. This condition constitutes a fundamental premise in the teacher-training context at the University of Cienfuegos, serving as the foundation of its didactic model. Based on the factual analysis carried out in this research, the objective was to design a Website as a teaching resource to strengthen the treatment of malacological content in the course General Zoology I within the Bachelor's Degree in Education, Biology program at the University of Cienfuegos. The study was conducted from January 2024 to January 2025. The methodology combined theoretical, empirical, and descriptive statistical methods, and the Website was developed as a multiplatform resource (both as an online portal and as an offline executable CD-ROM). As a result, the malacological content of General Zoology I was reinforced, with 773 visits to the site by

students, professors, and other users. Expert evaluation confirmed its relevance and effectiveness, highlighting the contribution of the Website to the teaching of malacological content in General Zoology I. The study also concluded that students exhibited significant limitations in malacological knowledge and in the use of ICTs as teaching-learning tools.

KEYWORDS: faunal biodiversity; biology; sustainability; general zoology

RESUMEN

La inclusión de las Tecnologías de la Información y Comunicaciones (TICs) como medio de enseñanza-aprendizaje es cada vez más necesario. Tal condición es premisa fundamental en el contexto de la formación docente de la Universidad de Cienfuegos asumiéndose como sustento del modelo didáctico. En el análisis fáctico que ocupó esta investigación se determinó como objetivo elaborar un sitio web como medio de enseñanza para fortalecer el tratamiento de los contenidos malacológicos de la asignatura Zoología General I en la Licenciatura en Educación, Biología de la Universidad de Cienfuegos. La misma se realizó de enero del 2024 a enero del 2025. Se aplicaron métodos investigativos como teóricos, empíricos y estadísticos descriptivos y se trabajó como Multiplataforma (como portal y como ejecutable offline (CD-ROM). Como resultado se logró el fortalecimiento de los contenidos malacológicos de la asignatura Zoología General I, con un total de 773 visitas al sitio web entre los que se destacan estudiantes, profesores y otros usuarios. La valoración realizada por expertos resultó satisfactoria, lo que pone de manifiesto la pertinencia y contribución del sitio web elaborado para el tratamiento de los contenidos malacológicos a partir de la asignatura Zoología General I y se concluye que existieron numerosas limitaciones en cuanto a los conocimientos malacológicos que poseen los estudiantes y el uso de las TIC como medio de enseñanza aprendizaje.

PALABRAS CLAVE: biodiversidad faunística; biología; sostenibilidad; zoología general

INTRODUCTION

Today, it is not enough to improve curricula, programs, teaching materials, and others; it is also essential to enhance the quality of teachers' and professors' work aimed at more meaningful and lasting learning. In this regard, Vahos, Muñoz & Londoño (2019) state that a prominent place is occupied by the need to incorporate teaching-learning media harmoniously and rationally into the teaching process, promoting meaningful learning to facilitate students' independent and creative activity.

Consequently, and according to the most recent definition by Pérez et al. (2022), the media of the teaching-learning process is the component that supports information through symbolic technologies, whose use in the teaching-learning process contributes to the achievement of objectives through its processing for the development of habits, skills, and values. Regardless of its materiality, code, and structure, it satisfies the demands of the subjects, the interaction context, and the organizational particularities that regulate its use.

In this sense, Cabral (2019) explains that media have been qualified as auxiliaries or aids, channels, supports, materials, resources, among other considerations.

In contemporary times, professors are often requested to plan their classes before the semester begins. Commonly used resources may be traditional or include technological tools, such as internet videos, Websites, Kahoot activities, and discussion forums. Given the wide variety of didactic elements available, the professor, based on their experience and judgment, determines which are most effective in the teaching-learning process to be more precise about the advantages offered by some over others (Medina, Salinas & Vargas 2025).

In any case, the media system developed for a subject included in the teaching-learning process plan of a degree program offered by higher education presupposes the widespread adoption of hybrid (b-learning), virtual (e-learning), mobile (m-learning), and ubiquitous (u-learning)

learning models, without ignoring the advantages of traditional perception and its resources, which leads to greater use of technologies (Pelletier et al., 2021).

In this sense, the creation of new teaching media using ICTs, their impact on the classroom, and their function as facilitators of socially accepted content in the teaching of biological sciences must employ teaching-learning media that promote knowledge, in accordance with the four educational pillars as proposed by Cortes & Espinoza (2024): learning to learn, learning to know, learning to be, and feeling the nature of the living world around them. This aims for students, especially those being trained as professors of this science who will be responsible for instilling in their students the pillar of living together in harmony with nature.

In the search for elements corroborating the use of ICTs in Zoology teaching, current researches addressing this topic from various perspectives have been identified. Contemporary studies highlight the integration of digital platforms and educational software that enable the zoological content learning, emphasizing tools, such as Wooclap for teaching statistics applied to veterinary sciences, which has implications for Zoology (Coronel et al., 2025).

Also, there is growing interest in teacher training for the effective use of ICTs in natural sciences and the challenges related to technological infrastructure (Gutiérrez & Sono, 2025), as well as in the didactic strategies development incorporating multimedia and hypertextual resources to improve morphological understanding in Zoology (Bermúdez & Santos, 2025). These lines of research agree that ICTs enhance scientific learning, promoting interactivity and access to diversified didactic resources, consolidating themselves as an indispensable medium in current zoological training.

The authors of this research, after a perceptual factual analysis of educational practice, agree that infotechnologies are not used efficiently concerning the information that students from Biology major should have regarding marine mollusks from their local study, since Cienfuegos is a

province surrounded by the sea with an extraordinary diversity of marine mollusk species.

The practical deficiencies exposed, as well as the absence of theoretical proposals aimed at changing this gap, reveal the insufficient use of ICTs as teaching-learning media to address the treatment of malacological content from General Zoology I subject in the Bachelor's Degree in Education, Biology at the University of Cienfuegos.

These considerations led to the objective of developing a Website that promotes the strengthening of teaching-learning media for the treatment of malacological content in the General Zoology I subject in the Biology major at the University of Cienfuegos.

MATERIAL AND METHODS

The research was conducted in the Department of Natural Sciences, School of Agricultural Sciences, University of Cienfuegos «Carlos Rafael Rodríguez»; using a technological development plus validation study type, with a non-probabilistic intentional population and sample of 37 students in their third year of the Bachelor's Degree in Education, Biology, who receive General Zoology I subject. Among them, 14 are from the full-time course and 23 belong to the part-time course modality.

Regarding professors, seven graduates in Biology and Masters in Educational Sciences were used as population and sample. They are part of the faculty of the Department of Natural Sciences who have taught the program under study, an essential criterion for their intentional selection.

Theoretical, empirical, and descriptive statistical research methods were employed, which are presented below: at the theoretical level, the historical-logical method was used to delve into the background and evolution of teaching-learning media based on technological development itself, as well as to systematize the didactic references that have guided the design of the developed medium, allowing the determination of the main theoretical tendencies in the didactic design of the Website.

The combination of inductive-deductive and analytical-synthetic methods was used in the search for theoretical and empirical information, through which it was possible to reveal the existing regularities in teaching-learning media, as well as to determine the successes and limitations of teaching-learning media in the teaching-learning process of the subject General Zoology I.

They were also used in processing the data obtained from the opinions of professors and students about the research field, the criteria of specialists regarding the proposal, and the generalizing synthesis of the results on the object of this research.

Another method was descriptive statistics, employed in obtaining, organizing, presenting, and interpreting the results of surveys on teaching-learning media, as well as for processing the expert consultation.

Empirical methods enabled verifying the research insufficiencies and delving into the causes, as well as perceiving possible solutions that could satisfy existing needs.

Documentary analysis of specialized bibliography analyzed the different conceptions of teaching-learning media, as well as their performance in the teaching-learning process of General Zoology I subject.

It was also used to determine the content, tasks, and didactic alternatives of the proposed teaching-learning medium.

To complement the information provided by this method, structured surveys and interviews were conducted, as shown in Table 1, with a total of 7 professors with experience in the subject program and also with 37 students receiving General Zoology I subject.

Variables to study	**Instrument applied for data collection**
Use and availability of teaching media	Interview to professors
State of knowledge about local marine malacology in Cienfuegos	Survey to students and professors
Use of ICTs as novel teaching-learning media	Survey to professors
Validation of the Website as a teaching medium to strengthen the treatment of malacological content in General Zoology I subject	Expert surveys

Table 1: Analysis of variables used in data collection (Source: Own elaboration)

For the development of the Website, it was necessary to use the Object-Oriented Hypermedia Development Methodology (Sámano, 2021), considering four phases and different tools that provide better development, such as Sublime Text: a text editor and source code editor created in Python originally developed as a Vim extension; eventually it created its own identity, still retaining a vi-style editing mode called Vintage mode. Photoshop CS4 was used for photo editing and retouching, and HTML (HyperTextMarkupLanguage) was used as a markup language to add external elements to the page (images, videos, scripts).

These are not embedded directly into the page code, but rather a reference to the location of said element is made via text. In the material selection process, the authors' knowledge of the subject and specialists from CITMA were consulted to group the contents, photos, and images used.

RESULTS AND DISCUSSION

This research has been developed under the qualitative and descriptive paradigm, seeking a deep and contextualized understanding of the development of the Website as a teaching-learning medium for the General Zoology I subject.

The validity and reliability of the findings are based on the meticulous application of data collection and analysis techniques, ensuring that interpretations and conclusions emerge solidly and transparently through

the expert method. Based on a preliminary diagnosis, the lines of work for the Website's assembly were designed, in correspondence with the detected needs and the context's particularities.

Diagnosis	%	Arguments
Need for malacological studies in Cienfuegos to increase learning of General Zoology I content	100%	Necessary to identify them in their natural environment, know their main characteristics, better master their classification, self-prepare these topics for exams, and understand their importance, biodiversity, benefits, and harms
Teaching-learning media employed by the professor when teaching malacological content of General Zoology I subject	100%	Posters Textbooks Animals preserved in the laboratory
The class is more motivating and allows greater cognitive assimilation when using digital support teaching media	100%	Engaging Developmental

Table 2: Descriptive statistical analysis of the student diagnosis (Source: Own elaboration, 2025)

Diagnosis to professors	%	Arguments
Knowledge and use of any digital teaching-learning medium that could be employed for treating malacological content in Cienfuegos	100%	They express ignorance and the need to develop a Website on marine mollusk species existing in the bay and coasts of Cienfuegos province Necessary as a teaching-learning medium that encourages virtual study of marine mollusks in their surrounding environment Essential as a teaching-learning medium to be assumed as a support for the didactic model in the teacher-training context

Table 3: Descriptive statistical analysis of the diagnosis to professors (Source: Own elaboration, 2025)

The results of the diagnosis corroborated those students advocate for knowledge of marine mollusks in their locality and express their desire for computer applications that guarantee the above. This also allowed the determination of the following deficiencies:

- ✓ Students and some professors lack knowledge about the marine mollusks inhabiting Cienfuegos.
- ✓ The major leadership does not direct these studies virtually nor encourage them.
- ✓ No training is offered on this topic to professors teaching the program.

Among the potentialities for work development, the following can be cited:

- ✓ Professors' availability to develop the proposal.

Considering the results obtained after applying the instruments, the development of the Website «Marine Mollusks in Cienfuegos» is proposed to solve the stated objective.

In the Website's development, its distinctive features were considered, such as:

Composition and structuring: in this aspect, web pages stood out as the elements composing the Website. These are the fundamental units that, linked together, form the whole and are generally structured around an index page or «Home Page».

Intentionality: given by the objective to which the site is directed. This aspect differentiates one type of Website from another in the vast majority of cases.

Unity of content and form: determined by its visual appearance, i.e., the homogeneity of its design in close unity with the contents addressed.

Functionality: in this aspect, the role of navigation stood out first, its effectiveness given by the correct functioning of hyperlinks and ease of navigation, as well as how web page components and web services were used to make the best use of the site.

Interactivity: one of the aspects that gave functionality to the Website.

The «Marine Mollusks in Cienfuegos» Website responds to the strengthening of malacological content in the subject General Zoology I and, at the same time, offers the assimilation of this knowledge from the locality's point of view, as it focuses its criteria on marine malacology in Cienfuegos. In the process of developing this site, the authors began with decision-making, considering essential aspects, such as target audience, methodological alternatives that support it, student needs for addressing malacological content in General Zoology I subject, studies of local marine mollusks, among others. All topics mentioned in the subject's program were selected, and local studies of marine mollusks from the coasts and bay of Cienfuegos were added. The design stage consists of a detailed description of each part of the audiovisual product. The Website «Marine Mollusks in Cienfuegos» is a simple site offering a variety of components, including images, videos, and information on the Mollusk Phylum. It allows both students and professors to navigate, accessing information through links and options that complement the content, also addressing marine malacology in Cienfuegos. The graphic structure of the Website consists of a banner (Figure 1).

Figure 1: Banner, Website homepage, and modules (Source: Own elaboration, 2025)

Located at the top, a body, and a footer. The text format was determined: Verdana 15, automatic color, justified; Verdana for titles and subtitles of each description of the topics complemented in the product. The previous text format was chosen due to the study of technical web design requirements, considered essential aspects in a computer product as it

prevents visual fatigue with the help of the colors used to design the «Marine Mollusks in Cienfuegos» Website, as well as considering students' Psychopedagogical characteristics, a source of motivation regarding the study of malacology. The «Marine Mollusks in Cienfuegos» Website consists of a homepage, which is the main page of the Website, providing a brief description of the objectives to be fulfilled with the proposal. It also consists of seven modules: Historical Background of Mollusks, which collects data on the background of marine malacology in general. It includes historical elements of the first malacological studies conducted in Cienfuegos and the most prominent personalities (Figure 2).

Figure 2: Modules comprising the Website related to marine malacology in Cienfuegos. (Source: Own elaboration, 2025)

The module called Mollusks contains all the information regarding the distinctive characters of the Mollusk Phylum. It also includes the module Classes of the Mollusk Phylum with a detailed description of the characteristics that generally and specifically distinguish the classes Aplacophora, Monoplacophora, Polyplacophora, Scaphopoda, Pelecypoda, Gastropoda, and Cephalopoda. There is also the module Mollusks and Biodiversity, which includes some elements of Biodiversity in Cienfuegos, fundamentally those components that affect it, such as the presence of mollusks that constitute invasive exotic species. The Systematics module addresses a necessary explanation of systematics and contains the list of Marine Mollusks of Cuba, the list of Marine Mollusks of Cienfuegos, and the description of 150 species of marine mollusks existing in the bay or nearby

coastal areas. Finally, the exercises module allows students to didactically and enjoyably check the knowledge acquired on the site. The Image Gallery is a very extensive photo gallery closely related to each module. It includes videos related to the Mollusks and Biodiversity module.

Results of the expert evaluation of the Website

The proposal was submitted to evaluation by the expert criteria method before its application. Different aspects requiring consideration were analyzed; criteria about the indicators to be evaluated were compiled, and information was processed, restructuring certain ideas before their practical application. A group of professionals specialized in Educational Informatics and Biology were the experts selected to critically evaluate the teaching-learning medium.

Criteria to validate	Evaluation Percentage (%)	Expert considerations
1. Necessity of the site and correspondence with educational use	100%	The site is necessary for teaching malacological content in General Zoology I subject
2. Level of updating and rigor of the knowledge system	100%	Updated contents aligned with the subject's learning
3. Adequate motivation and fit for the target population	100%	Allows good motivation and preparation of students, especially by incorporating local study
4. Level of feedback and reinforcement achieved	Not specified	Varied content in texts and images enables feedback
5. Possibilities for treatment in other subjects	100%	Improves learning quality in different disciplines of the Biology-Geography major
6. Possibilities for improving pre-professional performance	100%	Contributes to improving pre-professional performance through practical use
7. Scientific and methodological value of the site	Not specified	High scientific and methodological value; recommended for application in other degree programs and universities

Table 4: Results of the qualitative evaluation conducted by Biology professors on the quality of the developed Website (Source: Own elaboration)

Results of the quantitative evaluation by specialists on the quality of the «Marine Mollusks in Cienfuegos» Website

The analysis of the results of the evaluations issued by the experts was performed using the values of the inverse of the normal distribution.

Indicators	**5**	**4**	**3**	**Sums**	**Average (A)**	**N-A**
1	-0,5244	0,5244	3,4900	3,4900	1,1633	0,2183
2	1,2815	3,4900	-	4,7715	1,5905	-0,2089
3	0,5244	3,4900	-	4,0144	1,3381	0,0435
4	0,0000	0,8416	3,4900	4,3316	1,4439	-0,0622
5	0,0000	0,8416	3,4900	4,3316	1,4439	-0,0622
6	0,0000	0,8416	3,4900	4,3316	1,4439	-0,0622
7	0,2533	3,4900	-	3,7433	1,2478	0,1339
Cutoff points	0,2193	1,9313	1,9943	29,0140		

Table 5: Inverse of the normal curve (Source: Own elaboration, 2025)

$$N = \frac{Total\ de\ la\ suma}{\text{indicadores} \cdot \text{categorías}} = \frac{29{,}014}{21} = 1{,}3816$$

For this other group of experts, the study by Shagñay (2025) on the criteria for evaluating the quality of computer resources was considered, proposing the macrocategories shown in the following table.

Criteria to evaluate	Evaluation Percentage (%)	Considerations
1. Access to the Website	100 %	Enables quick and easy access to basic, specific, and updated information on mollusks; use of visual resources improves understanding and abstraction
2. Identification and documentation resources	90 %	Tools that allow identifying and documenting species, strengthening validation and learning
3. Author identification	100 %	Authorship clearly indicated, providing confidence and transparency in the information
4. Author authority	100 %	The author has recognized authority and knowledge on the subject, increasing content credibility
5. Information, structure, and design	90 %	Content structured systemically, according to the General Zoology I program, enabling study and comprehension
6. Relevance of contents	100 %	Pertinent information covering key topics of the subject, such as background, characteristics, and systematics of mollusks
7. Validity of contents	100 %	Precise and balanced data corresponding to objective reality, adequate in quantity for correct understanding
8. Values underlying the contents	90 %	Promote scientific and educational values, fostering reflective learning and positive attitudes toward marine conservation
9. Surfing within the document	100%	Intuitive and fast surfing, accessible even on devices with few resources, facilitating direct access to specific variables
10. Quality of links	100%	Functional, updated links directed to reliable sources or complementary materials
11. Affective and aesthetic aspects	100%	Attractive and pleasant design, with good distribution, colors, and typography adequate to enable reading and user experience

Table 6: Results of the qualitative evaluation conducted by Educational Informatics specialists on the quality and relevance of the developed Website (Source: Own elaboration, 2025)

As a final result, criteria about the validity of the Website and a rating of very adequate and quite adequate in all indicators evaluated by the experts were obtained.

Its appearance is pleasant and attractive to users; the different elements containing information are equitably distributed; the interaction required of users is consistent with their level of development regarding computer knowledge, and colors and font sizes are used to ensure information reaches users as desired.

The Website has a high scientific level with satisfactory results. The criteria of the Biology professors value its updated content for class development, and the Informatics specialists consider it has adequate technical value and aesthetics. It can be extended to other content related to the General Zoology I subject.

Evidently, the results obtained from the external evaluators' assessment theoretically guarantee the quality of the proposal and reaffirm the value of the conception on which its development is based.

The developed Website constitutes a set of logically interconnected web pages managed as a single entity, which does not differ from what is expressed by other authors.

CONCLUSIONS

With the development of the Website as a teaching-learning medium, the treatment of malacological content in the General Zoology I subject in the Bachelor's Degree in Education, Biology at the University of Cienfuegos is strengthened, based on the methodological alternatives that support it. The evaluation conducted by experts on the developed Website was satisfactory. The results achieved with the implementation of the «Marine Mollusks in Cienfuegos» Website in 2024-2025 and the evaluation by professors and students of the Biology major confirm its effectiveness and contribution to the knowledge of malacological content from local studies.

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