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ORIGINAL

Edublog for teaching mathematical modeling in ecology

Edublog para la enseñanza de la modelación matemática en ecología

Grecia Yareny Pérez Mar[1], Armando Cervantes Sandoval[1], Patricia Rivera García[1], Alejandro Josué Perales Avila[1]

[1]FES Zaragoza, Laboratorio de Aplicaciones Computacionales. Ciudad de México, México.

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Corresponding Author: Grecia Yareny Pérez Mar

ABSTRACT

Given the limited number of interactive educational resources for learning dynamic modelling in ecology, we seek to promote the use of Vensim software in the Quantitative Ecology course taught in the Biology degree program at FES Zaragoza. The objective was to develop an educational blog containing practical exercises solved step by step, covering from simple models to more complex ones, such as predator-prey models, management of aquatic systems and environmental processes. The exercises were addressed in a sequence that helps students understand ecological processes and strengthen their skills in mathematical modelling. The implementation of the edublog seeks, through step-by-step activities and simulations, to reinforce in students their ability to use modelling and simulation software tools, essential for their training in the area of quantitative ecology. The impact of the edublog was reviewed by applying a questionnaire to measure the clarity, relevance and usefulness of the content. Generating an academic support resource accessible at any time and from any place with an Internet connection, so that the student understands and applies the concepts of mathematical modeling from the perspective of technology-mediated self-learning.

Keywords: Edublog; Modeling; Vensim; Quantitative Ecology.

RESUMEN

Ante los pocos recursos educativos interactivos para el aprendizaje de la modelación dinámica en ecología, se busca promover el uso del software Vensim en el curso de Ecología Cuantitativa que se imparte en la carrera de Biología de la FES Zaragoza. El objetivo fue desarrollar un blog educativo que contiene ejercicios prácticos resueltos paso a paso, abarcando desde modelos simples, hasta otros más complejos, como los de presa-depredador, manejo de sistemas acuáticos y procesos ambientales. Los ejercicios se abordaron en una secuencia que permita ayudar a los estudiantes a entender los procesos ecológicos y fortalecer sus habilidades en la modelación matemática. La implementación del edublog busca, a través de las actividades y simulaciones paso a paso, reforzar en los estudiantes su capacidad para utilizar herramientas software de modelación y simulación, esenciales para su formación en el área de ecología cuantitativa. El impacto del edublog se revisó mediante la aplicación de un cuestionario, para medir la claridad, relevancia y utilidad del contenido. Logrando generar un recurso de apoyo académico accesible a cualquier hora y desde cualquier lugar con conexión a Internet, para que el estudiante comprenda y aplique los conceptos de modelación matemática desde la perspectiva del autoaprendizaje mediado por tecnología.

Palabras clave: Edublog; Modelación; Vensim; Ecología Cuantitativa.

INTRODUCTION

The Internet is useful not only for obtaining up-to-date information but also for producing information and creating environments for teacher-student interaction through various tools. It increases the opportunities for students to learn actively from home or at university, complementing face-to-face teaching.[1]

Incorporating Information and Communication Technologies (ICT) in educational processes is constantly creating new challenges in any area or level in a scenario torn between virtuality and face-to-face interaction to facilitate learning.[2] ICTs are developed from scientific advances in the fields of computing and telecommunications. They enable access to, production, processing, and communication of information presented in different codes (text, image, sound, etc.).[3]

Although the expression ICT was initially used to refer to all information and communication technologies, as well as educational technologies, more recently, the expression LKT has been used to refer to technologies that deal with learning and knowledge construction; the central idea of LKT is that both teachers and students can learn permanently outside educational institutions.[4]

TLC, technologies for learning and knowledge, is a concept that serves to identify technologies aimed at strengthening the teaching-learning process. This means that, through these technological mediations, the school promotes in students a constructive and responsible stance of criticism and analysis, disseminated or socialized through technologies of empowerment and participation (TEP), as these are the end of an educational process that is projected from the classroom to the social environment and that achieves the construction of collective knowledge of high impact.[5] An example of a CAT, due to the aforementioned characteristics of a TEP, is a blog or edublog.

A blog is a website created by one or more authors on which they periodically publish and share a series of articles, also called entries or "posts"[6] with other network users. Normally, each blog creator focuses on a specific topic.

In the educational field, blogs are called edublogs. Edublogs have a specific educational purpose and main objective of supporting the teaching-learning process.[7] In this case, the topic of interest for the elaboration of an edublog is dynamic modeling.

Systems dynamics is a computer simulation technique introduced initially by Jay W. Forrester of the Massachusetts Institute of Technology in the mid-1950s. Since the 1960s, the systems dynamics (SD) method has been widely used in many areas, such as economics, finance, environmental studies, healthcare, information technology, and biology.[8]

For this, it is recommended to successively integrate the different elements of ecosystem concepts into progressively more complex models, from the identification of components and the role of relationships to networks of interdependence.[9] To implement these concepts effectively, it is essential to have tools that allow these relationships to be translated into understandable and manageable models.

In this sense, Vensim is a graphic tool for creating simulation models that allow the conceptualization, documentation, simulation, analysis, and optimization of system dynamics models.[10] For its construction in the Vensim language, there are level variables, flow paths, auxiliary variables, constants, information lines, and delayed information lines. The combination of these elements can form a complex industrial model or an elementary model of a subsystem. The purpose of Vensim is to describe a real system in an imaginary model.[11]

METHOD

Selection of models: Eight dynamic models relevant to quantitative ecology were chosen, ranging from the prey-predator model to others related to intensive agriculture and business systems. These examples covered a variety of ecological dynamics and their impact on complex systems.

Development of examples: Each model was developed using Vensim software. The procedure included an introduction to the ecological context of each model, explanations of the mathematical equations involved, and a detailed step-by-step guide on how to build the model within the platform.

Implementation of an educational blog: The exercises were organized in an interactive edublog that facilitates students' access. The edublog provides textual content, simulations, and visual guides for each model.

Simulations and analysis: For each model, simulations were run with different scenarios and parameters. The results were analyzed to generate conclusions about the ecological dynamics and key interactions between the system's components.

Impact assessment: At the end of the edublog, students were administered a questionnaire to measure the clarity, relevance, and usefulness of the content. The responses were used to adjust and improve the resources provided.

DEVELOPMENT

This work began with the search for and selection of examples of dynamic modeling in ecology relevant to students of the Quantitative Ecology course. The models chosen included real-life situations, such as prey-predator interaction with prey saturation, the impact of intensive agriculture, and sustainable fishing.

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For each model, a context on the subject was provided, followed by an explanation of the equations involved, if necessary. Users could follow the development of each model through a step-by-step tutorial in Vensim. The explanations focused on key components of the software, such as the creation of state variables (stocks), flows, and relationships between elements.

The simulations in the Vensim software allowed us to observe the emergent behaviors of ecological systems under different conditions. Throughout the process, we analyzed the graphs' results, comparing the model's predictions with possible real ecological scenarios.

The edublog was designed to provide an accessible space where students and interested users could log in at any time and whenever needed, repeating the exercises and obtaining feedback through the questions and interactive activities. In addition, a Likert scale questionnaire was used to gather information on the students' experience and improve the design of the du blog.

RESULTS

Eight simulation models, including ecological systems and a social model, were developed. Each example was presented in a structured way (figure 1), allowing users to interact and learn in a progressive way.

The following models were created:

A prey-predator model with prey saturation (figure 2a).

A model with three stocks: two predators and one prey (figure 2b).

Mosquito model with four stocks (figure 2c).

Model of the effects of intensive agriculture (figure 2d).

Shrimp fishing model (figure 2e).

Toxin ingestion model (figure 2f).

Model of a pig study (figure 2g).

Innovative Companies model (figure 3).

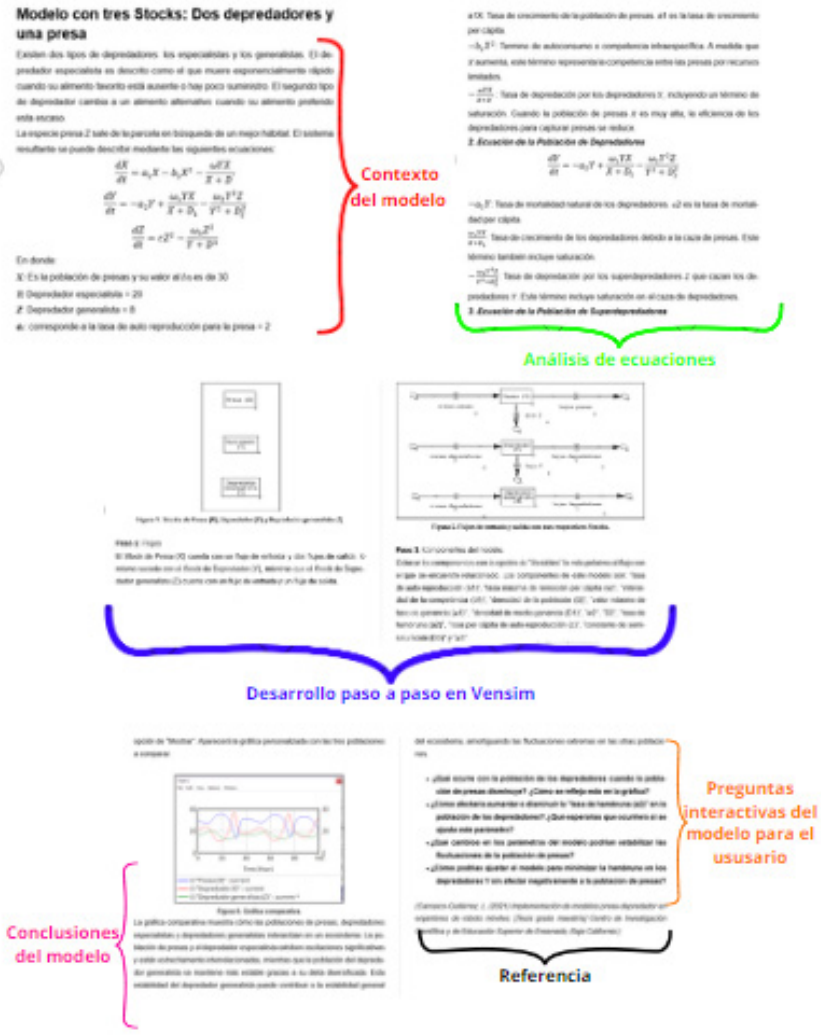

Figure 1. The structure of each example was: context of the model, equation analysis, step-by-step development in Vensim, model conclusions, and interactive model questions for the user

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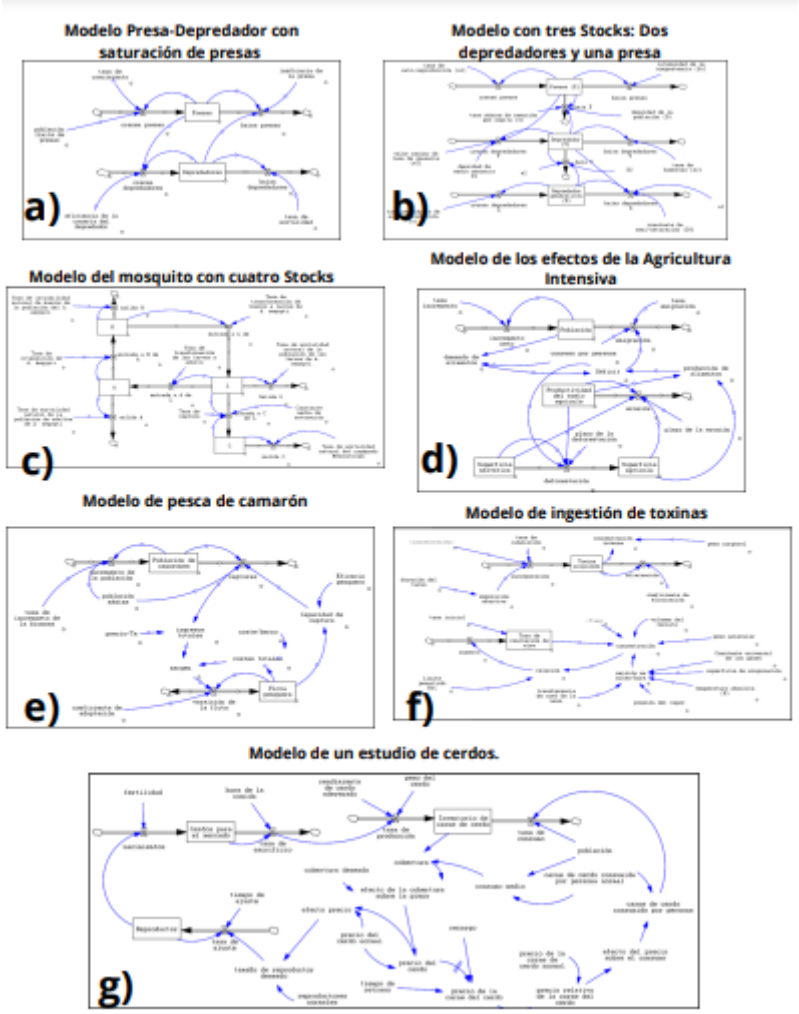

Figure 2. Modelos desarrollados

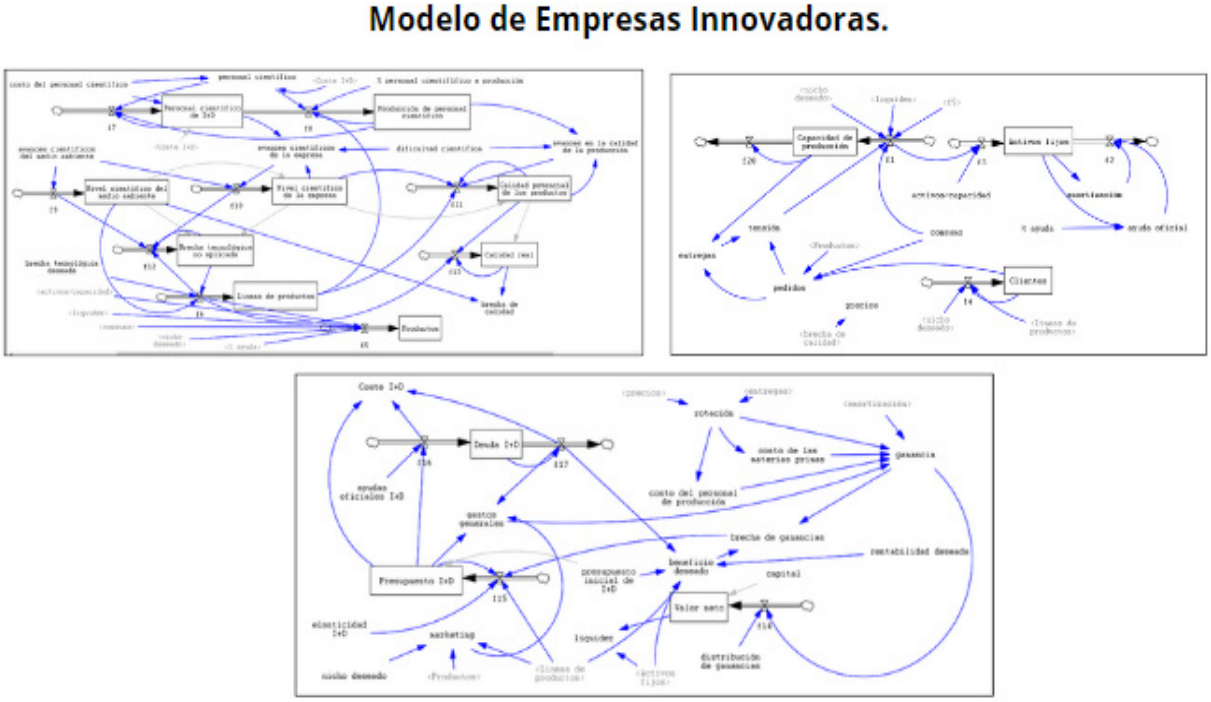

Figure 3. Diagrams that make up the Innovative Companies Model

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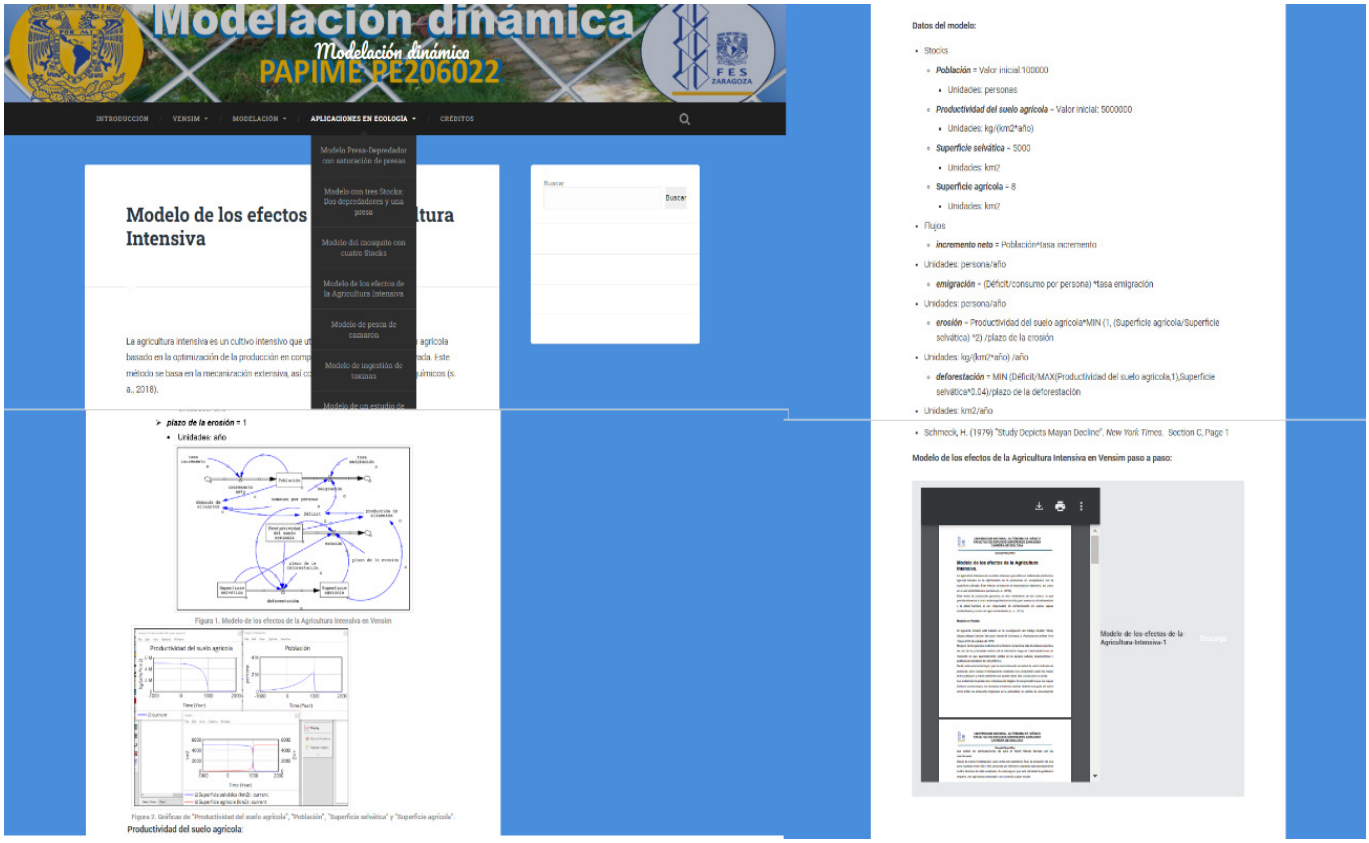

Figure 4. Interface of the edublog “Dynamic Modeling”. https://blogceta.zaragoza.unam.mx/modina/

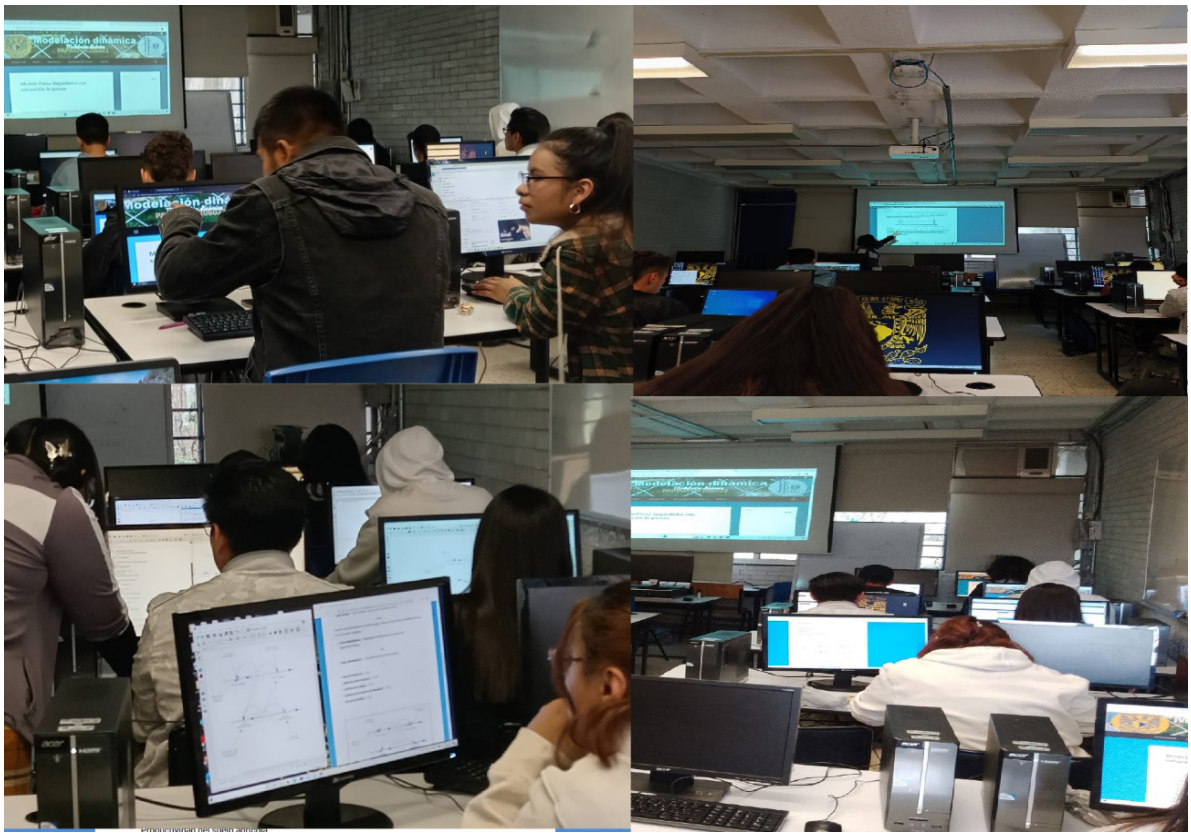

Figure 5. Presentation of the edublog to the Quantitative Ecology course at the FES Zaragoza

To find out the opinion of the students on the Quantitative Ecology course, a questionnaire was applied using a Likert scale, where the participants evaluated various aspects related to the usefulness and effectiveness of the dynamic modeling du blog. The scale ranged from “Strongly Disagree” to “Strongly Agree,” which provided

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a detailed insight into the students' perception of the accessibility, relevance, and impact of the edublog on their learning. The results reflect a largely positive opinion:

- Ease of use: 92,9 % of students consider the edublog easy to navigate.
- Relevance of the content: 92,8 % see it as a relevant tool for the course.
- The usefulness of examples and exercises: 78,6 % believe they help to understand dynamic modeling in ecology.
- Facilitation of using Vensim: 78,6 % say that the edublog helped them understand Vensim better.
- Understanding of concepts: 92,9 % feel the Edublog material reinforces the course concepts.
- Promotion of autonomous learning: 78,6 % indicated that the edublog encourages independent learning.
- Recommendation: 92,9 % would recommend the edublog to other students.

Additional comments: The students made constructive suggestions, such as including video tutorials, examples of common errors in Vensim and their solutions, and more group exercises. They also emphasized that the edublog is intuitive and helpful, although some pointed out that it could confuse those not previously introduced to the tool.

Figure 6. Results obtained from the questionnaire applied to students on the Quantitative Ecology course at the FES Zaragoza

DISCUSSION

The developed edublog has fulfilled its primary purpose of supporting learning in Quantitative Ecology through dynamic modeling with Vensim. Creating the edublog with examples of dynamic modeling in ecology allowed students to explore and understand complex concepts interactively and practically. During the development of the exercises, eight models were structured, covering real ecological situations and one social model, each with its respective context, equation analysis, and a step-by-step tutorial for implementation in Vensim. This work strategy not only facilitated the understanding of the modeled ecological systems but also allowed for the visualization of how the behavior of these systems emerged from the interactions between their

key components. The structure proposed for each model was well received by the students, as 92,9 % indicated that the platform is easy to navigate. This accessibility is crucial to ensure users can focus on the educational content without technical obstacles.

The fact that 92,8 % of the students consider the content of the edublog relevant to the course highlights the relevance of the examples chosen. This suggests that the models developed adequately cover the key concepts of the Quantitative Ecology course, facilitating a deeper understanding of ecological systems. However, despite the relevance of the content, 21,4 % of respondents expressed doubts about the usefulness of the examples and exercises in improving their understanding of dynamic modeling, which could indicate that specific models or activities require greater clarity or additional explanation. To find a possible solution, Howland JL et al.[12] recommend personalizing learning activities to address students' diverse learning styles, working strategies, and abilities using digital tools and resources.

Regarding the use of Vensim software, 78,6 % of students indicated that the edublog helped them better manage the tool, which suggests that the explanations provided on how to use the program are effective. However, some students indicated the need to include more details on possible errors and their solutions, which could help those facing specific technical difficulties, especially if they do not have direct support.

Another aspect that stands out is the promotion of autonomous learning. 78,6 % of students consider that the edublog has allowed them to learn more independently, which is a positive indicator for an online educational tool. This is also related to the fact that 92,9 % of respondents would recommend the edublog to other students, reinforcing its usefulness and perceived value in the academic environment.

Regarding the design and structure of the examples, the integration of a step-by-step guide made it easier for students to follow the development of the models without feeling overwhelmed, and the interactive questions at the end of each example encouraged critical thinking and the application of the concepts learned. However, student feedback suggested room for improvement, including common errors and their solutions and video tutorials to accompany the exercises. This feedback also reflected a demand for more interactive and detailed content, which could help those students who, as some mentioned, found the edublog confusing without a prior introduction to the tool.

CONCLUSIONS

The edublog has allowed students to interact more directly with dynamic simulation models, facilitating the visualization of ecological processes, understanding theoretical concepts, and connecting the two. The survey revealed that 92,9 % of students consider the platform easy to navigate, demonstrating its usability and accessibility as an educational tool. Furthermore, 78,6 % indicated that the edublog facilitated their use of the Vensim tool, reinforcing its efficiency for learning complex concepts. This practical and interactive approach has proven effective in enhancing the learning experience, allowing students to explore modeling concepts in ecology independently. In the future, incorporating students' comments and suggestions will further enrich the functionality and effectiveness of the edublog, consolidating it as a support resource for learning dynamic modeling in ecology.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.

Data curation: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.

Formal analysis: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.

Research: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.

Methodology: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.

Project administration: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.

Resources: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.

Software: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.

Supervision: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.

Validation: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.

Visualization: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.

Writing - original draft: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.

Writing - revision and editing: Grecia Yareny Pérez Mar, Armando Cervantes Sandoval, Patricia Rivera García, Alejandro Josué Perales Avila.