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ORIGINAL

Educational software supported by Artificial Intelligence techniques to strengthen teaching and learning in the subject of Programming I

Software educativo apoyado en técnicas de Inteligencia Artificial para el fortalecimiento de la enseñanza aprendizaje en la asignatura Programación I

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ABSTRACT

The research focused on the creation of an educational platform that offers interactive and personalized content, allowing the tool to adapt to the student's level, with the goal of optimizing the learning of key programming concepts. The type of research used was applied research, given that software was designed and built and implemented in a real-life public setting in a real-life educational context. A mixed-method experimental design was also employed, using quantitative and qualitative methods to evaluate both the numerical results of students' academic performance and the students' subjective perceptions and experiences when using the platform. NeuroCode was designed and built, with the support of artificial intelligence techniques, to improve teaching and learning in the Programming I course. This educational software includes an intelligent chatbot that provides real-time support to students, accurately resolving any questions they may have about programming concepts and/or logic problems. The chatbot adapts to the student's needs, providing personalized responses and helping to maintain uninterrupted learning continuity. In conclusion, the implementation of AI-based educational software is an effective tool for enhancing the teaching-learning process, as it provides students with a more interactive and efficient experience while also assisting teachers in their educational work.

Keywords: Educational Software; Artificial Intelligence; Computational Logic.

RESUMEN

La investigación se centró en la creación de una plataforma educativa que permite ofrecer un contenido que fuera interactivo y personalizado, a fin de que dicha herramienta pueda adaptarse al nivel del estudiante, con la meta de optimizar el aprendizaje de conceptos de programación que son considerados clave. El tipo de investigación que se usó fue la investigación aplicada, dado que se diseñó y construyó un software que se implementó en una situación pública real en un contexto educativo real. Asimismo, se empleó un diseño experimental con enfoque mixto, en el que se emplearon métodos cuantitativos y cualitativos a fin de evaluar tanto los resultados numéricos del rendimiento académico de los estudiantes, como las percepciones y experiencias subjetivas de los propios estudiantes al hacer uso de esta. NeuroCode fue diseñada y construida, con el apoyo de técnicas de inteligencia artificial, para mejorar la enseñanza y aprendizaje en la asignatura de programación I. Este software educativo incluye un chatbot inteligente que brinda soporte en tiempo real al estudiante, resolviendo las dudas que tengan sobre conceptos de programación y/o sobre problemas de

lógica de una forma precisa. Este se adapta a lo que el estudiante necesita, proporcionando respuestas personalizadas y ayudando a mantener la continuidad del aprendizaje sin interrupciones. En conclusión, y ayudando a mantener la continuidad del aprendizaje sin interrupciones. En conclusión, la implementación de un software educativo basado en IA constituye una herramienta efectiva para aumentar el proceso de enseñanza-aprendizaje ya que brinda a los estudiantes una experiencia más interactiva y eficiente al mismo tiempo ayuda también a los docentes en su labor educativa.

Palabras clave: Software Educativo; Inteligencia Artificial; Lógica Computacional.

INTRODUCTION

Despite the development of initiatives such as chatbots and self-learning, their implementation is still in its infancy, which results in low effectiveness and low acceptance (Acosta Bejarano, Organista Sánchez, & Sánchez Rodríguez, 2024). Similarly, (Alcántara, Pérez González, and Bueno García, 2024) state that dependence on technology can create inequalities in access to education, especially for those with fewer resources. The need for self-discipline and effort on the part of students is also a significant challenge. Despite the enrolment figures for self-learning courses, there is no data on dropout rates and academic performance, which suggests that there is still a long way to go before these tools reach their full potential in the educational sphere (Cabezas Sinaluisa, 2024).

Students who are at an early stage in the field of programming are, to a certain extent, overwhelmed by the demands of using textual languages, having to remember the instructions to be followed, the order to be followed, the specific instructions of each of the languages, the control words in English, etc. (Burgos Pérez & Velasco Guerrero, 2024). Likewise, (Castro Morales, Rodríguez Rodríguez, Molina Gullén, Bernal Álava, and Anzules Avila) state that this number of instructions overwhelms cognitive capacity and causes errors almost at the end of the whole process, which often limits the learning of these. However, (Chilan Carrasco, 2024) says that although it is theoretically possible to use tools such as PSeInt or similar ones, students usually consider them to be of little use since most of them are very literal and do not involve programming work in the laboratory.

The limited time invested in the course and the small number of students attending the course may make it impossible to delve deeper into the course and validate the results in general (Cucaita Murcia, 2023). In this sense, it is postulated that it would be interesting to transition towards visual programming environments that help to gradually transition towards textual languages in such a way that better and more adequate learning or development of computer skills is triggered (Da Cunha Lopes & Villalón Alejo, 2025).

Engineering students find it very difficult to study the subjects taught in the initial programming stage, including Algorithms, because of the complexity of the syntax and other introductory programming structures (Estrada Tangarife, 2024). Thus, (Fernández and Orellano, 2024) explain that traditional methodological methods, such as pencil and paper, are not very effective and are associated with high failure and dropout rates, reaching 53,8 % in some academic semesters. It has been proven that tools such as Scratch are practical as they improve the initial phase through block-based programming. Still, they are not exempt from limitations such as the inflexibility of the blocks and the non-appearance of syntax errors, which will complicate the transition to textual languages. All this shows that innovation in methodologies must be essential to help improve learning and dropout in programming (Florez Ospina, 2024).

Research is essential due to the high failure rates in the subject Logic and Algorithms I at the University of the Amazon, which has a failure rate of 67 %, as expressed by (Merlano, 2024). This failure rate affects student retention and increases the risk of dropout, which is a wake-up call for improving teaching techniques in the subject; in addition, students are also exposed to external factors that affect academic performance, such as emotional, family, and economic problems (Gómez Moncada, 2025). Along with a lack of knowledge in specific areas necessary and essential to Logic, Mathematics, and English (Castro Morales, Rodríguez Rodríguez, Molina Gullén, Bernal Álava, & Anzules Avila).

The series of obstacles, which added to a demotivation of 58,7 % due to the unattractive content and a pedagogical approach that they do not consider to be adjusted to their needs, give rise to the urgency of being able to develop innovative pedagogical strategies and comprehensive support (Lino Toala, 20225). Therefore, this research is essential to identify and develop methods that not only reduce failure rates but also help to increase students' interest and motivation in programming, thus improving their academic performance and retention at university (Londo Yuvaille, 2024).

NeuroCode's differentiating element lies in its particular work philosophy, which, when responding to a topic in an exercise, integrates audiovisual resources and interactive graphics and exercises that allow for the

consolidation of learning. This approach, which allows a unit of content to be given depth through reading and a practical exercise, is linked to a form of collaborative learning (connected) that makes the process more than just a personal exercise, creating a training proposal that is very attractive in its methodology.

METHOD

Type of research

The study is oriented around applied research, which allows the identification of needs, problems, or opportunities in a specific context whose solution is articulated through the use of the scientific method (Freitas Cardoso, 2024). In this environment, NeuroCode pursues a practical objective that aligns with resolving a practical problem, such as the difficulties in teaching Programming I based on designing and implementing an innovative educational platform. The aim is to produce valuable scientific knowledge that addresses the difficulties of learning programming in the classroom and that, in short, makes it possible to improve the education of students notably.

On the other hand, the experimental design is given by the fact that participants access an experimental group and a control group, so the uncontrolled variables are distributed probabilistically, reducing the variability according to the experimental conditions (Madrid Cardenas, 2025). NeuroCode is incorporated into this as an educational intervention to measure its impact on academic performance, understanding of concepts, and student motivation, comparing the results obtained between the groups that use the platform and those that use traditional methods.

Approach

The mixed research strategy combines quantitative and qualitative methods in the same research, and this approach is more comprehensive concerning the phenomenon. Generally, this type of research strategy is carried out through two phases of research, one quantitative with the collection of numerical data and the other qualitative with the collection of descriptive and subjective data (Ortiz Yumisaca, 2024). For the present study, the mixed research strategy will be used since the academic performance metrics extracted from the platform are considered quantitative data, and the opinions collected from students through surveys are considered qualitative data.

Development methodology

The choice of this methodology has been made according to the objectives that have been set, the existing resources and the characteristics of the project itself. In order for the tasks to be carried out correctly, with the appropriate distribution of resources, and even within the planned deadlines, it is necessary to choose an appropriate approach (Reyes Vega, 2024). The proposed methodology articulates structured and flexible practices that will allow for optimal management of the software development processes, which will allow us to ensure the quality of the deliverables and the satisfaction of the different stakeholders.

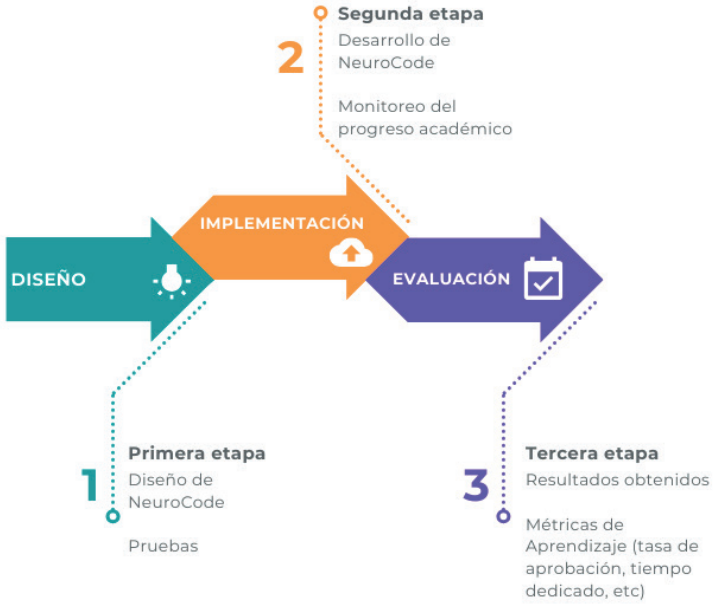

Figure 1. NeuroCode development methodology

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RESULTS

The present research aims to develop an innovative tool, combining the most modern technologies to provide a solution to very specific market needs. NeuroCode software aims to offer robust and scalable solutions, with an adequate alignment towards the highest quality standards, to satisfy the expectations of users and achieve long-term success.

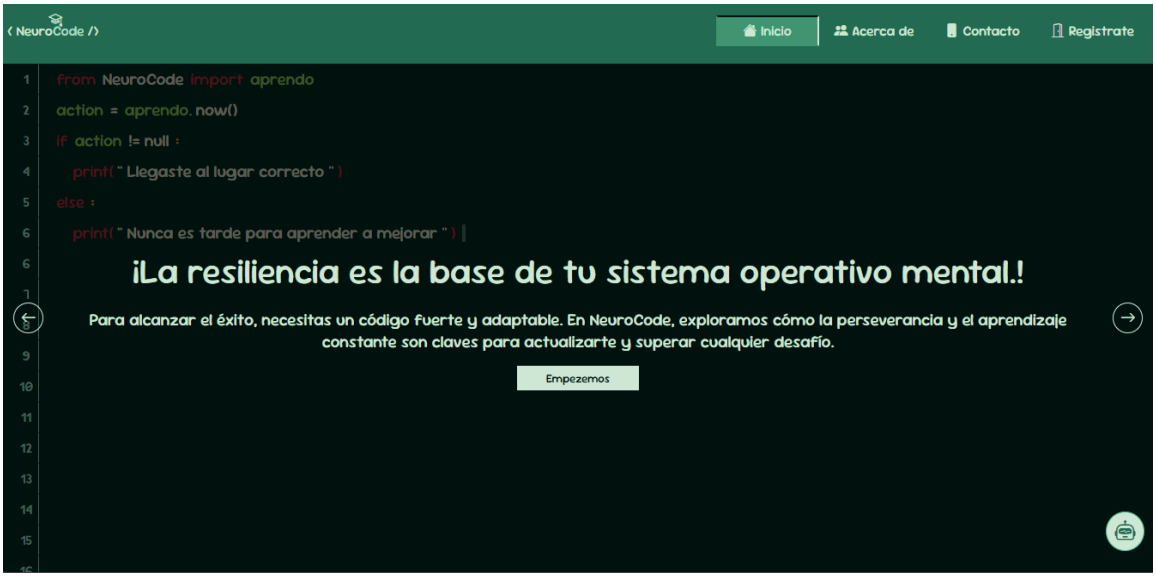

Figure 2. Main design NeuroCode

When the user enters the platform, they are presented with a screen that displays a message emphasizing the importance of resilience as a means for both personal and professional development. The fragment of the code that is displayed on the screen shows that the system uses programming with the aim of offering the user messages of motivational interest; these system messages are displayed as a function dependent on the action being carried out, spreading a positive message based on the importance of perseverance and continuous learning in order to overcome the difficulties that arise.

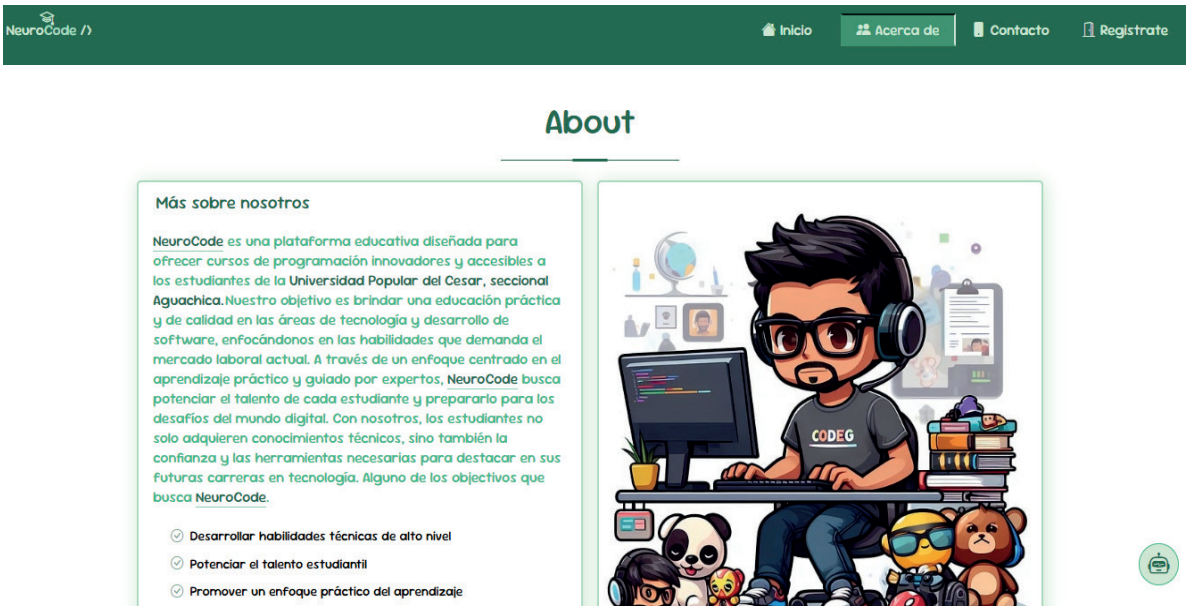

Figure 3. Important information NeuroCode

The software is framed as a platform that offers practical education of sufficient quality based on education in areas related to technology and software development, focusing on the subjects with the skills most in demand in the current job market. This platform aims, on the one hand, to develop the talent of the students, enhancing their high-level technical skills from a practical learning perspective; on the other hand, to highlight the importance of preparing students for the obstacles that the digital world poses, equipping them with the

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tools and knowledge to excel in their future careers in technology.

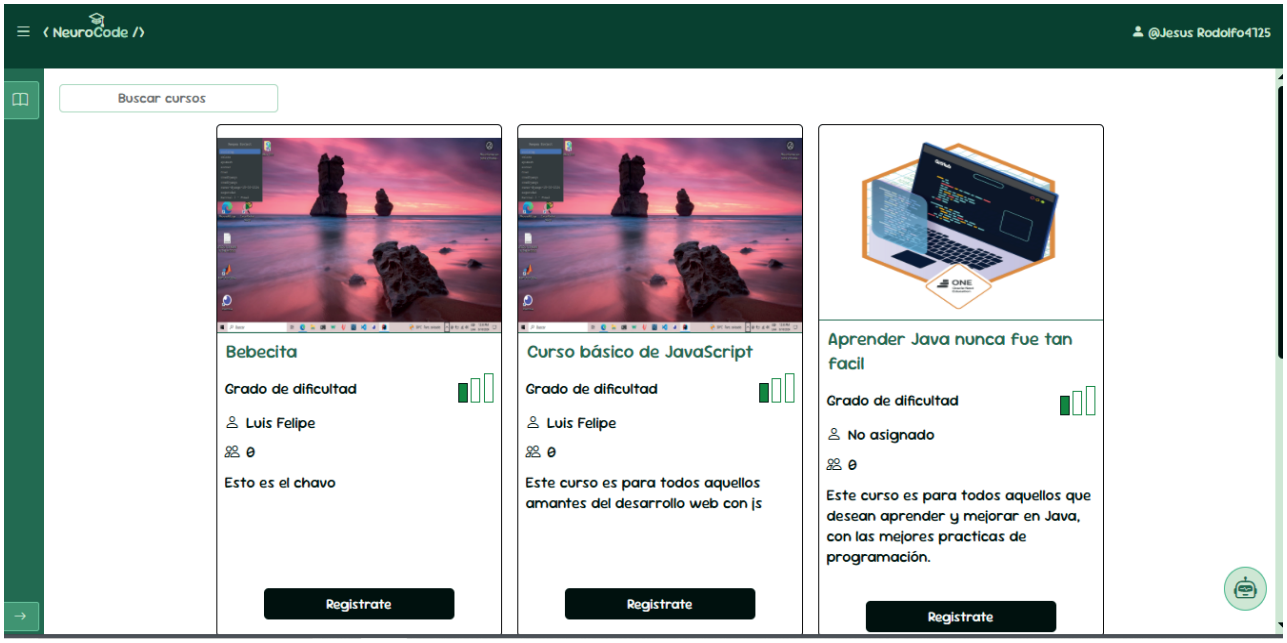

Figure 4. NeuroCode courses section

The image shows the NeuroCode interface, in the section on available courses. This section lists up to three courses that can be found on the platform, with a short descriptive text indicating the level of difficulty of the course. Each of the courses will have a registration button that will enable the student to access and register from the same platform. This interface aims to facilitate the discovery of and registration for the courses on offer, allowing students to choose options to improve their skills in a field related to programming.

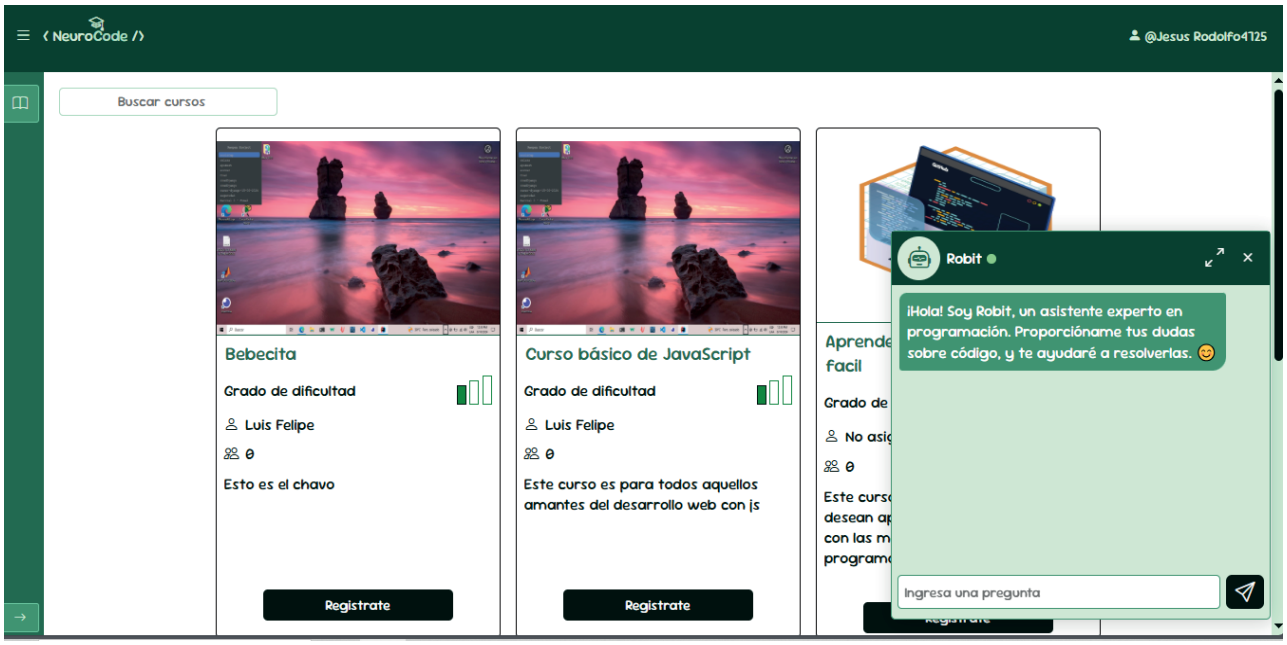

Figura 5. Chatbot de NeuroCode

The integration of the Rabit chatbot within the educational platform is of great importance, since it allows for the provision of instant, fast and accessible support for students, since, in this case, a virtual assistant can offer answers to the most common frequent questions that students have, guide the users of the platform and even offer instant explanations about the content that is being generated in the course. This means an improved student experience, as the student can get an answer without having to wait for the instructor or tutor to arrive.

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DISCUSSION

The design of an educational tool dedicated to enhancing the development of the teaching-learning processes of programming is proposed as a strategy that improves the quality and performance of the subjects' learning in the technology field. Thus, (Rodríguez Flores & Sánchez Trujillo, 2025) state that this educational tool can generate adaptive teaching-learning processes that consider students' needs and abilities by integrating artificial intelligence techniques. At the same time, (Ríos Badillo, 2024) says that this type of intelligence helps to feed solutions that offer content and support in generating exercises that vary according to how users perform and thus optimize study time and, therefore, school performance.

Finally, using a chatbot on the educational platform as a virtual assistant will allow questions to be answered in real time; that is, it will provide online assistance for students who need it. (Trujillo Beltrán & Chagüendo Azcarate, 2025) Explains that the assistant can guide users through programming problems, clarify concepts, provide examples, and collaborate with code debugging, promoting self-learning so that students can continue learning at their own pace and improving interaction in the educational process.

With the above, (Valderruten Blandón, 2024) considers that the use of artificial intelligence can also be rewarded in the optimization of educational resources since it allows in some way the automation of specific tasks, including the evaluation of exercises, the monitoring of progress, the tasks of identifying areas for improvement by students or even by educators themselves. Likewise, (Varela Suarez and Pertuz Sierra, 2023) explain that the importance of the operational load of educators can be reduced, which allows for adequate management of teaching, making it easier for educators to subsequently focus on offering personalized support in more complex tasks and on advancing in the development of more profound programming skills.

In this way, (Vásquez Molina & Viatela Bravo, 2024) the creation of AI-based educational software for teaching programming not only improves the interactivity and accessibility of the corresponding learning but also allows the teaching process to be personalized, thus optimizing the student's experience and increasing the chances of success in learning the necessary technological skills. On the other hand, (Zamora Hidalgo, 2024) says that including this technology also improves operational efficiency and allows for a more adaptive and practical educational approach.

CONCLUSIONS

Research into the development of educational software allows us to learn about innovations that meet the current demands of the education system. The research identifies the difficulties and limitations of the teaching-learning processes and, therefore, generates sufficient tools to contribute to improving the quality of education. It also improves teaching methods, updates pedagogical methods, and adjusts them to technological innovations supported in a digital environment.

The development of educational software and artificial intelligence is significant if we want to offer a personalized and effective form of learning. Thus, AI helps the software adapt to each student's pace and skill level while offering personalized solutions that optimize individual learning progress. In the same way, it allows repetitive tasks to be captured and carried out, tasks that prevent personalized attention to students. This provides trainers with better use of time for personalized attention or solving complex problems, improving the effectiveness of the educational process.

Implementing educational software with artificial intelligence in public universities is essential to promote democratizing access to quality educational resources. It manages to respond to the barriers to access to education, making it easier for students at public universities to use the advanced technology present in this type of research in their learning process, particularly in areas that tend to be fragile, such as programming and other highly technical areas. Consequently, it can help reduce educational inequalities, making it possible for more students to have a quality education regardless of their background or level of resources.

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CONFLICT OF INTEREST

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the results presented.

AUTHORSHIP CONTRIBUTION

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