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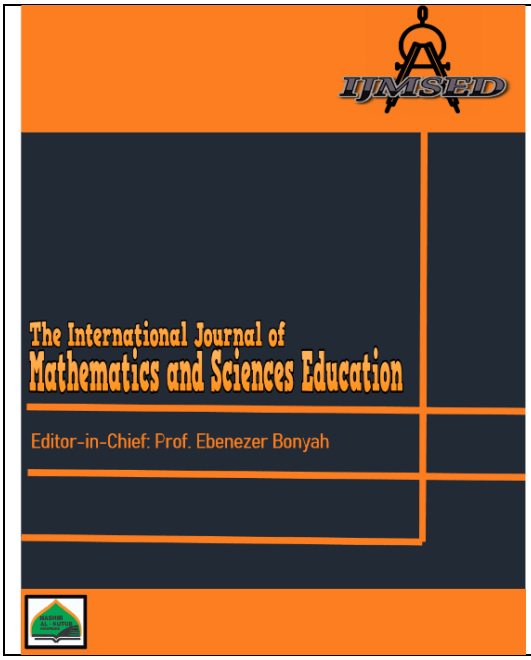

Bringing taxonomy to life: development of online learning tools for binomial nomenclature in high school

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Development of online media binomial nomenclature nomenclature in high school

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Abstract
Students often experience difficulties in understanding and memorizing the Latin-based binomial nomenclature due to the complexity and diversity of biological terms. This research aims to develop and assess the feasibility of an online media platform based on artificial intelligence and hosted via Blogspot for learning binomial nomenclature among high school students. The study employed a Research and Development (R&D) approach using the 4D model: Define, Design, Develop, and Disseminate. The product underwent expert validation by subject matter and media specialists, as well as limited and large-scale trials involving students from SMAN 2 Indramayu. Validation by material experts yielded an average score of 4.6, categorized as "very feasible," while media expert validation scored 4.0, deemed "feasible." Student responses indicated a positive reception with an average score of 73.33%, placing it in the “good” category. These findings suggest that the developed media is both practical and effective in enhancing student understanding of binomial nomenclature. The use of accessible digital platforms and integration of QR codes presents valuable implications for innovative biology instruction in the digital age.

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1. Introduction

Biology, as one of the fundamental branches of natural science, plays a pivotal role in advancing human understanding of life and its underlying processes (Roco & Bainbridge, 2002). It offers systematic knowledge about living organisms, encompassing their structure, function, growth, evolution, distribution, and interrelationships (Miller, 2016). Among the core elements of biological education is the field of taxonomy, the science of classifying organisms into a structured hierarchy based on shared characteristics and evolutionary lineage (Padial & De la Riva, 2021). Within taxonomy, the binomial nomenclature system introduced by Carl Linnaeus stands out as a revolutionary and enduring tool for scientifically naming organisms (Winston, J2018). Taxonomy not only provides a universal language for identifying and naming organisms but also serves as a foundational framework for understanding biodiversity and evolutionary relationships (Deans et al., 2012). Through the classification of species, students and researchers alike can trace phylogenetic lineages, recognize patterns of divergence and adaptation, and appreciate the intricate web of life that connects all living beings. Moreover, taxonomy underpins various applied fields such as conservation biology, ecology, agriculture, and medicine, where accurate identification of species is essential for sustainable practices and scientific innovation. The integration of modern technologies, such as molecular genetics and bioinformatics, has further refined taxonomic studies, enabling more precise classification and fostering deeper insights into the evolutionary dynamics of life on Earth (Biswas, 2023).

Binomial nomenclature assigns each species a unique, two-part Latin name consisting of a genus and a specific epithet, such as Homo sapiens for humans or Zea mays for maize. This system has not

only facilitated universal communication among scientists across cultures and languages but also established a consistent and stable method of identification in the biological sciences (Kirby, 2017). It underpins research in biodiversity, conservation, ecology, and medicine, and is considered a linguistic gateway to the biological world. Beyond its role in naming, binomial nomenclature serves as a critical tool in organizing biological information, supporting comparative studies, and linking scientific literature across disciplines. As taxonomy evolves with advances in genetic and molecular analysis, the binomial system remains a foundational reference point, bridging traditional morphological classification with modern phylogenetic insights (Hugenholtz et al., 2023). Its enduring relevance underscores the importance of standardized nomenclature in navigating the complexity and diversity of life forms.

Despite its global significance and foundational place in scientific literacy, binomial nomenclature remains one of the more abstract and challenging topics for high school students, especially in contexts where Latin is not commonly encountered (García-García et al., 2023). In Indonesia, for example, the teaching of taxonomy and nomenclature is part of the national curriculum in biology, particularly under topics like biodiversity, plant classification, and environmental science. Students are expected to not only comprehend the principles of biological classification but also apply them in identifying species, reading scientific texts, and participating in practical fieldwork.

However, numerous studies have indicated that students often struggle with mastering binomial nomenclature due to the unfamiliarity of Latin vocabulary, the lack of contextual reinforcement, and the limited availability of engaging learning resources. Research by Kurniawan et al. (2015) and Tsalatsatunnisa et al. (2018) reveals that learners experience difficulties in memorization, pronunciation, spelling, and application. These challenges are compounded by cognitive overload, as students are often introduced to large numbers of new scientific terms in short instructional periods, without the necessary scaffolding or real-world context to anchor their understanding.

Another major barrier lies in the dominant use of traditional pedagogical approaches, which often rely on rote memorization, static textbook illustrations, and teacher-centered instruction (Hoidn, S., & Reusser, K. (2020). These methods typically do not offer the interactivity, visual engagement, or personalization required to foster deep and meaningful learning (Sajja et al., 2025). In a rapidly changing educational environment where students are increasingly immersed in digital ecosystems—through social media, mobile apps, and multimedia platforms—the passive reception of information through printed texts may feel disconnected and demotivating.

Moreover, in biodiversity-rich countries like Indonesia, understanding scientific naming is not just a classroom exercise but a practical necessity. Indonesia is one of the world's megadiverse nations, home to thousands of endemic plant and animal species. Students need not only to learn names from books but to connect these names with the plants and animals they encounter in their environments. This connection is often missing in conventional instruction, which presents species from foreign contexts or provides no link to local biodiversity. As a result, the relevance of taxonomy to daily life is diminished, and its educational value weakened.

To bridge this gap between content and context, and between traditional and modern pedagogy, educators and researchers are increasingly exploring the potential of technology-enhanced learning (TEL). The integration of digital tools into biology instruction offers opportunities to create interactive, multimedia-rich, and learner-centered environments that can accommodate different learning styles and overcome the limitations of physical resources. Digital media can facilitate self-paced exploration, foster curiosity-driven inquiry, and promote student autonomy all of which are essential for mastering complex scientific concepts.

In recent years, several studies have demonstrated the promise of blogs, mobile applications, and digital games in enhancing science learning. Hutomo (2015) and Yulianto (2016), for instance, highlight the benefits of using blogs and smartphones as educational tools that support flexible and accessible learning, especially among high school students who are already familiar with these technologies. Blogs can function not just as static repositories of information but as interactive learning hubs—hosting text, images, video tutorials, quizzes, hyperlinks, and even QR codes that lead to further resources or field-based learning tasks.

Among the available platforms, Blogspot (now Blogger), a free and open-access blogging tool, has gained popularity due to its ease of use, customizability, and compatibility with mobile devices.

According to Zebua (2022), Blogspot has the capacity to integrate multiple media formats in a structured and pedagogically meaningful way. In the context of biology education, this allows teachers to present taxonomic material in ways that are both visually engaging and scientifically rigorous. For example, educators can embed photos of local plant species, videos on classification principles, and links to virtual herbariums directly into blog posts—providing learners with an enriched, multimodal learning experience.

However, despite the growing interest in such tools, there remains a notable lack of research-based, curriculum-aligned digital learning media specifically tailored to teaching binomial nomenclature in Indonesian schools. Most existing resources are fragmented, lacking in pedagogical coherence, or not contextualized to the Indonesian biodiversity framework. Furthermore, many have not undergone formal validation processes involving subject matter experts or field trials with students raising concerns about their instructional quality and educational impact.

This research addresses this critical gap by developing and validating a Blogspot-based online learning media designed specifically to enhance the teaching and learning of binomial nomenclature in high school biology. The media integrates curriculum-relevant content, interactive QR code features, visual and audio elements, and smartphone accessibility, all organized into a user-friendly blog interface. By leveraging these features, the platform aims to support students in learning scientific names more effectively helping them recognize, remember, and relate the names to real-life species. Importantly, the development process follows the 4D model (Define, Design, Develop, Disseminate) introduced by Thiagarajan et al., a widely used instructional design framework in educational research. This model ensures that media development is systematic, iterative, and evidence-based, beginning with a needs analysis, moving through design and expert validation, and culminating in field testing and dissemination.

The study not only evaluates the feasibility and usability of the developed media but also examines its pedagogical effectiveness through student responses. This dual focus ensures that the media is both scientifically accurate and engaging to learners. It also reflects a holistic approach to educational innovation, where technology is not introduced for its own sake, but as a deliberate response to clearly defined instructional challenges. Ultimately, the goal of this research is twofold: (1) to improve students' conceptual understanding and memorization of binomial nomenclature through a more interactive and contextually meaningful learning experience, and (2) to provide a scalable and replicable model for integrating low-cost, high-impact technology into biology education across Indonesia and other developing countries facing similar educational challenges.

2. Method

2.1 Research Design

This study utilized a Research and Development (R&D) approach, specifically following the 4D model developed by Thiagarajan (1974), which consists of four systematic stages:

a) Define: Conducted a needs analysis through interviews with biology teachers and students and curriculum analysis to identify learning problems in binomial nomenclature.
b) Design: Drafted the initial layout and content for the online learning media using Blogspot. Also prepared validation instruments.
c) Develop: Involved expert validation (media and subject matter), small-scale trials, and large-scale implementation.
d) Disseminate: The final product was disseminated on a limited scale after validation and revision.

2.2 Participants and samples

The population consisted of all Grade XI students at SMAN 2 Indramayu. Cluster random sampling was employed to select the sample. The participants included, two subject matter experts in biology, two media experts specializing in digital instructional media, 60 students who participated in limited and large-scale trials. One class was used for the small-scale trial and another for the large-scale trial.

2.3 Data Collection

Several instruments were used in the data collection process:

a. Expert Validation Sheets

Used by content and media experts. Example item: "Does the material align with the principles of binomial nomenclature?". Scored using a 5-point Likert scale.

b. Student Questionnaires
Administered after product trials. Example item: "This media helped me understand plant scientific names more easily." Composed of multiple-choice and Likert-type questions.

c. Structured Interviews
Conducted during the *Define* phase to identify teaching challenges and student needs.

d. Observation Sheets
Used during trials to evaluate usability, engagement, and technical barriers.

2.4 Data Analysis

The collected data were analyzed using quantitative descriptive techniques:

a. Expert Validation Scores, likert scale results were averaged and interpreted using predefined categories: Very Infeasible (1.0–1.8), Infeasible (1.9–2.6), Fair (2.7–3.4), Feasible (3.5–4.2), and Very Feasible (4.3–5.0)

b. Student Questionnaire Results
Analyzed using percentage formula:

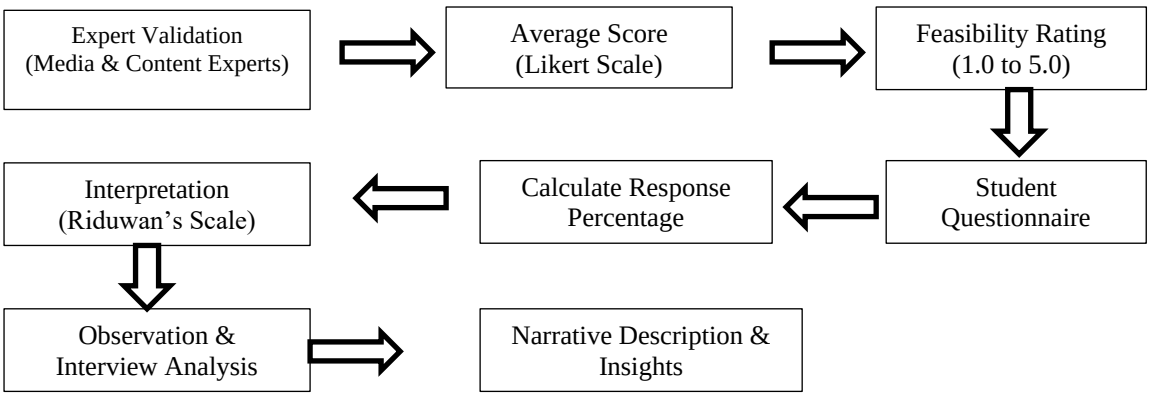
$$\text{Percentage} = \frac{\text{Total score}}{\text{Maximum possible score}}\ x\ 100\%$$

Interpretation based on Riduwan's scale: Very Poor (0–20%), Poor (21–40%), Fair (41–60%), Good (61–80%), and Excellent (81–100%).

c. Observation and Interview Data, narratively described to provide supporting context to the quantitative findings.

d. Data Analysis Flowchart
To provide a clearer overview of how the collected data were processed and interpreted throughout the research, the following flowchart illustrates the step-by-step procedures involved in the data analysis. This visual representation helps to demonstrate the logical sequence used in analyzing expert validations, student responses, and qualitative observations to determine the feasibility and effectiveness of the developed media (See Figure 1).

Figure 1
Data Analysis Flowchart



3. Results and Discussion

3.1 Results

This research followed the 4D development model consisting of four stages: Define, Design, Develop, and Disseminate. The results of each stage are presented below.

3.1.1 Define

In the define stage, a needs analysis was conducted through interviews with teachers and students at SMAN 2 Indramayu. The findings revealed that students had difficulty understanding and memorizing binomial nomenclature, primarily due to the complexity of Latin terminology and the vast

number of plant species. Teachers also expressed the need for innovative learning media that could be accessed easily and support independent learning. These findings confirmed the necessity of developing an interactive and accessible online learning tool to assist students in studying plant classification.

3.1.2 Design

Based on the results of the needs analysis, an online learning media platform was designed using Blogspot**.** The platform was structured to include key content on biodiversity and binomial nomenclature, supported by multimedia elements such as text, images, and videos. To enhance interactivity, QR codes were integrated, allowing students to access scientific information on various plant species instantly. The content was arranged according to scientific classification principles, with emphasis on accurate and engaging presentation.

3.1.3 Develop

This stage involved expert validation (content and media) and user testing (students) through small-scale and large-scale trials.

a. Content Expert Validation

Two subject matter experts assessed the content quality. As shown in Table 1, the average score was 4.6 on a scale of 5, placing the media in the "Very Feasible" category. Experts recommended revisions to the terminology and suggested using simpler, more communicative language.

Table 1
Content Expert Validation Results

Validator	Average Score
Subject Matter Expert 1	4.5
Subject Matter Expert 2	4.7
Overall Mean	4.6

b. Media Expert Validation

Two media experts evaluated the media design and usability. The average score was 4.13**,** categorized as "Feasible"**.** Suggestions for improvement included enhancing visual design, refining the formatting of scientific names, and improving ease of navigation to make the platform more user-friendly.

Table 2
Media Expert Validation Results

Validator	Average Score
Media Expert 1	4.0
Media Expert 2	4.25
Overall Mean	4.13

c. User Trial (Students)

User feedback was collected from student trials. The average percentage of positive responses was 73.33%**,** which falls into the "Good" category based on Riduwan's (2015) interpretation index. This result indicates that students found the media helpful, easy to use, and visually engaging.

Table 3
Student Response Summary

Evaluation Aspect	Percentage
Ease of use	72.33%
Visual appeal	74.33%
Content quality	73.33%
Overall Average	73.33%

3.1.4 Disseminate

The dissemination stage was carried out on a limited scale at SMAN 2 Indramayu. The developed online media was published via Blogspot and distributed to students using QR codes. While the product has not yet been broadly disseminated, it is considered ready for wider application. Future research is

recommended to expand the scope of materials, integrate more interactive features, and conduct trials with larger and more diverse samples.

3.2 Discussion

The development and implementation of online learning media for binomial nomenclature using the Blogspot platform has yielded valuable insights into the intersection of biology education and digital pedagogy. This study contributes to the ongoing discourse on how technology can support, enhance, and transform the teaching and learning of complex scientific content, particularly in the area of taxonomy—a traditionally challenging domain for high school learners. This discussion explores the findings from multiple dimensions: theoretical, pedagogical, cognitive, technological, and practical, while drawing connections to prior studies and identifying areas for future advancement.

Pedagogical Relevance of Binomial Nomenclature in Digital Format

Binomial nomenclature is a foundational concept in biological sciences, forming the basis for understanding the classification, naming, and identification of living organisms. Despite its centrality, students often find it difficult due to its use of Latin terminology, rigid structure, and lack of contextual grounding in many traditional classroom settings. According to Kurniawan et al. (2015) and Tsalatsatunnisa et al. (2018), students struggle not only with memorization but also with application, as the abstract nature of taxonomic categories often leads to disconnection from real-life biological phenomena.

The current study addresses this challenge by providing a blog-based digital learning environment designed to bridge the gap between theory and application. Through the use of multimedia elements (e.g., images, videos, links), the blog presents taxonomy content in a more digestible and interactive manner. This enhances conceptual understanding and supports differentiated instruction by allowing learners to revisit and engage with the content at their own pace and according to their own learning preferences.

Validity and Quality of the Developed Media

Validation results from both subject matter and media experts confirm that the blog-based media meets high standards of scientific accuracy and instructional effectiveness. The 4.6 mean score from content experts places the media in the “Very Feasible” category, suggesting strong content alignment with biological principles and curriculum requirements. Reviewers particularly noted the clarity of material presentation and the adherence to proper scientific conventions, though they suggested improvements in simplifying technical terms and increasing visual explanations.

These findings are in line with research by Putri & Ananda (2020), which emphasizes the critical role of instructional material quality in science learning. When content is delivered clearly, structured logically, and enriched with examples, students are more likely to engage with and internalize it. This is especially relevant in biology, where concept maps, classification charts, and structured naming systems are essential tools for cognition.

Constructivist, Connectivist, and Cognitive Learning Frameworks

From a theoretical standpoint, the media aligns well with the constructivist paradigm, which positions learners as active constructors of knowledge rather than passive recipients. By enabling students to interact with the content, access external sources via QR codes, and visualize organisms through multimedia, the blog supports experiential and contextual learning. This is essential in scientific subjects, where understanding is built not just on memorization but on making connections between concepts, categories, and real-world phenomena (Amri & Jafar, 2016).

In addition, this study embodies principles of connectivism, a theory proposed by George Siemens and Stephen Downes that focuses on the role of digital networks and external resources in modern learning. The use of QR codes in this study is a practical example of connectivist design-it allows learners to access up-to-date, peer-reviewed taxonomic data from trusted sources (such as scientific databases or herbarium collections) without being limited to a static textbook. Students become knowledge navigators, learning how to locate, evaluate, and apply external information to the task at hand.

Cognitively, the design of the media also addresses cognitive load theory by managing the amount of information presented and supporting learning through visual, auditory, and textual modalities. According to Mayer’s Cognitive Theory of Multimedia Learning, well-designed multimedia that

integrates relevant images and succinct verbal explanations reduces extraneous load and enhances germane processing, thereby improving learning efficiency. By minimizing distractions and focusing student attention on key ideas (e.g., genus-species structure, naming rules, classification examples), the blog facilitates deeper understanding.

Technological Integration and Student Engagement

The media expert validation score of 4.13, categorized as "Feasible," suggests that the design and usability of the blog were effective, though with room for refinement. Reviewers suggested clearer formatting of scientific names, consistent capitalization, and better visual layout-all critical elements in building a smooth and professional user experience. These findings echo the work of Lestari & Rahayu (2023) and Hutomo (2015), who emphasized the importance of coherent media structure, readability, and navigation ease in digital learning environments.

Perhaps one of the most significant findings was the positive student response (73.33%), indicating that learners found the media enjoyable, accessible, and supportive of their understanding. In a context where attention span and motivation are often limited—especially in abstract topics like binomial nomenclature—student approval is a crucial metric. As Zebua (2022) and Yulianto (2016) noted, blogs and smartphones are increasingly popular learning tools among students due to their flexibility, portability, and interactivity.

By integrating these tools in a structured, curriculum-aligned platform, the current study not only leverages existing student behavior (e.g., high smartphone usage) but also guides it toward educational goals. The blog acts as both a content delivery system and a learning management environment, supporting asynchronous learning, independent study, and access to supplementary resources.

Digital Literacy, Equity, and Accessibility

While the results are promising, it is important to acknowledge that the success of such technology-based initiatives relies heavily on digital literacy among both students and teachers. As Lestari et al. (2021) point out, digital tools cannot replace pedagogical quality unless users are adequately trained to maximize their potential. Future implementation of the developed media should be accompanied by professional development for teachers and digital literacy programs for students to ensure effective use.

Additionally, while blog platforms like Blogspot are free and widely accessible, there remain questions about equity of access, especially in schools with limited internet infrastructure or in rural areas. Ensuring that the digital divide does not exacerbate educational inequality is a major concern in the shift toward blended and online learning. Offline versions of the blog (e.g., downloadable HTML packages or USB-based learning kits) could be explored as inclusive alternatives.

Implications for Educational Practice and Policy

The success of this media highlights broader implications for science education reform. First, it demonstrates that simple, low-cost digital tools can make a measurable difference in student learning. The accessibility of Blogspot, combined with free image and video hosting, allows teachers and researchers to create robust learning experiences without institutional-level funding or infrastructure.

Second, the blog's modular design offers scalability and adaptability. Additional modules could be created for other topics in biology, such as cellular structure, genetics, evolution, or ecology. The current format could also be adapted to other disciplines, including chemistry (e.g., periodic table visualization), physics (e.g., simulations of motion), or environmental science (e.g., virtual field trips).

For educational policymakers, this study reinforces the importance of supporting teacher-led innovation and open educational resource (OER) development. Encouraging teachers to develop and share media through platforms like Blogspot or institutional repositories could lead to a wider culture of collaborative material creation and pedagogical experimentation.

Limitations and Future Research Directions

Despite its contributions, the study has several limitations. The development and testing of the media were limited to one school and a relatively small student sample. As such, the generalizability of the findings is constrained. Moreover, the assessment relied primarily on perception-based instruments (questionnaires and expert validation), without direct measurement of student learning outcomes or retention over time.

Future research could address these limitations by:

a. Conducting experimental studies to compare learning outcomes between students who use the media and those who do not.

b. Expanding the implementation to multiple schools and diverse student populations.
c. Incorporating longitudinal tracking to assess whether the media leads to sustained improvement in biology performance.
d. Exploring integration with augmented reality (AR) or gamification to increase engagement further.
e. Including teacher perspectives on the media's usability and instructional fit.

Additionally, developing a mobile application version of the media or integrating it with Learning Management Systems (LMS) like Moodle or Google Classroom could enhance its compatibility with school-wide digital ecosystems.

4. Conclusion

This study aimed to develop and evaluate a blog-based online learning media for teaching binomial nomenclature in high school biology. Based on the 4D development model (Define, Design, Develop, Disseminate), the research process produced a digital instructional product that is both feasible and effective according to expert evaluations and student feedback. Validation by content experts yielded a very high average score (4.6), indicating that the instructional material is scientifically accurate, well-structured, and suitable for classroom use. Media experts also rated the platform positively (mean score 4.13), recognizing its visual appeal, accessibility, and potential for enhancing independent learning, though minor revisions were suggested. Moreover, students responded positively during trials, with a satisfaction rate of 73.33%, categorized as "Good," affirming that the media was engaging, accessible via smartphones, and helpful for understanding the complexity of binomial nomenclature.

These findings confirm that integrating digital tools such as blogs and QR codes can significantly enhance the teaching of abstract biological concepts. The blog-based media effectively supports constructivist and connectivist learning by enabling interactive, student-centered, and networked learning experiences. It also promotes accessibility and flexibility, making it a practical and scalable solution for modern classrooms.

However, the study also recognizes limitations in sample size and scope of content, suggesting the need for further development, broader testing, and potential integration with interactive and adaptive technologies. In conclusion, the developed online learning media represents a valuable innovation for biology education, particularly in teaching taxonomy and binomial nomenclature. It offers an accessible, engaging, and pedagogically sound solution that can be expanded and adapted to support 21st-century science learning.

Author Contribution

Author 1: Conceptualization, Writing - Original Draft, Editing and Visualization;
Author 2: Writing - Review & Editing, Formal analysis, and Methodology;
Author 3: Validation and Supervision

Conflict of Interest

The authors declare no conflict of interest.

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