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Enhancing Maritime Education: An Evaluation of Teaching Strategies Through MCDM-AHP and TOPSIS

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ABSTRACT

This study evaluated the effectiveness and preferences of teaching strategies in maritime education by identifying and analyzing key criteria using Multi-Criteria Decision Making (MCDM) methods. Through a mixed-methods approach, the Analytic Hierarchy Process (AHP) was employed to determine the relative importance of criteria such as Learning Objectives, Learner Characteristics, Content Characteristics, and Technological Resources. Results revealed that Learning Objectives ranked as the highest-weighted criterion, with Skill Development, Critical Thinking, and Knowledge Acquisition emerging as the most important sub-criteria. Additionally, the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) was used to rank preferred teaching strategies. Practical Training was found to be the most preferred strategy, followed by Simulation and Case Studies, while Lecture received the lowest rank. These findings suggest a growing emphasis on experiential, competency-based, and student-centered approaches in maritime instruction.

1. Introduction.

In the evolving landscape of higher education, effective teaching strategies remain a cornerstone of quality instruction especially in specialized and highly technical fields such as maritime education. As the maritime industry increasingly aligns with international standards and rapidly advancing technologies, there is a growing demand for the effective and engaging delivery of subject content through innovative, student-centered approaches. Teaching in maritime programs requires not only mastery of specialized content but also the strategic use of methods that address diverse learner characteristics, available technological resources, and industry-aligned practical competencies.

Globally, research has identified several teaching strategies that significantly enhance student learning. Abulhul (2021) highlighted the effectiveness of short lectures to sustain attention, brainstorming to promote collaboration, group reports to reinforce academic writing, technology-based activities to develop self-directed learning, and PowerPoint presentations for content review. Similarly, Han (2021) emphasized that strategies such as feedback, scaffolding, and active learning positively influence both student engagement and teachers' self-concept. In the Philippine context, Magsucang et al. (2020) found that teaching strategies significantly affected students' attention, motivation, and class participation, with technology integration showing particular effectiveness. Likewise, Solatorio (2024) revealed a strong correlation between the diversity of strategies employed and overall teaching effectiveness among elementary teachers in Davao City. These findings collectively affirm the value of varied and responsive teaching methods in fostering educational outcomes.

Despite this wealth of literature, few studies have quantitatively assessed the prioritization of teaching strategies using structured decision-making tools particularly within maritime education. The complexity of instructional design in this field demands more than anecdotal or descriptive evaluation; it requires a rigorous framework that can guide educators in selecting strategies based on clearly defined, interrelated cri-

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teria. Addressing this gap, the present study employs Multi-Criteria Decision-Making (MCDM) methods specifically the Analytic Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) within the Saaty(1980) framework. These methods allow for a systematic evaluation of teaching strategies by weighing and ranking them against critical instructional criteria.

Using a descriptive mixed methods approach, this study begins with a comprehensive literature review to identify the main criteria and sub-criteria relevant to teaching in maritime education. These criteria are evaluated through AHP to determine their relative importance, followed by the application of TOPSIS to identify the most preferred teaching strategies based on aggregated criteria scores. The participants of this study are maritime educators from selected higher education institutions in Cebu City, whose judgments and insights serve as the foundation for the MCDM analysis.

Specifically, the study aims to identify the main criteria and sub-criteria to be considered when teaching maritime education, as identified through a comprehensive literature review. Additionally, it seeks to determine which main criterion is considered the most important in maritime education, as assessed using the Analytic Hierarchy Process (AHP), as well as which sub-criterion holds the greatest significance. The study also aims to identify which teaching strategies receive the highest weighted score when considering all criteria, as evaluated using the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS).By integrating quantitative tools into pedagogical evaluation, this research aims to generate a more structured and data-driven understanding of effective teaching strategies in maritime education ultimately supporting continuous instructional improvement aligned with global maritime standards.

2. Research Objectives.

2.1. Which main criterion is considered the most important in teaching maritime education as determined by the Analytic Hierarchy Process (AHP)?

2.2. Which sub-criterion is considered the most important in teaching maritime education as determined by the Analytic Hierarchy Process (AHP)?

2.3. Which teaching strategies have the highest weighted score when considering all criteria among maritime educators, as evaluated using the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)?

3. Literature Review.

The educational framework for maritime studies emphasizes several critical dimensions to ensure comprehensive learning outcomes. At its core is the Educational Objectives dimension, which prioritizes the development of practical skills and critical thinking abilities. These competencies prepare learners to analyze, evaluate, and synthesize maritime information effectively (Vong & Kaewurai, 2017). Knowledge acquisition forms the foundation by ensuring students grasp essential maritime concepts (Taha, 2018), while skill development focuses on enhancing hands-on competencies (James et al., 2014). Equally important is fostering critical thinking, which is vital for addressing complex maritime challenges (Enciso et al., 2017). Promoting a Professional Attitude is also essential, as it nurtures ethical standards and expected behaviors within the maritime profession (Havold, 2000; Hu, 2017; Rayos & Borbon, 2022).

Integrating Learner Characteristics into maritime education is key to addressing diverse learning needs. Recognizing varied learning styles allows for more inclusive and effective engagement with educational content (Dunn & Griggs, 2000; Pashler, 2008; Landrum & McDuffie, 2010). Moreover, understanding students' prior knowledge enables instructors to tailor instruction to learners' existing competencies (Pallis & Ng, 2011; Cunningham, 2015; Lau & Ng, 2015). Student motivation and enthusiasm for maritime studies significantly influence engagement and learning outcomes (Cunningham, 2015; Laguador, 2019; Melovic et al., 2022), while acknowledging diversity supports an inclusive and equitable learning environment (Du Plessis & Bisschoff, 2007; Gordon et al., 2010; Cole et al., 2011).

Content Characteristics are also central to effective maritime instruction. Educational content must strike a balance between complexity and learners' cognitive levels (De Agua et al., 2020; Gaspar, 2013; Patriarca & Bergstrom, 2017), while covering a comprehensive yet focused scope of maritime topics (Farrell, 1998; Panayides & Song, 2013; Gissi & de Vivero, 2016). Ensuring the relevance of content to real-world maritime practices enhances preparedness for industry demands (Reiher & Hahn, 2021; Rokseth et al., 2018; Konon, 2022). Additionally, integrating interactivity and hands-on learning helps bridge theoretical knowledge with practical application (Alkhatib, 2018; Campbell & Blair, 2018; Loveys & Riggs, 2019).

The integration of Technological Resources is increasingly vital in modern maritime education. The use of digital platforms and tools supports flexible learning formats such as online and hybrid delivery (Pinto & Leite, 2020; Dudar et al., 2021; Josue et al., 2023). Reliable, accessible, and user-friendly technology is crucial for both educators and learners (Luck et al., 2003; Delgado et al., 2015; Ahmed & Sabyasachi, 2014). When effectively integrated with traditional pedagogies, technology enhances the overall learning experience and supports the translation of theory into practice (Singer & Maher, 2007; Harris, 2009; Bhasin, 2012). However, the reliability of technological infrastructure must be ensured, as technical issues can hinder the learning process (Bauer & Adams, 2012; Narayan, 2012).

Maritime education plays a pivotal role in preparing individuals for careers in the global shipping industry. The quality of instruction is significantly influenced by the teaching strategies employed. The ever-evolving nature of the maritime industry — marked by rapid technological progress and regulatory changes — demands continuous innovation in teaching methods (De la Peña et al., 2020; Prabowo et al., 2021; Westwood, 2018; Parsons et al., 2018; Mitchell & Sutherland, 2020). Educators must remain updated with industry trends and be equipped with instructional skills that bridge academic knowl-

edge with industry practices (Chico, 2018).

Various research studies highlight effective teaching strategies that improve student learning in maritime education. These include short lectures to retain student attention, brainstorming sessions to promote collaboration, and group reporting tasks to enhance academic writing (Abulhul, 2021). Technology-based activities, such as multimedia presentations, support content review and encourage self-directed learning (Abulhul, 2021). Strategies like feedback, scaffolding, and active learning have been shown to boost student engagement and foster positive teacher self-concept (Han, 2021). In the Philippine context, Magsucang et al. (2020) reported that using diverse teaching strategies enhanced students' attention, motivation, and participation, with technology integration being notably effective. Similarly, Solatorio (2024) found a strong correlation between the use of varied strategies and overall teaching effectiveness, emphasizing the need for flexible and adaptive approaches in maritime instruction.

4. Research Method.

4.1. Research Design.

The study employs a descriptive mixed-methods approach, which is particularly effective for understanding and explaining complex phenomena in educational settings (Creswell & Plano Clark, 2018). The descriptive mixed-methods design was chosen because the initial phase involves conducting a comprehensive literature review to identify key criteria and relevant evaluation factors in teaching strategies. This qualitative phase allows for a detailed exploration of the nuances, contexts, and perspectives that shape educators' preferences and practices (Kozleski, 2017; Maxwell, 2013). This foundational step aids in recognizing existing practices, gaps, and challenges in maritime education, which are essential for tailoring future strategies and interventions (Tashakkori & Teddlie, 2010).

As described by Vaismoradi et al. (2013), descriptive research focuses on interpreting and understanding current conditions, making it ideal for assessing the present state of teaching practices in maritime education. By offering a detailed account of these conditions, the study is able to provide a comprehensive overview of the criteria that influence teaching strategy decisions among maritime educators.

Additionally, the study integrates quantitative methods to provide a robust analysis of the data, particularly through Multi-Criteria Decision-Making (MCDM) methods. These methods, specifically the Analytic Hierarchy Process (AHP) (Saaty, 1980) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) (Hwang & Yoon, 1981), enable the quantification of the relative importance of various teaching criteria and rank their preference among maritime educators. By using MCDM methods, the study enhances its capacity to provide data-driven insights into the decision-making processes related to teaching strategies.

Data collection was done through a researcher-developed questionnaire, based on key criteria and sub-criteria identified during the literature review. The development of the questionnaire involved several steps, including adaptation to the local context and validation by a panel of five experts to ensure its face and content validity (Polit & Beck, 2006). To ensure reliability, the questionnaire was subjected to pilot testing, where the feedback from a smaller sample was used to assess its clarity and effectiveness (Nunnally & Bernstein, 1994). The expert panel's review confirmed the relevance and applicability of the identified strategies and criteria in the current educational context. After refining the questionnaire, it was pre-tested for clarity and reliability to ensure the accuracy of the data collected. Finally, the refined and validated questionnaire was distributed to maritime educators for data collection, allowing for a comprehensive analysis of their perspectives on teaching strategies.

This mixed-methods approach, combining qualitative insights with quantitative rigor, provides a comprehensive framework for understanding and evaluating teaching strategies in maritime education, offering valuable insights into the criteria that drive educational decisions in this field (Bryman, 2016; Johnson & Onwuegbuzie, 2004).

4.2. Respondents of the Study.

The respondents of this study were maritime educators from various maritime schools in Cebu City, Philippines. A total of 120 maritime Instructors participated in the survey, which was distributed online via Google Forms. The inclusion criteria for participation required that respondents be teachers currently employed at maritime schools in Cebu City and have at least one year of teaching experience in maritime education. This ensured that the participants had sufficient experience and familiarity with the maritime education system to provide relevant insights into the study's focus on teaching strategies.

For this study, a convenience sampling technique was employed. This method was chosen because it allowed for practical and efficient data collection from maritime educators who met the inclusion criteria. Educators who expressed an interest in participating and met the necessary requirements were invited to take part in the survey. As long as the individual was a teacher at a maritime school in Cebu City with at least one year of teaching experience, they were eligible to participate. This approach allowed flexibility in participant selection, ensuring a broad representation of educators from various maritime institutions in the region.

Although convenience sampling is efficient and well-suited to this study's scope, it is important to acknowledge that it may introduce some bias, as participants who are more willing or have more free time to participate might have different perspectives from those who did not engage. Nevertheless, the sample size of 120 respondents was deemed sufficient to provide reliable data, ensuring a diverse range of viewpoints from experienced maritime educators.

The online survey method facilitated the collection of data from a wide group of educators, ensuring accessibility and ease of participation. Respondents could complete the survey at their convenience, which helped in maximizing participation and reaching a larger sample. To further encourage diversity in responses, invitations were sent to maritime schools across Cebu City, ensuring that educators from various institutions had the opportunity to contribute to the study.

4.3. Research Instrument.

The data needed for the present research were drawn from a researcher made questionnaire and the key criteria and sub criteria came from the literature review. The research instruments were revised, contextualized to the local setting, and underwent face and content validation by a jury composed of five members. The questionnaire also underwent pilot testing to assess its reliability.

The survey is designed to evaluate the Educational Framework in teaching strategies when teaching maritime Education among the maritime educators. The questionnaire comprises three parts: Demographic Profile, Importance of Criteria and Sub-Criteria when Choosing Teaching Strategies (Pairwise Comparison Matrix), and the weights of all the criteria to be considered among the teaching strategies. The first part of the survey collects demographic information including the educator's name, age, gender, civil status, highest educational attainment, rank, length of teaching experience, length of onboard experience, and the subjects taught. This section aims to understand the background of the participants and their teaching contexts.

The second part focuses on the criteria and sub-criteria that educators consider important when choosing teaching strategies. Participants are asked to perform pairwise comparisons of various criteria, such as Educational Objectives, Learner Characteristics, Content Characteristics, and Technological Resources. Each criterion is defined to guide the participants in their decision-making process. For example, Educational Objectives emphasize skill development and critical thinking, while Learner Characteristics recognize diverse learning styles. Participants rate the importance of each pair using a numeric scale ranging from 1 (Equally preferred) to 9 (Extremely preferred).

In the final section, participants indicate their level of preference for different teaching strategies based on specific criteria. The teaching strategies include Lecture, Simulation, Practical Training, Case Studies, and Group Work. Each strategy is evaluated on criteria such as Knowledge Acquisition, Skill Development, Critical Thinking, Professional Attitude, Background Knowledge, Learning Styles, Motivation, Diversity, Complexity, Scope, Relevance, Interactivity, Availability, Usability, Integration, and Reliability. Participants rate each strategy using a five-point Likert scale (1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree).

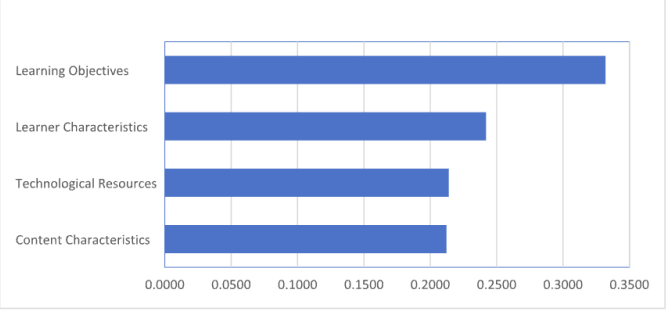
The research instrument was validated through face and content validation by a panel of five experts. The experts reviewed each item in the questionnaire, marking them as "Include," "Improve," or "Exclude." Items with an agreement ratio of 80% or higher were included in the final version, while those below 80% were excluded. Items marked as "Improve" were revised based on the panel's feedback.

For reliability, the instrument underwent pilot testing with 35 faculty members handling general education courses in Cebu City. A Cronbach's alpha test was conducted, with the following results: the main criteria (Educational Objectives, Learner Characteristics, Content Characteristics, and Technological Resources) had an alpha value of 0.721; the sub-criteria items for Lecture ($\alpha = 0.768$), Simulation ($\alpha = 0.842$), Practical Training ($\alpha = 0.890$), Case Studies ($\alpha = 0.874$), and Group Work ($\alpha = 0.859$) demonstrated good reliability, as all values were above the acceptable threshold of 0.70. Following pilot testing, the final version of the instrument was prepared and distributed to the target respondents.

5. Findings and Discussion.

RO2.1 Which main criterion is considered the most important in teaching maritime education as determined by the Analytic Hierarchy Process (AHP)?

Figure 1: Weights of the Decision Criteria.



Source: Authors.

The bar graph titled "Weights of the Decision Criteria" presents the relative importance of four key factors considered in instructional decision-making: Learning Objectives, Learner Characteristics, Technological Resources, and Content Characteristics. Among these, Learning Objectives received the highest weight (approximately 0.34), indicating that educators prioritize the alignment of teaching strategies with well-defined instructional goals. This finding aligns with Berk (2005), who emphasized that strategies such as short lectures, brainstorming sessions, and group reports are most effective when closely tied to clear learning objectives, as they help structure learning and clarify expectations for students. Learner Characteristics followed as the second most important factor (around 0.25), highlighting the importance of understanding students' backgrounds, learning styles, and individual needs. This is supported by a study from Pangasinan State University, which, as cited by Simonson et al. (2021), advocates for the integration of diverse teaching methods and technology to cater to varied learner profiles. Technological Resources and Content Characteristics received slightly lower weights (approximately 0.21 and 0.20, respectively), but their relevance remains significant. Jiang et al. (2024) emphasized that content quality and delivery enhanced by strategies such as active learning and timely feedback greatly influence student engagement and learning outcomes.

2.2. Which sub-criterion is considered the most important in teaching maritime education as determined by the Analytic Hierarchy Process (AHP)?

The table presents a detailed analysis of the relative importance of criteria and sub-criteria used in evaluating effective

Table 1: AHP criteria and sub-criteria weights and rankings (source table; no caption provided).

Criteria	Weight between the criteria (%)	Weight within the criteria (%)	Ranking within the criteria	Weight among sub criteria (%)	Overall ranking
Learner Objectives	0.3320				
Knowledge Acquisition		0.2596	3	0.0862	3
Skill Development		0.3083	1	0.1023	1
Critical Thinking		0.2829	2	0.0939	2
Professional Attitude		0.1492	4	0.0495	13
Learner Characteristics	0.2420				
Background Knowledge		0.2531	2	0.0612	6
Learning Styles		0.3185	1	0.0771	4
Motivation		0.2251	3	0.0545	9
Diversity		0.2033	4	0.0492	14
Content Characteristics	0.2122				
Complexity		0.2541	3	0.0539	.10
Scope		0.2638	1	0.0560	7
Relevance		0.2188	4	0.0464	16
Interactivity		0.2633	2	0.0559	8
Technological Resources	0.2139				
Availability		0.2201	4	0.0471	15
Usability		0.2437	2	0.0521	11
Integration		0.2377	3	0.0508	12
Reliability		0.2985	1	0.0638	5

Source: Authors.

teaching strategies. Among the main criteria, *Learning Objectives* received the highest overall weight at 33.20%, signifying its central role in instructional decision-making. Within this criterion, Skill Development emerged as the most critical sub-criterion with the highest weight (10.23%), followed by Critical Thinking (9.39%), Knowledge Acquisition (8.62%), and Professional Attitude (4.95%). These findings emphasize that maritime educators and decision-makers highly value the cultivation of practical skills and higher-order thinking abilities among students. This is consistent with Berk (2005), who asserted that aligning teaching strategies with clear and well-articulated learning objectives—such as fostering analytical skills through group reports, short lectures, and brainstorming—leads to improved student performance and engagement.

The second most important main criterion was Learner Characteristics at 24.20%. The most significant sub-criterion under this category was Learning Styles (7.71%), followed by Background Knowledge (6.12%), Motivation (5.45%), and Diversity (4.92%). These findings underscore the necessity of understanding and adapting to the diverse needs and preferences of learners. Simonson et al. (2021), in a study conducted at Pangasinan State University, highlighted the importance of recognizing individual learner profiles and recommended the use of diverse teaching methods and technology integration to meet student variability—strongly supporting the prioritization of learning styles and prior knowledge in instructional design.

Technological Resources and Content Characteristics were closely weighted at 21.39% and 21.22%, respectively. In the Technological Resources category, Reliability (6.38%) ranked as the most critical sub-criterion, followed by Usability (5.21%), Integration (5.08%), and Availability (4.71%). This reveals that educators prioritize dependable and user-friendly technology that can be seamlessly integrated into the teaching-learning process. This aligns with findings by Elumalai et al. (2020), who reported that reliable and user-friendly digital tools are essential for fostering student engagement and improving learning outcomes in online and hybrid environments.

Meanwhile, in the Content Characteristics category, Scope (5.60%) and Interactivity (5.59%) were the top sub-criteria, followed closely by Complexity (5.39%) and Relevance (4.64%). These results highlight that educators value content that is well-structured, interactive, and appropriately challenging. According to Jiang et al. (2024), content that encourages active learning and provides real-world relevance enhances student motivation and comprehension. Feedback and student engagement strategies were found to be especially effective in making content more interactive and meaningful.

2.3. Which teaching strategies have the highest weighted score when considering all criteria among maritime educators, as evaluated using the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)?

Table 2: TOPSIS preferred teaching strategies, relative closeness coefficients, and rankings (source table; no caption provided).

Preferred Teaching Strategies	Relative closeness coefficient (Ic)	Rank
Lecture	0.0910	5
Simulation	0.7298	2
Practical Training	0.7769	1
Case Studies	0.6958	3
Group Work	0.6815	4

Source: Authors.

The TOPSIS analysis on preferred teaching strategies among maritime educators reveals that Practical Training received the highest relative closeness coefficient (I_c = 0.7769), making it the most preferred strategy. This reflects the industry's emphasis on hands-on experience and the development of real-world competencies essential for shipboard readiness and operational safety. Supporting this, Eida Sison (2020) highlights the need to enhance curriculum practices in maritime education through more practical, competency-based approaches that mirror the demands of the global maritime industry. Simulation ranks second (I_c = 0.7298), reinforcing the value of technology-aided training that replicates shipboard scenarios in a controlled environment, as advocated by the International Maritime Organization (IMO) and studies like those by Yao et al. (2023), which found that simulation significantly enhances decision-making and technical skills. Case Studies (I_c = 0.6958) and Group

Work (I_c = 0.6815) follow, indicating a continued appreciation for collaborative and problem-based learning, which foster critical thinking and teamwork key competencies in maritime professions. Lecture, with the lowest score (I_c = 0.0910), ranks fifth, suggesting that traditional passive instructional methods are less favored when preparing students for the dynamic and practical realities of maritime careers.

6. Conclusion.

This study aimed to evaluate the most effective teaching strategies for maritime education by identifying and ranking key decision criteria and instructional approaches using the Analytic Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The findings reveal that Learning Objectives emerged as the most critical criterion, highlighting the necessity for well-defined and skill-oriented learning outcomes in shaping effective instruction. Among the sub-criteria, Skill Development, Critical Thinking, and Knowledge Acquisition were prioritized, reflecting the maritime educators' emphasis on practical, cognitive, and technical competencies essential for professional readiness.

Additionally, Learner Characteristics such as Learning Styles and Background Knowledge were highly valued, emphasizing the importance of student-centered instruction that accommodates diverse learning needs. Although Technological Resources and Content Characteristics were assigned slightly lower weights, sub-criteria like Reliability, Scope, and Interactivity were still recognized as important components in delivering quality education.

The TOPSIS results further validated these insights, revealing that Practical Training is the most preferred teaching strategy, followed by Simulation and Case Studies. These strategies offer authentic, experiential learning that aligns with the core competencies outlined in the STCW Code and meet the expectations of the maritime industry. In contrast, traditional Lecture methods ranked lowest, signaling a shift toward more dynamic and participatory approaches in maritime instruction.

Overall, the study highlights the importance of aligning instructional strategies with clearly defined objectives, learner needs, and technological integration. A competency - based and learner - centered approach, supported by active and practical teaching methods is essential to ensure that maritime graduates are well-prepared for the demands of the profession.

AI Use Declaration

Chat GPT was used as an AI-assisted tool during the preparation and revision of this manuscript, primarily to support language refinement and presentation, including grammar, sentence structure, clarity, coherence, readability, and the organization and refinement of ideas already developed by the authors. Its use was limited to editorial and linguistic assistance during the writing and revision of portions of the Introduction, Review of Related Literature, Methodology, Results and Discussion, and Conclusion. Chat GPT was not used to conduct the research, collect or generate research data, perform statistical analyses, or determine the study's findings. All research procedures, data collection, statistical analyses, interpretations, conclusions, and scholarly judgments were independently conducted and determined by the authors. The authors reviewed and revised all AI-assisted outputs and retain full responsibility for the originality, accuracy, scientific integrity, data, references, analyses, interpretations, and conclusions presented in the manuscript.

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