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INTEGRATED INQUIRY LEARNING WITH *PIIL PESENGGIRI* VALUES: A WAY TO IMPROVE STUDENTS' RESPONSIBLE CHARACTER IN BIOLOGY EDUCATION

APRENDIZAJE POR INDAGACIÓN INTEGRADA CON LOS VALORES DE PIIL PESENGGIRI: UNA VÍA PARA MEJORAR EL CARÁCTER RESPONSABLE DE LOS ESTUDIANTES EN LA EDUCACIÓN EN BIOLOGÍA

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Abstract
Numerous studies indicate that students often exhibit a low sense of responsibility. This research examined the impact of the Piil Pesenggiri Inquiry learning model on developing responsible character traits. The study utilized a quasi-experimental design with a sample size of 188 students in Metro City, Lampung, Indonesia. Classes were randomly selected to form three groups: an experimental class Piil Pesenggiri Inquiry learning model, a positive control class (guided inquiry), and a negative control class (conventional learning). To measure the character of responsibility, a validated questionnaire consisting of 30 statements was employed, ensuring the instrument's validity and reliability. Data analysis was conducted using the

Resumo
Inúmeros estudos indicam que os alunos frequentemente demonstram um baixo senso de responsabilidade. Esta pesquisa examinou o impacto do modelo de aprendizagem por investigação Piil Pesenggiri no desenvolvimento de traços de caráter responsáveis. O estudo utilizou um desenho quase-experimental com uma amostra de 188 alunos na cidade de Metro, Lampung, Indonésia. As turmas foram selecionadas aleatoriamente para formar três grupos: uma turma experimental com o modelo de aprendizagem Piil Pesenggiri Inquiry, uma turma de controle positivo (investigação guiada) e uma turma de controle negativo (aprendizagem convencional). Para medir o traço de responsabilidade, foi utilizado um

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Kolmogorov-Smirnov test, Levene test, ANCOVA test, and LSD post-hoc analysis. The results indicated that the Piil Pesenggiri Inquiry learning model significantly fostered a sense of responsibility, with a highest corrected mean score of 83.990 for the IPP group, compared to 81.020 for the guided inquiry group and 79.032 for the conventional learning group. These findings can serve as a reference for educators seeking to promote responsible character development and highlight the importance of integrating local wisdom in Indonesia into education.

Keywords: Piil Pesenggiri. Inquiry. Local Wisdom. Responsibility. Character.

questionário validado composto por 30 itens, garantindo a validade e a confiabilidade do instrumento. A análise dos dados foi realizada utilizando o teste de Kolmogorov-Smirnov, o teste de Levene, o teste ANCOVA e a análise post hoc LSD. Os resultados indicaram que o modelo de aprendizagem por investigação Piil Pesenggiri promoveu significativamente o senso de responsabilidade, com uma pontuação média corrigida mais alta de 83,990 para o grupo IPP, em comparação com 81,020 para o grupo de investigação guiada e 79,032 para o grupo de aprendizagem convencional. Essas descobertas podem servir como referência para educadores que buscam promover o desenvolvimento de um caráter responsável e destacam a importância de integrar a sabedoria local da Indonésia na educação.

Palavras-chave: *Piil Pesenggiri. Investigação. Sabedoria Local. Responsabilidade. Caráter.*

1 INTRODUCTION

The The concept of responsibility has been defined in various pieces of literature. Responsibility is a moral virtue that encompasses not only compliance with norms but also the execution of individual and institutional duties and roles effectively (G. Williams, 2008) It serves as a framework for understanding how people evaluate, sanction, and attempt to regulate each other's behavior (Schlenker *et al*., 1994). Additionally, responsibility reflects subjective feelings of self-regulation and internal commitment (Mameli *et al*., 2019). It is characterized as an individual's moral competence to achieve specific goals while adhering strictly to accepted principles related to duty, competence, and ability (Ghasemi *et al*., 2019).

Instilling a sense of responsibility in students is essential. Developing this quality in schools can significantly help students succeed and positively influence their future careers (Çağırgan & Soytürk, 2021). Responsibility motivates individuals to complete their tasks on time (Körükcü & Tangülü, 2021). and fosters student self-efficacy (Mameli *et al*., 2019). Students who possess a high level of responsibility tend to show greater internal motivation, engage more effectively in social interactions, and are less likely to resort to violence (Manzano-Sánchez, 2022).

Various studies indicate significant issues related to the character of responsibility among students. While implementing the online learning process during the COVID-19 pandemic, problems concerning student responsibility were highlighted (Muhammad *et al*., 2021). The pandemic's impact resulted in increased delays in the completion of learning tasks by students (Latipah *et al*., 2021; Unda-López *et al*., 2022). For instance, there was a noted increase in procrastination regarding school work among students in North Cyprus (Tezer *et al*., 2019). Similar trends were observed during online learning in Norway (Melgaard *et al*., 2021) and Germany (Auerswald *et al*., 2024), where students frequently postponed their assignments. Procrastination is often linked to factors such as anxiety, distress, time management, and self-control (Unda-López *et al*., 2022). The habit of irresponsibility, exemplified by delaying assignments, can adversely affect students' academic performance (Setiyowati *et al*., 2024). Further research reveals additional deviations in responsible behavior, including tardiness to school, skipping classes, fighting, mocking peers, and engaging in bullying, along with various moral and ethical issues (Yudhar, Agustang, and Sahabuddin 2021; Erfantinni *et al*. 2019).

Previous research has highlighted several ways to empower responsible behavior among students. Utilizing rewards and recognition, engaging in discussions, encouraging involvement, and providing non-directive guidance can significantly promote student responsibility (Lewis, 2001). Furthermore, learning through the documentation and reporting of environmental issues can enhance students' sense of responsibility (Hayik, 2020). The implementation of the pedagogical model of Personal and Social Responsibility (TPSR) has been shown to increase student accountability (Valero-Valenzuela *et al*., 2020). Additionally, class participation through the Jigsaw method fosters a sense of responsibility and active engagement in the overall learning process (Jainal & Shahrill, 2021). Lastly, high-structured cooperative learning strategies can effectively empower students to take on more responsibility (Cecchini *et al*., 2021).

Inquiry learning is an educational model that has the potential to foster a sense of responsibility among students. This approach encourages students to actively participate and take responsibility for their own learning as well as that of their peers (Saunders-Stewart *et al*., 2015). By sharing information, tools, and strategies, students engage in social responsibility and support each other's inquiry process (Jennings & Mills, 2009).

Research indicates that inquiry-based learning has a positive impact on students. Specifically, it enables them to transition from a passive role to a more constructive role in their education (Feyzioğlu & Demirci, 2021). Additionally, this method can enhance students' scientific knowledge (Vančugovienė *et al*., 2024) and increase their intrinsic motivation (Meulenbroeks *et al*., 2024). Furthermore, inquiry learning promotes active engagement in the classroom (Eltanahy & Forawi, 2019) and facilitates a better understanding of the material (Pavlova *et al*., 2020).

Inquiry-based learning has several weaknesses. First, formulating questions can be time-consuming (FitzGerald, 2011). Students often struggle with limited time, which hampers their ability to effectively navigate the research process (Ural, 2016; Putra, Prayitno, and Maridi 2018). To address the challenges associated with inquiry learning, this research integrates inquiry-based approaches with the local wisdom values of *Piil Pesenggiri.* The key elements of *Piil Pesenggiri* include *nemui nyimah* (productive), *nengah nyappur* (competitive), *sakai sambayan* (cooperative), and *juluk adek* (innovative) (Fachruddin, 2007).

Local wisdom encompasses the knowledge and principles of life that local communities employ to fulfill their needs (Haq *et al*., 2022).. It represents noble values that have been passed down through generations and are cherished by the community (Citrawan *et al*., 2024). Local wisdom serves as a guide, norm, and body of knowledge that the community trusts and follows in their daily lives (Suastra *et al*., 2017); Wibawa and Awaliah 2023). The integration of local wisdom values into learning is expected to enhance students' experiences.

Cultural integration in education, particularly in science learning, has started to be implemented in Indonesia (Arsih *et al*., 2019). Conducting laboratory experiments and developing booklets based on local wisdom can enhance students' knowledge and skills (Dewi *et al*., 2020). Integrating multicultural content into the curriculum has a positive impact on student achievement, motivation, self-efficacy, creativity, critical thinking, collaboration, and engagement in biology learning (Arsih *et al*., 2019) Local wisdom, such as Gusjigang, can be utilized in education to foster a better future (Asror *et al*., 2024).

Despite numerous studies highlighting the effectiveness of inquiry-based learning and character education, limited research has explicitly integrated local wisdom values into structured inquiry models to foster students’ responsibility in biology education.

Most existing studies tend to focus either on cognitive outcomes or general character development without contextualizing learning within culturally embedded value systems. Therefore, this study offers a novel contribution by integrating *Piil Pesenggiri* an indigenous Lampung philosophical value system into an inquiry learning framework. This integration not only enriches the pedagogical approach but also provides a culturally responsive model that bridges scientific learning with moral character development. Consequently, this research aims to examine whether the *Piil Pesenggiri* inquiry learning model significantly enhances students' responsibility character compared to guided inquiry and conventional learning. This study is innovative compared to previous research, as it implements the *Piil Pesenggiri* integrated inquiry learning approach to cultivate responsible character traits among students. The aim of this research was to assess the effect of implementing *Piil Pesenggiri* i inquiry learning on students' sense of responsibility. This research hypothesises that Piil Pesenggiri's integrated inquiry learning model significantly influences responsible character

2 MATERIALS AND METHODS

2.1 Research design

This research utilized a quasi-experimental design with a nonequivalent group pretest-posttest format. The population for this study comprised high school students in Metro City, Lampung. A random sampling method was employed to select participants. The sample consisted of 188 students from class X at SMA Negeri 6 Metro and SMA Yos Sudarso Metro. Each school selected 3 classes that would implement the *Piil Pesenggiri* integrated inquiry learning model (the specifics of which are outlined in Table 2), guided inquiry, and conventional learning methods. Details regarding the implementation of these treatments are presented in Table 1. Throughout this research, ethical principles were strictly adhered to. All participants provided informed consent, and their confidentiality rights were protected.

Table 1

Quasi-experimental design

Pretest	Treatment	*Posttes t*
O1	*Piil Pesenggiri* Inquiry	O4
O2	Guided inquiry	O5
O3	Conventional	O6

In the table, O1, O2, and O3 represent pretest scores, while O4, O5, and O6 represent posttest scores.

Table 2

Syntax of the Piil Pesenggiri Inquiry Learning Model

No	Syntax of *Piil Pesenggiri* Inquiry	Student Activities
1	Exploration and analysis of phenomena	Students Productively organize information based on the results of exploration
2	Formulate questions, share and exchange information	Students formulate questions based on the information they previously obtained Students have the opportunity to convey ideas regarding the formulation of questions Students visit other groups to exchange the information they have
3	Investigation planning	Students work together to innovate and develop hypotheses, determine variables, and design investigations
4	Investigation	Students work together to perform data collection Siswa menyusun data secara inovatif
5	Analysis and proof	Students cooperate to perform data analysis and organize discussions in innovative ways
6	Compile new knowledge	Students work together to innovate and construct new knowledge
7	Knowledge communication and innovation	Students present the results of group discussions Students actively ask questions, respond to questions Students cooperate to organize knowledge innovatively based on the experience gained during the presentation
8	Evaluation and Competition	Students work on questions and compete for group progress

2.2 Instruments, and data collection techniques

The responsible character was measured using a questionnaire consisting of 30 statement items. Indicators of responsible behavior included respect, participation, effort,

self-regulation, and concern (Hellison, 2011). The character value of responsibility was measured using an instrument with a scoring scale of 1-4. The instrument validity was confirmed using Pearson Product-Moment correlation, with all items exceeding the critical r-value ($r > 0.198$). Reliability analysis yielded a Cronbach's Alpha of 0.903, indicating excellent internal consistency. These results confirm that the instrument is both valid and reliable for measuring students' responsibility character. Table 3 is a Grid of the responsibility character measurement instrument.

Table 3

Grid of the responsibility character measurement instrument.

No.	Assessment Aspect	Score
1	Respect	6
2	Participation	6
3	Effort	6
4	Self-direction	6
5	Caring	6

2.3 Data analysis technique

Responsibility character data was then analyzed using Analysis of Covariance (ANCOVA). The use of ANCOVA was intended to control initial differences in students' responsibility scores (pretest) and to examine the effect of the learning model on posttest outcomes. The pretest scores were treated as covariates, while the posttest scores were the dependent variable. Effect size interpretation was also considered to evaluate the practical significance of the findings. Before testing the hypothesis, the data was tested for prerequisites through a normality test (Kolmogorov-Smirnov test) and a homogeneity test (Levene statistical test). For the normality test, if the p-value is $>\alpha$ 0.05 then the data is normally distributed (Table 4). The results of the homogeneity test are presented in Table 5. If the analysis indicates a significant difference, further testing will be conducted using the Least Significance Difference (LSD) Test.

Table 4

Summary of One Sample Kolmogorov-Smirnov test results

Variabel	Kolmogorov-Smirnov's Significance Value (sig)		Distribution
	Initial Test	Final Test	
Responsible character	0.200	0.200	Normal

Table 5

Summary of homogeneity test with Levene's test

Variabel	Levene's Significance Value (sig).		Distribution
	Initial Test	Final Test	
Responsible character	0.674	0.086	Homogeneous

3 RESULT

The study aimed to improve the character of responsibility through *Piil Pesenggiri* inquiry learning. The results showed that the *Piil Pesenggiri* inquiry learning model could foster the character of responsibility. Table 6 shows the results of the ANCOVA analysis.

Table 6

Summary of ANCOVA Analysis Results of the Effect of Learning Models on Responsible Character

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	525.212[a]	3	175.071	8.876	.000
Intercept	2709.409	1	2709.409	137.363	.000
Initial Test	197.099	1	197.099	9.993	.002
Class	524.708	2	262.354	13.301	.000
Error	3629.305	184	19.724		
Total	1248920.229	188			
Corrected Total	4154.517	187			

Table 6 showed that the p-value was 0.000 < 0.05, so there was an influence of the learning model on student character. With these results, further tests were conducted with the LSD Test. The LSD test results are presented in Table 6.

Table 7

Summary of LSD Test Results for Character of Responsibility in the Learning Model

No	Model	Initial Test	Final Test	Difference	Increase (%)	Corrected mean	Notation
1	*Piil Pesenggiri* inquiry	65.71	83.01	17.31	26.34	83.990	a
2	Guided inquiry	70.49	81.23	10.73	15.23	81.020	b
3	Conventional	72.88	79.83	6.95	9.54	79.032	c

Table 7 shows the corrected mean value for the character of responsibility. The corrected mean score of students who received *Piil Pesenggiri* inquiry learning obtained the highest responsibility character score, reaching 83.990, and was significantly different from the corrected mean of responsibility character in guided inquiry learning which reached 81.020, and conventional which only reached 79.032. These results indicated that the character of responsibility taught using the *Piil Pesenggiri* inquiry learning model was better when compared with guided and conventional inquiries.

4 DISCUSSION

The results of data analysis showed that *Piil Pesenggiri* inquiry learning obtained the highest increase in average scores compared to other learning models. These results indicated that the *Piil Pesenggiri* inquiry learning model could significantly improve the character of responsibility. The increase was due to the learning steps in the *Pesenggiri Piil* inquiry, providing learning experiences that supported the development of responsible character. The findings of this study can be theoretically explained through the integration of constructivist learning theory and culturally responsive pedagogy. Inquiry learning aligns with constructivist principles by actively engaging students in knowledge construction (Collazos *et al*., 2014), while *Piil Pesenggiri* values provide a socio-cultural framework that reinforces responsibility through moral internalization (Tran, 2019).

This dual approach allows students not only to understand scientific concepts but also to develop a sense of accountability grounded in cultural identity. Therefore, the effectiveness of this model lies in its ability to merge cognitive engagement with affective and moral dimensions of learning.

The first steps were the exploration and analysis of the phenomenon. Each student tried to find out what important information was in the discourse. It showed how each student had a responsibility as a group member. Working in groups, students were responsible for the quality of their individual and group work (Tal & Tsaushu, 2018). Group work allowed students to build confidence in working collaboratively to achieve common goals (Llewellyn, 2013). In this step, each student could express an opinion regarding the significant information they found. Students would exchange information with each other, so there was the possibility of differences of opinion. In this case, it facilitated students with the habit of respecting each other if there were differences of opinion. Students working together to complete tasks through exploration, composing questions, and compiling information could foster responsibility (Collazos *et al*., 2014). Concern and responsibility could develop when students cooperated in discussion teams (Soutter & Clark, 2024).

The second steps involved formulating questions and sharing information. During this stage, students had the opportunity to express their ideas on how to create these questions. Visiting other groups allowed them to exchange the information they had gathered. Collaborative discussions enabled students to interact, gain insights, and develop diverse solutions (Alsmadi *et al*., 2023; Ma *et al*., 2023).. Students working in small groups could support one another (Gillies, 2003).. This environment encouraged students to take responsibility. Group work did not only convey scientific knowledge but also fostered teamwork skills (Tran, 2019).

In the third step, students actively collaborated to develop a plan for their investigation that addressed the formulated questions. This process allowed them to practice good decision-making skills as they determined the appropriate investigation design. Engaging in designing investigations provided valuable experience in making sound decisions (Chang *et al*., 2022). It encouraged a sense of responsibility, ensuring the effective execution of the investigation. Student-led discussions could cultivate responsibility (Soutter & Clark, 2024). In many cases, group work helped students learn

from different contexts, shared and challenged ideas, and distributed tasks fairly (Llewellyn, 2013).

The fourth step was an investigation. Students would share tasks and work together to collect data. Students working in groups could add and expand the knowledge they had learned from new situations (Taraban *et al*., 2007). Responsibility was encouraged through group work, asking and responding to each other (Boaler, 2006). The division of tasks for group members could foster the character of responsibility, due to students' sense of responsibility to help each other achieve a common goal (Allen, 2006). The character of responsibility could be developed by dividing tasks within a group (Lickona, 1996).

The fifth steps were analysis and proof. In this step, students would discuss with their group mates to develop a discussion. Students interacted with each other and exchanged opinions and information to solve problems. When students had face-to-face interactions with other students, it created a sense of responsibility to respect other students (Bergmark, 2008). Working as a team, and helping each other to solve problems could develop the character of responsibility (D. D. Williams *et al*., 2003). Class discussions had the potential to encourage students to become more active in the learning process and improve the student learning experience (McKee, 2015). Students learned to construct and negotiate knowledge together and build positive peer relationships (Llewellyn, 2013).

The sixth step was compiling new knowledge. At this stage, students conducted discussions to compile the knowledge they gained based on the discussion results. Discussion activities encouraged students to be more active in groups. The activities focusing on students could foster a sense of responsibility (Mameli *et al*., 2020). They gave students a sense of responsibility for their assignments (Schneider, 2010); Coulter and Onufer 2022). During the discussion process, students were responsible for sharing information and providing responses regarding the material (Lo, 2010).

The seventh step was communication and knowledge innovation. In this step, students made presentations regarding the results of group work. During the presentation, each group member was responsible for conveying their task. In this step, students would actively ask questions and respond to questions. In the presentation stage, each group member was responsible for answering questions from other groups. Each group member

would try to complete the tasks he was responsible for. Each group member would try to contribute to the presentation. The group would be serious about showing their best performance to succeed in the presentation. The presentation trained students to help each other group members. When a group member answered a question incompletely, the other members would help to complete it. Discussion activities could provide students with the experience of interacting with each other, teaching each other, and sharing their experiences (Kanchana & Cherukuri, 2024). Group presentations encourage students to assume responsibility by requiring them to collaborate effectively and contribute individually to collective outcomes. Related presentations include a division of tasks for each group member to assign specific responsibilities (Murray, 2017). Discussion activities to solve problems allowed students to participate and take responsibility for the discussion (Yücel & Usluel, 2016).

In this step, students also performed activities to compile new knowledge based on the experience gained during the presentation. Students had discussion activities to determine what knowledge they gained from the presentation results. Discussion activities could foster involvement and responsibility (Astalini *et al*., 2024). Completing their own tasks to achieve common goals could encourage responsibility in teamwork (Yusuf *et al*., 2015).

The eighth steps were evaluation and competition. In this step, students worked on the given questions. The value taken was the group value. Each student was responsible for assisting the group to get a reward. Assessment could encourage students' responsibility (Keppell *et al*., 2006). One way teachers foster students' feelings of responsibility is by using assessment systems, such as assessing group work, group activities, and final tests (Boaler, 2006). Classroom assessment could improve student performance by sharing clear learning goals and involving students in the assessment process, helping them take more responsibility for learning (Woytek, 2005).

When students had assignments or questions to work on, they had to complete them well and on time. Students had to manage their time well to work on questions and complete them according to the given time limit. Giving regular assignments could develop students' sense of responsibility (Hidayati *et al*., 2023). Working on questions independently taught students not to always depend on others and fostered a sense of self-confidence. In completing questions, students had to be careful and thorough, which

fostered a sense of responsibility to provide the best results. Students solved questions. They were responsible for taking responsibility for the results they achieved, either good or bad grades, to learn the responsibility for every action they took. The responsibility was determined by whether individuals completed their tasks and bore the consequences of their behavior. Social responsibility can be learned and taught through experience (Körükcü & Tangülü, 2021).

The novelty of this research is implementing the *Piil Pesenggiri* inquiry learning model to empower responsible characters. The findings of this research revealed that there are significant differences in the character of responsibility in learning models. These results can be a reference in developing responsible character. These results also showed the integration of local wisdom values can support learning and improve the quality of learning.

The findings of this research suggest that the *Piil Pesenggiri* inquiry learning model can serve as an effective alternative for teachers aiming to enhance student competence. One key outcome of this study is that the *Piil Pesenggiri* inquiry model fosters a sense of responsibility among students. It is anticipated that nurturing this character trait will encourage students to take greater responsibility for completing school assignments and managing everyday tasks. Education should focus on building good character in students (Jamaluddin *et al*., 2022). It is essential that this character development extends beyond the classroom and proves beneficial in students' adult lives (Maisyaroh *et al*., 2023). Another important implication of this research is the need to incorporate local wisdom into the learning process. By integrating local wisdom into education, the younger generation can be better prepared to tackle the challenges posed by contemporary developments. This integration not only enriches character education but also promotes a generation that embodies strong values while honoring local cultural heritage (Marhayani, 2016).

The *Piil Pesenggiri* inquiry learning model is expected to be an alternative educational approach to developing students' character and competencies. However, this research focused primarily on fostering one specific character trait: responsibility. Future studies should explore the inquiry learning model to cultivate additional positive character traits. Another limitation of this research was that the subjects were solely high school students. Future research should aim to apply the *Piil Pesenggiri* inquiry model

across various educational levels. Researchers using the *Piil Pesenggiri* inquiry learning model should carefully consider and facilitate each learning process step to ensure its effectiveness. Challenges often arise during the stages of formulating questions and sharing information. During these interactions, students may feel pressured to defend their ideas when groups visit each other. It is important to remember that the purpose of these group visits is to assist those who are encountering difficulties, rather than to protect one group's perspective. From a practical perspective, this model can be implemented by biology teachers to promote both academic and character development simultaneously. Teachers are encouraged to incorporate local cultural values into lesson design, particularly in collaborative and inquiry-based activities, to enhance students' engagement and responsibility.

5 CONCLUSION

The research concludes that the *Piil Pesenggiri* inquiry learning model can effectively develop the character of responsibility. The *Piil Pesenggiri* inquiry learning model obtained the highest increase in corrected average scores compared to other learning models. There is a significant and higher influence of the *Piil Pesenggiri* inquiry learning model in improving the character of responsibility. This improvement stems from the learning steps in the *Piil Pesenggiri* inquiry providing learning experiences that foster the development of responsible character. These research findings can be a reference for educators aiming to cultivate character, particularly the character of responsibility. The recommendation for future research is to expand the implementation of the *Piil Pesenggiri* inquiry learning model across various educational levels. Subsequent studies could explore the effectiveness of the *Piil Pesenggiri* inquiry learning model on the character of responsibility in terms of gender, demographics, or academic ability. Further research can also apply the *Piil Pesenggiri* inquiry approach to improve 21st-century skills.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

AUTHORS' CONTRIBUTION

A.L. contributed to the conceptualization and methodological design of the study, conducted data collection and investigation, performed the formal analysis, curated the dataset, and prepared the initial draft of the manuscript, including visualizations. **S.M.** supervised the research process, supported the conceptual and methodological development, validated the analytical procedures, managed project administration, and provided critical revisions and editorial improvements to the manuscript. **F.R.** contributed to data collection, formal analysis, and visualization, as well as the review and editing of the manuscript. **M.S.S.** supported the validation processes, provided institutional and academic resources, supervised specific aspects of the research, and contributed to the review and editing of the manuscript. **H.** contributed to conceptual refinement, methodological consultation, and critical review of the manuscript.

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