RESEARCH ARTICLE

Promoting students' environmental literacy through PBIB learning model

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Abstract: Low literacy levels are believed to be one of the causes of environmental damage problems. It is felt that the current implementation of the problem-based learning model is still not optimal in increasing students' environmental literacy, especially regarding sustainable issues. This research aims to (1) produce a sustainable issue-based learning model, and (2) test the level of validity and reliability of the model. The research was carried out at Malang State University and PGRI University Semarang involving biology learning experts, educational technology experts, and environmental experts as research subjects. The instrument in this research is an expert validation sheet. Validation results were analyzed using the average score while reliability was analyzed using percentage agreement. The research results show that the development of PBIB syntax including orientation, concept strengthening, observation, investigation, report, and reflection is classified as valid with a score of 3.87, while the reliability is 3.88 (reliable). This research indicates that the PBIB model can be used in learning and potentially increase students' environmental literacy.

Keywords: Environmental literacy; sustainable development goals; PBIB

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Introduction

Indonesia faces various environmental problems, including the accumulation of pesticide waste, decreased groundwater quality due to forest clearing (Ifada et al., 2021), and decreased air quality due to urbanization and industrialization (Kusuma et al., 2023). These environmental problems arise due to developments in science and technology followed by infrastructure development without being balanced by human awareness, sensitivity, skills, and a sense of responsibility toward the environment (Aznar-Díaz et al., 2019; Hsu et al., 2018; Ifada et al., 2021; Kusuma et al., 2023).

Various steps to reduce and prevent environmental problems have been carried out across sectors. One sector that is considered to have a key role is schools. Schools are considered to have a strategic role in society, especially in preparing future generations who are aware and care about the environment. In addition, schools are considered to have the ability to adapt to environmental developments (Alkaher & Goldman, 2018; Amoah & Addoah, 2021; Clayton et al., 2019). Adjustments that schools may make include being part of optimizing the literacy environment for students (Angraini et al., 2022; Potter, 2009). Students' environmental literacy is an ability that needs to be optimized, with the hope that students will have the ability to support sustainable development and provide protection for nature (Derman et al., 2016; Kaya & Elster, 2018; Veisi et al., 2019). Environmental literacy is related to ecological knowledge, awareness, sensitivity, and responsibility regarding the influence of human activities on natural resources (Derman et al., 2016; Haske & Wulan, 2015). Research results in several Asian countries show that students' environmental literacy is at a low to moderate level (Liang et al., 2018; Rijal et al., 2018; Solheri et al., 2022; Veisi et al., 2019).

Efforts to increase students' environmental literacy in schools are done through implementing learning models. Learning models designed to increase environmental literacy include sustainability-based inquiry learning models, meta-Collaborating Inquiry Community (meta-CIC), social, environmental, economic and political (SEEP) model, and PBL model combined with argumentation (Adler et al., 2016; Fettahlıoğlu & Aydoğdu, 2020; Juntunen & Aksela, 2013). However, the four learning models that aim to increase students' environmental literacy still need to be optimized. This is based on the results of research on the application of a sustainability-based inquiry learning model which is known to have not been able to improve students' environmentally responsible attitudes and behavior (Fettahlıoğlu & Aydoğdu, 2020; Juntunen & Aksela, 2013). Furthermore, the implementation of the meta-CIC learning model has not been able to increase students' environmental literacy. In line with this, the implementation of SEEP learning has also not been able to optimally improve students' cognitive skills (Erdogan, 2015).

The studies above recommend the need for further strategic steps in efforts to increase students' environmental literacy. Recommendations given include (1) increasing environmental literacy by optimizing students in dealing with environmental conflicts, (2) building student knowledge through collaboration, (3) increasing students' responsible behavior towards the environment by optimizing student pre-knowledge, (4) learning is needed of a recreational nature, (5) improving students' cognitive skills can be done by involving students in active cognitive skills activities and observing the environment, (6) activities to improve cognitive skills (Adler et al., 2016; Fettahlıoğlu & Aydoğdu, 2020; Juntunen & Aksela, 2013).

Currently, there is no learning model specifically designed to increase students' environmental literacy at the secondary school level. A model that specifically raises and discusses issues related to sustainable environmental development. Therefore, the specific objectives of this research are (1) to produce a learning model that can foster students' environmental literacy through continuous study and learning steps, and (2) to determine the level of validity and reliability of the learning model developed.

Method

This R&D research adapts the development model (Plomp & Nieveen, 2013). The research stages are shown in Figure 1. The research was conducted for three years at Malang State University and PGRI University Semarang. The focus of the research is to produce a quality PBIB model based on the level of content and construct validity, as well as the level of reliability to increase students' environmental literacy. The main product of this research is the PBIB model in the form of a model book. The PBIB model book contains (1) rationale, (2) model development objectives, (3) model orientation, (4) conceptual framework, (5) model characteristics, (6) model components, (7) planning learning activities, and (8) implementation of the PBIB model. This research involved three experts as subjects, including biology learning experts, educational technology experts, and environmental experts.

This research began with data collection on (1) the condition of students' environmental literacy, (2) teaching activities on material related to the field of environmental literacy, and (3) empirical studies of the environment and learning models that encourage students' environmental literacy. The results of literature and field studies were used to develop the PBIB model design. The PBIB model development design in the form of a model book was validated by three experts using validated learning model quality assessment instruments. Model quality is determined by the level of validity and reliability of the learning model (Plomp & Nieveen, 2013). The quality of the PBIB model is based on the level of validity and reliability. Validity is carried out on the content and construction of the learning model. The instrument used is an observation sheet. Validity data was obtained from the validation results of three experts including biology learning experts, educational technology experts and environmental science experts. The validation results were analyzed descriptively using the average validity score referring to the criteria in Table 1 (Makhrus, 2018).

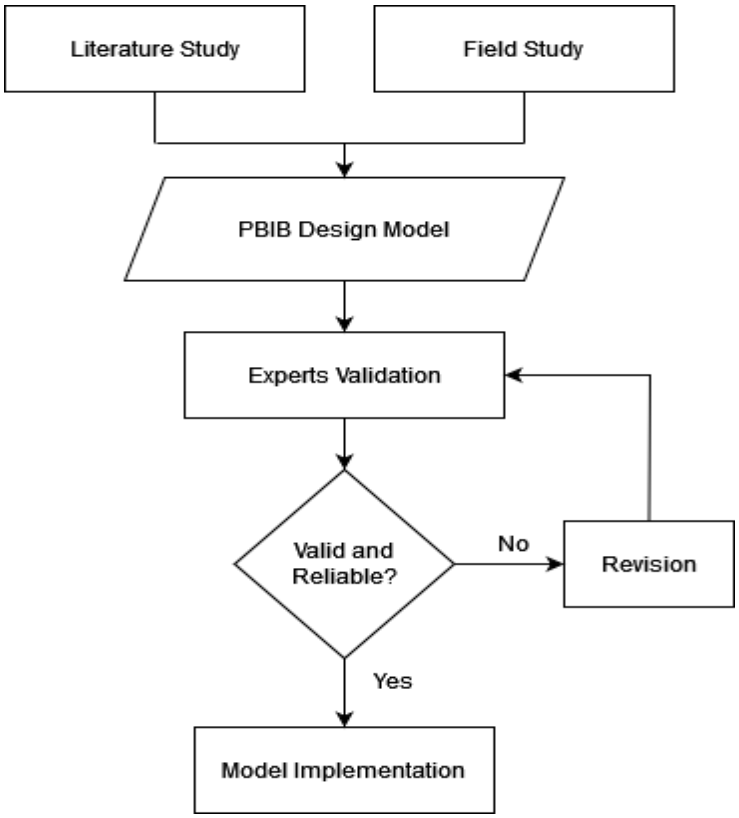

Figure 1. PBIB model development syntax

Table 1. Criteria for assessment of the validity of the PBIB learning model

Score Interval	Assessment criteria	Information
3.25 ≤ P < 4.00	Very Valid	It can be used without revision
2.50 ≤ P < 3.25	Valid	Usable with little revision
1.75 ≤ P < 2.50	Medium	It can be used with many revisions
1.00 ≤ P < 1.75	Less	Unable to use and requires consultation

Reliability was analyzed by percentage of agreement, the PBIB model was declared reliable if the reliable value was 75% $R = \left[1 - \frac{A-B}{A+B}\right] x\ 100\%$ (Borich, 1990).

Information:
R: Reliability coefficient
A: Validator assessment that provides high marks
B: Rating of validators who give low scores

Results and Discussion

Rational for a PBIB Model

The PBIB model is built based on recommendations from research results, empirical foundations, and learning theories as explained in Figure 2. The first phase of the PBIB model is orientation. The orientation step is designed to build students' attention to the learning that will be carried out and encourage students to ask questions regarding environmental conditions. Efforts to build student attention are carried out by orienting learning objectives, presenting environmental conditions through the media of directing student assignments, and conveying the abilities that must be possessed to achieve learning objectives. This phase is supported by learning theory which states that to arouse students' willingness to ask questions and interest in the learning that will be carried out, students must pay attention (Bandura, 1992; Joyce et al., 2017).

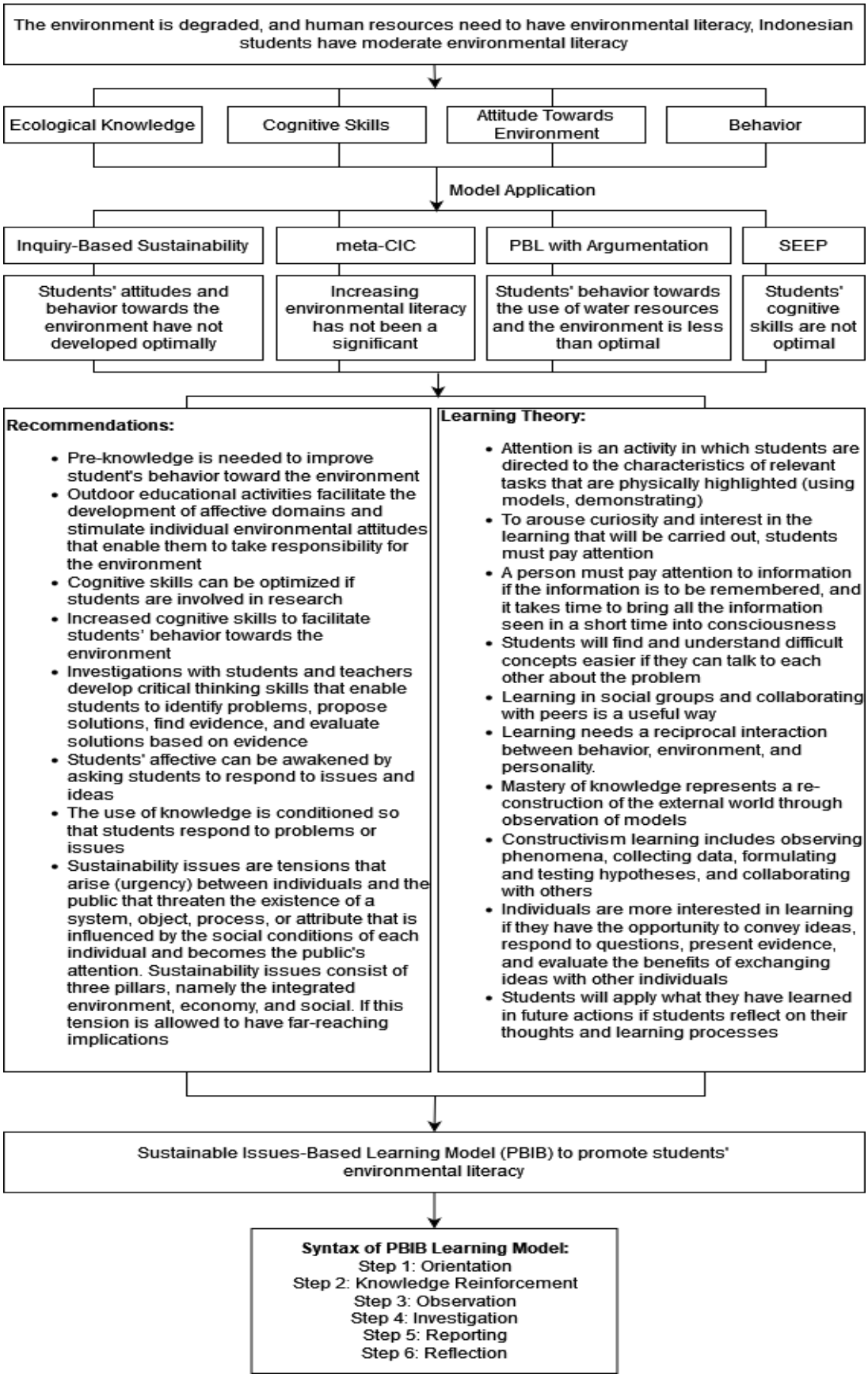

Figure 2. The rational of developing PBIB learning model

We place strengthening students' conceptual knowledge and knowledge as the second stage. This stage is designed to strengthen students' knowledge base. Students' knowledge needs to be optimized, because based on the results of observations it is known that students experience learning difficulties at the next stage due to lack of knowledge. By strengthening knowledge, students are expected to be able to develop water behavior towards the environment (Fettahlıoğlu & Aydoğdu, 2020). The phase of strengthening student knowledge is carried out by dividing the class into several heterogeneous groups and presenting questions for discussion by the student groups. This phase is built on learning theory which emphasizes learning in social groups and collaboration with peers is a useful way (Ratner et al., 2002; Warini et al., 2023). In addition, learning needs to involve reciprocal interactions between behavior, environment, and personality (Schunk, 2012). The existence of group activities discussing questions given by the teacher is expected to be able to intervene in students' knowledge.

Armed with the knowledge they already have, at the next stage students are expected to be able to apply the knowledge they have through contextual learning experiences. The use of knowledge is conditioned so that students respond to problems or problems through observation activities in the environment (Hollweg et al., 2011; Nuraini et al., 2020). This observation phase is designed to intervene in the use of knowledge, cognitive skills, attitudes and environmentally responsible behavior. The learning activity in this phase is for students to identify the components of a system that exists in nature by observing the surrounding environment. Environmental observation is conditioned as a form of recreation related to nature for students. This activity is based on recommendations which state that outdoor educational activities facilitate the development of the affective domain, and stimulate students' environmental attitudes that enable them to be responsible for the environment. Furthermore, observation is an activity that can intervene in students' cognitive skills. By improving students' cognitive skills, students' responsible behavior towards the environment will be facilitated (Erdogan, 2015; Schunk, 2012).

The fourth phase is designed to associate students' cognitive skills, knowledge, attitudes and environmentally responsible behavior. Stage four learning activities are based on recommendations which state that cognitive skills can be optimized if students are involved in observation or experimental activities (Erdogan, 2015). So in this phase, students are given space to analyze data sourced from observations to find environmental problems, and formulate sustainable problems, determine problems that have the potential to develop into problems, and determine anticipatory solutions to the formulation of sustainability problems. Activities in this phase are based on constructivist learning activities which include observing phenomena, collecting data, formulating and testing hypotheses, and collaborating with other people. Activities in this phase are also based on recommendations which state that student effectiveness can be raised by asking students to respond to problems and ideas. The issue used in the PBIB model is the issue of sustainability.

The problem of poaching is a tension that arises between individuals and society which threatens the existence of a system, object, process or attribute that is influenced by the social conditions of each individual and is of concern to society. The departure issue consists of three pillars, namely environmental, economic and social integration. If this tension is left unchecked, the impact will be very broad. Some examples of relevant sustainable issues discussed in the PBIB model are threats to biodiversity (environment), (2) potential growth in human numbers (social), (3) threats of poverty, violence, or disease (economic), (4) the desire for marine habitats to support livelihoods coastal cities, (5) maintenance of renewable resources so that we can support economic development.

Data from investigations carried out in stage four are used in preparing the report. Report preparation is the fifth stage of the PBIB model. This phase is designed so that students can communicate and defend the results of the investigations they have carried out. Learning activities in this phase are designed in such a way that knowledge and cognitive skills are an aerial intervention. This phase is supported by theory which states that individuals are more interested in learning if they have the opportunity to convey ideas, ask questions, present evidence, and hear the benefits of exchanging ideas with other individuals (Amoah & Addoah, 2021; Schuler et al., 2018).

The PBIB model learning steps end with reflection. This stage is mainly designed to intervene in students' behavior towards the environment. The learning activity stage involves students reflecting on their knowledge, cognitive skills, and attitudes from the context of the problem formulation and research results in the form of expression, preparing action plans by thinking proactively about the context of the problem formulation and its results. This phase is based on a theory which states that students will apply what they have learned in future actions if students reflect on their thinking and learning processes (Schuler et al., 2018).

PBIB Model Quality Assessment

The quality of the PBIB model is based on content and construct validity, as well as reliability. Content validity and reliability are presented in Table 2 and construct validity and reliability are presented in Table 3. Content validity and reliability include the developmental needs based on current knowledge.

The results of content validation and reliability show that the learning model is very valid and reliable. Based on content validity and reliability, the PBIB model can be used without revision with a high score on a scale of 4. The construct validity and reliability of the PBIB model include (1) the rationale for the PBIB model, (2) the conceptual logic of model development, (3) syntactic consistency, (4) construction of social system logic, reaction principles, support systems, impact of learning and mentoring, (5) consistency of planning, and (6) consistency of implementation.

Table 2. Analysis results of content validation and reliability of the PBIB model

No	Component	PBIB Model Validity and Reliability			
		Average Validity Score	Criteria	Reliability	Criteria
A	The need for PBIB model development				
1	Appropriate way of thinking optimization environmental literacy	4	very valid	100	Reliable
2	Optimizing environmental literacy	4	very valid	100	Reliable
3	Basis of PBIB model recommendation	4	very valid	100	Reliable
4	Supporting sustainable development	3.33	very valid	86	Reliable
B	PBIB model design based on the latest knowledge				
1	Use of up-to-date resources	4	very valid	100	Reliable
2	The use of learning theory foundations	4	very valid	100	Reliable
3	Use of empirical basis	4	very valid	100	Reliable
4	Development plan	3.67	very valid	86	Reliable

Table 3. Analysis results of construct validation and reliability of the PBIB learning model

No	Component	PBIB Model Validity and Reliability			
		Average Validity Score	Criteria	Reliability	Criteria
1	Rationale of PBIB model goals	3.9	very valid	100	Reliable
2	Logical conceptual framework development of the PBIB model	4	very valid	100	Reliable
3	PBIB model syntax consistency	4	very valid	100	Reliable
4	The logical of social systems, reaction principles, support systems, and the impact of the PBIB model	3.8	very valid	92	Reliable
5	PBIB model planning consistency	4	very valid	100	Reliable
6	Consistency of the implementation of the PBIB learning model	3.6	very valid	92	Reliable

The results of the construct validity and reliability of the PBIB model show that the learning model is declared very valid and the results of the reliability coefficient analysis show that it is reliable. Based on construct validity and reliability, the PBIB model is declared very valid and can be used without revision. The novelty of the PBIB model lies in the form of intervention. The PBIB model intervention prioritizes environmental literacy components which include (1) ecological knowledge, (2) cognitive skills, (3) attitudes towards the environment, and (3) behavior towards the environment. The potential for the PBIB model to have the ability to intervene in environmental literacy is because the PBIB model has a syntax that includes (1) Orientation, (2) Strengthening Knowledge, (3) Observation, (4) Investigation, (5) Reporting, and (6) Reflection. Each phase of the learning model is designed to have intervention capabilities for environmental literacy components.

Student attention interventions are carried out to provide clearer explanations of students' tasks and abilities (Abdullah et al., 2019; Bandura, 1992; Slavin, 2014). Several researchers say student knowledge and behavior interventions can be carried out in groups to optimize identifying, comparing, and hypothesizing problems (Bandura, 1992; Fettahlıoğlu & Aydoğdu, 2020; Schunk, 2012). Furthermore, interventions designed at the observation stage provide thinking space for students to actualize cognitive knowledge in the form of attitudes and behavior towards a responsible environment. This observation activity is also strongly indicated to maximize and elaborate knowledge, cognitive skills, attitudes, and responsible behavior to become increasingly developed (Erdogan, 2015; Hollweg et al., 2011; Schunk, 2012).

Students' sense of responsibility towards the environment is also believed to become stronger when they carry out in-depth investigations regarding the problems they face. According to several experts, interventions provided by teachers can optimize the ability to analyze various factors that are closely related to the emergence of environmental problems. Moreover, sustainable environmental issues are related to several fields such as economics, society, and culture. Collaboration between students can also optimize critical thinking activities in investigating, processing, and interpreting data. It is believed that selecting sustainable environmental issues can place students with holistic thinking skills that are always connected to various possible impacts or follow-ups in the future. This is what differentiates the PBIB model from other similar models.

The model intervention framework was obtained through a study of research results on the application of Inquiry based sustainability, meta-CIC, PBL with argumentation, and SEEP learning models to environmental literacy. The four models found several weaknesses and needed to be optimized. The PBIB model is known to have novelty when compared to the Inquiry-based sustainability, meta-CIC, PBL with argumentation, and SEEP models. The novelty of the PBIB model when compared to the Inquiry model lies in the orientation phase, knowledge strengthening, and investigation by formulating sustainability issues, and reflection. Where this step is not found in the Inquiry syntax. The novelty of the meta-CIC model with the PBIB model lies in the knowledge-strengthening phase, investigation by formulating sustainability issues, reporting, and reflection. The novelty of the PBIB model when compared to the SEEP model lies in the orientation, observation, and investigation phases to formulate sustainability issues, reporting, and reflection. The novelty of the PBIB model when compared to the PBL model combined with arguments lies in the investigation phase by formulating sustainability issues and reflection.

Conclusion

The results of this study can be concluded that 1) the PBIB learning model has been produced with syntax (1) orientation, (2) knowledge reinforcement, (3) observation, (4) investigation, (5) report, and (6) reflection, 2) the level of validity is stated to be very valid and the reliability is declared to be reliable. So, this PBIB learning model can be used for learning and has the potential to improve student environmental literacy.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

P. Prasetiyo: writing original draft preparation, methodology, analysis, revision and editing. **M. H. I. Al Muhdhar:** methodology, draft review, and editing. **I. Ibrohim:** methodology, draft review, and editing. **M. Saptasari:** methodology, draft review, and editing.

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