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Development of a project-based home materials model in science learning to enhance students' creative disposition

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Abstract

This study develops and evaluates the feasibility of a Project-Based Home Materials (PjBL-HM) model in science learning to enhance students' creative disposition at the elementary level. Creative disposition—comprising inquisitiveness, persistence, imagination, collaboration, and discipline—is a crucial 21st-century competence. However, conventional science instruction often lacks contextualization, active engagement, and opportunities for creative thinking. The PjBL-HM model integrates household materials into science projects, providing a low-cost and locally relevant alternative for schools with limited laboratory infrastructure. Employing the Educational Design Research (EDR) method, the model was validated by experts and tested with 28 fifth-grade students for practicality, and with two groups (VA and VB, 28 students each) for effectiveness. Data were collected through expert validation sheets, observation checklists, student questionnaires, and pre-/post-tests using a creative disposition scale. Results showed that the model had high levels of content and construct validity (average scores of 3.87 and 3.85, respectively). The practicality test yielded an average score of 4.27, indicating strong student engagement and ease of implementation. The effectiveness analysis based on N-gain scores implied that the experimental group (VA) achieved a higher mean N-gain (0.76) than the control group (VB) (0.45), indicating a substantially greater improvement in students' creative disposition. These findings indicate that the PjBL-HM model is valid, practical, and effective in fostering creative dispositions through contextualized, project-based science learning using everyday materials.

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1. Introduction

Creative disposition is a fundamental component of 21st-century science education, particularly at the elementary level, where students are expected not only to master content knowledge but also to develop creative thinking, problem-solving, and collaborative skills. However, conventional instructional models that emphasize lectures and rote memorization often restrict students' opportunities to think creatively and independently. Such approaches fail to provide sufficient space for exploration, inquiry, and authentic problem solving, thereby hindering the development of students' higher-order thinking skills (Wang, 2021; Efendi & Prima, 2020; Cheung & Hui, 2023).

This situation is further exacerbated in underprivileged schools, where limited learning facilities restrict students' access to direct experimental activities. Many elementary schools, particularly those in remote or economically disadvantaged areas, lack the basic infrastructure necessary to support meaningful science learning. As a result, the learning process tends to become passive, and students' understanding of scientific concepts remains limited (McNair et al., 2021). Consequently, science education at the elementary level has not yet fully supported the development of students' creative dispositions, including inquisitiveness, persistence, imagination, collaboration, and discipline.

Creative disposition is also closely related to students' self-confidence and engagement. Learners who are encouraged to explore new ideas and persist in facing challenges tend to demonstrate stronger problem-solving skills and greater adaptability within dynamic learning environments. Research has proven that education fostering creativity helps students become more flexible and intrinsically motivated in their learning (Akpur, 2024; Payne & Grant-Smith, 2023). An open and supportive classroom climate, in which students feel safe to take risks, make mistakes, and learn from failure, constitutes a crucial element in nurturing creativity (Kang, 2020).

To address these challenges, innovative instructional models such as Project-Based Learning (PjBL) have been increasingly adopted. PjBL is an inquiry approach that bridges theory and practice by engaging students in authentic projects, enabling them to conduct scientific investigations, design experiments, and present findings within meaningful contexts. This model fosters collaboration, independent learning, and reflection, all essential elements for developing creativity (Sukarso et al., 2022; Wang, 2021). When implemented effectively, PjBL has been demonstrated to enhance students' critical and creative thinking skills and their overall learning outcomes.

One promising innovation within PjBL is the integration of home materials, namely the use of household items as primary resources for science learning. Utilizing simple materials makes science education more accessible, affordable, and relevant to students' everyday lives. This approach enables learning to take place beyond the formal school environment, strengthening the connection between scientific concepts and real-world experiences (Holle & Miller, 2021; Kitanovska-Kimovska et al., 2023). By engaging students in science projects using readily available materials at home, educators can create direct, applied learning experiences that foster creativity, independence, and environmental awareness. This approach is also aligned with the values of sustainability, as it encourages the reuse of household items and reduces reliance on costly tools and laboratory equipment (Bouckaert, 2023).

Nevertheless, the implementation of PjBL in elementary schools continues to face various challenges, particularly limited teacher competence in designing innovative instruction and a lack of appropriate teaching resources and materials. Many teachers have not received sufficient training in managing interdisciplinary, problem-oriented projects, which reduces the effectiveness of PjBL in fostering students' creative dispositions (Payne & Grant-Smith, 2023; Safa et al., 2021). Therefore, there is a need for a PjBL model based on home materials that is feasible, practical, and effective, and aligned with the contextual realities of elementary education in Indonesia.

This study develops and evaluates the feasibility of a Project-Based Home Materials (PjBL-HM) model to enhance students' creative dispositions in science learning. The model is expected to serve as a practical and contextually relevant solution that promotes exploration-based learning, strengthens the connection between science and real-life experiences, and supports the holistic development of students' character and creative skills.

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2. Literature review

2.1 Project-based learning

Project-Based Learning (PjBL) is a student-centered instructional approach that positions projects as the core of the learning process, enabling the development of knowledge, skills, and attitudes through exploration and synthesis of information (Sulistyo & Waluyo, 2019). PjBL encourages students to confront real-world challenges and strengthens interdisciplinary learning (Mutanga, 2024), and positions them as active participants (Shpeizer, 2019), thereby creating a learning environment conducive to fostering creative dispositions such as inquisitiveness, divergent thinking, and persistence.

Based on a cognitive perspective, PjBL has been demonstrated to strengthen scientific literacy (Mims et al., 2025), support scientific inquiry and enhance higher-order thinking skills, as well as creativity (P. He et al., 2023). These conditions directly encourage students to think originally, seek innovative solutions, and develop resilience as part of their creative dispositions. Moreover, engagement in contextual projects has been proven to increase motivation, self-efficacy, and enjoyment in learning, while also reinforcing students' science identity (Al-Kamzari & Alias, 2025; Rehman et al., 2025; Zhang & Ma, 2023). Compared to traditional approaches, PjBL is more effective in improving learning outcomes, affective attitudes, and critical thinking skills (Nursalim et al., 2024), thereby creating exploratory spaces that foster creativity. Best practices in PjBL include small-group collaboration (Hsu, 2020), integration of technology, and connecting projects with the community (Schneider et al., 2022), all of which strengthen students' creative thinking and problem-solving competencies (Krajcik & Czerniak, 2018).

The implementation of PjBL also faces several challenges, such as the cultural shift required from traditional learning models, issues in collaboration (Günzel & Brehm, 2024), and the tension between the depth and breadth of subject matter (J. Zhang et al., 2023). Nevertheless, the literature provides strong evidence that PjBL holds significant potential to support the systematic and contextual development of creative dispositions in elementary science education.

2.2 Project-based home materials

Project-Based Learning (PjBL) is a student-centred instructional model that promotes active learning by engaging students in real-world projects. Through inquiry-based activities, PjBL facilitates the development of knowledge, skills, and attitudes relevant to both academic content and future careers (Shpeizer, 2019; Y.-H. Wang, 2020). The integration of PjBL with home materials has gained attention for its potential to enhance science learning by making it more practical, accessible, and contextually relevant.

Several defining features characterize the effectiveness of PjBL. Firstly, student autonomy is central to PjBL, enabling learners to take ownership of their learning, develop independence, and self-regulate throughout the process. Secondly, collaboration is a foundational component in which students work in groups and cultivate interpersonal skills such as communication, leadership, and teamwork. Thirdly, real-world relevance is emphasized, as PjBL projects are often designed to address authentic problems, thereby increasing the meaningfulness and applicability of the learning process (Kokotsaki et al., 2016; Thabethe & Mwambakana, 2025). Furthermore, inquiry-based learning serves as the core pedagogical approach within PjBL, allowing students to develop critical thinking and problem-solving competencies through exploration and guided investigation (Y.-H. Wang, 2020).

The integration of home-based materials within PjBL offers multiple educational benefits. One primary advantage is practical application. When students use household items in science-related tasks such as building physics models, they bridge the gap between theory and practice, fostering a more concrete understanding of scientific concepts. Moreover, home materials enhance accessibility, as they are widely available and reduce dependency on specialized resources, thereby promoting inclusivity and equity in learning opportunities (Günzel, 2024). This approach also nurtures creativity and innovation, as students must find novel ways to utilize everyday items, a process that encourages divergent thinking and resourcefulness. Research highlights several pedagogical advantages of combining PjBL with home materials. Students exhibit a deeper understanding of subject matter when engaged in hands-on, practical projects. The method also contributes to the development of critical 21st-century skills, such as collaboration, communication, and time management. Additionally, real-world relevance and tangible learning experiences serve to elevate student engagement and motivation, both of which are crucial for sustained academic interest (Thabethe & Mwambakana, 2025; L. Zhang & Ma, 2023).

Despite its benefits, implementing integrative PjBL faces notable challenges. Resource constraints may limit students' access to suitable materials, demanding institutional creativity and support to ensure equitable participation. Furthermore, group dynamics can sometimes hinder effective collaboration, with issues such as unequal workload distribution requiring structured group management strategies (Günzel & Brehm, 2024). Another critical consideration is balancing teacher guidance with student autonomy. Educators must scaffold learning while still allowing students the freedom to explore, fail, and iterate independently. Several strategies can support the successful adoption of integrative PjBL. Structured scaffolding is essential for guiding students through the inquiry process and ensuring learning progression. Leveraging technology such as digital tools, virtual simulations, and multimedia resources can further enrich the learning experience and compensate for material limitations (Shpeizer, 2019; Coyne et al., 2016). Additionally, encouraging regular reflection throughout the project fosters metacognitive awareness, deeper understanding, and personal growth.

The literature underscores the promise of integrating PjBL with home materials as an effective and inclusive strategy for enhancing science education. This approach not only deepens conceptual understanding and promotes essential skill development but also makes learning more engaging and personally relevant. However, to realize its full potential, educators must consider contextual challenges and apply thoughtful pedagogical designs that balance structure with student agency.

2.3 Creative disposition

Creative disposition refers to a relatively stable tendency or mental attitude that drives individuals to think, behave, and act creatively across various situations. According to the 4P Creativity Model framework (Lucifora et al., 2025), creativity can be understood through four dimensions: person (individual characteristics), process (mechanisms of creative thinking), press (supportive environment), and product (creative outcomes). In this context, creative disposition is primarily associated with the person dimension, encompassing personality traits, motivation, values, and attitudes that facilitate the emergence of creativity (Kang, 2020)

In general, creative disposition is characterized by traits such as openness to experience, cognitive flexibility, curiosity, nonconformity, willingness to take intellectual risks, and intrinsic motivation to explore new ideas (Penagos-Corzo & Saucedo, 2021; Szorc, 2020). Individuals with a high level of creative disposition tend to generate ideas that are both novel and useful, consistent with the psychological definition of creativity. Both internal and external factors influence creative disposition. At the individual level (child-level variables), aspects such as tolerance for ambiguity, confidence in one's ideas, and persistence in problem-solving contribute significantly. At the environmental level (teacher-level variables), teaching style, teachers' attitudes toward creativity, and the level of support in the learning environment play crucial roles (Kang, 2020).

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From a positive psychology perspective, creative disposition is also associated with dispositional mindfulness—the ability to be fully present in the moment —which can enhance psychological capital (PsyCap), a construct comprising optimism, self-efficacy, resilience, and hope. These factors serve as mediators in strengthening creative motivation and ideational performance (W. He, 2024). In addition, creative confidence, or the belief in one's ability to generate creative ideas, is also a vital component of creative disposition (Álvarez-Huerta et al., 2022).

Several instruments have been developed to measure creative disposition, including the Measurement Tool of Creative Disposition for Teachers in Early Childhood Education (Kang, 2020), the Creative Behaviour Questionnaire KANH (Szorc, 2020), the Traits of Creative Potential Questionnaire (TCPQ-12), which assesses exploratory orientation, flexibility, and self-motivation (Penagos-Corzo & Saucedo, 2021), and the Marmara Creative Thinking Dispositions Scale (Akpur, 2024). These instruments generally assess a combination of cognitive (e.g., fluency, originality, and elaboration) and characterological (e.g., motivation, risk-taking attitudes, and persistence) dimensions.

Creative disposition can be viewed not merely as the ability for divergent thinking, but also as a mindset, a set of values, and an internal drive that influences an individual's tendency to continuously seek new solutions and transform ideas into something useful. A deep understanding of creative disposition is crucial in education, particularly in Project-Based Learning, as it lays the foundation for innovation and the successful implementation of creative ideas in real-world contexts.

3. Method

This study employed a research-and-development design using the Educational Design Research (EDR) approach. EDR combines practical problem-solving with theoretical investigation, making it a valuable methodology for advancing both educational theory and practice. Its iterative, collaborative, and real-world-oriented nature ensures that the solutions developed are effective and grounded in authentic educational contexts (McKenney & Reeves, 2021; Jacobsen & McKenney, 2024). The Educational Design Research (EDR) process in this study comprised four phases: needs analysis, intervention design, implementation, and evaluation. In the needs analysis, classroom observations and teacher interviews were conducted to identify key instructional problems, particularly limited experimental activities and low levels of students' creative disposition. These findings informed the design requirements for a low-cost, context-based learning model. In the intervention design, a prototype of the PjBL-HM model was developed based on the needs analysis and relevant learning theories. The prototype was validated by subject-matter and media experts and subsequently revised. The implementation phase involved applying the revised PjBL-HM model in classes V through project-based learning supported by teacher scaffolding, along with a student practicality test to capture learners' responses to the model. In addition, the evaluation phase examined the model's effectiveness using a quasi-experimental pretest–posttest design. This approach allows researchers to understand the contexts and challenges faced by practitioners while generating knowledge that can be used to improve educational practice (McKenney, 2024).

The subject of this developmental research was the PjBL-HM model in science learning, designed to enhance students' creative dispositions. The model was implemented with elementary students at SDN 1 Bayumulek, West Lombok Regency. For the practicality test, 28 students from class VA participated, while the effectiveness test was conducted with two classes, VA and VB, each consisting of 28 students.

The data collection instruments included a model validation sheet, a practicality questionnaire, and a creative disposition questionnaire, all administered during the effectiveness test. The model validation sheet was used to assess both content validity and construct validity. Content validity assesses the model's currency and the strength of its theoretical and empirical foundations. Construct validity, on the other hand, assesses the consistency of the model's components. The instruments for assessing content and construct validity are presented in Table 1.

Table 1. Instruments for content and construct validities

Content Validity Components	Construct Validity Components
Relevance of content	Consistency of Model Components
Alignment with curriculum	Alignment with Learning Theories
Connection to local context (home materials)	Coherence Across Steps
Scientific accuracy	Integration of the Model
Integration of science and local wisdom	Flexibility of Implementation
Active student engagement	Empowerment through the Model
Suitability to student characteristics	Clarity of Model Design
Meaningfulness of learning	

The practicality test instrument consists of a questionnaire administered to students after the limited trial of the PjBL-HM model. The questionnaire includes five aspects: (1) the model is easy to understand, (2) the instructions are easy to follow, (3) the activities are enjoyable, (4) the materials are relevant to the students' environment, and (5) the implementation time is appropriate. In addition, classroom observations were conducted to determine the feasibility of implementing the PjBL-HM model. For the effectiveness test, a creative disposition questionnaire was administered before (pre-test) and after (post-test) the learning activities. The instrument items for measuring students' creative dispositions are presented in Table 2.

Table 2. Creative disposition instrument

No	Creative Disposition Indicators	Item Number
1	Inquisitive	1-12
2	Persistent	13-24
3	Imaginative	25-36
4	Collaborative	37-48
5	Dicipline	49-60

The validity of the learning model is analyzed using a qualitative descriptive technique. Validation scores from the expert evaluators are categorized into four levels: highly valid, valid, less valid, and invalid. The final validation score for each aspect was determined based on the mode score from three (3) validators (Erman et al., 2022). Data analysis for model implementation was conducted using a qualitative descriptive approach, while students' responses from the practicality test questionnaire were analyzed descriptively. The effectiveness test data are analyzed using a difference test to assess the impact and consistency of the learning model on students' creative dispositions. Specifically, the analysis compares the mean N-gain scores of creative dispositions between the two classes, employing an independent t-test for statistical verification.

4. Results

As part of the development process for the PjBL-HM model, expert validation was conducted to assess the learning model's content feasibility. This validation encompassed several key aspects, including the relevance of the material to learning objectives, alignment with the curriculum, connection to the local context, scientific accuracy, and the meaningfulness of learning for students. The evaluation also considered students' active engagement, the integration of science with local wisdom, and the suitability of the model for elementary school learners' characteristics. The experts carried out the assessment using an instrument designed on the basis of indicators of relevance, coherence, and content accuracy. The results of the content validation are presented in Table 3 below.

Table 3. Content validation results of the project-based home materials model

No	Content Aspects	Assessment Indicators	Score	Category
1	Relevance of Content	The learning material aligns with the established basic competencies/learning objectives.	4	Highly valid
2	Alignment with Curriculum	The model supports achieving the national curriculum (e.g., *Kurikulum Merdeka* or Curriculum 2013).	4	Highly valid
3	Connection to Local Context (Home Materials)	The material utilizes locally relevant resources accessible to students.	4	Highly valid
4	Scientific Accuracy	The content and activities are consistent with valid scientific principles and knowledge.	4	Highly valid
5	Integration of Science and Local Wisdom	The model integrates scientific concepts with cultural/local values that shape students' character.	4	Highly valid
6	Active Student Engagement	The model enables students to be actively engaged in discovering, problem-solving, and exploring the material.	4	Highly valid
7	Suitability for Student Characteristics	The material is adapted to students' cognitive and social developmental levels.	3	Valid
8	Meaningfulness of Learning	Learning through the model provides students with meaningful experiences.	4	Highly valid
		Average	**3.87**	**Highly valid**

The content validation results for the PjBL-HM model, presented in Table 3, demonstrate an average score of 3.87, indicating very valid. Almost all aspects imply very high ratings, particularly content relevance, curriculum alignment, connection to the local context, scientific accuracy, and meaningfulness of learning. This indicates that the model aligns well with curriculum requirements and can provide students with science learning that is both contextual and meaningful. However, one aspect requiring further attention is its suitability to student characteristics, which is rated as valid, suggesting the need for refinement to achieve optimal effectiveness.

In addition to content validation, construct validation was also conducted to ensure the consistency and coherence of the PjBL-HM model design. The aspects evaluated included the suitability of model components, alignment with learning theories, step coherence, integration of elements, implementation flexibility, empowerment through the model, and clarity of design. The results of the construct validation are presented in Table 4 below.

Table 4. Construct validation results of the project-based home materials model

No	Content Aspects	Assessment Indicators	Score	Category
1	Consistency of Model Components	Each component of the model (objectives, syntax, teacher/student roles, evaluation) supports the others and forms a coherent whole.	4	Highly valid
2	Alignment with Learning Theories	The model refers to relevant learning theories (e.g., constructivism, PjBL, contextual learning).	3	Valid
3	Coherence Across Steps	The sequence of learning steps is logical and continuous.	4	Highly valid
4	Integration of the Model	The integration of content, approach, media, and assessment mutually supports the learning objectives.	4	Valid
5	Flexibility of Implementation	The model allows adaptation across various home-learning contexts and student locations.	4	Highly valid
6	Empowerment through the Model	The model provides opportunities for students' active and creative empowerment.	4	Highly valid
7	Clarity of Model Design	The model components are explained systematically, in detail, and are easy to understand.	4	Highly valid
		Average	**3.85**	**Highly valid**

The construct validation results in Table 4 indicate an average score of 3.85, which is categorized as highly valid. Most aspects, such as consistency of model components, coherence across steps, flexibility of implementation, empowerment through the model, and clarity of design, are rated as highly valid. Meanwhile, the aspects of alignment with learning theories and model integration are rated as valid, indicating the need for further refinement. Overall, these findings confirm that the PjBL-HM model has a systematic, consistent, and flexible structure that supports science learning at the elementary level.

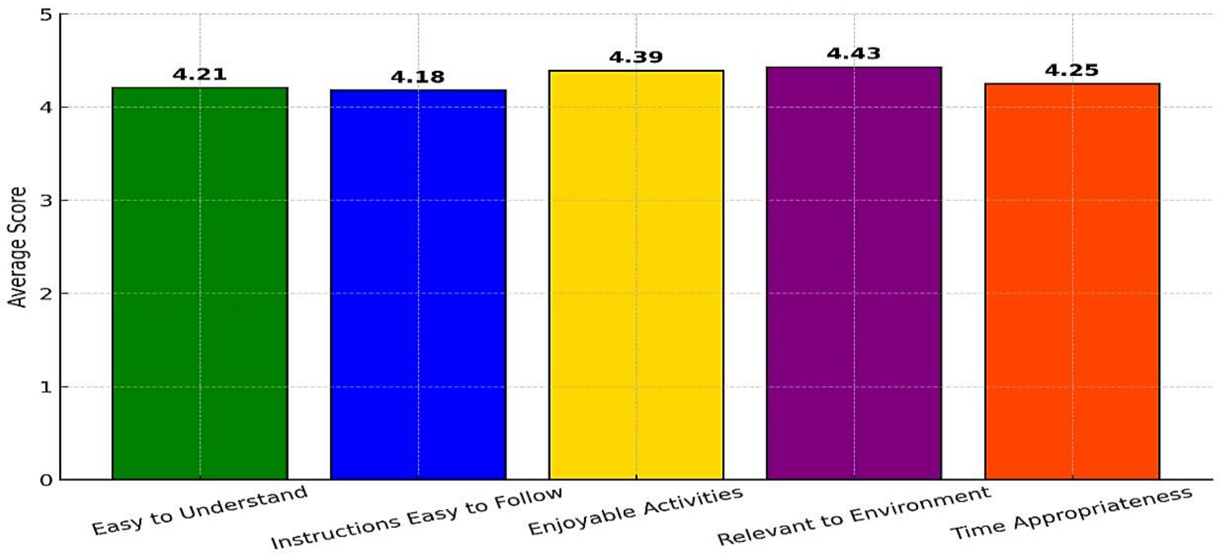

Figure 1. Practicality test results of the project-based home materials model

In addition to content and construct validity, this study also examined the practicality of the PjBL-HM model through students' responses following its limited classroom implementation. Practicality is considered essential, as it determines the extent to which the model can be

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understood, followed, and implemented easily by learners in real learning contexts. The assessment covered five indicators: ease of understanding the model, clarity of instructions, enjoyment of activities, relevance to students' environment, and adequacy of implementation time. The practicality results also indicated that students not only found the learning activities easy to follow but also experienced them as meaningful and enjoyable. The results of the practicality test are illustrated in Figure 1.

The practicality test results presented in the graph illustrate that all aspects achieved high average scores, ranging from 4.18 to 4.43. These findings reveal that the PjBL-HM model is not only valid in terms of content and construct but also practical for implementation, as it provides a learning experience that is enjoyable, easy to follow, and relevant to students' everyday lives.

To examine the effectiveness of the PjBL-HM model in enhancing students' creative dispositions, a comparative test was conducted using pre-tests and post-tests in the experimental class (VA) and the control class (VB). This test was to determine the extent to which implementing the model influenced the development of creative dispositions, including inquisitiveness, persistence, imagination, collaboration, and discipline. The following graph illustrates the differences in students' creative disposition scores before and after the intervention, thereby depicting the improvement in creative disposition across both groups. The distribution of pre-test and post-test scores for the experimental and control classes is presented in Figure 2.

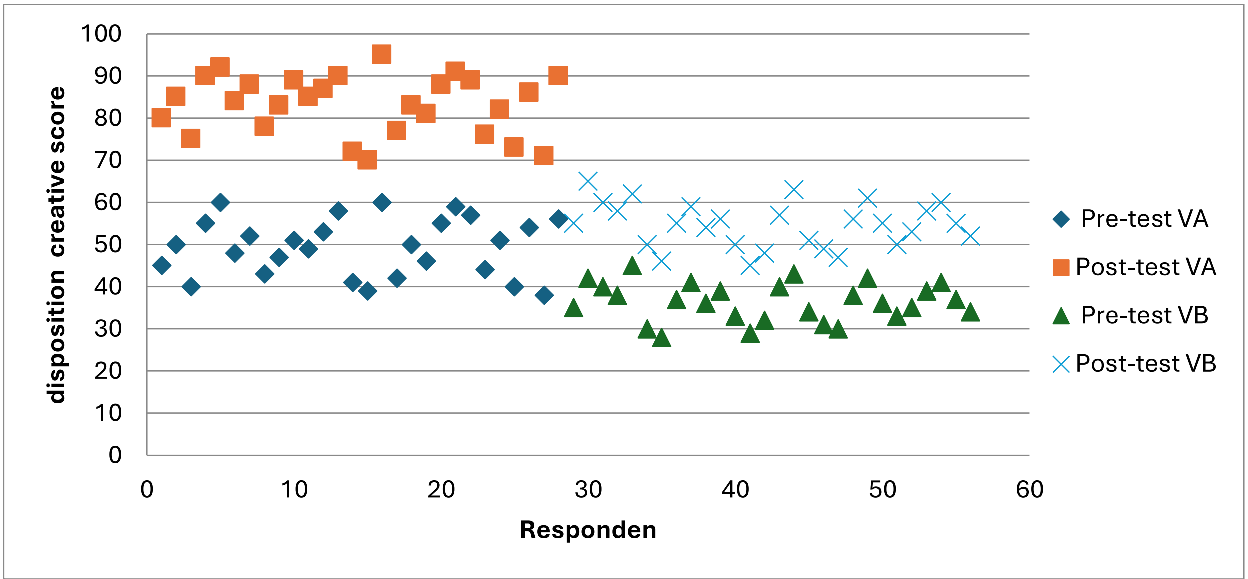

Figure 2. Distribution of pre-test and post-test scores in the experimental and control classes

The pre-test and post-test results for creative disposition reveal a significant improvement in the experimental class (VA) compared to the control class (VB). In class VA, students' pre-test scores range from 40 to 60 and consistently increase on the post-test, reaching from 70 to 95. This improvement indicates that implementing the PjBL-HM model effectively fosteres the optimal development of students' creative dispositions. In contrast, in class VB, which receives conventional instruction, pre-test scores range from 30 to 45 and indicate only a moderate increase in the post-test, reaching from 45 to 65. Although the improvement is observed, the gain is lower than that in class VA. Thus, these findings confirm that the PjBL-HM model is more effective than conventional teaching in enhancing elementary students' creative dispositions.

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The analysis of creative disposition indicators was conducted based on the mean scores for each indicator. The results of the N-gain analysis of creative disposition for each indicator are presented in Table 5.

Table 5. N-gain data of creative disposition for each indicator

Creative Disposition Indicators	VA		VB	
	N-gain	Category	N-gain	Category
Inquisitive	0.72	High	0.42	Low
Persistent	0.64	Medium	0.27	Low
Imaginative	0.76	High	0.25	Low
Collaborative	0.83	High	0.68	Medium
Disciplined	0.88	High	0.67	Medium
Average	0.76	High	0.45	Low

The N-gain analysis presented in Table 5 indicates a notable difference in the improvement of creative dispositions between the experimental class (VA) and the control class (VB). In class VA, almost all indicators fall into the high category, namely inquisitive (0.72), imaginative (0.76), collaborative (0.83), and disciplined (0.88). Only the persistent indicator falls into the medium category (0.64). This implies that implementing the PjBL-HM model effectively promotes students' overall development of creative dispositions, with the most pronounced impact observed in collaboration and discipline. Conversely, in class VB, which employs conventional teaching methods, the improvement in creative dispositions is relatively lower. The indicators inquisitive (0.42), persistent (0.27), and imaginative (0.25) are categorized as low, whereas collaborative (0.68) and disciplined (0.67) are categorized as medium. These findings indicate that while conventional instruction still produces positive effects, its effectiveness is considerably more limited than that of the PjBL-HM model.

5. Discussion

The development and implementation of the PjBL-HM model in science learning at elementary schools represents an innovation designed to address the challenges of 21st-century education. This model seeks to bridge the gap between scientific theory and students' real-world experiences by using simple, readily accessible household materials. The approach aligns with the principles of Project-Based Learning, which emphasize inquiry, collaboration, and problem-solving, while remaining relevant to the context of Indonesian elementary schools, where laboratory facilities are often limited (Retno et al., 2025). Therefore, PjBL-HM holds potential not only as a more contextualized and meaningful teaching strategy but also as a practical solution for enhancing the quality of science learning across diverse school settings.

Within the framework of educational research, the evaluation of a new model needs to be conducted comprehensively across three main dimensions: validity, practicality, and effectiveness. Validity ensures that the model is grounded in a strong theoretical, contextual, and structural basis. Practicality emphasizes the extent to which the model can be easily implemented and actively engage students in the learning process. Effectiveness, meanwhile, refers to the model's impact on meaningful learning outcomes, particularly in fostering creative dispositions such as inquisitiveness, persistence, imagination, collaboration, and discipline.

The content and construct validation of the PjBL-HM model yielded excellent results, with average scores of 3.87 and 3.85, respectively. These findings indicate a high level of consistency among experts regarding the relevance and clarity of the learning model. This is consistent with previous research emphasizing the importance of connecting learning to the local context and

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actively engaging students in science education (McNair et al., 2021; Hæsum et al., 2023). Experts noted that using household materials in science projects can enhance student engagement and facilitate a deeper understanding of scientific concepts through hands-on experiences (Zamith et al., 2020; Soroa et al., 2020). Construct validity is further reinforced by a coherent, flexible, and easily understandable instructional design. This demonstrates that the PjBL-HM model has a systematic learning structure that can be implemented across diverse classroom settings while maintaining the collaborative and reflective essence of the learning process (Deed et al., 2022).

A limited trial involving 28 students from class VA produced an average practicality score of 4.27, categorized as "practical." Student feedback indicated that the learning process was enjoyable and easy to follow, particularly because the materials used were familiar and readily available at home. This supports previous findings showing that materials relevant to students' everyday lives can enhance learning motivation (Holle & Miller, 2021). Active student engagement in contextualized activities demonstrated that the model effectively fosters sustained interest in science learning (Kitanovska-Kimovska et al., 2023). Furthermore, the high practicality indicates that PjBL-HM offers opportunities for both independent and collaborative learning. By utilizing household materials, students are freer to experiment, test new ideas, and develop creative solutions without being constrained by limited laboratory facilities. This aligns with the perspective that Project-Based Learning can enhance students' self-efficacy and confidence in mastering scientific concepts (Mehrotra et al., 2021). Moreover, enjoyable and real-life-based learning experiences not only promote short-term engagement but also nurture sustainable creative dispositions, such as inquisitiveness, persistence, and collaborative skills (Cheung & Hui, 2023). Therefore, the results of this practicality trial confirm that the PjBL-HM model is suitable for broader implementation, as it offers inclusive, contextualized science learning that motivates students to continuously explore scientific knowledge.

The pre-test and post-test results indicate that the PjBL-HM model is more effective than conventional teaching in enhancing elementary school students' creative dispositions. The significant improvement observed in the experimental class confirms that Project-Based Learning utilizing household materials can provide contextualized, meaningful learning experiences that align with students' everyday lives (Holle & Miller, 2021). These findings suggest that the PjBL model outperforms conventional instructional approaches in fostering creativity, engagement, and active learning (Defianty & Wilson, 2023; Rahmawati et al., 2023).

The N-gain analysis revealed that the collaboration (0.83) and discipline (0.88) aspects experienced the greatest improvements, indicating that PjBL-HM not only enhances cognitive aspects but also social skills such as teamwork, responsibility, and self-management (Kang, 2020). Meanwhile, the persistent indicator remained in the medium category (0.64), suggesting that perseverance requires habituation through repeated projects and a supportive learning environment (Payne & Grant-Smith, 2023). In contrast, most indicators in the control class fell into the low category, particularly inquisitive, persistent, and imaginative, indicating that conventional instruction provides limited opportunities for student exploration, questioning, and imagination (Y.-P. Wang, 2021). This interpretation is empirically supported by the substantially higher mean N-gain achieved by the experimental group (0.76) compared to the control group (0.45), indicating that the PjBL-HM model produced a markedly greater improvement in students' creative disposition than conventional instruction. The magnitude of this difference reveals that learning activities grounded in household-material-based projects provided more meaningful opportunities for inquiry, imagination, and collaboration, thereby enabling students to engage more actively in the learning process and to develop creative dispositions more effectively within a contextualized science learning environment. Therefore, PjBL-HM can be considered a more inclusive and contextual alternative for science learning, capable of supporting the development of students' creative dispositions (McNair et al., 2021).

The PjBL-HM model supports the development of various aspects of students' creative dispositions, including inquisitiveness, persistence, imagination, collaboration, and discipline. Through household-material-based projects, students are provided opportunities to experiment, take intellectual risks, and reflect on their learning processes, elements essential to creative and critical thinking (Nikiforidou & Jones, 2023). Additionally, the model's design naturally promotes learning autonomy and team collaboration. In group projects, students learn to negotiate, share responsibilities, and communicate ideas, skills that are vital in both educational and real-world contexts (Karakaya Cirit & Aydemir, 2023). This social dimension of creativity serves as an important facilitator for innovation at both individual and collective levels within the classroom.

The research findings reveal that the PjBL-HM model offers a feasible instructional alternative for elementary science learning, particularly in contexts with limited laboratory resources. Teachers are encouraged to integrate household materials into project-based activities to promote active engagement and the development of creative dispositions, especially collaboration and discipline. However, effective implementation requires deliberate instructional scaffolding, including clear project guidelines, structured group roles, and ongoing formative feedback. To address the moderate improvement observed in persistence, the model should be implemented across multiple project cycles with gradually increasing task complexity. These findings also imply the need for targeted professional development to support teachers in designing and managing contextualized project-based learning.

Despite its positive outcomes, this study has several limitations that warrant careful consideration. The research was conducted at a single elementary school with a relatively small sample, limiting the generalizability of the findings. Additionally, the reliance on self-report measures to assess creative disposition may introduce subjective bias. The quasi-experimental design and the short intervention duration further limit the ability to capture the long-term development of creative dispositions, particularly persistence. Future studies should involve larger and more diverse samples, employ longitudinal and experimental designs, and integrate multiple data sources, such as classroom observations and interviews, to provide a more robust evaluation of the PjBL-HM model. Further research may also explore integrating PjBL-HM with other pedagogical frameworks, such as STEAM or technology-enhanced learning, to assess its scalability and broader applicability in elementary science education.

6. Conclusion and implications

This study demonstrates that project-based home materials (PjBL-HM) is a valid, practical, and effective approach for science instruction at the elementary school level. Expert validation indicated that the model is particularly strong in terms of contextual relevance, curriculum alignment, and meaningful student activities. The model's practicality was further confirmed by positive student responses, with learners finding the activities enjoyable and easy to follow. Empirically, the model's effectiveness was evident in the significant improvement of creative dispositions in the experimental class compared to the control class. Specifically, the model fostered the development of five key dimensions of creative disposition—inquisitive, persistent, imaginative, collaborative, and disciplined—through project-based activities grounded in direct exploration with readily available household materials. As an Educational Design Research (EDR) product, the main research contribution is the development of a structured and replicable PjBL-HM model comprising learning syntax, defined teacher and student roles, household-material-based project activities, and assessment indicators aligned with five dimensions of creative disposition.

The model was effective in fostering students' inquisitiveness, imagination, collaboration, and discipline, while persistence requires implementation across multiple project cycles.

The research findings imply a significant contribution to advancing science education in elementary schools. First, the model supports an inclusive, contextual, and learner-centred approach to teaching and learning. Second, its success in enhancing students' creativity provides a strong foundation for integrating home material-based PjBL into the national curriculum.

Credit authorship contribution statement

Nanang Rahman: To develop a learning model, Methodology, Formal analysis, Data curation, and Conceptualization. **Nursina Sari: Project Administration, to assist in the effectiveness testing and data** curation. **Hafiza Abas**: help with finding relevant references and creating discussions.

Declaration of competing interest

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

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. Because the data include human participant information, they are not publicly available to protect participant privacy.

Ethical Declaration

This study was conducted in accordance with research ethics. Participation was voluntary, informed consent was obtained, and respondents' confidentiality was assured.

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Declaration of AI statement

An artificial intelligence (AI)–based tool, namely ChatGPT (OpenAI), was used in a limited manner to assist with grammatical refinement and improvement of writing clarity. The use of AI did not influence the scientific substance of the research. All manuscript content was thoroughly reviewed and approved by the authors, who take full responsibility for the accuracy and integrity of the work.

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