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DEVELOPMENT OF LKPD BASED ON PjBL WITH A DEEP LEARNING APPROACH TO IMPROVE STUDENTS' SCIENCE LEARNING OUTCOMES IN CLASS

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ABSTRACT
This study aims to develop a valid, practical, and effective Student Worksheet (LKPD) based on Project Based Learning (PjBL) with a Deep Learning approach to improve elementary school students' science learning outcomes. The novelty of this study lies in the integration of Project Based Learning syntax with a Deep Learning approach in developing LKPD to create more meaningful and student-centered learning. This study uses a Research and Development (R&D) method with a 4-D model that includes the Define, Design, Develop, and Disseminate stages. The study involved validator experts, learning practitioners, and fifth-grade students of SDN 101764 Bandar Klippa. Data were collected through interviews, questionnaires, and learning outcome tests, then analyzed descriptively quantitatively, N-Gain tests, and paired sample t-tests. The results of the study indicate that the developed LKPD meets the criteria of being valid, very practical, and effective and is able to improve students' science learning outcomes. Thus, LKPD based on PjBL with a Deep Learning approach is suitable for use as an open material to improve science learning outcomes in elementary schools.

INTRODUCTION
Natural and Social Sciences (IPAS) learning is one of the core subjects in the implementation of the Independent Curriculum in elementary schools, designed to develop critical thinking, problem-solving, and scientific skills through contextual learning. According to (Handayani, 2022), IPAS learning is no longer oriented towards procedural concept

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mastery but emphasizes the development of 21st-century competencies centered on students. However, the implementation of this goal still faces various challenges. The OECD (2023) report, based on the results of the Programme for International Student Assessment (PISA) 2022, shows that Indonesian students' literacy and numeracy skills are still low, with approximately 82% of students falling below level 2 in reasoning and problem-solving skills. This condition indicates that most students still experience difficulty connecting IPAS concepts to real-life phenomena (Nikmah, 2025).

These problems are exacerbated by the learning environment in elementary schools, which is still dominated by conventional approaches. Hidayatullah (2025) stated that the implementation of science and science learning has not been optimal because the learning process is still teacher-centered through lecture methods. This finding aligns with research by Nasution and Mustika (2025), which shows that low student involvement in scientific activities leads to difficulties in understanding concepts in depth. Furthermore, Evitasari et al. (2025) revealed that teachers still experience limitations in designing active, interactive learning that aligns with the characteristics of the Independent Curriculum. This problem was also found at SDN 101764 Bandar Klippa, where observations showed that students' cognitive learning outcomes only reached 40%, while psychomotor learning outcomes were 28%. These low achievements indicate that students have not received adequate opportunities to investigate, explore, and construct knowledge independently.

One factor contributing to the low quality of science learning is the limited use of teaching materials capable of facilitating active learning. Dewi and Pratama (2024) explain that learning still relies on textbooks, thus limiting students' opportunities to explore concepts independently. In fact, Student Worksheets (LKPD) have the potential as teaching materials that can guide students in conducting scientific investigations (Damayanti et al., 2022), improve scientific literacy (Ulliva & Prodjosantoso, 2025), and train higher-order thinking skills (HOTS) (Noprinda & Soleh, 2019). However, according to (Setyawan et al., 2025), most LKPDs used in schools still contain material summaries and practice questions that are mechanistic and therefore unable to encourage students to think critically, creatively, or reflect on their learning process. This condition indicates the need to develop LKPDs that not only present learning activities but also are able to build meaningful understanding.

One feasible alternative is to develop student worksheets (LKPD) that integrate the Project-Based Learning (PjBL) model with the Deep Learning approach. The PjBL model provides learning experiences through project completion related to real-life problems, thereby enhancing critical thinking, collaboration, and problem-solving skills. On the other hand, the Deep Learning approach emphasizes meaningful learning through conceptual understanding, reflection, and active student involvement in the learning process (Setyawan et al., 2025). Thus, the integration of these two approaches has the potential to produce a learning process that is not only oriented towards project completion but also encourages students to build in-depth understanding. The findings of (Hasruddin, 2018) also show that learning that connects real-life contexts with meaningful learning activities can enhance students' analytical skills and creativity.

Various previous studies have demonstrated that HOTS-based and contextual worksheets (LKPD) can improve student learning outcomes (Mariska & Trisnawati, 2025). Other studies have also shown that the implementation of the PjBL model is effective in improving learning activities and outcomes through project-based learning, while the Deep Learning approach can strengthen conceptual understanding, reflective skills, and create more meaningful learning experiences (Citra & Fithri, 2025). However, these studies still develop the two approaches separately. Research on PjBL-based LKPD generally focuses more on the project stage, while research on Deep Learning examines the implementation of learning approaches without integrating them into the LKPD design. Thus, there is still a research gap in the lack of an available LKPD for science and science that systematically integrates Project-Based Learning syntax with Deep Learning principles in a single learning product. This gap is the basis for the novelty of the research, namely developing PjBL-based LKPD with a Deep Learning approach as teaching material that is able to increase student involvement while deepening understanding of concepts in science learning.

Based on this description, this study aims to develop Student Worksheets (LKPD) based on Project-Based Learning with a Deep Learning approach in science and natural sciences learning in elementary schools, and to test the validity, practicality, and effectiveness of the developed product. The research results are expected to produce innovative teaching materials that support the implementation of the Independent Curriculum and provide empirical contributions for teachers in creating more meaningful, contextual, and student-centered science and natural sciences learning.

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METHOD

This research is a research and development (R&D) that aims to produce Student Worksheets (LKPD) based on Project Based Learning (PjBL) with a Deep Learning approach in fifth grade elementary school science learning. Product development refers to the 4-D model developed by Thiagarajan, Semmel, and Semmel which includes the stages of define, design, develop, and disseminate (Thiagarajan et al., 1974). The research was conducted at SDN 101764 Bandar Klippa in the even semester of the 2025/2026 Academic Year. Validators consisted of material experts, media experts, linguists, and learning practitioners selected based on their competence in assessing product quality. Trials were carried out in stages, namely individual trials (3 students), small groups (9 students), and field trials (25 students) according to the stages of research and development to obtain input and gradual product improvements.

The define stage includes needs analysis, student characteristics, curriculum, and learning materials. The design stage includes designing PjBL-based student worksheets (LKPD) with a Deep Learning approach, compiling research instruments, and developing evaluation tools. Next, in the develop stage, the product is validated by experts, revised according to the validator's suggestions, and then piloted with students to obtain data on the product's practicality and effectiveness. The disseminate stage is carried out through limited implementation in schools and dissemination of the product to teachers as an alternative teaching material. Data were collected using interviews, validation sheets, teacher and student response questionnaires, and learning outcome tests (pretest and posttest). All instruments were first validated through expert judgment before being used in the research.

Data analysis was conducted using quantitative descriptive methods. Validation data were analyzed using average scores to determine the level of product validity, while questionnaire data were analyzed using percentages to determine the level of practicality of the worksheet. Product effectiveness was analyzed using the Normalized Gain (N-Gain) test, while differences in learning outcomes before and after the use of the worksheet were analyzed using the Paired Sample t-test with the help of SPSS version 26 at a significance level of 0.05. Before the t-test was conducted, a normality test was first conducted using Shapiro Wilk to ensure the data met the assumptions of parametric analysis.

RESULT AND DISCUSSION

Results

Results of the Feasibility Validation of the PjBL-Based Student Worksheet with a Deep Learning Approach

To obtain an overview of the feasibility of the developed product, validation was conducted by material experts, language experts, and media experts. The validation process aimed to ensure that the PjBL-based Student Worksheet with a Deep Learning approach met the quality standards of teaching materials before being implemented in learning. A summary of the validation results is presented in Table 1:

Table 1. Summary of Final Results of the PjBL-Based Student Worksheet Validation with a Deep Learning Approach

Validation Aspect	Assessment Indicators	Validator 1 (%)	Validator 2 (%)	Average (%)	Category
Content	Content appropriateness, Project-Based Learning (PjBL)-based presentation feasibility, learning feasibility, and the Deep Learning approach	98.67	98	98.34	very worthy
Language	Suitability to students' developmental level, communicativeness, and coherence and consistency of the flow of ideas	96	80	88	very worthy
Media	Language use, material presentation, graphic design, and assessment	82.4	80.8	81.6	worthy

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Validation Aspect	Assessment Indicators	Validator 1 (%)	Validator 2 (%)	Average (%)	Category
	Overall average			**89.31**	**very worthy**

Source: Primary data processed by the author (2026)

Based on Table 1, it is known that all aspects of the assessment obtained a category of adequate to very adequate. The material aspect obtained an average percentage of 98.34% with a very adequate category, which indicates that the content of the material is in accordance with learning outcomes, student characteristics, PjBL syntax, and Deep Learning principles. The linguistic aspect obtained a percentage of 88.00% with a very adequate category, which indicates that the language used is communicative, appropriate to the developmental level of elementary school students, and has a coherent and easy-to-understand delivery flow. Meanwhile, the media aspect obtained a percentage of 81.60% with a decent category, which indicates that the LKPD display has met the presentation, graphical, and readability aspects so as to support the learning process. Overall, the average validation result reached 89.31% with a very adequate category, so that the developed LKPD is declared to meet the quality standards as teaching materials for use in science learning in elementary schools.

Results of the Practicality Test of PjBL-Based Student Worksheets with a Deep Learning Approach

The results of the study indicate that PjBL-based Student Worksheets with a Deep Learning Approach have a very high level of practicality. The practicality of the product was evaluated through assessments by educational practitioners, individual testing, small group testing, and field testing with students. A summary of the practicality test results is presented in Table 2:

Table 2. Summary of Practicality Test Results of PjBL-Based Student Worksheets with a Deep Learning Approach

Practicality Aspect	Respondents	Percentage (%)	Category
Educational Practitioner Evaluation	Grade V Teacher	94.4	Highly Practical
Individual Trial	3 Students	91.5	Highly Practical
Small Group Trial	9 Students	95	Highly Practical
Field Trial (Students' Responses)	25 Students	86.76	Highly Practical
Overall Average		**91.92**	**Highly Practical**

Source: Primary data processed by the author (2026)

Based on Table 2, it is known that all stages of the practicality test obtained a very practical category with an average percentage of 91.92%. The assessment of educational practitioners obtained a percentage of 94.40%, individual tests 91.50%, small group tests 95.00%, and field tests 86.76%. These results indicate that the developed LKPD is easy to use by teachers and students, has clear instructions, systematic presentation of materials, and easy-to-understand learning activities. Thus, LKPD based on PjBL with a Deep Learning approach is declared very practical and can be applied in learning sciences grade V elementary school.

Results of the Effectiveness Test of PjBL-Based LKPD with a Deep Learning Approach

The results of the study indicate that the use of PjBL-based student worksheets (LKPD) with a Deep Learning approach effectively improved the science learning outcomes of fifth-grade students at SDN 101764 Bandar Klippa. This effectiveness was demonstrated by the increase in students' average scores after participating in the learning using the developed LKPD. The average pre-test score of 61.76 increased to 91.04 on the post-test. Furthermore, classical learning completion also experienced a significant increase, from 32% before learning to 100% after using the LKPD. These results indicate that all students met the Learning Objective Achievement Criteria (KKTP) after participating in the learning process.

This improvement in learning outcomes was confirmed by the Normalized Gain (N-Gain) analysis, which obtained a score of 0.7749 or 77.49%, categorized as high. This value indicates that the improvement in learning outcomes is in the high category, indicating that the use of LKPD has a significant impact on mastery of the human respiratory system material.

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The effectiveness of the product was further strengthened by the results of the hypothesis test using a Paired Sample t-Test. The analysis showed a significance value (Sig. 2-tailed) of 0.000, lower than the 0.05 level of significance. Furthermore, the calculated t-value was -10.046, indicating a significant difference between the pretest and posttest results. Therefore, the alternative hypothesis (H_a) was accepted, indicating that the use of PjBL-based student worksheets with a Deep Learning approach significantly improved students' science learning outcomes.

In addition to the improvement in learning outcomes, the standard deviation also decreased from 17.743 in the pretest to 7.705 in the posttest. These results indicate that students' abilities became more evenly distributed after participating in the learning process. Therefore, the developed student worksheets not only improved learning outcomes but also reduced the ability gap between students within the class.

Discussion

Discussion of the Results of the Validation of the Feasibility of the PjBL-Based Student Worksheet with a Deep Learning Approach

The results of the study indicate that the PjBL-based Student Worksheet with a Deep Learning approach has met the criteria of being highly suitable for use in science learning in elementary schools. This high level of suitability is due to the systematic development process using the 4-D model: define, design, develop, and disseminate. In the define stage, an analysis of learning needs, student characteristics, the curriculum, and the materials to be developed is conducted to ensure that the resulting product aligns with real-world conditions in schools. Next, in the design stage, a Student Worksheet is drafted that integrates PjBL syntax with Deep Learning principles. The developed product is then validated by experts in the develop stage and refined through a revision process based on various input provided. These stages contribute to improving the quality of the material content, presentation of illustrations, use of language, and systematically structured learning activities, making the Student Worksheet easier to use for both teachers and students (Sibarani, 2024).

The results of this study reinforce the opinion of (Purwasi & Fitriyana, 2020), who stated that expert validation is a crucial stage in development research and development to ensure that a learning tool meets the appropriateness of content, presentation, language, and graphics before being implemented in the learning process. Through this validation process, various product weaknesses can be identified early on so they can be corrected before use in the trial phase. Therefore, the high validation results in this study indicate that the developed Student Worksheets (LKPD) meet quality standards as suitable teaching materials for use in science and science learning.

The findings of this study also align with those of (Dewi, 2023), who stated that PjBL-based learning tools have a high level of suitability after undergoing expert validation. Research by (Zusniarni, 2024) also showed that PjBL-based Student Worksheets were deemed valid because they presented material systematically, used easy-to-understand language, and provided learning activities that encouraged student engagement. These similar results indicate that the PjBL model is an effective approach to developing teaching materials because it guides students' learning through structured activities oriented toward solving real-world problems.

However, this research differs from previous studies. Most previous studies have only developed worksheets (LKPD) based on the PjBL syntax without integrating a Deep Learning approach into the learning activities. In this study, each stage of the project not only directs students to produce a product but is also designed to enable students to understand concepts more deeply through observing, asking questions, investigating, discussing, reflecting on learning outcomes, and relating the material to problems encountered in everyday life. Thus, students not only understand the concept of the human respiratory system but also understand the scientific reasons behind each phenomenon studied.

The integration of PjBL syntax and the Deep Learning approach is a key advantage of the developed worksheets. The PjBL syntax provides opportunities for students to learn through direct experience in completing projects, while the Deep Learning approach helps students build deeper conceptual understanding through meaningful, mindful, and joyful learning. The combination of these two approaches ensures that the learning process is not only oriented towards completing tasks but also encourages students to think critically, connect concepts to real-life experiences, and reflect on their learning outcomes.

These characteristics align well with the objectives of science learning in the Independent Curriculum, which emphasizes active, contextual, and student-centered learning. Through the developed student worksheets (LKPD), students have the opportunity to construct knowledge through inquiry, collaboration in groups, communication of project results, and

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reflection on their learning experiences. These activities enable students to gradually build understanding, making the acquired knowledge more meaningful and lasting compared to learning that focuses solely on the delivery of information by the teacher.

Based on this description, it can be concluded that the developed student worksheets based on the PjBL (Problem-Based Learning) approach not only meet the eligibility criteria as teaching materials, based on expert validation, but also possess characteristics that support more active, contextual, and meaningful science learning. These results demonstrate that integrating the PjBL model with the Deep Learning approach can produce innovative and relevant learning tools to support the implementation of the Independent Curriculum in elementary schools.

Discussion of the Practicality of PjBL-Based LKPD with a Deep Learning Approach

The high level of practicality indicates that the developed Student Worksheets (LKPD) meet the needs of both teachers and students. From the teacher's perspective, the LKPD was deemed to have clear instructions, systematic presentation of the material, easy-to-understand language, and learning activities appropriate to the learning environment at school. Meanwhile, from the student perspective, the LKPD was deemed engaging because it included relevant illustrations, sequential steps, and learning activities that encouraged active engagement throughout the learning process. These conditions facilitated students' ability to follow each stage of the learning process without experiencing difficulty understanding the instructions.

The results of this study indicate that the practicality of a teaching material is influenced not only by its attractive appearance but also by the appropriateness of the content, language use, instructions, and learning activities to the characteristics of the students. The LKPD in this study used simple, communicative language, and the activity steps were structured step by step, making them easily understood by elementary school students. Furthermore, each learning activity was designed to help students understand the material through direct learning experiences, thus making the learning process more focused and less confusing.

The practicality of the Student Worksheet (LKPD) is also supported by the systematic implementation of the PjBL syntax. Each learning activity begins with the presentation of a problem related to everyday life, then students are directed to discuss, gather information, carry out projects, present work results, and reflect on the learning process. This sequence of activities helps teachers manage learning because each stage is clearly structured in the LKPD. Furthermore, students receive guidance that makes it easier for them to understand what to do at each stage of learning, thus making learning activities more structured.

The Deep Learning approach integrated into the Student Worksheet (LKPD) contributes to the high level of practicality of the product. Learning not only focuses on completing projects, but also provides opportunities for students to understand concepts more deeply through activities such as observing, asking questions, discussing, connecting material to everyday experiences, and reflecting on learning outcomes. These activities help students build understanding based on learning experiences, making the material easier to understand and more meaningful.

The results of this study align with those of (Fatimah, 2024), who stated that Student Worksheets (LKPD) based on Project-Based Learning (PjBL) can improve the practicality of learning by providing clear instructions, systematic activities, and increasing student engagement during the learning process. Research by (Tarisna et al., 2023) also showed that the use of Student Worksheets (LKPD) based on Project-Based Learning (PjBL) received an excellent response from students because it created more active, engaging learning and facilitated student understanding. These similar results demonstrate that the Project-Based Learning (PjBL) model is an effective approach for producing teaching materials that are easy to use for both teachers and students.

However, this study differs from previous research. Generally, PjBL-based student worksheets (LKPD) emphasize project completion as the final learning outcome. Meanwhile, the LKPD developed in this study integrates Deep Learning principles at every stage of the learning process. Students are not only asked to complete projects but are also guided to understand concepts, connect the material to everyday life, express opinions, engage in discussions, and reflect on the learning process. This integration makes the LKPD not only easy to use but also capable of creating a more meaningful learning experience.

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The positive responses from teachers and students during the trial demonstrated that the Student Worksheet (LKPD) successfully created more active, student-centered learning. The teacher acted as a facilitator, guiding students through each stage of the project, while students actively observed, discussed, collaborated, solved problems, and presented their work. This created a more interactive learning environment, thereby increasing student motivation to participate.

Furthermore, the high student response rate demonstrated that the LKPD was able to enhance learning motivation. The presentation of material linked to real-life problems and the use of simple project activities made students feel that science learning was more relevant to their lives. As a result, the learning process became more enjoyable, less monotonous, and maintained students' attention throughout the learning process.

Based on this description, it can be concluded that the PjBL-based LKPD with a Deep Learning approach has a very high level of practicality. This practicality is reflected in its ease of use by teachers, its ease of understanding by students, and its ability to create active, engaging, and meaningful learning. Thus, the developed LKPD is suitable for use as an alternative innovative teaching material to support the implementation of science and science learning in accordance with the characteristics of the Independent Curriculum in elementary schools.

Discussion of the Effectiveness of PjBL-Based LKPD with a Deep Learning Approach

Improved student learning outcomes occur because the learning process implemented through Student Worksheets (LKPD) provides opportunities for students to actively construct knowledge. In each learning activity, students not only read material or answer questions, but also observe phenomena, identify problems, discuss in groups, conduct simple investigations, complete projects, present results, and reflect on the learning they have undertaken. These activities encourage students to be directly involved in the learning process, so that the concepts learned are not merely memorized but understood through real-life learning experiences.

The PjBL model plays a role in providing contextual learning experiences. Through project completion, students learn to connect concepts about the human respiratory system with phenomena encountered in everyday life. This type of learning helps students understand the benefits of the material being studied, making the knowledge gained more meaningful. When students find their own answers to problems through project activities, their understanding of the concepts becomes stronger than if they only receive explanations from the teacher.

On the other hand, the Deep Learning approach strengthens the learning process by emphasizing conceptual understanding, critical thinking skills, and reflection. Students are not only guided to obtain correct answers but also to understand the scientific reasoning behind each concept learned. Through this deeper thinking process, students are able to connect new knowledge with previous experiences. This makes the material learned easier to understand, retains longer in memory, and is easier to apply to different situations.

The results of this study align with research by (Sari, 2026), which stated that implementing the Project-Based Learning (PjBL) model can improve science learning outcomes because students gain hands-on learning experiences through project completion. Research by (Renanda et al., 2025) also showed that project-based learning has a positive influence on concept mastery because students are actively involved in the learning process. These similar results indicate that the Project-Based Learning (PjBL) model is an effective learning model for improving student learning outcomes, particularly in science in elementary schools.

In addition to aligning with previous research, the results of this study also support the view of (Rezeqi & Hartono, 2024), who stated that the Deep Learning approach encourages students to learn meaningfully, mindfully, and joyfully. Meaningful learning helps students understand the relationship between subject matter and real life. Mindful learning encourages students to think critically about every piece of information they receive, while joyful learning creates a learning environment that makes students more motivated to participate in each learning activity. These three principles were evident during the implementation of Student Worksheets (LKPD), when students actively discussed, collaborated, expressed their opinions, and presented project results without relying solely on the teacher.

One important finding of this study was the equitable distribution of student learning abilities, as indicated by a decrease in the standard deviation from 17.743 in the pretest to 7.705 in the posttest. This decrease indicates that student abilities have become more homogeneous after participating in the learning process. In other words, the use of Student Worksheets not only increased the class average but also reduced the ability gap between students. Students who previously

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had low learning outcomes experienced significant improvements, enabling them to achieve learning mastery alongside other students. This finding demonstrates that the developed worksheets (LKPD) can accommodate differences in learning abilities through collaborative activities, group discussions, and guidance during project completion.

This finding is one of the strengths of this study compared to previous research. Most previous studies have focused on improving average grades or learning mastery as indicators of success. Meanwhile, this study demonstrates that the use of PjBL-based worksheets with a Deep Learning approach not only improves learning outcomes but also contributes to equitable learning abilities within the classroom. Thus, the benefits of the developed product are felt not only by high-ability students but also by those who previously struggled to understand the learning material.

Based on all of the above discussion, it can be concluded that PjBL-based worksheets with a Deep Learning approach are effective for use in science learning in elementary schools. This effectiveness is supported by the characteristics of active, contextual, collaborative, and reflective learning, which can improve learning outcomes while creating equitable student abilities. These findings reinforce that the integration of the PjBL model with the Deep Learning approach is a relevant alternative to support the implementation of the Independent Curriculum.

CONCLUSION

This research successfully developed a Student Worksheet (LKPD) based on Project Based Learning (PjBL) with a Deep Learning approach on the Human Respiratory System material for fifth grade elementary school students using the 4-D development model. The resulting product has met the criteria of being valid, practical, and effective so it is suitable for use as a teaching material in science learning.

The main contribution of this research lies in the integration of Project-Based Learning syntax with Deep Learning principles into a single worksheet (LKPD). This integration results in learning that is not only oriented towards project completion but also encourages students to build in-depth conceptual understanding through exploration, reflection, collaboration, and problem-solving activities related to everyday life. Thus, the developed LKPD is able to support the implementation of the Independent Curriculum through more active, contextual, and meaningful learning.

Project-Based Learning (LKPD) with a Deep Learning approach can be used as an alternative, innovative teaching material to support science learning in elementary schools. Teachers can also develop similar LKPDs for other science topics to further student-centered learning and encourage higher-order thinking skills.

Further research is recommended to test the implementation of LKPD at different levels of education, develop products on other science and science materials, and use experimental research designs involving control groups so that product effectiveness can be compared more comprehensively and research results have a broader level of generalization.

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