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PjBL TO ENHANCE STUDENTS' CREATIVE THINKING SKILLS IN BIOLOGY LEARNING

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ABSTRACT

Creative thinking skills are important for students to generate new ideas and products that solve problems. This study aims to measure the improvement of students' creative thinking skills through the implementation of the PjBL model. The sample was selected using purposive sampling, given that this class had the lowest scores and the lowest level of engagement in the learning process compared with other courses. The research method was classroom action research conducted in several cycles. The value of creative thinking skills was assessed through essay questions, which were evaluated using a creative thinking rubric developed by Kholid et al. (2023). The implementation of the PjBL learning model was assessed using an observation sheet for the PjBL learning syntax. Data analysis used normalized gain (N-Gain) calculations. The results showed an increase in students' creative thinking skills. This increase was seen from the N-Gain score, which was 0.29 in the low category in cycle I and increased to 0.52 in the medium category in cycle II. These results indicate that the PjBL learning model can improve students' creative thinking skills by training them to argue and generate new ideas in the form of products. Teachers and future researchers are expected to enhance students' thinking skills through innovative learning models.

Keywords: biology; CAR; creative thinking; high school; PjBL

INTRODUCTION

Learning in the 21st century must be able to encourage creative thinking skills (Ghazali *et al*., 2025; Marshel & Ratnawulan, 2020). Creative thinking skills include fluency, flexibility, originality, and the ability to elaborate ideas (Dananjoyo *et al*., 2022; Handayani *et al*., 2021). Fathoni and Siswono (2023) and A. Handayani and Koeswanti (2021) explain that creative thinking skills are skills used to generate ideas or concepts in problem solving (Lee & Lee, 2024; Sinaga *et al*., 2024). Creative thinking skills are defined as mental processes that enable students to generate appropriate and accurate responses, allowing them to examine problems from multiple perspectives and produce rich, diverse ideas or concepts (Saidah *et al*., 2020). Consistent with this, Candra *et al*. (2019) emphasized that the ability to articulate good ideas in learning processes, such as discussions and Q&A sessions, can enhance students' creative thinking skills. Therefore, creative thinking skills play a crucial role in the learning process (Astutik *et al*., 2020; Rahman *et al*., 2020; Satria *et al*., 2024).

A good learning process can significantly improve students' creative thinking skills (Kirana & Cahyowati, 2020; Muhammad *et al*., 2024; Rahman *et al*., 2020). Improving creative thinking skills includes various approaches, namely training (Manurung *et al*., 2021), problem-based learning (Hidayah *et al*., 2023), and projects (Ekayana *et al*., 2025). One effective learning model for effective learning processes and the development of creative thinking skills is Project-Based

Learning (PjBL) (Atmojo *et al*., 2024; Azizah *et al*., 2024). Nurhamidah and Nurachadijat (2023) explain that PjBL is an innovative student-centered learning model. In PjBL learning, the teacher's role is crucial: a facilitator who guides students throughout the project-creation process and a motivator who fosters students' enthusiasm for learning. Furthermore, Saragih *et al*. (2021) reported an increase in students' Higher Order Thinking Skills (HOTS), such as analysis, evaluation, and creative thinking, through challenging project assignments. Consistent with these findings, Sartika (2025) reported that the implementation of PjBL was effective in improving students' critical thinking skills, particularly in solving complex problems in project-based tasks. Similarly, a study by Darmuki and Hidayati (2023) showed that PjBL successfully developed students' higher-order thinking skills, particularly in synthesis and decision-making, through the completion of interdisciplinary projects. In addition, findings from Sukarso and Muslihatun (2021) confirmed that PjBL contributed to improving students' creative thinking skills, as evidenced by their ability to generate original ideas and innovative solutions to given project challenges. Theoretically, PjBL is considered capable of improving creative thinking skills because it positions students as active participants in a learning process that demands the exploration of ideas, open-ended problem-solving, and the creation of tangible products. In PjBL, students are presented with authentic problems that do not have a single correct answer, thereby encouraging fluency and flexibility in generating alternative solutions (Saidah *et al*., 2020; Handayani *et al*., 2021). The project design and development process also fosters originality, as students are required to generate original ideas and products based on their own understanding (Sukarso & Muslihatun, 2021). Furthermore, the reflection and evaluation stages in PjBL provide space for students to elaborate ideas in greater depth through product improvement and development, which are important indicators of creative thinking skills (Candra *et al*., 2019; Sari *et al.*, 2023). Thus, active student involvement in each stage of PjBL theoretically creates a learning environment conducive to the development of creative thinking skills.

The relationship between PjBL and students' creative thinking skills can be explained through its theoretical alignment with the core dimensions of creativity, namely fluency, flexibility, originality, and elaboration. During the problem identification and project planning stages, students are encouraged to generate multiple ideas and alternative solutions, which supports fluency and flexibility. The design and production stages of the project require students to propose unique concepts and products, thereby fostering originality. Meanwhile, the presentation, reflection, and revision stages provide opportunities for students to refine, expand, and improve their ideas, which directly contributes to elaboration. Through these interconnected stages, PjBL facilitates a systematic process of creative thinking development rather than merely producing creative outcomes.

Based on the study results, the PjBL learning model plays an important role in the learning process. PjBL learning not only equips students with theoretical knowledge but also improves their creative thinking skills. This is consistent with the findings of Wafiyah *et al*. (2025), who found that through PjBL, students are more active in exploring various approaches and creating diverse products, reflecting a significant

increase in fluency and originality in creative thinking. Similarly, research by Sari *et al*. (2023) shows that assigning authentic projects in the PjBL model effectively encourages creative thinking skills, open-mindedness, elaboration, and problem sensitivity, which are important indicators of creative thinking. Another study by Khauzanah and Wardani (2023) confirms that implementing PjBL in the learning process improves students' ability to generate new ideas and design unique solutions to given projects, indicating a significant increase in the originality and elaboration of students' creative thinking. Khoiruddin and Suwito (2021) also explained that implementing PjBL learning can help students succeed by encouraging student engagement and improving creative thinking skills throughout the learning process. By directly engaging in the planning, implementation, and presentation of projects, students not only deepen their understanding of the subject matter but also improve their creative thinking skills, which are crucial for future success (Sholeh *et al*., 2024). Although many studies have reported positive effects of PjBL on students' creative thinking skills, previous findings indicate varied outcomes depending on classroom contexts. Differences in teacher readiness to implement student-centered learning, limited project duration, and insufficient learning resources have been identified as factors that may constrain the effectiveness of PjBL (Andita & Kurniawati, 2024; Dayanti & Barokah, 2025; Evenddy *et al*., 2023). In line with this, preliminary observations in class XI IPA 4 show low student engagement and limited opportunities for active idea generation due to predominantly teacher-centered instruction. Such conditions may hinder the optimal development of creative thinking skills, suggesting that the impact of PjBL needs to be examined within specific classroom contexts. Therefore, this study investigates the implementation of PjBL in class XI IPA 4 to understand how contextual factors influence the development of students' creative thinking skills in biology learning. Although various studies have reported the effectiveness of PjBL in improving students' creative thinking skills, most rely on experimental or quasi-experimental designs. In contrast, classroom action research (CAR) in high school biology that explicitly reports improvements in students' creative thinking skills using N-Gain analysis remains relatively limited.

Although previous studies have consistently reported the effectiveness of PjBL in enhancing students' creative thinking skills, empirical evidence based on CAR, particularly in senior high school biology contexts, remains limited. Most existing studies employ experimental or quasi-experimental designs that focus on outcome comparisons rather than documenting gradual improvement across learning cycles. Furthermore, few CAR studies explicitly utilize N-Gain analysis as a quantitative indicator to measure the magnitude of students' creative thinking development over successive instructional cycles. The use of N-Gain is essential in CAR contexts because it provides a standardized measure of learning improvement, allowing researchers to capture incremental changes in students' creative thinking skills more objectively.

Furthermore, the limited number of CAR reports that examine the gradual improvement of creative thinking skills through the learning cycle using quantitative N-Gain indicators indicates an

empirical gap that requires further study. However, in practice, the classroom learning process remains conventional, with teachers relying on the lecture method as the primary means of delivering lesson material (Khoiriyah *et al.*, 2024; Prameswara & Pius X, 2023). This method is not entirely ineffective, as direct explanations enable teachers to convey concepts systematically and in a manner easily understood by students (Awwaliyah & Fatimah, 2024; Hutasoit, 2021). Furthermore, teachers have attempted to foster interaction by asking questions during instruction to stimulate thinking and assess students' understanding of the material presented.

Based on researchers' observations, several teachers in class XI IPA 4 still use conventional teaching methods, such as lectures. In conventional learning, the teacher is the center of information, and students are merely recipients, as most students still adopt a passive attitude when faced with teacher questions. Students tend to be silent, reluctant to answer, or only provide brief responses without in-depth explanations. This may be due to factors such as low self-confidence, fear of giving incorrect answers, or a lack of creative-thinking habits in the learning process. As a result, the two-way learning expected does not occur optimally, as communication is more teacher-centered, and active student participation remains limited. This condition has implications for students' low cognitive engagement. It contributes to the lack of improvement in creative thinking skills, which should develop through active interaction and the exchange of ideas during learning activities (Nabila, 2025; Rozi & Hafidz, 2024; Salsabila & Karomah, 2024).

The contribution of this research lies in applying the PjBL learning model in class XI IPA 4, which has low levels of creative thinking skills and student engagement, to assess the extent to which the PjBL learning model can improve students' creative thinking skills through active involvement in biology learning projects. This research is important because, in class XI IPA 4, creative thinking scores are very low; therefore, it is necessary to improve these skills immediately. Thus, this research examines how the PjBL model can enhance students' creative thinking skills in class XI IPA 4. By implementing PjBL, it is hoped that students will not only be actively involved in the learning process but also develop creative thinking skills through direct experience in completing projects.

METHODS

This research design was Classroom Action Research (CAR), implemented in two cycles. Each cycle consisted of four stages: planning, implementation, observation, and reflection. In the planning stage, the researcher developed a teaching module using the PjBL learning model syntax, designed evaluation instruments in the form of pre- and post-test questions measuring creative thinking skills, and prepared observation sheets to assess the implementation of the learning model. The implementation stage involved deploying learning tools in the classroom in accordance with the PjBL steps. Next, the observation stage was used to document the learning process and to assess student engagement and the creative thinking skills that emerged during it. The final stage, reflection, aimed to evaluate the

effectiveness of the learning implementation and formulate improvements for the next cycle. Cycle II was implemented as a follow-up to the reflection results of Cycle I, continuing the same stages but with enhancements to aspects that were not yet optimal.

The research subjects consisted of 32 students of class XI IPA 4 at SMA Negeri Balung, Jember, aged 16–17 years, comprising both male and female students, with an academic background in science. The subjects were selected through purposive sampling, as this class had the lowest academic achievement and the lowest level of learning engagement among classes at the same grade level.

In this classroom action research, the researcher served as the classroom teacher during the learning implementation, while an independent observer conducted the observation using a structured observation sheet. To minimize potential researcher bias, data triangulation was applied by comparing test results with observational data across each cycle.

The subjects of this study were 11th-grade science students at SMA Negeri Balung, selected through purposive sampling, given that this class had the lowest grades and the lowest level of engagement compared with other courses. The research instruments included pre- and post-tests comprising five descriptive questions for each cycle, as well as an observation sheet for the implementation of the learning process. Students' creative thinking skills were measured using a scoring rubric encompassing four dimensions: fluency, flexibility, elaboration, and originality. Each dimension was assessed on a 1–4 scale, with 4 indicating excellent achievement and 1 indicating poor achievement. The fluency score was determined by the number of ideas or questions relevant to the learning context, the flexibility score by the number of alternative answers generated, the elaboration score by the students' ability to develop ideas or products logically and engagingly, and the originality score by the level of uniqueness and novelty of the students' answers. Experts validated all instruments to ensure compliance with the creative thinking skill indicators.

All research instruments were validated by two experts: a biology Education lecturer and an experienced senior high school biology teacher. The validation process focused on the relevance of indicators, clarity of scoring criteria, and suitability of the instruments for measuring creative thinking skills in biology learning. Instrument revisions were conducted based on expert feedback until the instruments were deemed valid and feasible for use.

Research data were obtained through the results of students' creative thinking skills tests in each cycle and observations of the implementation of the learning process. Quantitative data were analyzed using the Normalized Gain (N-Gain) formula to determine the increase in students' creative thinking skills, with categories of high (N-Gain > 0.7), medium ($0.3 \leq$ N-Gain ≤ 0.7), and low (N-Gain < 0.3). The results of the N-Gain calculation were then presented in tabular form to systematically illustrate the increase in each cycle. The formula that can be used to calculate the N-Gain Score is:

$$NGain = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Ideal score} - \text{Pretest score}}$$

RESULTS AND DISCUSSION

The research results indicate that students' creative thinking skills increased from the low to the medium category following the implementation of the PjBL learning model over two cycles. The results of the research in cycles I and II are presented in Table 1.

Table 1. Improvement in Students' Creative Thinking Skills in Cycle 1 and Cycle II

Cycle	Description of Value		Improvement (%)	N-Gain	Category
	Rata-rata Pre-Test	Rata-rata Post-Test			
I	24	47	29	0.29	Low
II	38	70	52	0.52	Moderate

Based on Table 1, it is known that there was a 29% increase in students' creative thinking skills in Cycle I, with an N-Gain value of 0.29, which is still in the low category. Therefore, as a follow-up to these results, this study continued to Cycle II. The results in Cycle II showed a 52% increase in students' creative thinking skills, with an N-Gain value of 0.52, which is in the moderate category. Therefore, it can be concluded that the research objective has been achieved.

The N-Gain value is calculated by comparing the difference between the post-test and pre-test scores with the difference between the ideal maximum score and the pre-test score. This analysis is used to determine the proportional increase in students' creative thinking skills based on their initial abilities. Based on the results of the study, in Cycle I, students' creative thinking skills showed limited improvement. The average pre-test score increased from 24 to 47 in the post-test, resulting in an N-Gain value of 0.29, equivalent to 29%, which is in the low category. These results indicate that the implementation of the PjBL model in Cycle I has not provided optimal improvement, so corrective action is needed in the next cycle.

In Cycle II, the results showed a significant improvement in students' creative thinking skills. The average pre-test score increased from 38 to 70 in the post-test, with an N-Gain value of 0.52, equivalent to 52%, which is in the moderate category. Based on the standard gain category, this increase indicates that the implementation of the PjBL model in Cycle II was more effective in improving students' creative thinking skills. The increase in the N-Gain value from low in Cycle I to moderate in Cycle II indicates an improvement in the quality of learning after reflection and refinement of actions.

The empirical findings in this study indicate that the improvement in students' creative thinking skills aligns with the learning mechanisms inherent in each phase of PjBL. In the fundamental question-setting stage, students are encouraged to express ideas and questions related to contextual problems, which directly stimulates the fluency aspect of thinking, as also reported by Wahyuningtyas *et al*. (2024) and Saidah *et al*. (2020). The project planning and development phase encourages students to generate various alternative solutions and adapt ideas to existing conditions, thus triggering flexibility of thinking, in line with the findings of Sukarso and Muslihatun (2021)

and Handayani *et al*. (2021). Furthermore, the project implementation and refinement phase provides space for students to develop ideas in more depth, add details, and refine the product, which contributes to increased elaboration aspects (Candra *et al*., 2019; Sari *et al*., 2023). In the presentation and evaluation phase of the results, students are required to present the product uniquely and defend the resulting idea, thus encouraging the emergence of originality of thinking, as also found in the research of Khafah *et al*. (2023) and Wafiyah *et al*. (2025). Thus, the results of this study strengthen empirical evidence that the stages in the PjBL model can systematically facilitate the development of students' creative thinking skills. The improvement in students' creative thinking skills found in this study is similar to the results of previous research. This is in line with the results of research by Aflah *et al*. (2023), Khafah *et al*. (2023), and Lestari and Ilhami (2022), who reported that the implementation of the PjBL model can improve students' creative thinking skills. It was proven that students were able to follow the learning according to the designed learning scenario. During the learning process, many students were brave enough to express their ideas, and some students were brave enough to come to the front of the class to present their products. This directly involves students in the learning process and can spark students' curiosity, which can improve creative thinking skills. Thus, students become more active in the learning process.

Empirical findings in this study indicate that improving students' creative thinking skills emphasizes active involvement in constructing knowledge through solving real-world problems. Each step of PjBL contributes to the development of indicators of creative thinking skills through distinct mechanisms. In the fundamental question-setting step, students are encouraged to generate ideas and questions related to contextual problems, thereby improving fluency, as reported by Wahyuningtyas *et al*. (2024) and Saidah *et al*. (2020). The project planning and development steps encourage students to generate various alternative solutions and adapt ideas to existing conditions, which plays a crucial role in developing flexibility, in line with findings (Sukarso & Muslihatun, 2021; Handayani *et al*., 2021).

Of all the PjBL steps, the project implementation and refinement steps make the strongest contribution to improving creative thinking skills, particularly in elaboration and originality. In this step, students are actively involved in developing ideas in depth, adding details, and revising the product through reflection, thereby fostering elaboration skills (Candra *et al*., 2019; Sari *et al*., 2023). Furthermore, the presentation and evaluation steps require students to present the product uniquely and defend the resulting ideas, thereby fostering originality, as reported by Khafah *et al*. (2023) and Wafiyah *et al*. (2025).

The results of this study are consistent with those of Aflah *et al*. (2023), Khafah *et al*. (2023), and Lestari and Ilhami (2022), who concluded that implementing PjBL is effective in improving students' creative thinking skills. Therefore, this study strengthens empirical evidence that the main mechanism of PjBL, specifically student involvement in systematic project development and refinement, plays a role in facilitating the improvement of creative thinking skills.

Improving students' creative thinking skills is inseparable from the steps of the PjBL learning model, as in Cycle I. The

first step is determining fundamental questions (Wayuningtyas *et al*., 2024). These questions serve as triggers for students, encouraging them to solve problems and engage in real-world activities relevant to their environment. However, observations indicate that some students still experience difficulty in developing independent questions. Students tend to be hesitant or even lack confidence. Consequently, teachers often need to provide sample questions to guide the questioning process. The second step is designing a product plan. This planning process includes establishing rules for project planning, implementing activities, and identifying readily available tools and materials to support project needs. In this second step, creative thinking skills play a crucial role, enabling innovative design by generating new ideas. This is evident in the improvement in flexibility indicators, where students learn to adapt to various ideas, as well as in students' skills in elaborating ideas, transforming initial concepts into more comprehensive project plans.

In the third step, students and teachers develop a project schedule. This scheduling activity includes creating a timeline and setting deadlines for each assignment. Furthermore, during this step, students also receive guidance on effective strategies and methods for completing student projects, such as time management, individual accountability, and group collaboration. However, observations indicate that some students remain passive during the schedule preparation process. Students tend to wait for teacher direction or follow their peers' decisions without actively contributing, such as proposing task priorities or assigning roles based on each student's expertise. The fourth step involves monitoring project progress. According to Noviati (2021), during the monitoring stage, teachers must monitor all student activities, including student activity in completing projects and problem-solving. During project implementation, students often face unexpected challenges and obstacles. This is where flexibility in thinking plays a crucial role. Students must be able to adjust their initial plans if technical issues arise, resource availability changes, or new, better ideas emerge.

Furthermore, as the project progresses and students' understanding deepens, the ability to elaborate on ideas also plays a crucial role. Students may discover new ways to develop the project, add details not previously considered, or even combine ideas that emerged during the implementation process. This elaboration not only adds value to the project results but also demonstrates students' creative thinking skills.

The fifth step is evaluating the results. This process involves each group appointing a representative to present and communicate the results of their project to the other groups (Fathonah *et al*., 2024). When group representatives present their project results, fluency plays a crucial role in fostering students' creative thinking skills, as they need to convey information verbally in a fluent, clear, and structured manner. Students must be able to respond to questions from other groups or the teacher spontaneously and relevantly, demonstrating their ability to generate appropriate ideas and answers. This allows each student to contribute diverse ideas to problem-solving, as they are required to think originally and establish authenticity in presenting their project results. However, observations indicate that many students do not actively listen to their peers'

presentations, for example, being busy preparing their own group materials or conversing with their peers outside the topic. Furthermore, teachers often focus solely on assessing the completeness of documents without providing detailed feedback on strengths, weaknesses, or suggestions for project development. As a result, students miss the opportunity to reflect on and improve their project work.

The final step in the PjBL learning model is evaluating the learning experience. According to Yuniarti *et al*. (2021), in this step, students and teachers reflect together on the entire series of activities and project results, both in groups and independently. The reflection process fosters students' creative thinking skills, requiring students to review the whole project journey. Flexibility in thinking plays a crucial role because students must be open to various perspectives, including successes, failures, and areas for improvement. This evaluation step should be a valuable opportunity for students to hone their self-assessment skills. However, many students tend to be passive during the evaluation, answering only as needed when asked by the teacher without providing in-depth feedback. Furthermore, teachers sometimes only ask for general responses without more structured guiding questions.

Based on the reflection conducted, the following findings were obtained: 1) students had difficulty asking questions, 2) students still appeared passive during the learning process, 3) time management issues, 4) teachers were insensitive to classroom conditions, and 5) students and teachers lacked experience with the syntax of the PjBL learning model. However, students' creative thinking skills still require further development. Therefore, the research continued in Cycle II.

The implementation of PjBL learning in Cycle II improved the quality of learning implemented in Cycle I, both for teachers and students. This was done with the aim of building improvement and continuity in the learning process and providing opportunities for students to become more familiar with the PjBL learning flow. According to Fatima and Choirunnisa (2024); Saputra *et al*. (2024), the systematic steps in the PjBL learning model, such as determining fundamental questions, designing product plans, developing production schedules, monitoring project progress, testing and assessing results, and reflecting on/evaluating learning experiences, remain the foundation for stimulating active and in-depth learning and enhancing students' creative thinking skills.

Reflections on the second cycle clearly demonstrated significant positive improvements in all aspects of the learning process. These changes were not only one-sided but also improved the quality of teaching and learning for both teachers and students in the classroom. Teachers began to demonstrate a much greater sensitivity to classroom conditions, identifying and responding to various issues that arose among students. Meanwhile, student engagement began to increase, shifting from a passive approach to a more engaged one. This improvement was further reinforced by the rapid progress in students' questioning skills, where they were no longer asking for answers. Still, it was able to formulate more in-depth questions and encourage broader exploration of the material.

Overall, the increase in students' activity, questioning, and creative thinking skills in cycle II indicates that the continuous implementation of PjBL has a positive impact on the learning process.

This success is also supported by improvements in teachers' ability to manage the classroom and understand students' characteristics, which contribute to the effectiveness of PjBL implementation. These findings confirm that PjBL is not only effective in improving students' creative thinking skills but also in deepening their understanding of the learning material. The findings at each step of PjBL indicate that the success of PjBL implementation is determined not only by the learning design but also by teacher readiness. Teachers need to be competent in providing appropriate scaffolding, especially during the planning and organization stages of the project, so that students can participate actively and independently. The implementation of PjBL also requires flexible time allocation and the availability of supporting resources, such as clear project guides and assessment instruments. School support, including teacher training and line management, is an important factor in the effective and sustainable implementation of PjBL.

Furthermore, equally important was the improvement in students' creative thinking skills. This improvement was evident in the way students approached and completed project assignments. Students were better able to generate original and innovative solutions and were better able to overcome project obstacles with unconventional approaches. In short, this second cycle successfully created a more productive learning environment, where all elements supported each other to achieve higher competencies. Overall, the increase in student activity, questioning skills, and creative thinking skills in cycle II indicates that the implementation of the continuous PjBL learning model has a significant positive impact on the learning process. This is also supported by the improvement in teachers' abilities in managing the class and understanding students' conditions, which also contributes to the successful implementation of the PjBL learning model. This learning not only improves students' creative thinking skills but also effectively improves their understanding of the subject matter. These results prove that PjBL is an effective learning model in enhancing students' creative thinking skills.

CONCLUSION

The implementation of the PjBL learning model was able to improve the creative thinking skills of grade XI IPA 4 students from low to moderate in two cycles. These results indicate that the use of the PjBL learning model is effective in encouraging students to be more active in seeking, collecting, and applying information during the learning process. This increase in learning activities contributes directly to improving students' creative thinking skills, so that students become more independent and reflective in learning. These findings confirm that the PjBL learning model can be used as an alternative learning strategy oriented towards improving higher-order thinking skills. Further research is recommended for classes or schools with similar learning problems, using CAR with the PjBL model, focusing on reflection outcomes in each learning cycle to improve students' thinking skills optimal.

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