Implementation of Problem-Based Learning: What is the Influence on Students' Reasoning Ability in Elementary Schools?

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Abstract: This study aimed to determine the effect of applying the PBL learning model on the reasoning abilities of fourth-grade elementary school students Muhammadiyah 1 Krian. Types of experimental research and using one group pre-test-post-test design method. The population in this study were 23 fifth-grade students at SD Muhammadiyah 1 Krian. The researcher used a saturated sampling technique because population sizes were small. Reasoning ability data was obtained from essay tests before and after the application of PBL. Then the study results were analyzed using descriptive statistical techniques and the N-Gain test using the SPSS version 26 software. The results of this analysis indicate the reasoning ability of the pre-test post-test results showed a significant difference between the average value of the pre-test (63.26) and post-test (82.74), and. those using the N-Gain test obtained an average of 0.52 which indicates the moderate category, so using this PBL learning model can affect the reasoning abilities of elementary school students.

Abstract: Tujuan penelitian ini adalah mengetahui pengaruh penerapan model pembelajaran PBL terhadap kemampuan reasoning (penalaran) siswa kelas IV SD Muhammadiyah 1 Krian. Jenis penelitian eksperimen dan menggunakan metode one group pre-test-postest design. Populasi dalam penelitian ini adalah siswa kelas V SD Muhammadiyah 1 Krian yang berjumlah 23 orang. Peneliti menggunakan teknik sampling jenuh karena ukuran populasinya kecil. Data kemampuan reasoning (penalaran) ini diperoleh dari tes essai sebelum dan sesudah penerapan PBL. Kemudian hasil penelitian dianalisis menggunakan teknik statistik deskriptif dan uji N-Gain menggunakan bantuan software SPSS versi 26. Hasil analisis ini menunjukkan kemampuan reasoning hasil pre-test post-test yang signifikan antara rata-rata nilai pre-test (63,26) dan post-test (82,74) dan yang menggunakan uji N-Gain diperoleh dengan rata-rata 0,52 yang menunjukkan dengan kategori sedang, maka dengan menggunakan model pembelajaran PBL ini dapat mempengaruhi kemampuan reasoning siswa sekolah dasar.

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A. Introduction

Around the world, that attracts scientists to research a comparative study between countries in mathematics, science, and literacy, namely Trend In International Mathematics And Science Study (TIMSS). In general, TIMSS aims to monitor the outcomes of the education system in terms of achievement of student learning in Mathematics and Science. TIMSS is conducted regularly every four years, namely in 1995, 1999, 2003, 2007, 2011, and 2015. Indonesia is one of the countries that became TIMSS objects in the four last period. The results of a survey in 2007 which was conducted regularly every four years by the Trends in International Mathematics and Science Study (TIMSS), showed that Indonesia still had a low ranking, namely 35th out of 49 countries. While the survey results in 2011 showed a decline in Indonesia's ranking to 40th out of 42 countries. The results of the two surveys show that the ability of Indonesian students still needs to be higher than the average of students from other countries. In (Boulifa & Kaaouachi 2022), The results of the TIMSS survey can be used as material for evaluating the implementation of policies to improve the quality of education by experts and decision-makers in each participating country because the TIMSS research results are very valid and can describe quality or quality of education.

Currently, Indonesian society is still in a period of transition from oral culture to written culture. Reading habits in Indonesia are categorized as very low (Kamilah & Ruqoyyah, 2022). Improved learning as part of the education system needs to be further developed by all parties involved (Basuki & Anriani, 2023). It aims to be able to overcome problems in reading habits. The 21st century is a period of massive transformation from an industrial society to a knowledge society. Especially in elementary schools, student's lack of interest in reading becomes a problem in the habituation of very low literacy (Hasibuan & Prastowo, 2019). (Pusparini, 2019) In connection with this new standard transitional period, the importance of literacy habituation in students must be able to set aside time for literacy in order to enrich knowledge and insights into education from an early age. (Tarmidzi & Astuti, 2020). The lack of awareness of parents and teachers causes a lack of interest in reading by elementary school students because they need support or encouragement. So teachers must hold greater responsibility in increasing student literacy to meet the demands of the 21st century. The ability to use science and technology in the 21st century has led to the term scientific literacy. Opinion (Eliza, 2022), scientific literacy is knowledge and skill to gain scientific understanding to make it easier to respond to a question, gain new knowledge, tell scientifically and conclude information and characteristics and understand the characteristics of scientific concepts. So many things must be done to fix its weaknesses in the education system, for example, education equity for educators, access to education, and limitations of learning facilities (Fenanlampir et al., 2019).

Literacy skills are essential in life in the 21st century. Agree with (Winarni et al., 2020). Scientific literacy is a student's ability to know a concept, then understand, explain, present, and apply science in everyday life related to the material studied so that they have a positive attitude and affect the surrounding environment. Meanwhile, (Wahyu et al., 2020) scientific literacy is students' skills in distinguishing scientific knowledge based on fact and

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the ability to manage and interpret data. In the last few decades, many researchers have studied scientific literacy. This aims to obtain and characterize the urgency regarding scientific literacy in elementary schools. This scientific literacy can make it easier to study science and technology, which are continuously developing at this time (Efendi, 2021). Therefore scientific literacy is critical to be mastered by students. So that scientific literacy must be instilled in elementary school to focus on building student knowledge and to make students apply it in everyday life (Elviani et al., 2020). Because the achievement of scientific literacy in schools has a function of various characteristics, for example, the school context, such as the teaching process, resources at school, and the school's learning background (Winarni et al., 2022). In addition, scientific literacy can optimize students' learning abilities in supporting their learning achievement (Kimianti & Prasetyo, 2019). Literacy has become a requirement that must be owned because it supports students in solving everyday problems.

According to TIMSS (Mullis et al., 2021), the scientific literacy indicator is 1). Knowledge (knowing), 2). Applying (Applying), 3). Reasoning. The scientific literacy indicator in the knowledge domain (knowing) will assess a student's knowledge of a fact and broad-based accurate knowledge to enable students to succeed in cognitive activities. Then in the applying domain, students must apply the knowledge obtained. At the same time, the domain of reasoning (reasoning) requires students to be actively involved in explaining a fact or analyzing, drawing conclusions, and expanding a new understanding. On this basic understanding of reasoning, students are shown tasks embedded in story problems where students need strong prior beliefs (Zulkipli et al., 2020). The sub-indicators of reasoning are 1). Analyzing, 2). Unify, 3). Formulate questions, hypothesize or predict, 4). Design investigation, 5). Evaluation, 6). Conclude, 7). Generalize, 8). Justify. With this sub-indicator, students can solve a problem around them well. This reasoning learning is indeed to equip students with broad knowledge to master and have creativity in formulating or solving a problem.

Reasoning learning is where students can think openly about various perspectives and new evidence, according to (Sulianto et al., 2020). Reasoning itself is the principle underlying a relationship between several patterns so students can solve it. Scientific literacy is expected to develop students to meet a need for development in this global era (Mukti, 2018). Reasoning indicator is instrumental for elementary school students to broaden their understanding and draw suitable conclusions about data. Because to prepare to face various challenges of modern life in advancing science and technology, this reasoning helps students think critically, rationally, and creatively (Mahmudah et al., 2021). Learning that applies this reasoning makes students aware that they must engage in practice by providing resources or class time does not necessarily improve their skills, so it will require direct and directed instruction, even if students feel that they are literate in some of the data they have obtained because they can understand some of the basic information from data visualization, this research shows that there is a clear difference in students' ability to analyze it effectively careful and thorough.

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Based on the results of observations pre-research on November 7, 2022, at Muhammadiyah 1 Krian Elementary School, learning related to scientific literacy still needs to be improved due to the lack of effective learning models. The learning model applied during science learning activities is still teacher-oriented, namely, learning centered on the teacher. Students become less enthusiastic about participating in the learning process because students only passively listen to the teacher's explanation without any variation in learning. The learning process needs to help develop students' ability to understand scientific literacy. This will be the main problem causing elementary school students' low scientific literacy skills.

Seeing this condition, innovation is needed to improve the quality of learning to foster elementary school students' scientific abilities in applying scientific concepts to learning materials. Teachers should choose the best learning strategy for their professional demands (Nurlaelah, 2023). By using the Problem-Based Learning learning model, is a learning model that is suitable to be applied. As stated by (Hartati & Sholihin, 2015), the Problem-Based Learning model is the development of a curriculum and lesson delivery system that is aware of the need for teaching that is characterized by problems concrete be a context for students to learn critical thinking and problem-solving skills and acquire the necessary knowledge and skills (Muhartini et al., 2023). The principle of this learning process is to give a problem to students related to everyday problems because they will know the effect of this scientific literacy. The purpose of using the Problem-Based Learning learning model is to develop students' ability to solve a problem through reasoning abilities. In addition, to foster independent learning in students. Independent learning can be formed when students collaborate to identify information, strategies, and learning resources relevant to solving a problem.

Reasoning ability can be interpreted as an ability in students to find knowledge, skill, and context in a problem. Problem-Based Learning This is a solution to improve the quality or ability of students. The purpose of this Problem-Based Learning is to determine students' ability to think critically in solving a problem and to be able to build their abilities. So that the relationship between scientific literacy and Problem-Based Learning learning is to foster students' scientific literacy by bringing learning models closer so that they can build their abilities with a problem faced in the future. Like (Lendeon & Poluakan, 2022), the Problem-Based Learning learning model requires students to read and find a solution to a question so that they can solve a problem to form students' scientific literacy to increase independence.

The steps in PBL include identifying various questions, so students can easily understand a question, then conducting scientific investigations (Sancar-Tokmak & Dogusoy, 2023). For the most part, elementary school students generally have such a great curiosity that a learning process is needed that can channel students' curiosity to gain knowledge. From the inquiry activity, students will read independently to improve their literacy. (Shofiyah & Wulandari, 2018) Mentioning the syntax in Problem-Based Learning, there are 5 phases, including phase (1) orienting students in a problem, phase (2) organizing

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students in learning, phase (3) assisting in the investigation process independently or in groups, phase (4) developing and present the work and exhibit it and phase (5) analyze and evaluate the process of solving a problem.

PBL has advantages over students in understanding concepts, involving students actively to solve a problem, and demanding to think highly. So that students are more likely to be independent in the learning process because they can study independently or in groups. The deficiencies in PBL are that for students who tend to be lazy, the purpose of forming this learning model needs to be achieved properly and efficiently. This is because the implementation of PBL takes longer than conventional learning. Like previous researchers (Alatas & Fauziah, 2020), PBL is learning based on scientific phenomena in the environment around students, summarizing facts, conducting assessments, and then applying them to solve a problem. This learning model significantly dominates students' literacy skills to relate the learning process scientifically to a problem because scientific literacy is a provision for students in the 21st century to face a challenge and directly correlate in building a new generation with a solid scientific mindset and attitude that can effectively communicate knowledge.

The general research objective is to analyze the effect of the Problem-Based Learning (PBL) method on the reasoning abilities of elementary school students. While the research objectives specifically were to analyze the effect of the application of the Problem-Based Learning (PBL) method on the reasoning abilities of 5th-grade students at SD Muhammadiyah 1 Krian and to obtain helpful information and recommendations for teachers and schools in developing learning strategies that are more effective in improving the reasoning abilities of grade 5 students.

B. Method

This research uses a quantitative research approach. Quantitative research is a type of research that can produce several findings using several statistical calculations or a measurement (Jaya, 2020). This research is a type of pre-experimental research that compares scores before and after applying problem-based learning. The research method design using the one-group pre-test-post-test design was chosen because it consisted of one group, so there was no comparison with the control group.

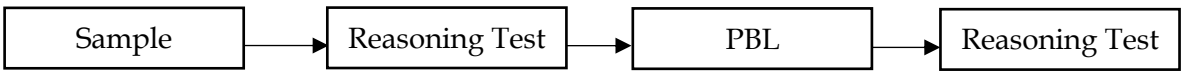

Figure 1. Pre-Experimental Research Design

The independent variable was shown by the treatment, namely the PBL method. In contrast, the dependent variable was the students' reasoning ability which could be shown by the difference between the pre-test and post-test (O_1 - O_2).

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Table 1. Research Design One Group Pre-Test-Post-Test Design

Pre-test	Treatment	Post-test
O_1	X	O_2

The population and sample in this study were fifth-grade students at SD Muhammadiyah 1 Krian, totaling 23 students. The population is the whole group for collecting data (Sugiyono, 2021). The population in this study were fifth-grade students at SD Muhammadiyah 1 Krian. Meanwhile, the saturated sample used in this study was fifth-grade students at SD Muhammadiyah 1 Krian. The researcher used a saturated sampling technique because all population sizes, namely less than 30 students, were relatively small.

The data source for this researcher came from students' pre-test and post-test scores on the use of the PBL learning model on the effect of heat on changes in temperature and the shape of objects in everyday life. The research instrument used was a test in the form of essay questions. This essay test consists of several questions related to reasoning abilities, according to Timss (Mullis et al., 2021). Each question item in the test is carried out according to the K13 curriculum implemented by the school.

The technique of collecting data by using student test techniques in the form of written tests is given before and after the teaching process with the PBL learning model is carried out. Before using PBL learning, it is called a pre-test; after using the PBL learning model, it is called a post-test. This test technique was carried out to measure students' reasoning abilities. According to Meltzer, Pre-test, and post-test scores, the data analysis technique uses N-Gain (Oktavia et al., 2019). The choice of the N-Gain analysis technique is due to the relatively small number of samples. The following is the N-Nain calculation formula.

$$\text{N-Gain} \quad \frac{S_{post} - S_{pre}}{S_{Maks} - S_{pre}}$$

Information:
N-Gain: Declare the gain normality test
S_{post} : Declare the post-test value
S_{pre} : Declare the value of the pre-test
S_{max} : Declare the maximum score

The values obtained can be categorized using the score interpretation criteria in the following table:

Table 2. N-Gain Score Interpretation Criteria

N-Gain Value	Category
$g > 0.7$	Tall
$0.3 \leq g \leq 0.7$	Currently

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N-Gain Value	Category
g < 0.3	Low

After conducting the N-Gain analysis, the results can be interpreted to see how much the PBL Learning Model improves students' reasoning abilities. If most students have N-Gain scores in the high category, the PBL Learning Model significantly improves students' reasoning abilities. Meanwhile, if most students have N-Gain scores in the moderate category, this indicates that the PBL Learning Model has a moderate effect on improving students' reasoning abilities. If most students have N-Gain scores in the low category, the PBL Learning Model has a limited effect on improving students' reasoning abilities.

C. Result and Discussion

Results

Based on the implementation of the research conducted on fifth-grade students of SD Muhammadiyah 1 Krian totaling 23 students on May 15 in essay questions with reasoning indicators tested for construct validity, the results were 3.42, which means good. Content validity was obtained with the highest value, 0.770, which means valid to use, and the reliability test with a result of 0.851 is classified as reliable or in the high category. Then on May 16, 2023, pre-test and post-test data were obtained. After obtaining the complete student scores, the data is tabulated to the spreadsheet application. Then an analysis of reasoning thinking skills is performed using the N-Gain formula. The results of data analysis will be used as a basis for interpreting the effect of the PBL on the ability to think reasoning according to the syntax of the PBL.

Figure 2. Students Orientation

The first phase is to orient students to a problem. In this phase, the teacher will introduce students to a problem in everyday life that they will explore, namely, proving the shape of an object. The teacher explains that objects around us have various shapes, and

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students need to identify these shapes. By using real examples in the environment around students, the teacher provides adequate explanations to build an initial understanding of objects' various shapes and forms.

Figure 3. Students Organizing

The second phase is organizing students in learning. Students are divided into small groups of 4-5 children in this phase. Each group was given the task of organizing and planning their experimental activities. For students who do not understand how to plan an experiment, the teacher will provide a simple illustration as material for discussion so they can find a creative, experimental plan. Students will experiment with the shape of objects and their properties, and the teacher will ensure that each member understands the tasks of each student so that they can study well.

Figure 4. Assisting Students Investigation

The third phase is assisting in the investigation process independently or in groups. In this phase, the teacher will monitor student involvement in collecting data during experiments in the learning process, both in groups and individually. Students begin to

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investigate with the teacher's guidance to understand the objects' shapes. They seek information about various objects and their shapes through books, the internet, or other sources. The data that has been collected will be monitored by the teacher to suit the learning objectives. After that, they planned an experiment to prove the object's shape.

Figure 5. Presenting the Work

The fourth phase is developing and presenting the work and exhibiting it. In this phase, the teacher will continue to accompany and monitor students in conducting discussions and making reports to each group to be presented. Students start doing experiments according to the plans they have made. They collected data on the results of the experiment. After that, they develop a presentation or results explaining the findings and conclusions from their experiment. The work results will be presented to other groups in the class.

The fifth phase is to analyze and evaluate the problem-solving process. In this phase, the teacher guides during presentation activities and encourages students to give a rebuttal or suggestion to other groups. Then the teacher will jointly conclude the material that has been studied together. After the presentation, students analyze and evaluate the process of their experiment. They compare the results obtained with initial expectations and seek a deeper understanding of the shape of objects. The teacher provides feedback and facilitates student reflection on the process and results of the experimental activity.

Learning using the PBL model is very important for students because it is an effort to improve the learning process in class, where using this PBL model with an experimental method emphasizes students being actively involved in solving a problem. Problems encountered in everyday life. So that students can get experience that finds a solution to a realistic problem, and will emphasize the use of good communication, collaboration with friends, and literature sources that formulate ideas and develop their reasoning skills. The picture below is of a student in an experiment in class. Based on the analysis results, the influence of the PBL learning model can improve the reasoning abilities of elementary school students.

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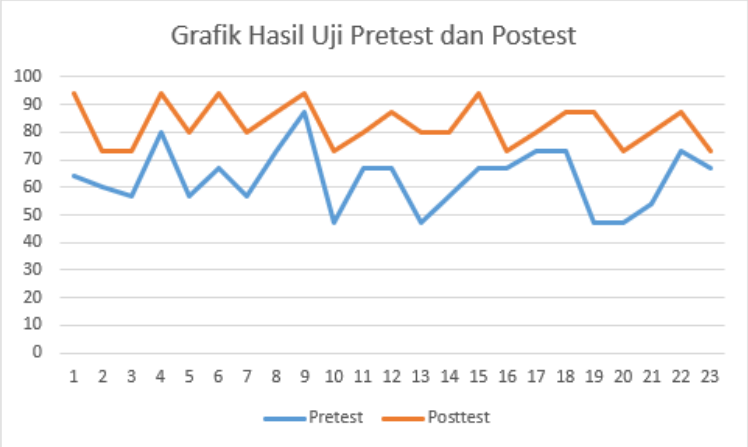

Figure 6. Graph of Pre-test and Post-test Test Results

Based on Figure 3, the post-test test scores are above the pre-test values. All students showed improvement in scores from the pre-test test. This shows that PBL overall improves all students' reasoning and thinking skills. Namely students' serial numbers 1, 6, and 15. This shows that these students experienced a significant increase in reasoning abilities after following the PBL. Using the PBL Learning Model greatly benefits these students' reasoning abilities.

Then, most students, namely students number 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 18, 20, 21, and 22, have an N-Gain score that enters the medium category. This shows that the PBL Learning Model has a moderate impact on improving the reasoning abilities of these students. Even though their improvement was not as significant as that of students with high N-Gain scores, there was still significant improvement in their reasoning abilities.

Then, several students had low N-Gain scores, namely students 16, 17, and 23. This indicated that the PBL Model had a limited effect on improving the reasoning abilities of these students. A learning approach or strategy is needed that aligns with their needs to improve reasoning abilities. (Dharma et al., 2022) Therefore the reasoning abilities of these students must be increased in all excellent and appropriate encouragement or learning models so that students can have a broad knowledge. Reasoning ability applies to a science concept because a student can state a scientific reason if the student has broad-minded knowledge. Reasoning ability is part of higher-order thinking and can be trained in students at all stages of development (Wardani et al., 2022).

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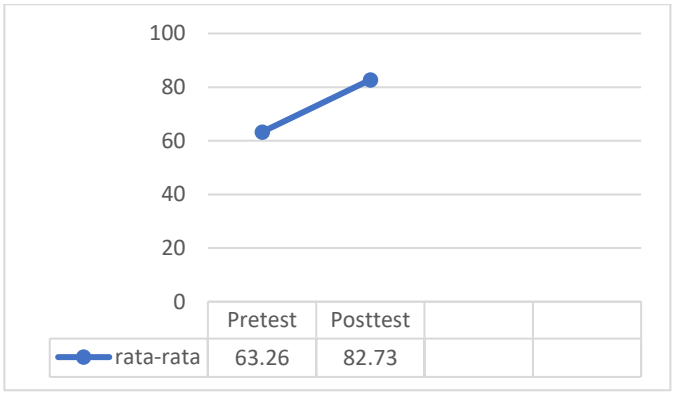

Figure 7. Graph of Average Pre-test and Post-test Scores

Figure 4 shows a significant difference between the average pre-test (63.26) and post-test (82.74). This difference indicates that after participating in learning or intervention, students experience increased reasoning abilities. This increase can be attributed to the influence of the PBL model used in the study.

Table 3. N-Gain Score Graph

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
N_Gain_Score	23	.18	.83	.5266	.18559
N_Gain_Persen	23	18.18	83.33	52.6611	18.55866
Valid N (listwise)	23				

The results of the N-Gain calculations show that most students experience an increase in their reasoning abilities after following the PBL. However, the level of improvement varies between students with high, medium, and low N-Gain scores. Overall, the average N-Gain score for all students is 0 .52, included in the "Moderate" category. Where is the problem-based learning model classified as influential in the learning process.

Discussion

The results of this study support several previous studies which generally show the effect of PBL on improving reasoning skills in elementary school students. The PBL model can improve science (Wardani et al., 2022). This PBL model is very alternative in solving a problem and can attract students' attention in the learning process because students can be motivated to participate actively in learning. Using a fun, exciting material presentation model so can make it easier for students to understand the material and not boring for students so that it can influence learning success.

Based on the results of observations of student activities using the PBL model, the average calculation results for this indicator are excellent and vary in each of the results of these indicators. It can be seen that between the average pre-test scores (63.26) before being

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given a learning model. Then the post-test value is obtained (82.74). This shows that the PBL model is problem-based, which makes students active in learning because this learning can study independently or in groups. Students can give various opinions regarding the material effect of heat on changes in temperature and shape of objects in everyday life.

PBL can improve reasoning in science learning by dramatically influencing students' reasoning abilities and developing critical reasoning abilities in classifying information (Kibtiyah, 2022). Meanwhile, PBL is a learning model emphasizing authentic problems so students can construct their knowledge independently, develop high skills, and increase their confidence in dealing with a problem. Because this PBL can have a good impact, students can be motivated, so applying this learning model to class V SD Muhammadiyah 1 Krian is very influential.

D. Conclusion

Based on the research results, it can be concluded that there is a difference, and the results of the N-Gain test show that it is in the "moderate" category. This shows that the increase in reasoning abilities that receive learning based on PBL learning models in a learning material can be better. The average increase for the pre-test and post-test was 19.47.

The implication of this research is to provide support and recommendations for implementing the PBL method in the teaching practice of elementary school students, integrating it into the curriculum, enhancing teacher professional development, and stimulating further research in this field.

Suggestions for further research are to involve a control group and randomization methods to increase the research's validity. Then, further research may involve observing and measuring students' thinking and reasoning abilities over a more extended period. This can help understand the long-term effects of implementing the PBL method. In addition, future research can involve a more diverse sample from various schools and levels of education to increase the generalizability of the research results.

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