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The Effectiveness of the Match Mine Strategy in Mathematics Learning

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ABSTRACT

Mathematics learning often becomes challenging for students when classroom instruction relies heavily on teacher-centered methods that limit active participation, communication, and conceptual development. Although cooperative learning strategies have been recognized for improving student engagement and understanding, the specific effectiveness of the Match Mine strategy in mathematics remains underexplored. This lack of empirical evidence creates uncertainty for educators seeking structured, student-centered approaches that enhance learning outcomes. The purpose of this study is to determine the effectiveness of the Match Mine strategy in improving students' conceptual understanding, motivation, and engagement in mathematics, as well as to examine teachers' perceptions and implementation practices. A quantitative research design was used, involving 31 primary school students and several mathematics teachers. The methodology consisted of five phases: a pre-test to establish baseline understanding, a teaching session using the Match Mine strategy, a post-test using identical items, distribution of questionnaires to students and teachers, and comprehensive quantitative analysis using descriptive statistics and significance testing. The findings show a clear improvement in student learning following the intervention. Post-test scores increased, with the mean rising from 8.19 to 8.84, and fewer students scoring in the lower range. The paired t-test indicated a statistically significant difference between pre-test and post-test results, confirming that the improvement was meaningful and not due to chance. Teacher feedback also revealed moderate to high acceptance of the strategy across all experience levels, with the strongest support from teachers with more than ten years of teaching experience. In conclusion, the Match Mine strategy demonstrates strong potential to enhance conceptual understanding, engagement, and overall learning in mathematics classrooms while being well-supported by practicing teachers.

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1. Introduction

1.1 Research Background

Learning mathematics can be difficult especially if students need to understand abstract ideas, solve problems and develop spatial reasoning. Student-centered cooperative learning strategies are becoming more and more crucial in math classrooms because traditional teaching methods might not fully engage students or foster deep understanding. One such strategy is the Match Mine technique, a Kagan-style cooperative learning structure in which paired students designated as a sender and a receiver, work together to replicate arrangements using verbal instructions. Match Mine has been adapted for various mathematical topics, including geometry, number and representation tasks in mathematics education, and places an emphasis on accurate mathematical terminology, listening, spatial language, and reasoning. This collaborative framework not only promotes active engagement but also assists students in articulating mathematical concepts with more clarity. Through consistent practice, learners gain increased confidence in conveying and interpreting mathematical concepts. Prieto-Saborit *et al*., [1] found that successful cooperative learning in mathematics relies on teacher training and instructional design, while López *et al*., [2] showed that combining it with visual thinking improves students' interpretation, communication and engagement in mathematical tasks. Successful implementation also depends on teacher facilitation and instructional design, while strategies like Match Mine provide students with opportunities to actively develop 21st-century skills such as communication, reasoning and collaboration. Therefore, this study aims to determine the effectiveness of the Match Mine strategy in improving students' understanding of mathematical concepts, how it affects their motivation and engagement in learning, as well as to investigate teachers' perceptions and implementation practices in mathematics classrooms.

1.2 Problem Statement

There is little published empirical evidence that specifically quantifies Match Mine's effects on student's conceptual understanding of mathematical concepts, student's motivation and engagement in mathematics lessons, and teacher's perceptions and implementation practices in regular mathematics classrooms, despite the fact that it is marketed as an effective cooperative learning structure for developing mathematical communication and reasoning. Thus, this study details instructor's opinions and classroom practices when utilising the method and examines if incorporating Match Mine into maths lectures results in quantifiable improvements in student knowledge, motivation and engagement. Although cooperative learning strategies have been widely recognised for enhancing students' academic achievement, motivation, and classroom interaction, there is limited empirical research that specifically investigates the Match Mine strategy within mathematics education. Match Mine is often promoted as an effective cooperative learning technique to foster mathematical communication, reasoning, and conceptual understanding. However, most existing studies on cooperative learning focus broadly on models such as Think-Pair-Share, Jigsaw, or Student Teams Achievement Divisions (STAD) and rarely isolate Match Mine as a distinct pedagogical intervention. Furthermore, few studies have examined how teachers implement Match Mine in real classroom settings, including the fidelity of implementation and teachers' perceptions regarding its practicality and effectiveness. There is also a lack of quantitative data linking the use of Match Mine to specific improvements in students' conceptual understanding, motivation, and engagement in mathematics lessons. This absence of targeted research limits educators' ability to make evidence-based decisions about adopting the Match Mine strategy in regular classrooms.

Therefore, this study seeks to bridge this gap by (1) exploring teachers' perceptions and implementation practices of the Match Mine strategy, and (2) determining its effectiveness in enhancing students' conceptual understanding, motivation and engagement in mathematics learning. The findings aim to provide empirical evidence on the value of Match Mine as a cooperative learning strategy and to inform best practices for its classroom application.

1.3 Research Objectives

The purpose of this research are; To determine the effectiveness of the Match Mine strategy in improving students' understanding of mathematical concepts; To examine the impact of the Match Mine strategy on students' motivation and engagement in learning mathematics; To investigate teacher's perceptions and implementation practices of the Match Mine strategy in mathematics classrooms.

1.4 Literature Review

21st-century education emphasizes the development of critical thinking, collaboration, creativity and active student engagement. Teaching strategies that foster these skills are increasingly important in modern classrooms. In this context, Yanti and A. A. [3] indicates that the Match Mine type cooperative learning model significantly improves students' mathematical communication skills, including their ability to propose ideas, reflect on concepts, solve problems, and engage in discussions, suggesting its effectiveness as a student-centered strategy in mathematics learning. Comparing cooperative learning to typical teacher-centered instruction, it has been demonstrated that students' mathematics performance is greatly improved. According to Nurjamaludin *et al*., [4], claim that the Make a Match model leads to higher post-test scores and increased engagement since students must actively match questions with right answers, assuring complete participation. This interactive framework promotes deeper conceptual understanding, teamwork and rapid recall. Cooperative assignments, as contrast to passive listening, require students to explain and defend their arguments, which improves understanding. Similarly, Che Aziz *et al*., [5] found that cooperative learning has a favorable effect on secondary school students' ability to understand algebraic expressions, demonstrating that collaborative group work can improve mathematics performance relative to conventional teaching methods. Maulida [6] also highlights that cooperative learning is crucial for boosting students' motivation and engagement, particularly in mathematics where traditional teacher-centered approaches frequently result in poor comprehension and little involvement.

It has also been demonstrated that Match Mine cooperative learning greatly enhances elementary school students' mathematics communication and connection skills. In comparison to control courses, students exposed to the Match Mine method had significantly superior post-test results in mathematical communication and establishing connections, according to a quasi-experimental study conducted in Makassar by Alfrida *et al*., [7]. These cooperative matching tasks challenge students to analyze peer reasoning and articulate mathematical linkages, leading to deeper conceptual understanding. Mathematical communication is seen as an essential talent since it enables students to articulate ideas, interpret representations, and improve problem-solving abilities. Monariska *et al*., [8] state that teacher-centered instruction and limited interaction in math lessons are to blame for students' continued poor communication abilities. The Match Mine cooperative learning methodology enables students to explain representations, discuss ideas, and develop a common understanding in order to address this problem. Results indicate that students who are taught using Match Mine outperform those who are taught conventionally in terms of post-test scores and communication skills improvement. Evidence from other student-centered

approaches further supports the effectiveness of cooperative learning principles. Research by Aziz et al., [9] on innovative pedagogical approaches, including the flipped learning model, underscores the efficacy of active, student-centered strategies in improving understanding and engagement. Likewise, Klang *et al*., [10] emphasize the value of teaching materials and structured supervision in promoting mathematical reasoning. Students are able to concentrate on comprehension rather than memory through problem-solving activities that are in line with conceptual models, such as proportionality, multiplicative structures, and geometry. Students are better able to recognize patterns, make connections between concepts, and apply tactics in a variety of circumstances when cooperative learning is paired with well-designed resources. These studies highlight the need for organized implementation and regular teacher training in order to get these advantages. Cooperative learning (CL) in undergraduate mathematics and science has been demonstrated to be most effective when structured aspects like group roles, size, and defined CL principles are actively used. Through meaningful peer engagement, these frameworks foster positive dependency and accountability, assisting students in gaining a better conceptual understanding. According to Møgelvang *et al*., [11], the article also states that CL improves STEM learning outcomes by strengthening knowledge of disciplinary information and boosting academic self-efficacy. Additionally, research shows that well-designed CL strategies enable more equitable participation in science and math classes by reducing gender differences in STEM confidence. Johari and Sulaiman [12] showed that student performances in secondary school algebra are much enhanced by collaborative learning, with considerable improvements seen between pre-test and post-test scores. Additionally, their results showed that students were positively motivated and accepted collaborative techniques. This suggests that structured peer interaction, akin to the Match Mine strategy, can improve conceptual understanding and mathematical engagement. In contrast to traditional lecture-based training, which frequently leaves students inert and unmotivated in mathematics classrooms, cooperative learning offers an active, student-centered alternative. By encouraging students to work together, share ideas, and develop understanding, cooperative learning enables them to create knowledge rather than merely absorb it [13]. By asking students to pair question and answer cards, the Make-a-Match model in particular fosters engagement and creates a dynamic learning environment. Evidence demonstrates that this cooperative enhances learning results, with mastery levels sharply increasing over the course of subsequent learning cycles. Cheng's [14] research corroborates this, indicating that cooperative learning is more efficacious for tasks necessitating higher-order thinking, although individual accountability is crucial to guarantee significant contribution.

2. Methodology

This study was conducted at a primary school located in the district of Kuala Terengganu, Terengganu, using a quantitative research design to evaluate the effectiveness of the Match Mine instructional strategy. The research involved 31 students as the main participants, alongside several teachers who contributed evaluative insights regarding the teaching approach. There are five phases involved in order to evaluate the research's result. The five phases can be outlined through the following Figure 1:

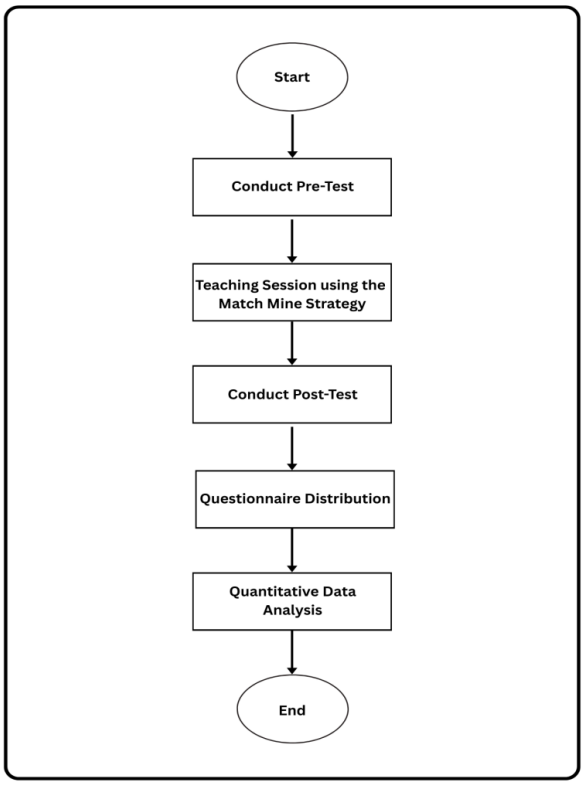

Fig. 1. Flowchart of methodology

2.1 PHASE I: Conducting Pre-Test

Data collection began with the administration of a pre-test, conducted within a 12 minute timeframe and consisting of 10 questions that varied in cognitive difficulty, including four low-level items, four medium-level items, and two high-level items. The purpose of this pre-test was to establish students' initial level of understanding before the intervention took place.

2.2 PHASE II:Teaching Session using the Match Mine Strategy

Following the pre-test, the researcher carried out a teaching session using the Match Mine strategy which requires students to communicate, interpret, and replicate instructions collaboratively.

2.3 PHASE III: Conduct Post-Test

After the instructional session, a post-test was administered using the same set of questions and the same 12 minutes duration. The utilisation of identical test items allowed for the assessment of equivalence and score stability, enabling precise measurement of learning improvement. The difference between the pre-test and post-test scores was used as the primary quantitative indicator of the effectiveness of the Match Mine strategy.

2.4 PHASE IV: Questionnaire Distribution to Students and Teachers

Upon completion of the testing phase, a structured questionnaire was distributed to the students to gather quantitative feedback on their perceptions of the Match Mine activity, including aspects

such as engagement, clarity, and perceived learning value. Questionnaires, which are basically a set of written statements or questions given to participants to complete, are one method of gathering data claimed by Narimawati and Praratya [15]. A similar questionnaire was subsequently administered to teachers to obtain their professional perspectives regarding the practicality, effectiveness and pedagogical suitability of the strategy within the classroom context. For this research, the instrument included a closed questionnaire consisting of statements with multiple predetermined responses for respondents to select.

2.5 PHASE V: Quantitative Data Analysis

The collected quantitative data were analyzed using Microsoft Excel to organize, compute, and interpret the results efficiently. Descriptive statistics including means, paired t-test, p-values, and differences between pre-test and post-test scores were calculated to assess students' learning gains.

3. Results

3.1 Pre-test and Post-test of the Match Mine Strategy

Students took a pre-test prior to the intervention and a post-test following the Match Mine activity in order to assess its efficiency. The purpose of the pre-test was to evaluate students' preliminary comprehension of the subject and pinpoint their areas of strength and growth. Following the learning exercise, students took a post-test to gauge their level of comprehension and material mastery. It is possible to analyse how the instructional technique affects student performance and learning outcomes by comparing these two sets of results in table 1 for the pre test and table 2 for the post test.

Table 1
Pre test and post test for the match mine strategy

PRE TEST		POST TEST	
NUMBERS OF STUDENT	MARKS	NUMBERS OF STUDENT	MARKS
0	1	0	1
0	2	0	2
1	3	0	3
0	4	0	4
0	5	1	5
2	6	0	6
4	7	2	7
10	8	7	8
9	9	11	9
5	10	10	10

The results of the pre-test and post-test for the 31 students indicate a clear improvement in overall performance following the implementation of the Match Mine activity. Based on the histogram in figure 2, the pre-test distribution shows that student scores were more widely dispersed, with some students scoring as low as 3 to 6 marks. The highest concentration of pre-test scores appears around 8 to 9 marks, indicating that while many students demonstrated moderate understanding initially, a notable portion still performed below the expected level. In contrast, the post-test distribution exhibits a substantial upward shift in student achievement. Lower scores between 5 and 7 marks decreased significantly, while the majority of students achieved marks between 8 and 10. The number of students scoring the highest mark 10 increased prominently,

suggesting a stronger mastery of the content after the intervention. This upward trend demonstrates that students not only improved but did so collectively, reflecting a more consistent level of understanding across the group. Overall, the comparison between pre-test and post-test results supports the conclusion that the Match Mine activity was effective in enhancing students' conceptual understanding and performance. The reduction in low scores and the increase in high-achieving students suggest that the instructional approach contributed positively to student engagement, comprehension, and retention of the targeted concepts. This improvement highlights the potential of interactive and collaborative learning strategies in promoting better learning outcomes.

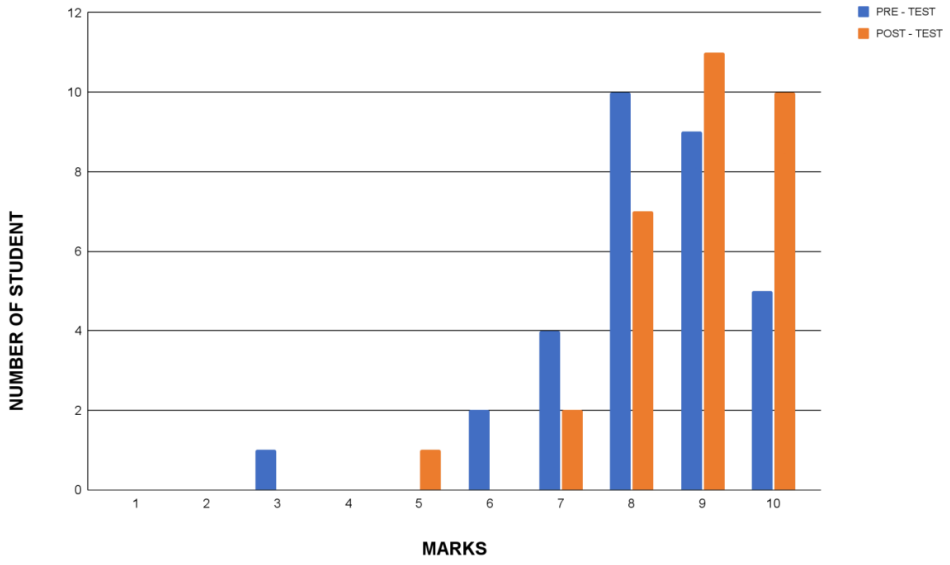

Fig. 2. indicates the number of student versus marks for the pre and post test

3.1.1 Mean score analysis

Mean score analysis is a key approach in educational research for evaluating student performance and determining whether a teaching strategy effectively enhances learning. In this study, the mean scores were specifically used to compare students' results before and after participating in the Match Mine activity. By examining the average scores from the pre-test and post-test, the analysis provides a clear indication of how the activity influenced students' understanding of the content. Because Match Mine is designed to encourage active engagement, peer interaction, and conceptual clarity, an increase in the post-test mean score serves as direct evidence that the activity helped improve students' comprehension and overall mastery of the material. The mean score and improvement were calculated using the following formula: x = (1) Σx n As shown in table 2, the students' performance demonstrated a clear improvement, as reflected in the calculated mean values. The post-test mean increased to 8.84, compared to the pre-test mean of 8.19, indicating an average improvement of 0.65 points. Although this numerical increase may appear modest, it is meaningful within the context of classroom assessment because it represents a consistent upward shift across the entire group of students. The rise in mean scores suggests that students were better able to comprehend, interpret, and apply the subject matter after participating in the activity.

Furthermore, the higher post-test mean implies that the Match Mine teaching method effectively enhanced students' engagement and mastery of the learning content. This improvement reflects not only increased understanding but also a more accurate internalization of concepts as a result of the interactive and collaborative nature of the activity. Overall, the findings affirm that the instructional

approach employed was beneficial and contributed to measurable gains in students' academic performance.

Table 2
Mean for the pre-test and post-test

MEAN		
PRE TEST	POST TEST	(POST TEST-PRE TEST)
8.19	8.84	0.65

3.1.2 Paired sample t-test results

The significance of the difference between pre-test and post-test scores was determined using the paired t-test, calculated with the following formula: t = (2) $D\ S\ D$ / n where; ● D = mean difference between paired scores ● S = standard deviation of the differences D ● n = number of paired observations The pre-test and post-test scores for the same set of students differed significantly, according to the paired t-test analysis, which yielded a value of t = 6.523. This finding implies that most students' performance consistently improved after the instructional intervention, rather than being the consequence of random variance. The success of the used teaching strategy is further supported by the high t-value. 3.1.3 Significance of the p-value The statistical significance of the difference between pre-test and post-test scores was assessed using the p-value, which is derived from the t-test using the following formula: p = $P(T \geq |\ t$ (3) $observed\ |)$ where; ● t = calculated t-value from the paired t-test $observed$ ● $P(T \geq |\ t$ = probability of observing a t-value as extreme as, or more extreme $observed\ |)$ than, the calculated value under the null hypothesis

The calculated p-value was 3.26×10^{-7}, which is considerably lower than the widely recognized significance threshold of 0.05. This very small p-value suggests that the difference between the pre-test and post-test scores is statistically significant and very improbable to have happened by random chance. In other terms, the chance that the noted enhancement occurred by coincidence is nearly insignificant. This outcome offers solid empirical evidence for the intervention's effectiveness. Thus, it can be assertively determined that the teaching approach utilized, specifically the Match Mine strategy, resulted in a notable and beneficial effect on students' academic achievement. The significant change in scores indicates a better grasp of the mathematical concepts covered, while also implying increased engagement, clearer comprehension, and more efficient learning methods supported by the activity's collaborative framework. This discovery emphasizes the importance of interactive, student-focused methods in mathematics instruction and underscores the effectiveness of the Match Mine strategy as a dependable resource for enhancing learning results. 3.2 Teacher Experience and Levels of Acceptance Based on Table 3, teacher experience and levels of acceptance are key factors in understanding how effectively the Match Mine activity can be integrated into classroom practice. In this study, teacher experience is grouped into three categories which are 1 to 5 years, 6 to 10 years, and more than 10 years while acceptance of the activity is classified as Low, Moderate, or High. The findings reveal that, regardless of their years of experience, most teachers show moderate to high levels of acceptance toward implementing Match Mine. Notably, teachers with more than ten years of experience form the largest proportion within the Moderate category and a substantial number are also represented in the High acceptance group. These patterns indicate that the activity is well-received across different professional stages, with particularly strong support from more experienced teachers. A summary of these patterns is presented in the table below.

Table 3
Rate of acceptance correlated by teacher experience

	RATE OF ACCEPTANCE		
TEACHER EXPERIENCE	LOW	MEDIUM	HIGH
1-5 YEARS	2	8	10
6-10 YEARS	1	29	30
10 YEARS AND ABOVE	0	138	112

As shown in figure 3, the input received from teachers about the Match Mine activity shows a robust positive reception among various teaching experience levels. Teachers with 1 to 5 years of experience indicated moderate levels of acceptance, showing few responses in the low range. This indicates that even novice teachers acknowledge the importance of the activity in enhancing student learning, although their acceptance is still evolving as they acquire more teaching experience. Teachers with 6 to 10 years of experience showed greater acceptance, with significant rises in both medium and high levels. This group exhibits higher confidence and value for the activity, suggesting that educators with more developed classroom management and teaching abilities can more effectively incorporate Match Mine into their instructional methods. The steady increase in acceptance from low to high levels denotes an expanding awareness of the activity's efficacy.

The highest level of acceptance was noted among teachers with over a decade of experience. This group achieved the greatest number of responses in the medium and high categories, showing almost no presence in the low category. The significant rise, especially in the medium category, suggests that seasoned teachers view the activity as very advantageous for improving student involvement and comprehension of concepts. Their favorable feedback indicates that Match Mine is well-suited to enduring classroom practices and is regarded as an effective teaching resource across different skill levels. Together, these findings indicate that teacher acceptance rises alongside teaching experience, highlighting the activity's importance and applicability in various educational environments.

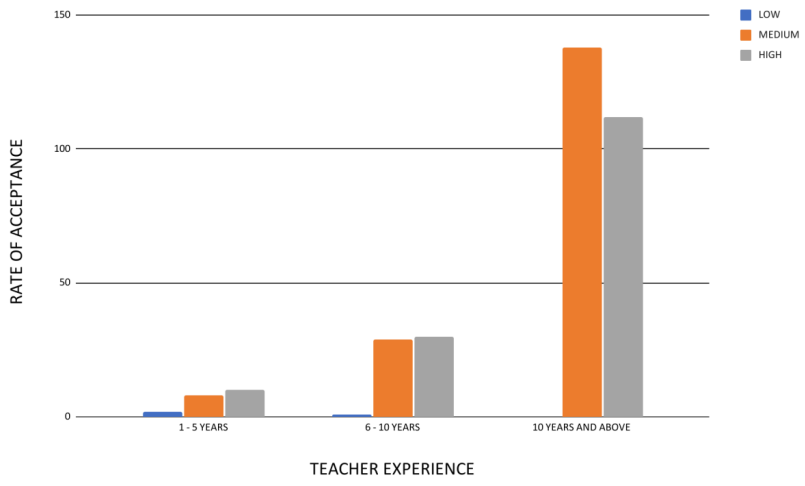

Fig. 3. Indicates about the rate of acceptance versus teacher experience

4. Conclusions

The results of this research collectively indicate that the Match Mine activity serves as an effective teaching method that improves student learning and is positively regarded by teachers with varying

levels of experience. The analyses from the pre-test and post-test indicate evident academic enhancement, featuring increased average scores, fewer low performers, and a considerable increase in the number of students achieving 8–10 marks following the intervention. Statistical analyses further reinforce this conclusion, as the paired sample t-test reveals a highly significant difference between pre- and post-test results, backed by an extremely low p-value, suggesting that the observed improvement is not due to chance. Moreover, teacher feedback indicates a high level of acceptance for the activity, with the strongest support from those possessing over ten years of experience, implying that Match Mine is both effective and flexible for different classroom situations. In summary, the findings confirm that Match Mine successfully enhances student involvement, deep comprehension, and steady performance gains while receiving widespread backing from teachers, establishing it as a beneficial educational resource for improving learning results. Acknowledgement
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