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The Effect of Using Educational Software on Developing Mathematical Problem-Solving Skills among Primary School Pupils: An Analytical Study from the Perspective of Mathematics Teachers in Some Basic Education Schools in Zawiya City.

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Abstract:

This study aimed to investigate the effect of using educational software on developing mathematical problem-solving skills among Grade Six primary school pupils. The study adopted a descriptive-analytical approach to examine pupils' performance before and after the educational intervention. The study sample consisted of 140 pupils from five basic education schools. A 25-item mathematics problem-solving test was administered as a pre-test and post-test, with a maximum score of 25 points.

The results revealed a clear improvement in pupils' performance following the educational intervention. The overall mean score increased from 14.70 in the pre-test to 21.72 in the post-test, with an overall mean gain of 7.02 points. In terms of percentage, the overall performance increased from 58.80% to 86.88%**.** Among the five schools, Manarat Al-Ilm Basic Education School achieved the highest mean gain, reaching 7.53 points, equivalent to 30.12 percentage points. These findings indicate that the use of educational software had a positive effect on improving pupils' mathematical problem-solving skills.

The study recommends expanding the use of educational software in mathematics teaching, providing appropriate training for teachers, improving the technological infrastructure of schools, and conducting future studies using larger samples and longer intervention periods.

Keywords: Educational Software, Mathematical Problem-Solving, Problem-Solving Skills, Primary School Pupils, Basic Education, Mathematics Teaching, Mathematics Teachers, Academic Achievement.

1.Introduction

Education has witnessed rapid development as a result of advances in information and communication technology, leading to the use of modern tools such as educational software in teaching and learning. Educational software can provide interactive learning environments that encourage pupils to participate, practice mathematical skills, and receive immediate feedback. Mathematics education requires not only learning arithmetic procedures but also developing pupils' thinking, reasoning, analysis, and problem-solving skills. Mathematical problem-solving enables pupils to apply their knowledge to new and unfamiliar situations and requires the use of different strategies and approaches (Leppäaho, 2018, p. 374). Study indicates that excessive reliance on routine exercises may limit pupils' learning to familiar procedures and reduce opportunities for developing mathematical thinking (Näveri et al., 2011, p. 169). Therefore, mathematics instruction should provide pupils with opportunities to investigate problems and actively search for solutions (Pehkonen et al, 2013, p. 13). Educational software can support this process by offering interactive activities that allow pupils to explore problems, identify errors, correct their solutions, and receive immediate feedback. It can also provide varied mathematical tasks that encourage pupils to apply different problem-solving strategies. The effective use of educational software depends largely on the mathematics teacher's ability to select appropriate programs and integrate them with lesson objectives. Teachers also play an important role in guiding pupils, encouraging mathematical communication, and monitoring their progress.

Accordingly, the present study examines the effect of using educational software on developing mathematical problem-solving skills among primary school pupils, from the perspective of mathematics teachers. The study is conducted with 140 pupils from five schools in Zawiya, aiming to provide an applied perspective on the potential role of educational software in improving mathematical problem-solving skills.

2.Problem Statement

The ability to solve mathematical problems is one of the fundamental skills that primary school pupils should acquire because it contributes to the development of logical thinking, analysis, reasoning, and the ability to apply mathematical knowledge to different situations. However, some pupils may experience difficulties when dealing with mathematical problems, particularly in understanding the problem, identifying the given information and the required information, selecting the appropriate operation or strategy, carrying out the solution steps, and verifying the correctness of the answer.

These difficulties may, in some cases, be associated with traditional teaching methods that may focus more on presenting rules and solution procedures than on actively involving pupils in thinking, practicing, and experimenting. Furthermore, differences in pupils' abilities and learning levels may make it difficult for a single teaching approach to meet the needs of all learners equally.

At the same time, technological developments have made it possible to employ educational software in mathematics teaching. Such software provides interactive activities, repeated practice, immediate feedback, and opportunities for pupils to attempt solutions and correct their mistakes. Consequently, educational software may provide an appropriate approach for supporting the development of mathematical problem-solving skills among primary school pupils.

Therefore, the present study seeks to investigate the effect of using educational software on developing mathematical problem-solving skills among pupils in five schools in Zawiya: Zawiya Central Primary School, Manarat Al-Ilm Basic Education School, Al-Tali'a Basic Education School, Othman Ibn Affan Basic Education School, and Zawiya Shuhada Basic Education School, with a total sample of 140 pupils.

Accordingly, the problem of the study can be expressed through the following main question:

What is the effect of using educational software on developing mathematical problem-solving skills among primary school pupils in the selected schools in Zawiya?

The following sub-questions arise from the main question:

1. What is the level of pupils' mathematical problem-solving skills before using educational software?
2. What is the level of pupils' mathematical problem-solving skills after using educational software?
3. Are there statistically significant differences between pupils' mean scores on the pre-test and post-test of mathematical problem-solving skills?
4. What is the amount of improvement achieved by pupils after using educational software?

3.Specific Objectives

The study aims to:

1. Determine the level of mathematical problem-solving skills among the 140 pupils before and after using educational software.
2. Examine the differences between pupils' performance on the pre-test and post-test of mathematical problem-solving skills.
3. Measure the amount of improvement in pupils' mathematical problem-solving skills following the use of educational software.

4. Determine the effectiveness of educational software in developing key mathematical problem-solving skills, including understanding the problem, identifying the given information and requirements, planning and implementing the solution, and verifying the answer.

4.Significance of the Study

The significance of this study arises from its focus on integrating modern educational technology with the development of mathematical problem-solving skills among primary school pupils. The significance can be presented from two perspectives:

4.1. Theoretical Significance

The study contributes to the theoretical literature concerning the use of educational software in mathematics education, particularly in relation to the development of mathematical problem-solving skills.

It also provides a theoretical framework explaining the potential relationship between educational software and the skills required to solve mathematical problems, including understanding, analysis, planning, implementation, and verification.

Furthermore, the findings may provide a basis for future Studyers interested in investigating the use of educational technology in mathematics education in different educational contexts.

4.2. Practical Significance

The practical significance of the study lies in the possibility of using its findings to improve mathematics teaching methods in the schools included in the study: Zawiya Central Primary School, Manarat Al-Ilm Basic Education School, Al-Tali'a Basic Education School, Othman Ibn Affan Basic Education School, and Zawiya Shuhada Basic Education School.

Mathematics teachers may benefit from the findings by gaining a clearer understanding of the effectiveness of educational software in training pupils to solve mathematical problems.

School administrators may also benefit from the results when planning to support the use of modern educational technologies in classrooms.

Pupils may benefit from interactive learning environments that provide greater opportunities for practice, feedback, repeated attempts, and correction of errors.

Finally, educational supervisors and curriculum planners may use the findings when developing mathematics teaching strategies and integrating educational software into the teaching and learning process.

5.Study Terms

5.1. Educational Software

Educational software refers to computer-based programs designed to support teaching and learning through interactive activities, practice, feedback, and assessment **(**Alessi & Trollip, 2001, pp. 3, 48–49**)**.

Operationally: In this study, educational software refers to the digital programs and applications used to teach mathematics, with the aim of helping Grade Six pupils understand mathematical problems, practice solution procedures, and develop problem-solving skills.

5.2.Educational Software Used in the Study:

1. Photomath**:** A mathematics application that provides step-by-step solutions to mathematical problems and helps pupils understand solution procedures and check their answers.
2. GeoGebra**:** Interactive mathematics software used to represent mathematical concepts and problems visually, particularly in geometry, algebra, and graphing.
3. IXL**:** An interactive platform that provides progressively structured mathematics exercises and helps pupils develop their mathematical skills through practice and feedback.

5.3. Mathematical Problem-Solving Skills

Mathematical problem-solving skills involve a systematic process through which the learner understands the problem, identifies the unknown and the available information, develops an appropriate plan, carries out the plan, and reviews the solution. Polya presents these stages as four major phases: understanding the problem, devising a plan, carrying out the plan, and looking back (Polya, 1957, pp. 5–16)**.**

NCTM also places problem solving among the major processes and goals of school mathematics and emphasizes the role of worthwhile mathematical problems in developing students' mathematical thinking **(**Hiebert, J. 2003**,** p. 52**)**.

Operationally: In this study, mathematical problem-solving skills refer to the pupils' ability to understand and analyze mathematical problems, identify the given information and the required outcome, select an appropriate strategy, implement the solution, and verify the answer, as measured by the pre-test and post-test.

5.4. Primary School Stage

Primary education is defined as the first level of formal education and focuses on providing learners with fundamental knowledge and skills, including reading, writing, and arithmetic. UNESCO Institute for Statistics classifies primary education as ISCED Level 1 (UNESCO Institute for Statistics, 2015, pp. 27–28)**.**

Operationally: In this study, the primary school stage refers to the educational level to which the pupils participating in the study belong and in which the mathematics intervention was implemented.

Primary School Pupils

Primary school pupils are learners enrolled in educational programs classified at the primary level. At this level, learners acquire basic knowledge and skills that establish a foundation for subsequent education **(**UNESCO Institute for Statistics, 2015, pp. 27–28)**.**

Operationally: In this study, primary school pupils refer to the 140 pupils who constituted the study sample and were enrolled in the five participating schools.

5. 5.Mathematics Teachers

Mathematics teachers are responsible for organizing mathematical learning experiences, selecting appropriate mathematical tasks, supporting pupils' mathematical thinking, and assessing their learning. NCTM emphasizes the importance of teachers' roles in selecting worthwhile mathematical tasks and supporting students' mathematical development **(**Hiebert, J**.** 2003, pp. 18, 52)**.**

Operationally: In this study, mathematics teachers refer to the teachers who participated in the questionnaire component of the Study in order to identify their views regarding the use of educational software and its role in developing pupils' mathematical problem-solving skills.

6.Presentation and Analysis of the Study Results

6.1 Description of the Study Sample

The study sample consisted of **140 primary school pupils** distributed across five schools. The distribution of the study sample is presented in Table (1).

Table (1): Distribution of the Study Sample by School

No.	School	Sample Size	Percentage
1	Zawiya Central Primary School	35	25.0%
2	Manarat Al-Ilm Basic Education School	32	22.9%
3	Al-Tali'a Basic Education School	27	19.3%
4	Othman Ibn Affan Basic Education School	25	17.9%
5	ZawiyaShuhada Basic Education School	21	15.0%
Total		140	100%

The table shows that Zawiya Central Primary School had the largest number of participants, with 35 pupils (25.0%), whereas Zawiya Shuhada Basic Education School had the smallest number, with 21 pupils (15.0%).

6.2. Pre-Test and Post-Test Results

The mathematics problem-solving test was administered before and after the educational intervention. The maximum possible score on the test was 25 points.

Table (2): Descriptive Statistics for the Total Sample

Test	N	Mean	Standard Deviation
Pre-Test	140	14.70	2.70
Post-Test	140	21.72	2.96
Gain	140	7.02	1.83

Mean scores of the 140 pupils before and after the educational intervention, out of 25 points.

The results demonstrate a clear increase in pupils' mean scores. The mean increased from 14.70 in the pre-test to 21.72 in the post-test, representing an average improvement of 7.02 points. This indicates a noticeable improvement in the pupils' mathematical problem-solving performance following the educational intervention.

6.3.Calculation of the Gain Score

The improvement achieved by each pupil was calculated using the following equation

$Di = the\ gain\ score\ for\ each\ pupill$……..(1)

$X_{POST} = the\ pupil's\ post - test\ score$……(2)

$X_{Pre} = the\ pupil's\ post - test\ score$……..…(3)

Mean Gain % = (Post-Test Mean − Pre-Test Mean) ÷ 25 × 100…(4)

7.Analysis by School

7.1.Zawiya Central Primary School

The sample from Zawiya Central Primary School consisted of 35 pupils.

Table (3): Results for Zawiya Central Primary School

Indicator	Value
N	35
Pre-Test Mean	14.91
Post-Test Mean	21.51
Mean Gain	6.60

The results for the 35 pupils at Zawiya Central Primary School were analyzed by comparing their pre-test and post-test scores and calculating the mean gain. This comparison was used to determine the extent of improvement in pupils' mathematical problem-solving performance following the educational intervention.

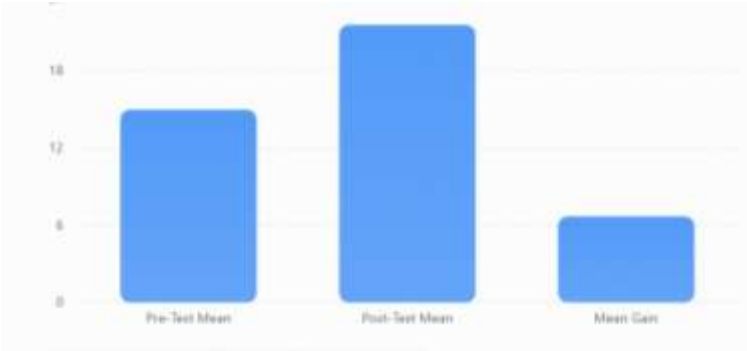

Figure (1): Comparison of Pre-Test, Post-Test, and Mean Gain at Zawiya Central Primary School.

The mean score increased from 14.91 in the pre-test to 21.51 in the post-test, with a mean gain of 6.60 points. This indicates a clear improvement in pupils' mathematical problem-solving performance following the educational intervention.

7.2.Manarat Al-Ilm Basic Education School

The sample from Manarat Al-Ilm Basic Education School consisted of 32 pupils.

Table (4): Results for Manarat Al-Ilm Basic Education School.

Indicator	Value
N	32
Pre-Test Mean	15.00
Post-Test Mean	22.53
Mean Gain	7.53

The results indicate that the mean score increased from 15.00 in the pre-test to 22.53 in the post-test. The mean gain was 7.53 points, indicating a clear improvement in pupils' mathematical problem-solving performance following the educational intervention.

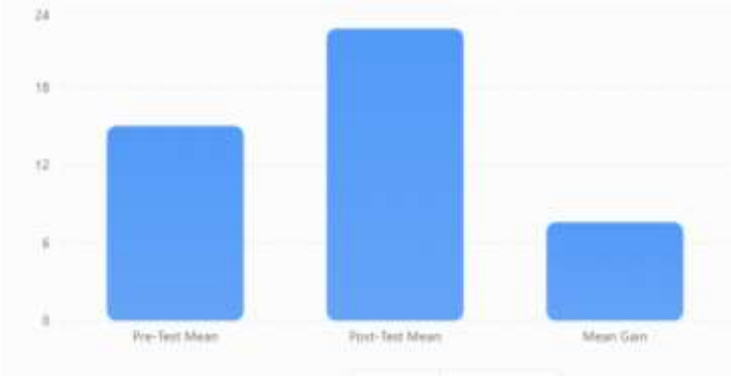

Figure (2): Comparison of Pre-Test, Post-Test, and Mean Gain at Manarat Al-Ilm Basic Education School .

The figure shows a noticeable increase in the mean score from 15.00 in the pre-test to 22.53 in the post-test. The 7.53-point mean gain demonstrates substantial improvement in pupils' mathematical problem-solving performance after the educational intervention.

7.3.Al-Tali'a Basic Education School

The sample from Al-Tali'a Basic Education School consisted of 27 pupils.

Table (5): Results for Al-Tali'a Basic Education School.

Indicator	Value
N	27
Pre-Test Mean	14.59
Post-Test Mean	21.85
Mean Gain	7.26

The results presented in Table (5) indicate a clear improvement in the performance of pupils at Al-Tali'a Basic Education School following the educational intervention. The sample consisted of 27 pupils, and the mean score increased from 14.59 in the pre-test to 21.85 in the post-test. The mean gain was 7.26 points, indicating a noticeable improvement in pupils' mathematical problem-solving skills following the intervention.

Figure (3): Comparison of Pre-Test, Post-Test, and Mean Gain Results at Al-Tali'a Basic Education School.

Figure (3) shows a clear difference between the pre-test and post-test results of pupils at Al-Tali'a Basic Education School. The mean score increased from 14.59 in the pre-test to 21.85 in the post-test, representing an improvement of 7.26 points. This increase indicates a noticeable improvement in pupils' mathematical problem-solving skills following the educational intervention and reflects its positive effect on developing these skills.

7.4.Othman Ibn Affan Basic Education School

The sample from Othman Ibn Affan Basic Education School consisted of 25 pupils.

Table (6): Results for Othman Ibn Affan Basic Education School

Indicator	Value
N	25
Pre-Test Mean	13.84
Post-Test Mean	20.52
Mean Gain	6.68

The results presented in Table (6) indicate a clear improvement in the performance of pupils at Othman Ibn Affan Basic Education School following the educational intervention. The sample consisted of 25 pupils, and the mean score increased from 13.84 in the pre-test to 20.52 in the post-test. The mean gain was 6.68 points, indicating a noticeable improvement in pupils' mathematical problem-solving skills following the educational intervention.

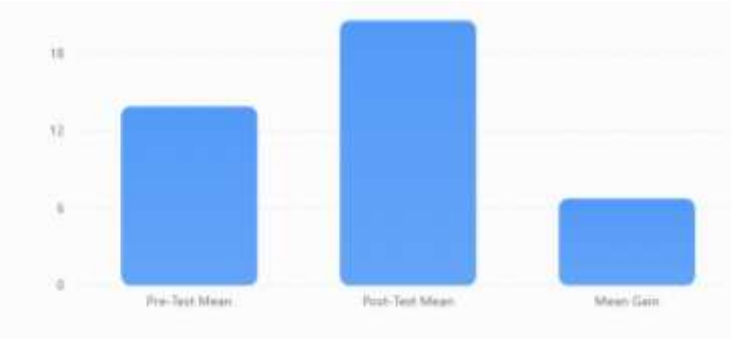

Figure (4): Comparison of Pre-Test, Post-Test, and Mean Gain Results at Othman Ibn Affan Basic Education School

Figure (4) illustrates the difference between the pupils' pre-test and post-test mean scores. The mean score increased from 13.84 in the pre-test to 20.52 in the post-test, with a mean gain of 6.68 point**s**. This increase demonstrates a clear improvement in pupils' mathematical problem-solving performance following the educational intervention.

7.5.Zawiya Shuhada Basic Education School

The sample from Zawiya Shuhada Basic Education School consisted of 21 pupils.

Table (7): Results for Zawiya Shuhada Basic Education School…….

Indicator	Value
N	21
Pre-Test Mean	15.05
Post-Test Mean	22.10
Mean Gain	7.05

The results presented in Table **(7)** indicate a clear improvement in the mathematical problem-solving performance of pupils at Zawiya Shuhada Basic Education School following the educational intervention. The sample consisted of 21 pupils. The mean score increased from 15.05 in the pre-test to 22.10 in the post-test, representing a mean gain of 7.05 points. This increase indicates a noticeable improvement in pupils' mathematical problem-solving skills following the educational intervention.

Figure (5): Comparison of Pre-Test, Post-Test, and Mean Gain Results at Zawiya Shuhada Basic Education School

Figure (5) illustrates the difference between the pupils' pre-test and post-test mean scores. The figure shows an increase in the mean score from 15.05 in the pre-test to 22.10 in the post-test. The mean gain of 7.05 points demonstrates a clear improvement in pupils' mathematical problem-solving performance following the educational intervention.

8. Comparison of the Five Schools

Table (8): Percentage Comparison of Pre-Test, Post-Test, and Mean Gain by School

School	N	Pre-Test (%)	Post-Test (%)	Mean Gain (%)
Zawiya Central Primary School	35	59.64%	86.04%	26.40%
Manarat Al-Ilm Basic Education School	32	60.00%	90.12%	30.12%
Al-Tali'a Basic Education School	27	58.36%	87.40%	29.04%
Othman Ibn Affan Basic Education School	25	55.36%	82.08%	26.72%
Zawiya Shuhada Basic Education School	21	60.20%	88.40%	28.20%
Total	140	58.80%	86.88%	28.08%

The results presented in Table (8) show a clear improvement in pupils' performance across all five schools. The pre-test percentages ranged from 55.36% to 60.20%, whereas the post-test percentages ranged from 82.08% to 90.12%.

Manarat Al-Ilm Basic Education School recorded the highest post-test percentage (90.12%) and the highest mean gain (30.12%). This was followed by Al-Tali'a Basic Education School, with a post-test percentage of 87.40% and a mean gain of 29.04%. Zawiya Shuhada Basic Education School recorded a post-test percentage of 88.40% and a mean gain of 28.20%.

For the total sample of 140 pupils, the overall pre-test percentage was 58.80%, compared with 86.88% in the post-test, resulting in an overall mean gain of 28.08 percentage points. These findings demonstrate a consistent and substantial improvement in pupils' mathematical problem-solving performance following the educational intervention.

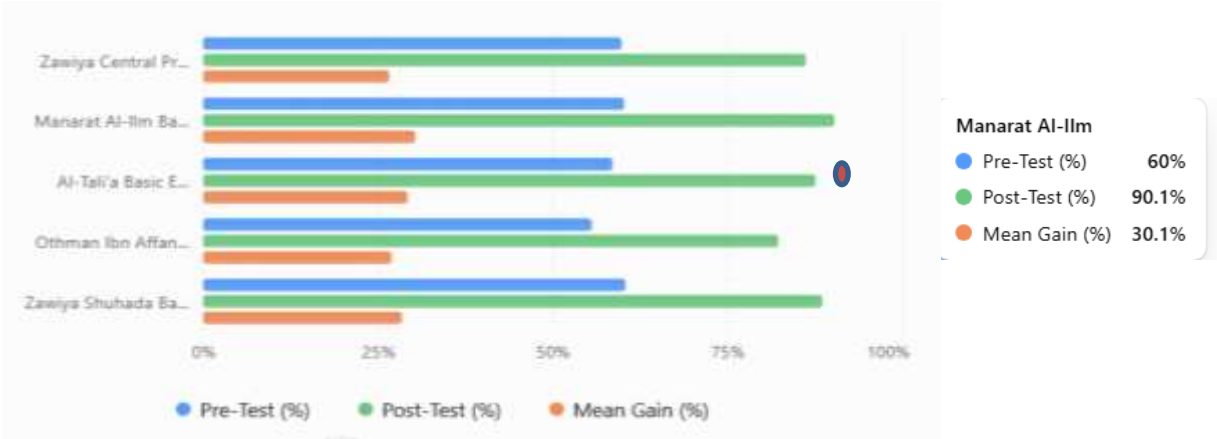

Figure (6): Percentage Comparison of Pre-Test, Post-Test, and Mean Gain by School**.**

Figure (6) presents the percentages of the pre-test, post-test, and mean gain for the five schools. The results show that the post-test percentage was higher than the pre-test percentage in all schools. Manarat Al-Ilm Basic Education School recorded the highest post-test percentage (90.12%**)** and the highest mean gain (30.12%**).** Overall, the figure demonstrates a clear and consistent improvement in pupils' mathematical problem-solving performance following the educational intervention.

Study Findings

Based on the analysis of the pre-test and post-test results for the study sample of 140 pupils from five basic education schools, the study reached the following findings:

1. The results showed a clear improvement in pupils' mathematical problem-solving performance following the educational intervention using educational software. The mean score increased from 14.70 in the pre-test to 21.72 in the post-test.
2. The overall mean gain was 7.02 points out of 25 points, indicating a noticeable improvement in pupils' performance after the educational intervention.
3. The overall performance percentage increased from 58.80% in the pre-test to 86.88% in the post-test, reflecting clear progress in pupils' ability to solve mathematical problems.
4. Manarat Al-Ilm Basic Education School achieved the highest mean improvement among the five schools, with a gain of 7.53 points, equivalent to 30.12 percentage points.
5. The comparison among the five schools showed that improvement occurred in all schools, with mean gains ranging from 6.60 to 7.53 points, indicating a consistent positive trend following the educational intervention.
6. Overall, the findings indicate that the use of educational software can contribute positively to developing mathematical problem-solving skills among Grade Six pupils, by providing interactive activities, practice exercises, and feedback that support improved performance.

Study Recommendations

Based on the findings of the study, the following recommendations are proposed:

1. Expand the use of educational software in teaching mathematics at the primary education level, particularly in mathematical problem-solving.
2. Provide mathematics teachers with training on selecting appropriate educational software and using it effectively in the classroom.
3. Develop and use educational software suitable for Grade Six pupils, taking into account their different learning levels and individual differences.
4. Provide schools with appropriate technological infrastructure, including computers and presentation equipment, as well as Internet access when necessary.
5. Use educational software to provide interactive activities and multi-level mathematical problems that help pupils understand the problem, select an appropriate solution strategy, carry out the solution, and verify the answer.
6. Conduct future studies using larger samples and longer intervention periods, while comparing different types of educational software to identify those that are most effective in developing mathematics and problem-solving skills.

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