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# Systematic literature review: Learning geometry transformation using PMRI

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## *Abstract*

*This study aims to conduct a systematic literature review related to geometric transformation learning using the Indonesian Realistic Mathematics Education (PMRI) approach. The research method employed was a Systematic Literature Review (SLR). The research data consisted of journal articles discussing PMRI-based geometric transformation learning. The article selection criteria included relevance to the research topic, publication in reputable journals, and alignment with PMRI principles. The results indicate that PMRI-based learning can improve students' understanding of geometric transformation concepts through the use of realistic contexts. Therefore, PMRI can be considered an effective approach for teaching geometric transformation.*

***Keywords**: PMRI, Geometry Transformation, Systematic Literature Review*

## Abstrak

Penelitian ini bertujuan untuk melakukan kajian literatur sistematis terkait pembelajaran transformasi geometri menggunakan pendekatan Pendidikan Matematika Realistik Indonesia (PMRI). Metode penelitian yang digunakan adalah *Systematic Literature Review* (SLR). Data penelitian berupa artikel jurnal yang membahas pembelajaran transformasi geometri berbasis PMRI. Kriteria pemilihan artikel meliputi kesesuaian topik, publikasi pada jurnal bereputasi, serta keterkaitan dengan prinsip PMRI. Hasil kajian menunjukkan bahwa pembelajaran berbasis PMRI mampu meningkatkan pemahaman konsep transformasi geometri melalui penggunaan konteks yang realistis. Dengan demikian, pendekatan PMRI dapat dijadikan sebagai alternatif dalam pembelajaran transformasi geometri.

**Kata kunci**: PMRI, Transformasi Geometri, *Systematic Literature Review*

## INTRODUCTION

Mathematics is a crucial subject in education, particularly for enhancing students' logical, analytical, systematic, critical, and creative thinking abilities. Geometry transformation is one of the essential topics in mathematics learning that requires students to understand abstract concepts through visual and contextual representations. Geometric transformation includes translation, reflection, rotation, and dilation, which are fundamental concepts taught at the secondary school level (Firdiana et al., 2022; Mashingaidze, 2012; Rezat et al., 2014). Mastery of the concept of geometric transformation is important because it can help students understand other mathematical concepts, such as Cartesian coordinates, symmetry, and line equations (Ada & Kurtuluş, 2010; Faulina & Andriyani, 2020; Febrian & Perdana, 2018; Lestari et al., 2020).

However, many students experience difficulties in understanding geometric transformation concepts due to the abstract nature of the material. Various studies indicate that students continue to struggle with understanding the concept of geometry transformation (Fitriani et al., 2021; Hanipah et al., 2022; Lestari et al., 2020). This can be caused by several factors, such as an ineffective learning approach, lack of use of teaching aids, and lack of teacher understanding of the concept of geometric transformation (Ada & Kurtuluş, 2010; Fan et al., 2017; Ridha et al., 2020). Some of the difficulties students face in geometric transformations include not being able to understand the concept of the problem, being less thorough in calculating translation, reflection, rotation, and dilation, and being unable to determine Cartesian coordinates accurately (Ridha et al., 2020).

One of the learning approaches that emphasizes contextual understanding is Pendidikan Matematika Realistic Indonesia (PMRI) (Hasbi et al., 2021; Mutaqin et al., 2021; Safrizal et al., 2022). PMRI focuses on the use of realistic contexts to support students in constructing mathematical concepts independently (Adha et al., 2023; Fitriani et al., 2021; Hasbi et al., 2021). In learning geometry transformation, This approach can enhance students' understanding of geometry transformation by allowing them to learn through problems that are relevant to their everyday lives (Nirawati et al., 2020; Pangestika et al., 2022; Yanny et al., 2023). Several previous studies have reported that PMRI can improve students' conceptual understanding in geometry learning (Hartati et al., 2018; Novrika et al., 2016). The study reveals that implementing PMRI can support students in understanding the concept of geometry transformation, particularly reflection.

Based on the explanation above, this study aims to review research related to learning geometric transformation using the PMRI approach. This approach can help students learn through contextual problems that are relevant to everyday life. Therefore, the implementation of Indonesian Realistic Mathematics Education in teaching geometric transformations should be continually developed and further explored through research. This study focuses on identifying research trends, learning outcomes, and instructional strategies applied in PMRI-based geometric transformation learning.

## METHOD

This study employed a Systematic Literature Review (SLR) method to analyze research related to geometric transformation learning using PMRI. Calderón & Ruiz (2015) The SLR method was conducted systematically to identify, evaluate, and synthesize relevant research findings. The SLR research procedure can be seen in Figure 1:

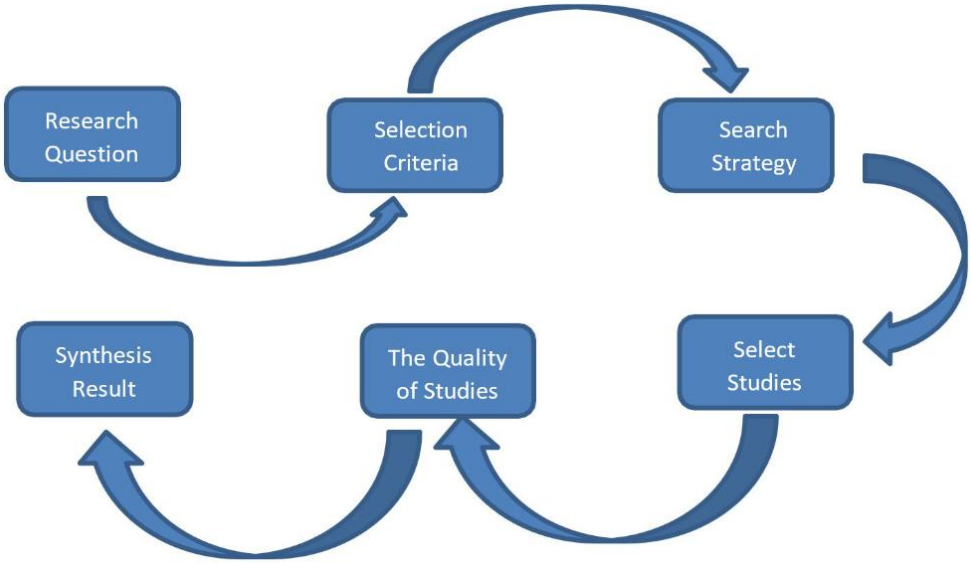


**Figure 1. SLR Research Procedure (Modification, Zawacki-Richter et al., 2020)**

The research procedure consisted of several stages, including article identification, screening, eligibility assessment, and data analysis. The article selection criteria include: (inclusion) design research articles on validation of geometric transformation material studies based on PMRI, indexed by Scopus or SINTA, and published between 2018-2024; (exclusion) irrelevant articles, articles/proceedings not indexed by Scopus/SINTA, or published before 2018. The search strategy involved searching PMRI learning design articles for geometric transformation material. The study selection process includes examining the title, language, year of publication, abstract, content, and journal index. Evaluation of study

quality analyzes the relevance of the article to the research objectives. The synthesis stage combines information from the selected articles to answer the research questions.

## RESULTS AND DISCUSSION

In this study, articles were searched using Google Scholar, Sinta, and Scopus. The articles searched had keywords, namely geometric transformation material, realistic mathematics education, PMRI, and design research. The search results contained 33 articles discussing geometric transformation learning. Then select studies were carried out, so the researcher got 8 articles that were relevant to the research topic. The following article search process is explained in Figure 2.

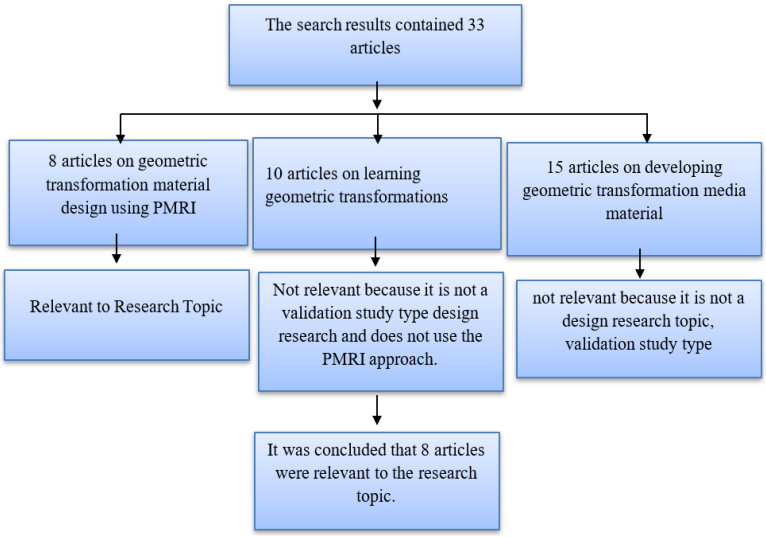


**Figure 2. Article Selection Process**

Furthermore, from 33 articles obtained from the search process. There are 25 articles that are not relevant and 8 articles that are relevant to the research topic and then the 8 articles are continued with the Synthesis result process which will be described in table 1.

**Table 1. Synthesis Results Article Results**

| Number | Article Accreditation | Results |
|---|---|---|
| 1 | Scopus | This research demonstrated that a reasoning-based approach to teaching transformation geometry satisfied all tenets of Realistic Mathematics Education. The pedagogical design fostered active learning of key transformation geometry concepts through practical mathematical engagement. Utilizing the context of Malay woven motifs presented authentic and relevant problems, thereby facilitating students' conceptual understanding of the subject. The study highlighted how the learning process, focused on mathematical content knowledge, incorporated individual, |

| Number | Article Accreditation | Results |
|---|---|---|
| | | collaborative, and teacher-guided activities (Febrıan & Astutı, 2018). |
| 2 | Proceedings indexed by Scopus | Ninth-grade students at SMP Negeri 6 Semarang participated in a study exploring the use of Realistic Mathematics Education in learning geometric transformations. The learning trajectory, based on the Tedhak Siten tradition, comprised six activities: defining and identifying properties of geometric transformations; determining formulas and outcomes for reflections, translations, rotations, and dilations; and solving contextual problems related to geometric transformations (Hardiyanto et al., 2024). |
| 3 | Sinta 3 | This research demonstrates the effectiveness of a Hypothetical Learning Trajectory incorporating local context, such as the Cirebon Red Mosque, in teaching geometric transformations, particularly reflections. The study highlights the benefits of using culturally relevant and readily accessible contexts from students' daily lives. (Hamidah et al., 2024). |
| 4 | Proceedings indexed by Scopus | The resulting learning trajectory design, based on realistic mathematics education for teaching reflection, involves the following steps: students analyze Riau batik motifs to identify reflection characteristics, draw Riau batik motifs following pre-determined rules, record the initial and final points of the reflected batik motifs, and derive the reflection formula (Filda & Armiati, 2023). |
| 5 | Scopus | This learning trajectory, employing a South Sumatra dance context and a floor tile Cartesian coordinate model, effectively enhanced students' understanding of transformation geometry concepts. The three-activity design, based on the RME approach, guided students to discover the formal concepts of translation and reflection through observation, analysis of dancer positions, and application of Cartesian coordinates. This approach proved beneficial in developing students' mathematical abilities and conceptual understanding (Rawani et al., 2023). |
| 6 | Proceedings indexed by Scopus | Student learning activities comprise four stages: analyzing a video of a Central Javanese historical building; determining, drawing, and formulating the reflection of shapes in a Cartesian coordinate system; determining, drawing, and formulating the reflection of shapes across lines parallel to the x and y axes; and solving reflection-related problems. The study's findings suggest that these activities, using the context of Central Javanese historical buildings, effectively enhance students' understanding of reflection (Nursyahidah et al., 2020). |
| 7 | Sinta 2 | This study demonstrates how bamboo weaving motifs effectively facilitated ninth-grade students' understanding of dilation and reflection in transformation geometry. The design experiments revealed that this context stimulated student comprehension of these concepts. Student-generated strategies and models illustrated how their contributions fostered their initial understanding of reflection and dilation (Maryati & Prahmana, 2021). |
| 8 | Sinta 2 | This study found that exploring rotation problems using Palembang songket patterns as a context enhanced students' inductive reasoning abilities. The use of songket patterns as a starting point in mathematics learning facilitated the development of students' inductive reasoning skills in solving rotation problems (Sari & Putri, 2021). |

The results of the literature review indicate that PMRI has been widely applied in geometry learning, particularly in improving students' conceptual understanding of the concept of geometric transformation and making learning more meaningful. Several studies reported that PMRI-based learning supports students in understanding geometric transformation concepts through contextual activities (Inharjanto & Lisnani, 2019; Nursyahidah et al., 2020). The context of local wisdom is very effective for geometric transformation material because the context of local wisdom is close to students and students are motivated by learning geometric transformation with the context of local wisdom. In line with this, the principle of self-developed models in PMRI bridges student learning from real situations to concrete situations, or from informal mathematics to formal mathematics (Zulkardi et al., 2025, 2020; Zulkardi & Putri, 2010).

## CONCLUSION

Based on the results of the systematic literature review, PMRI has a positive impact on students' understanding of geometric transformation. This approach has been proven to help overcome students' difficulties in understanding geometric transformation concepts, thereby minimizing the potential for misconceptions. Designing PMRI-based learning materials is an effective alternative solution, although each study emphasizes the need for specific focus and adjustments in designing geometric transformation materials to optimize learning outcomes.

The articles analyzed were from reputable journals indexed by Sinta and Scopus. The study results indicate that the initial problem commonly encountered in these studies is student misconceptions about geometric transformation concepts. The application of context in PMRI acts as a conceptual bridge that helps students build a more comprehensive understanding, while the series of designed learning activities generates local instructional theory (LIT) as a theoretical contribution from these studies. It is recommended for further researchers to design geometric transformation learning with a local wisdom context.

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