Empowering Parents through Andragogy: A Systematic Review on Parental Involvement in Children's Mathematics Learning

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ABSTRACT

This study examined parental involvement in children's mathematics learning through an andragogical approach as the foundation for developing a lifelong learning–based parental empowerment model. The study addressed the problem that many parents, although willing to assist their children, often lack effective strategies to support mathematics learning at home. To provide a systematic understanding of this issue, a Systematic Literature Review (SLR) was conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. The review process involved identifying, screening, and analyzing relevant studies retrieved from academic databases such as Google Scholar, ERIC, Scopus, ScienceDirect, and SpringerLink. Out of 200 initially identified publications, 30 studies met the inclusion criteria and were analyzed thematically. The results indicated that applying andragogical principles effectively improved parents' awareness, motivation, and confidence as adult learners in guiding their children's mathematics learning. Furthermore, integrating Indonesian Realistic Mathematics Education (PMRI) and deep learning approaches promoted contextual, reflective, and meaningful learning experiences. The synthesis concluded that the integration of andragogy, parental involvement, and realistic learning approaches provided a solid conceptual basis for developing a lifelong learning–oriented parental empowerment model that strengthens collaboration between schools and families.

Keywords: *andragogy, mathematics learning, parental involvement, PMRI*

1. INTRODUCTION

Mathematics learning at the elementary school level is a complex process, as it is influenced not only by students' internal abilities but also by external factors such as parental involvement and the home learning environment. Various studies have shown that parents' attitudes, beliefs, and self-confidence toward mathematics significantly affect their children's motivation and academic achievement (Maloney et al., 2015; Soni & Kumari, 2015; Liu & Leung, 2021). When parents experience anxiety or doubt about mathematics, such attitudes are often transmitted to their children, creating a less supportive learning atmosphere at home.

Conversely, positive and well-directed parental involvement has been shown to enhance children's interest, confidence, and achievement in mathematics. Parents play an essential role as facilitators, motivators, and learning partners who provide both emotional support and academic guidance (Purwanto & Kurniasih, 2018; Cacabilos & Vargas, 2022; Wang & Sheikh-Khalil, 2022). However, most parental involvement

practices to date have focused mainly on motivational support and the provision of learning resources, rather than on helping parents themselves learn and develop conceptual understanding of mathematics.

This situation reveals a critical gap: many parents are involved, yet not fully empowered as adult learners who can effectively support their children's learning. Without appropriate knowledge and learning strategies, parental involvement risks reinforcing misconceptions or increasing learning anxiety for both the child and the parent. Therefore, parental engagement needs to be complemented with approaches that empower parents cognitively and reflectively, in line with their characteristics as adult learners.

The andragogical approach, which emphasizes experience-based, problem-oriented, and self-directed learning, is highly relevant in this context. According to the principles of andragogy proposed by Knowles (Henschke, 2016; Fitzsimons, 2005; Merriam & Baumgartner, 2020), adults learn most effectively when the learning process is directly connected to real-life experiences, values prior knowledge, and provides autonomy in how new information is understood. In the context of family education, applying these principles can transform parents' roles from passive companions to reflective facilitators who actively guide their children's mathematics learning.

Although the potential of andragogical principles in empowering parents has been widely discussed, systematic studies specifically evaluating their implementation in mathematics learning remain limited. Most existing research focuses on a single aspect either parental involvement or adult learning without integrating both perspectives into a unified analytical framework (Rahmawati & Hiryanto, 2023). Therefore, a comprehensive review is needed to examine how andragogical principles have been applied to support parents' roles in children's mathematics learning at the elementary school level.

This study aims to address this gap through a Systematic Literature Review (SLR) based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. A total of 30 scholarly articles published between 2012 and 2025 were thematically analyzed to identify trends, best practices, and challenges in applying andragogical principles within the context of parental involvement. Through this synthesis, the study seeks to provide a comprehensive understanding of how experience-based learning, contextual relevance, and active participation can empower parents as adult learners and reflective facilitators in supporting their children's mathematics learning.

2. METHODOLOGY

The method employed in this study is the Systematic Literature Review (SLR). This method was chosen because it provides a systematic, transparent, and replicable approach for identifying, selecting, analyzing, and synthesizing literature relevant to the research topic (Petticrew & Roberts, 2006; Tranfield, Denyer, & Smart, 2003). In this context, the SLR was used to examine how parental involvement in children's mathematics learning, particularly at the elementary school level, has been implemented, and to what extent andragogical principles have been applied or can be integrated within this process.

This study not only aims to understand how parents are involved affectively or motivationally, but also seeks to explore the extent to which parents comprehend mathematical concepts and employ effective ways to teach them to their children from an adult learning perspective. The SLR procedure followed six main stages as outlined by Triandini et al. (2019) and adhered to the PRISMA reporting standards (Moher et al., 2009; PRISMA 2020) to ensure transparency and accountability. These six stages include:

- Formulating research questions;
- Conducting a systematic literature search;
- Establishing inclusion and exclusion criteria;
- Assessing the quality of the selected studies;
- Extracting data; and
- Conducting thematic analysis and synthesis.

The literature search was conducted across major academic databases Google Scholar, ERIC, Scopus, ScienceDirect, and SpringerLink using combinations of English and Indonesian keywords (e.g., "parental involvement in mathematics learning," "andragogy in education," "adult learning," "*Keterlibatan orang tua*"). The review focused on articles published between 2012 and 2025 to capture both historical developments and recent findings. The initial search (May 2025) yielded 200 potential articles, which were then screened through several stages: identification, abstract screening, full-text review, and quality assessment using evaluation instruments suited to the respective methodological approaches (Higgins et al., 2019).

The literature search was conducted using a structured keyword strategy to ensure comprehensive and systematic retrieval of relevant studies. Keywords were developed based on the core concepts of the study, namely parental involvement, andragogy, adult learning, and mathematics learning. To ensure transparency and replicability of the literature search process, the keyword search strategy and the use of Boolean operators are explained in the following subsection.

The search terms were applied using Boolean operators (AND, OR) to broaden and refine the search results across databases. The main search strings included:

1. (“parental involvement” OR “family involvement” OR “parent participation”) AND (“mathematics learning” OR “mathematics education” OR “math achievement”)
2. (“andragogy” OR “adult learning” OR “adult education”) AND (“parent education” OR “family education”)
3. (“parental involvement” AND “andragogy”) AND (“mathematics learning” OR “realistic mathematics education” OR “PMRI”)

To capture studies published in the Indonesian context, equivalent Indonesian keywords were also used, such as: “*keterlibatan orang tua*” AND “*pembelajaran matematika*”, “*andragogi*” AND “*pendidikan keluarga*”

These search strings were applied consistently across all databases (Google Scholar, ERIC, Scopus, ScienceDirect, and SpringerLink). Filters were used to limit results to peer-reviewed journal articles, full-text availability, and publications between 2012 and 2025. This strategy ensured that the selected studies were both relevant and methodologically robust, in accordance with PRISMA guidelines.

The inclusion criteria for this study were: (a) peer-reviewed empirical articles discussing parental involvement in mathematics learning; (b)studies addressing or applying andragogical principles; and (c) research conducted within the context of primary or secondary education. The exclusion criteria included: non-empirical articles (e.g., opinion papers or reports without data), studies outside the context of mathematics education, and publications without full-text access. All included articles were labeled by year and title, and analyzed both manually and thematically to identify the research focus, methodology, key findings, evidence of andragogical application, and forms of parental involvement. The extracted data were organized and visualized (in tables and diagrams) to reveal emerging trends, best practices, and research gaps, forming the basis for recommendations on andragogy-based parental empowerment programs.

3. RESULT AND DISCUSSION

3.1. Results of Analysis

This study was conducted using a Systematic Literature Review (SLR) that followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method. The analysis process was carried out through four main stages: identification, screening, eligibility assessment, and inclusion of the final results.

At the initial stage, the researcher conducted a literature search through several major academic databases, namely Google Scholar, ERIC, Scopus, ScienceDirect, and SpringerLink. The search used a combination of English and Indonesian keywords such as “parental involvement in mathematics learning,” “andragogy,” “adult learning in parenting,” and their Indonesian equivalents, “keterlibatan orang tua dalam pembelajaran matematika” and “pembelajaran orang dewasa dalam pendidikan

keluarga." The initial search yielded 200 scientific articles that were potentially relevant to the research topic. A preliminary verification process was then carried out to ensure data accuracy. From this process, it was found that 32 articles were duplicates, 80 were irrelevant based on the keywords, and 25 were removed because they lacked full text or abstracts. Consequently, 58 articles proceeded to the screening stage.

During the screening stage, each article was examined based on its title and abstract, considering its relevance to the main focus of the study, namely the application of andragogical principles in parental involvement in children's mathematics learning. From this screening, 8 articles were eliminated due to irrelevance to the research context, leaving 50 articles for further examination (reports sought for retrieval).

However, of these, 5 articles could not be accessed in full text, resulting in 45 articles advancing to the eligibility assessment stage. At this stage, all articles were read thoroughly and evaluated according to the established inclusion and exclusion criteria. The evaluation excluded 15 articles for not meeting the research requirements: 9 did not focus on the context of children's mathematics learning, and 6 did not discuss andragogical principles or adult learning theories. Finally, 30 articles met all the criteria and were included in the systematic analysis. As each article represented a unique study, the number of "studies included in the review" and "reports of included studies" were both 30.

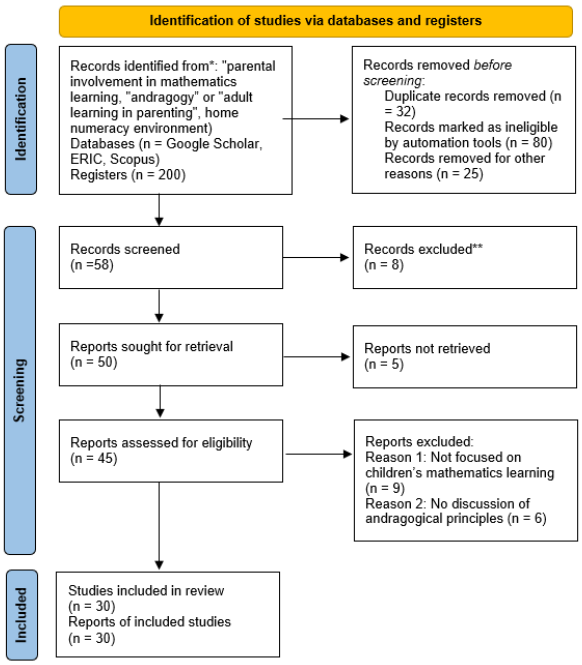

Figure 1. Metode PRISMA

3.2 Determination of Inclusion Results

The determination of inclusion and exclusion criteria was carried out carefully to ensure that the articles analyzed were truly relevant to the research objectives and

possessed adequate academic credibility. The inclusion criteria comprised several key considerations. First, the selected articles were national or international scholarly publications released between 2012 and 2025. These articles were required to specifically discuss parental involvement in children's mathematics learning or the application of andragogical principles or adult learning, in accordance with the theoretical framework of this study. Another criterion was that the articles had to be published in peer-reviewed journals and contain verifiable empirical data, ensuring that the analysis was grounded in a solid scientific basis.

Meanwhile, the exclusion criteria were established to filter out articles that did not meet academic and methodological standards. Articles were excluded from the analysis if they were non-academic works, such as opinion pieces or activity reports lacking clear research methodology. Likewise, studies that discussed parenting topics in general without specific reference to mathematics learning were not included in the review. In addition, duplicate articles or those without full-text access were also excluded to maintain the validity and consistency of the literature review findings.

3.3 Search Results and Article Distribution

The literature search conducted across five academic databases (Google Scholar, ERIC, Scopus, ScienceDirect, and SpringerLink) yielded 200 potential articles, which, after undergoing the PRISMA-guided screening process, resulted in 30 articles that met the inclusion criteria for in-depth analysis.mFrom the 30 reviewed articles, a significant increase in publication trends was identified beginning in 2020, particularly on topics related to the application of andragogical principles, parental involvement in children's learning, and Realistic Mathematics Education (RME/PMRI) combined with deep learning approaches.This increase aligns with the shift in educational paradigms in the post-pandemic era, during which the roles of families, local cultural contexts, and adult learning principles have become increasingly recognized as essential components in children's education.

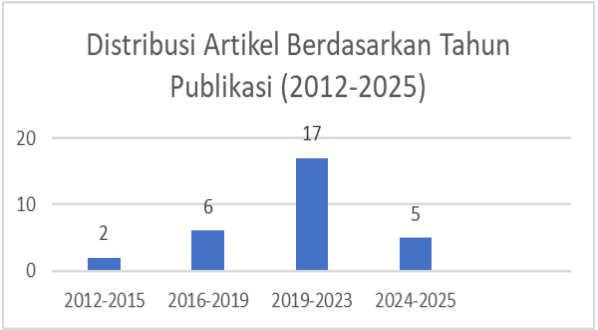

Figure 2. Distribution of Articles by Year of Publication (2012–2025)

The data in the table above indicate that more than half of the articles (57%) were published between 2020 and 2023, reflecting a growing interest in family-based,

contextual, and reflective learning approaches. This trend suggests that researchers have increasingly focused on the connections between parental roles, andragogical principles, and meaningful mathematics learning strategies within both formal and non-formal educational contexts.

3.4 Distribution by Research Method

Of the 30 articles analyzed, most employed qualitative approaches, including designs such as literature reviews, grounded theory, phenomenology, and design-based research. These approaches were widely used to explore learning experiences, patterns of parental involvement, and the implementation of andragogical principles in real-world contexts.

Several other articles utilized quantitative approaches, such as descriptive correlational studies and structural equation modeling (SEM), which focused on examining the relationships among learning motivation, parental involvement, and children's learning outcomes. Meanwhile, a smaller number of studies adopted mixed-methods designs to obtain a more comprehensive understanding of the phenomena under investigation.

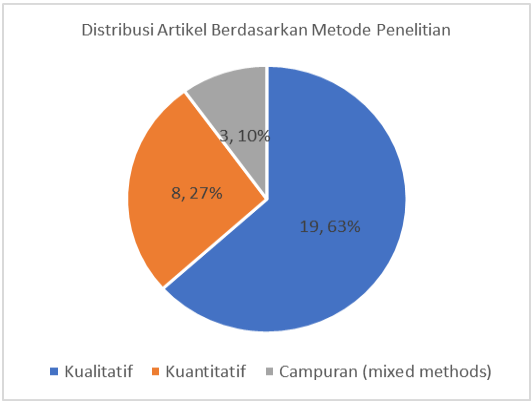

Figure 3. Distribution of Articles Based on Research Methods

Based on the distribution above, qualitative research continues to dominate, reflecting the nature of the topic, which emphasizes the exploration of meaning, learning experiences, and reflective processes from the perspectives of adults and families. However, quantitative studies have begun to increase in recent years, particularly to verify the empirical impact of applying andragogical principles and parental involvement on children's mathematics learning outcomes.

3.5 Distribution by Research Themes

The thematic analysis of the thirty articles that passed the selection process revealed four major themes that became the primary focus within the reviewed literature. These themes reflect the integration of andragogical approaches, parental involvement, and realistic and deep mathematics learning.

Table 1. Distribution of Articles by Main Themes

Research Theme	Number of Articles	Description of Focus
Integration of PMRI and Deep Learning in Mathematics Education	9 articles	Examines the implementation of the Realistic Mathematics Education approach (RME/PMRI) combined with deep learning strategies to enhance students' conceptual understanding.
Application of Andragogical Principles in Adult Learning and Family Education	8 articles	Explains how andragogical principles (Knowles) are applied in training programs for parents and teachers as adult learners.
Parental Involvement and Emotional Support in Children's Mathematics Learning	7 articles	Describes the role of parents as facilitators, motivators, and guides in supporting children's learning at home.
Challenges and Strategies for Parent Empowerment Through Reflective Learning	6 articles	Identifies the challenges and strategies for empowering parents through experience-based training and andragogical reflection.

This thematic distribution shows that most studies emphasize integrative efforts between realistic mathematics education approaches and adult learning. These findings indicate that the application of andragogical principles is not only relevant to formal adult education, but can also be implemented within the family education context, particularly in supporting children's mathematics learning through contextual and meaningful approaches.

3.6 Synthesis of Findings

From the overall analysis of the thirty articles selected through the Systematic Literature Review process, a comprehensive picture emerges regarding the relationship between andragogical principles, parental involvement, and realistic-based mathematics learning. In general, the findings indicate that andragogy is effective in enhancing parents' and teachers' learning awareness as adult learners. Principles such as contextual relevance, appreciation of prior experiences, and learner autonomy enable parents to be better prepared to take an active role in supporting their children's academic development.

In addition, parental involvement in mathematics learning has been shown to positively influence children's motivation and learning outcomes. This involvement is reflected in home learning support, active communication with teachers, and emotional encouragement that fosters children's confidence in understanding abstract mathematical concepts. Several studies even demonstrate that andragogy-based training for parents can improve their ability to explain mathematical concepts in contextual and engaging ways.

From the perspective of instructional approaches, studies examining PMRI (Indonesian Realistic Mathematics Education) and deep learning show that both approaches effectively promote meaningful learning that is relevant to real-life situations. Through activities grounded in everyday contexts and local culture, students not only grasp mathematical concepts procedurally but also connect them to daily experiences. This approach simultaneously strengthens parents' roles as facilitators in creating reflective and context-rich learning environments at home.

Furthermore, the findings highlight that andragogy-based empowerment programs hold substantial potential as effective strategies for strengthening collaboration between schools and families. Such programs enable parents to gain new insights into how to support their children's learning processes while also fostering a sense of confidence and ownership in contributing to their children's educational success.

3.7 Discussion

The findings of this systematic literature review indicate that parental involvement in children's mathematics learning cannot be separated from andragogical principles, which position parents as adult learners. As adult learners, parents possess life experiences, intrinsic motivation, and diverse learning needs. Therefore, effective support strategies must be grounded in an understanding of these characteristics (Knowles, 1980).

The results from the 30 reviewed articles show that the application of andragogical principles in family education has a significant impact on increasing parents' learning awareness and their active role in supporting their children's education. Parents do not merely function as providers of learning resources; they also serve as facilitators, motivators, and learning partners. This aligns with the findings of Purwanto & Kurniasih (2018) and Cacabilos & Vargas (2022), which emphasize that parents' emotional and cognitive involvement is positively correlated with children's mathematics achievement.

Furthermore, the thematic analysis reveals a strong relationship between andragogy, parental involvement, and realistic learning approaches (PMRI). In this context, adult learning principles such as relevance, experience, active participation, and reflection are proven effective when combined with Realistic Mathematics Education (RME), which is grounded in real-life contexts. The PMRI approach helps parents understand mathematical concepts contextually, enabling them to explain material to children in ways that are simple, meaningful, and closely connected to daily experiences.

In addition, the emergence of deep learning as an approach emphasizing conceptual understanding and reflective thinking contributes to the improvement of

learning quality. When parents understand the principles of deep learning, they can guide their children to move beyond memorizing formulas toward understanding the reasoning behind mathematical concepts. This is consistent with the findings of Rodrigues (2012) and Mujib et al. (2019), who found that experience-based and reflective learning enhances students' critical thinking skills and confidence in learning mathematics.

Nevertheless, the review also identifies several challenges in applying andragogical principles within family education contexts. Many parents face limitations such as lack of time, insufficient understanding of mathematics content, and low confidence in assisting their children. Several studies, including those by Hadiyanti & Dewi (2020) and Bahar et al. (2021), show that educational background and socioeconomic conditions also influence the extent to which parents can play an effective role. Therefore, educational institutions both formal and non-formal need to provide andragogy-based training to help parents develop learning support strategies that align with their children's needs.

Beyond offering direct benefits to children's learning, the application of andragogical principles also has broader implications for community empowerment and family literacy development. By recognizing themselves as lifelong learners, parents not only contribute to their children's academic growth but also help cultivate a learning culture within the family environment. This aligns with the spirit of non-formal education and lifelong learning, which positions the family as a primary foundation for human capacity development.

Conceptually, the integration of andragogy, parental involvement, and realistic learning approaches in mathematics can serve as a foundation for developing an andragogy-based parent empowerment model. This model emphasizes collaboration between schools, families, and communities in creating a participatory, contextual, and meaningful learning ecosystem. In the long term, such a model is expected to strengthen parents' abilities as reflective learning facilitators, enabling children's learning processes to become more independent and sustainable.

4. CONCLUSION

This study concludes that parental involvement in children's mathematics learning is closely linked to the application of andragogical principles as the foundation of adult learning. Through a PRISMA-based Systematic Literature Review (SLR), thirty articles were identified that collectively provide a comprehensive understanding of how andragogy, parental involvement, and realistic learning approaches (PMRI) can be integrated to build a reflective, independent, and sustainable family education ecosystem. The main findings show that implementing andragogical principles such as valuing prior experience, ensuring contextual relevance, and encouraging active

participation has a positive impact on enhancing parents' awareness and roles as adult learners.

Parental involvement grounded in andragogical approaches not only improves children's motivation and mathematics learning outcomes but also strengthens the relationship between home and school through constructive communication and collaboration. In addition, the integration of PMRI and deep learning approaches in the learning process has been shown to create more meaningful and contextually relevant mathematics learning experiences for children. Within this context, parents act as facilitators who not only help children understand academic content but also foster curiosity, critical thinking, and reflective abilities.

Furthermore, the findings demonstrate that andragogy-based empowerment programs can serve as an effective strategy for strengthening the capacity of families as learning agents. By understanding the characteristics and learning needs of adults, such programs can support parents in developing contextual pedagogical skills aligned with their children's developmental needs, particularly in mathematics learning. Thus, it can be concluded that the integration of andragogical principles, parental involvement, and realistic learning approaches forms a strong conceptual framework for developing a lifelong learning–oriented parent empowerment model. This model is expected to serve as a foundation for designing more effective family education programs that are adaptive to contemporary changes and oriented toward meaningful learning for both children and parents.

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