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The GASING method and pedagogical transformation in elementary school: A teacher perspective

Puspita Baity [*], Tita Mulyati, Abubakar

Master's Program in Primary School Teacher Education, UPI Regional Campus Cibiru, Universitas Pendidikan Indonesia, West Java, Indonesia

[*] Correspondence: puspitabaity17@upi.edu

Abstract

Mathematics learning in elementary schools continues to face challenges, including students' perceptions of mathematics as difficult, procedural teaching practices, and low engagement. These challenges highlight the need for instructional approaches that improve student learning and foster teachers' pedagogical transformation. This study examined the pedagogical transformation of elementary school teachers who teach mathematics following the implementation of the GASING method in their teaching. A mixed-methods sequential explanatory design was employed involving 27 teachers, of whom 6 selected for interviews. Data were collected through questionnaires and semi-structured interviews and were analyzed using descriptive statistics and thematic analysis. The findings indicate that teachers' pedagogical transformation was high across the dimensions of perceptions, pedagogical strategies, and professional reflection. Teachers increasingly view errors as learning opportunities, adopt more contextual and student-centered instructional strategies, and engage more actively in professional reflection. These findings suggest that the GASING method can support teachers' pedagogical transformation and contribute to more meaningful, reflective, and student-centered mathematics learning in elementary schools in Indonesia.

Keywords: elementary mathematics learning; GASING method; pedagogical transformation; professional reflection; teacher perspective

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Introduction

Mathematics learning in elementary schools continues to present significant challenges, as many students perceive mathematics as an abstract, difficult, and unengaging subject that reduces their motivation and active participation in learning. In addition, mathematics is often perceived as a collection of formulas and procedures that must be memorized, limiting students' opportunities to develop a deeper conceptual understanding of mathematical ideas rather than merely mastering computational procedures. This perception is closely associated with instructional practices that continue to prioritize procedural approaches, in which teachers primarily emphasize mechanical problem-solving procedures rather than fostering students' conceptual understanding and mathematical reasoning. Such instructional practices limit students' opportunities to construct mathematical meaning and develop deeper conceptual understanding (Hiebert & Grouws, 2007; National Council of Teachers of Mathematics, 2000; Rittle-Johnson et al., 2015). The dominance of procedural instruction is further reinforced by classroom practices that are often monotonous, rigid, and disconnected from students' everyday experiences, causing mathematics to appear detached from meaningful real-life contexts. Consequently, mathematics instruction tends to emphasize obtaining correct answers rather than cultivating students' reasoning, argumentation, and problem-solving abilities.

Moreover, the persistence of teacher-centered instructional practices positions teachers as the primary source of knowledge, while students remain passive recipients of information, merely imitating demonstrated procedures and engaging minimally in constructing their own mathematical understanding. Such classroom practices reduce students' opportunities to actively explore mathematical ideas, communicate their reasoning, and participate in meaningful learning experiences. Consequently, these conditions hinder the development of students' learning motivation, engagement, and critical thinking skills (Anggraini et al., 2024; I. S. Dewi et al., 2023)

In response to these challenges, the implementation of the Merdeka Curriculum emphasizes student-centered learning, the strengthening of numeracy skills, and the development of critical thinking as essential components of twenty-first-century competencies. Within this policy framework, teachers are expected to design contextual, reflective, and meaningful learning experiences that enable students not only to master mathematical procedures but also to connect mathematical concepts with real-life situations. Therefore, transforming mathematics instruction in elementary schools has become increasingly important to align classroom practices with national educational priorities while strengthening students' numeracy competencies (Y. L. Dewi & Hidayat, 2025)

To address these challenges, the Gampang, Asyik, dan Menyenangkan (GASING) method offers an alternative instructional approach that emphasizes meaningful, contextual, and student-centered mathematics learning. The GASING method emphasizes the gradual and contextual presentation of mathematical concepts that are closely connected to students' everyday experiences. Such an approach is intended to promote students' interest, encourage active participation, and facilitate meaningful conceptual understanding by demonstrating the relevance of mathematics to real-life situations. Recent studies have also shown that integrating the GASING method with a critical pedagogy approach can improve elementary students' critical thinking skills by promoting dialogue, reflection, and conceptual understanding during mathematics learning (Baity et al., 2026; Hiebert & Grouws, 2007; Melisa et al., 2026; Surya, 2010). Furthermore, the implementation of innovative instructional approaches not only enhances students' learning experiences but also contributes to transforming teachers' pedagogical practices, instructional beliefs, and professional orientations as key agents in the learning process (Deng, 2018; Depaepe et al., 2013; Habiyaremye et al., 2022; Jewarut et al., 2024). This transformation is reflected in changes in how teachers design instruction, select strategies for delivering concepts, and redefine their roles from mere transmitters of knowledge to facilitators who actively promote student engagement. In the context of modern pedagogy, this shift indicates a transition from instruction-centered learning toward more transformative, reflective, and student-centered approaches that prioritize students' thinking processes. Previous studies have also demonstrated that teachers' pedagogical transformation is closely associated with the development of Pedagogical Content Knowledge, reflective capacity, and the ability to adapt to more humanistic and contextual learning approaches (Dewi et al., 2023; Ghufron, 2025; Jewarut et al., 2024).

Although numerous studies have examined the effectiveness of innovative instructional methods in improving elementary students' mathematics learning outcomes, most of these studies primarily focus on students' cognitive achievements, such as conceptual understanding and test performance. Research that specifically investigates how such instructional methods influence teachers' pedagogical transformation, particularly from the perspective of classroom teachers as the primary agents of instruction, remains relatively limited. In addition, studies that position the GASING method as a catalyst for changes in teaching practices, professional reflection, and the reconstruction of teachers' pedagogical beliefs are still scarce in the literature. The novelty of this study lies in examining the GASING method as a catalyst for the pedagogical transformation of elementary school teachers who teach mathematics from their own perspectives, a dimension that has received limited attention in previous research.

The pedagogical transformation of teachers in this study is grounded in three main theoretical perspectives. First, Pedagogical Content Knowledge (PCK), proposed by Shulman, emphasizes that effective teacher competence extends beyond mastery of subject matter to include the ability to transform content into forms that are meaningful and understandable for students through appropriate pedagogical strategies (Shulman, 1986). PCK provides an essential foundation for elementary school teachers who teach mathematics, enabling them to present abstract mathematical concepts in concrete, gradual, and meaningful ways that align with students' cognitive development (Depaepe et al., 2013; Habiyaremye et al., 2022). Second, Transformative Learning Theory, introduced by Mezirow, conceptualizes learning as a process through which individuals transform their frames of reference by engaging in critical reflection on their experiences (Mezirow, 1997). This theory is relevant for explaining how teachers' experiences in implementing the GASING method can trigger shifts in professional perspectives, teaching beliefs, and pedagogical practices from procedural approaches toward more reflective and thinking-oriented learning processes (Deng, 2018; Depaepe et al., 2013; Habiyaremye et al., 2022). Third, Critical Pedagogy, as articulated by Paulo Freire, conceptualizes learning as a dialogical process that fosters the development of critical consciousness among both teachers and students (Freire, 1970). Within this perspective, teachers are not merely transmitters of knowledge, but facilitators who create opportunities for dialogue, problem-posing, and active student participation in constructing understanding. The integration of these three theoretical perspectives provides a strong conceptual foundation for understanding how the GASING method can function as a catalyst for the pedagogical transformation of elementary school teachers who teach mathematics (Fleming, 2022).

Building upon this conceptual framework, the present study addresses a gap in the existing literature regarding how innovative instructional approaches contribute to teachers' pedagogical transformation from the perspective of elementary school teachers who teach mathematics. Although previous studies have investigated innovative instructional methods in mathematics education, limited attention has been given to this dimension. This gap provides an important rationale for examining teachers' pedagogical transformation following the implementation of the GASING method.

Accordingly, this study explores three main dimensions of teachers' pedagogical transformation: changes in teachers' perceptions of mathematics learning, transformations in pedagogical strategies employed during instruction, and teachers' professional reflection on their teaching practices. Through this perspective, the study is expected to provide empirical insights into how the GASING method contributes not only to improving the quality of student learning but also to reconstructing teachers' pedagogical knowledge, classroom interaction patterns, and orientations toward fostering students' mathematical thinking in more reflective and meaningful ways.

Methods

This study employed a mixed-methods approach with a sequential explanatory design, which sequentially integrates quantitative and qualitative methods to obtain a more comprehensive understanding of the phenomenon under investigation. In this design, the initial phase involves the collection and analysis of quantitative data, followed by a qualitative phase aimed at explaining, elaborating, and interpreting the findings from the previous stage (Draucker et al., 2020; Ivankova et al., 2006). The selection of this design is based on its suitability for empirically capturing teachers' pedagogical transformation through numerical data, while also enabling a deeper understanding of teachers' experiences and perspectives through qualitative inquiry. The participants of this study consisted of 27 elementary school teachers who had implemented the GASING method in mathematics instruction. From this group, six teachers were selected as interview informants using purposive sampling based on the results of the questionnaire.

The implementation of the GASING method was carried out during mathematics instruction covering four fundamental arithmetic topics: addition, subtraction, multiplication, and division. The learning activities followed the core principles of the GASING method, which emphasize gradual learning from concrete experiences to abstract mathematical representations and mental arithmetic (*mencongak*) (Gou et al., 2024; Gultom & Usman, 2024; Surya, 2010).

Learning began by introducing mathematical concepts through concrete objects available in students' everyday environment, enabling them to construct mathematical meaning through direct experience. After students demonstrated an understanding of these concepts using concrete representations, instruction gradually progressed to abstract mathematical representations and was followed by mental arithmetic (*mencongak*) activities. In teaching multiplication, students were guided to understand multiplication conceptually as repeated addition rather than memorizing multiplication facts, whereas division was introduced as the inverse of multiplication to strengthen students' conceptual understanding of the relationship between the two operations (Situmorang et al., 2024; Surya, 2010).

In the quantitative phase, data were collected using a closed-ended questionnaire developed based on the three main indicators of this study: changes in teachers' perceptions of mathematics learning, pedagogical strategies, and professional reflection. Before data collection, the instrument was subjected to validity and reliability testing. Item validity was examined using the Pearson product–moment correlation technique, while internal consistency was assessed using Cronbach's Alpha coefficient. The results of the validity and reliability analyses are presented in the Results section. The questionnaire data were analyzed using descriptive statistics, including percentages, mean scores, and score categorization, to describe teachers' pedagogical transformation.

The subsequent phase involved qualitative research conducted after the completion of the quantitative analysis. In this stage, semi-structured interviews were conducted with six teachers selected through purposive sampling based on the quantitative findings. The selection of participants based on quantitative results represents a key characteristic of the sequential explanatory design, in which quantitative data serve as the basis for determining the focus of qualitative exploration (Draucker et al., 2020; Wicaksono & Rahman, 2023). The interview data were analyzed using thematic analysis, which included processes of data reduction, coding, theme identification, and interpretation of the meanings derived from teachers' experiences in implementing the GASING method. The qualitative findings were integrated with the quantitative results during the interpretation stage to explain and enrich the statistical findings obtained from the questionnaire. This process generated a comprehensive understanding of changes in teachers' perceptions, instructional practices, and professional reflection following the implementation of the GASING method. Thus, the sequential explanatory design not only captures general trends but also provides deeper insights into the underlying experiences shaping teachers' pedagogical transformation

Results

Instrument validity and reliability testing

Instrument validity was assessed using the Pearson product-moment correlation technique between item scores and total scores. The analysis showed that calculated correlation coefficients ranged from 0.544 to 0.853. All coefficients exceeded the critical value (*r*_{table} = 0.381, *n* = 27), indicating that all questionnaire items were valid and appropriate for use in this study. The detailed results are presented in Table 1.

Table 1. Instrument validity test results

Item	Correlation Coefficient (*r*)	Description
P1	0.544	Valid
P2	0.603	Valid
P3	0.648	Valid
P4	0.676	Valid
P5	0.709	Valid
P6	0.731	Valid
P7	0.853	Valid
P8	0.812	Valid
P9	0.779	Valid
P10	0.821	Valid
P11	0.795	Valid
P12	0.853	Valid
P13	0.744	Valid
P14	0.768	Valid
P15	0.726	Valid
P16	0.701	Valid
P17	0.689	Valid
P18	0.732	Valid

Based on the results presented in Table 1, all questionnaire items (P1 to P18) demonstrate correlation coefficients ranging from moderate to very strong categories. The highest correlation values were observed for items P7 and P12 (0.853), while the lowest value was found for item P1 (0.544). These findings indicate that all items contribute effectively to measuring the pedagogical transformation of elementary school teachers.

Subsequently, a reliability test was conducted to determine the internal consistency of the questionnaire items using Cronbach's Alpha coefficient. The results of the reliability analysis are presented in Table 2.

Table 2. Instrument reliability test results

Variabel	Item	Cronbach's Alpha	Description
Teachers' Pedagogical Transformation	18	0.942	Highly Reliable

The analysis results indicate that the Cronbach's Alpha coefficient is 0.942, which falls into the very high category. This finding demonstrates that the instrument has excellent internal consistency in measuring the construct of elementary school teachers who teach mathematics' pedagogical transformation. The strong interrelatedness among the items further indicates that they consistently measure the same construct, ensuring that the data obtained are reliable and trustworthy. Thus, the research instrument used in this study meets the criteria for validity and reliability, indicating that the data are suitable for further analysis.

Teachers' pedagogical transformation

The analysis was conducted on data from 27 teacher respondents by grouping the data into three main indicators: teachers' perceptions, pedagogical strategies, and professional reflection. The results of the analysis are presented in Table 3.

Table 3. Teachers' Pedagogical Transformation Based on Indicators

Indicators	Mean	Standard Deviation	Category
Teachers' Perceptions	21.33	2.83	High
Pedagogical Strategies	21.33	3.15	High
Professional Reflection	22.07	2.78	High

Based on Table 3, all indicators of teachers' pedagogical transformation fall within the high category. The professional reflection indicator has the highest mean score (22.07), followed by teachers' perceptions and pedagogical strategies, which have identical mean scores (21.33). These findings indicate that the implementation of the GASING method has a positive impact on teachers' pedagogical transformation as a whole. This transformation is evident not only in teachers' understanding of mathematics learning, but also in the instructional strategies they employ and their ability to reflect on their teaching practices.

To further illustrate the distribution of teachers' pedagogical transformation scores, the histogram is presented in Figure 1.

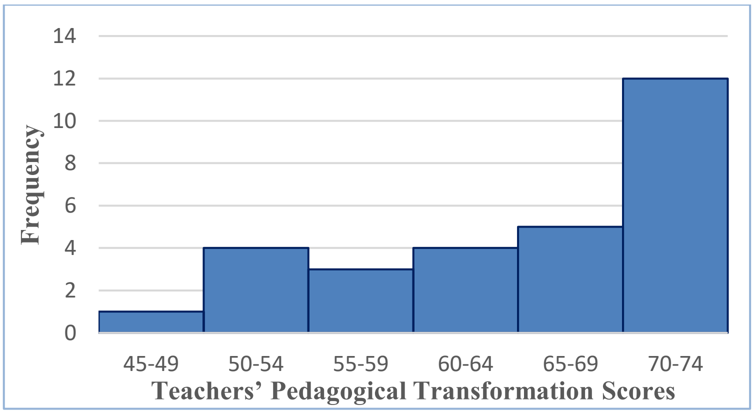

Figure 1. Histogram of teachers' pedagogical transformation score distribution

Based on the histogram in Figure 1, the distribution of teachers' pedagogical transformation scores tends to fall within the high category. This is indicated by the dominance of frequencies in the score range of 70–74, suggesting that most teachers experienced a high level of pedagogical transformation following the implementation of the GASING method. This clustering of data within the high category further supports the descriptive analysis results presented in Table 3.

Comparison across indicators

Based on the descriptive analysis, all three indicators of teachers' pedagogical transformation teachers' perceptions, pedagogical strategies, and professional reflection are categorized as high. However, there are slight differences in the mean scores across the indicators, indicating variations in the level of transformation within each aspect. The professional reflection indicator obtained the highest mean score (22.07), while teachers' perceptions and pedagogical strategies both had identical mean scores (21.33). Although the differences in mean scores are relatively small, these findings suggest that the most prominent transformation occurs in the aspect of teachers' professional reflection. To further illustrate the comparison across indicators, the results are presented in the bar chart in Figure 2.

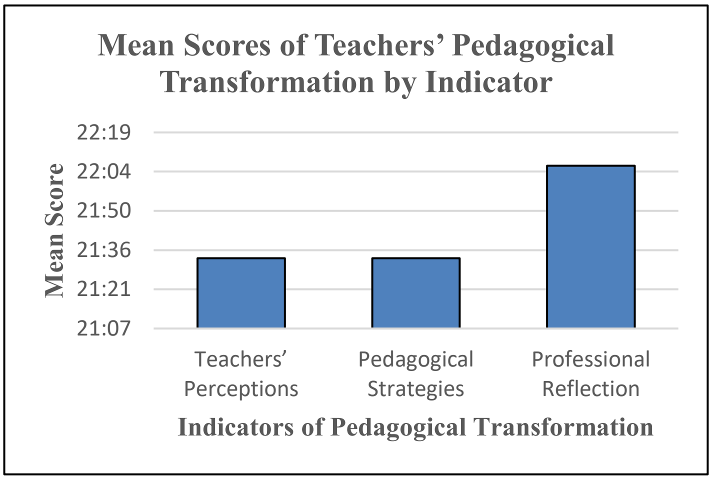

Figure 2. Mean scores of teachers' pedagogical transformation by indicator

Based on Figure 2, the professional reflection indicator has a higher mean score compared to the teachers' perceptions and pedagogical strategies indicators. This finding indicates that professional reflection is the most dominant aspect of teachers' pedagogical transformation following the implementation of the GASING method. The high achievement in the reflection indicator suggests that teachers not only experienced changes in their understanding and instructional practices, but also developed a deeper ability to evaluate and reflect on their teaching experiences. Meanwhile, the relatively balanced mean scores between the perceptions and pedagogical strategies indicators indicate that changes in teachers' perspectives on mathematics learning occur in parallel with changes in the instructional strategies they apply.

Thus, the comparison results indicate that teachers' pedagogical transformation occurs in a gradual and layered manner, beginning with changes in perceptions, followed by transformations in pedagogical strategies, and culminating in a deeper stage of professional reflection. These findings further confirm that professional reflection represents the peak of the pedagogical transformation process experienced by teachers in implementing the GASING method.

Analysis of relationships among indicators

The analysis results indicate that all questionnaire items have significant relationships with the total score, with correlation coefficients ranging from 0.544 to 0.853. These values fall within the moderate to very strong categories, indicating that each indicator is strongly associated with the overall construct of teachers' pedagogical transformation.

The high correlation values observed across most items indicate that changes in one indicator tend to be accompanied by changes in other indicators. This finding suggests that teachers' pedagogical transformation does not occur in isolation but is interconnected and forms a cohesive process. Furthermore, the consistency of relationships among items is reinforced by the very high reliability coefficient (Cronbach's Alpha = 0.942), reflecting excellent internal consistency. Therefore, the indicators of teachers' perceptions, pedagogical strategies, and professional reflection function not only as independent components but also as interrelated elements that collectively shape teachers' pedagogical transformation as a whole.

Based on these findings, teachers' pedagogical transformation involves interconnected changes in teachers' perceptions, instructional strategies, and professional reflection, indicating that these three dimensions develop simultaneously throughout the implementation of the GASING method. This mutually reinforcing relationship indicates that the process of pedagogical transformation occurs in a systemic and continuous manner within instructional practice.

Interview findings

Changes in teachers' perceptions of mathematics learning

The interview results indicate that the implementation of the GASING method promotes changes in teachers' perceptions of mathematics learning in elementary schools. These changes are particularly evident in how teachers interpret students' errors, the learning process, and the goals of mathematics instruction. Prior to implementing the GASING method, some teachers tended to view students' errors as indicators of their inability to understand the material. However, after the implementation of the GASING method, a shift in perspective was observed, with teachers beginning to regard errors as a natural and essential part of the learning process. Errors are no longer perceived as something to be avoided, but rather as a valuable source of information for understanding students' thinking processes.
One teacher stated:
"Errors are not something to be avoided, but rather an essential part of understanding learning concepts."

In addition, teachers also experienced a shift in how they conceptualize mathematics learning, moving from an emphasis on final outcomes toward a greater focus on the learning process. Teachers began to pay closer attention to how students construct their understanding, rather than merely evaluating the correctness of their answers.
This is reflected in the following statement:
"Now I focus more on how students think, rather than just their final answers."

Changes in teachers' perceptions are also evident in how they view students' roles in the learning process. Students are no longer positioned as passive recipients of information, but rather as active agents who engage in constructing knowledge through exploration and discussion. Overall, the interview findings indicate that the implementation of the GASING method encourages a shift in teachers' perceptions from outcome-oriented learning toward process-oriented learning, from avoiding errors to utilizing them as an essential part of the learning process, and from passive student roles toward active engagement in learning. This transformation in perception serves as a foundational basis for subsequent changes in other pedagogical aspects.

Transformation of teachers' pedagogical strategies

The interview findings indicate that the implementation of the GASING method promotes transformation in the pedagogical strategies employed by teachers in mathematics instruction. These changes are evident in how teachers deliver content, manage classroom interactions, and engage students in the learning process. Before implementing the GASING method, the learning process tended to be dominated by teacher explanations, with a strong emphasis on procedural problem-solving. In this context, teachers functioned primarily as transmitters of information, while students largely followed prescribed steps with limited opportunities for meaningful exploration.

However, after the implementation of the GASING method, instructional strategies shifted toward more contextual, gradual, and student-centered approaches. Teachers began to adopt simpler strategies that are closely connected to students' everyday experiences when explaining mathematical concepts, making it easier for students to understand the material.
One teacher expressed:
"Now, when I begin a lesson, I start with the simplest concepts so that students can truly understand the underlying ideas."

In addition, classroom interactions became more dialogic. Teachers no longer dominated the learning process, but instead provided greater opportunities for students to ask questions, experiment, and express their ideas. Students were encouraged to actively engage in the learning process through both discussion and exploration.
This is reflected in the following statement:
"Students are now more active; they are willing to try and are no longer afraid of making mistakes."

Changes in pedagogical strategies are also reflected in the shift of teachers' roles from content deliverers to facilitators of learning. Teachers now place greater emphasis on guiding students' learning processes, providing direction, and supporting students in constructing their understanding independently.
One teacher stated:
"I now focus more on guiding students rather than simply providing them with the answers."

Overall, the interview findings indicate that the implementation of the GASING method promotes a shift in teachers' pedagogical strategies from procedural, teacher-centered instruction toward more contextual, interactive, and student-centered learning. This transformation enables students to engage more actively in the learning process and to develop a deeper understanding of mathematical concepts.

Teachers' professional reflection

The interview findings indicate that the implementation of the GASING method not only impacts teachers' instructional practices but also fosters the development of professional reflection on the learning process. This is reflected in the increased awareness among teachers in evaluating their teaching and in understanding students' learning needs more deeply. Prior to implementing the GASING method, some teachers tended to focus primarily on students' learning outcomes, particularly the accuracy of answers and problem completion. Evaluation was largely based on final results, with limited attention given to students' thinking processes. However, after implementing the GASING method, teachers began to engage in more critical reflection on their teaching practices. They not only assessed whether students could produce correct answers, but also considered how students understood concepts and the thinking processes they used in solving problems.
One teacher stated:
"I now frequently reflect on my teaching after each lesson, questioning whether students truly understand the material or are simply memorizing it."

In addition, teachers demonstrated increased sensitivity to the difficulties experienced by students and made efforts to adjust their instructional strategies based on their reflective insights.
This is illustrated in the following statement:
"If students do not understand, I try to find alternative ways to help them grasp the material."

Professional reflection also encourages teachers to become more open to change and improvement in their instructional practices. Teachers are no longer confined to a single method, but instead begin to adopt more flexible and adaptive approaches tailored to students' needs.
This is reflected in the following statement:
"I now try new ways of teaching more frequently."

Overall, the interview findings indicate that the implementation of the GASING method encourages teachers to become more reflective in their instructional practices. This reflection extends beyond students' learning outcomes to include the learning process, the strategies employed, and teachers' understanding of how students learn. Therefore, professional reflection emerges as the most dominant aspect of teachers' pedagogical transformation.

Discussion

The findings of this study indicate that the implementation of the GASING method serves as a catalyst for the pedagogical transformation of elementary school teachers who teach mathematics in a comprehensive manner. This transformation is not limited to the technical aspects of instruction but also encompasses changes in teachers’ perceptions, pedagogical strategies, and professional reflection, which are interconnected and form an integrated process of change. This discussion is structured around these three main aspects of pedagogical transformation, analyzed within a theoretical framework to provide a comprehensive understanding of changes in teachers’ instructional practices through the implementation of the GASING method. These findings are supported by quantitative results showing that all indicators fall within the high category, as well as by qualitative data that illustrate observable changes in instructional practices. This indicates that the pedagogical transformation that occurs is not partial, but rather develops systematically through meaningful learning experiences. This is consistent with previous studies suggesting that instructional innovation can significantly promote changes in teachers’ pedagogical practices by strengthening student-centered instruction and supporting continuous professional learning (Deng, 2018; Depaepe et al., 2013; Shure et al., 2025).

Transformation of teachers’ perceptions in mathematics learning

Changes in teachers’ perceptions of mathematics learning indicate a fundamental shift from an outcome-oriented approach toward a process-oriented perspective. Teachers increasingly viewed errors as an integral part of the learning process and placed greater value on students’ ways of thinking rather than focusing solely on final answers. This is reflected in a teacher’s statement: *“Errors are not something to be avoided, but rather an essential part of understanding concepts.”* (Research Data, 2026). These findings suggest that teachers increasingly perceive errors as an integral component of students’ knowledge construction, rather than merely as indicators of failure. This shift reflects a reconstruction of teachers’ perspectives on mathematics learning from previously procedural orientations toward more conceptual and reflective approaches.

These changes are consistent with Transformative Learning Theory proposed by Mezirow, which emphasizes that learning transformation occurs through critical reflection on experience (Mezirow, 1997). The implementation of the GASING method provided teachers with new instructional experiences that challenged their previous assumptions about mathematics teaching and encouraged them to critically reflect on their instructional practices. Through continuous engagement with concrete, contextual, and student-centered learning activities, teachers gradually reconstructed their beliefs about effective mathematics learning. This process illustrates Mezirow's notion that transformative learning occurs through changes in individuals' frames of reference resulting from critical reflection on experience.

Furthermore, these findings are supported by previous studies indicating that changes in teachers’ perceptions contribute to improvements in instructional quality and student engagement in the learning process (Deng, 2018). The present findings are also consistent with those reported by Depaepe et al. (2013), who argued that changes in teachers' pedagogical understanding influence how mathematical concepts are represented and communicated in the classroom. Recent evidence further suggests that practice-based professional development encourages teachers to reconsider their instructional beliefs and adopt more student-centered pedagogical practices, thereby supporting meaningful changes in classroom instruction (Shure et al., 2025). Similarly, Habiyaremye et al. (2022) emphasized that teachers' professional growth is characterized by a gradual shift toward instructional practices that prioritize conceptual understanding and meaningful student engagement. In the present study, these changes were reflected in teachers' increasing appreciation of students' reasoning processes and their recognition of mistakes as valuable learning opportunities rather than indicators of failure (National Council of Teachers of Mathematics, 2000).

Therefore, the shift in teachers' perceptions is not merely conceptual but serves as a foundation for changes in instructional strategies and professional reflection. These findings demonstrate that pedagogical transformation begins with changes in teachers' beliefs about how mathematics should be learned before being translated into classroom practice, ultimately fostering more reflective, student-centered, and conceptually oriented instruction.

Transformation of pedagogical strategies from the perspective of pedagogical content knowledge

The transformation of teachers' pedagogical strategies is reflected in the shift toward more contextual, gradual, and student-centered instructional approaches. Teachers no longer dominate the learning process, but instead assume the role of facilitators who guide and support students throughout their learning experiences. This is evident in a teacher's statement:
"I now act more as a facilitator, rather than always providing the answers." (Research Data, 2026). This statement indicates a shift in teachers' roles from transmitters of information to active facilitators of learning who support student engagement. Moreover, this transformation suggests that teachers are beginning to develop more adaptive, simplified, and student-responsive instructional strategies aligned with learners' characteristics.

These findings indicate an enhancement of Pedagogical Content Knowledge (PCK), as proposed by Shulman, which refers to teachers' ability to transform abstract mathematical concepts into more concrete and comprehensible forms for students (Shulman, 1986). From the perspective of Pedagogical Content Knowledge, this transformation demonstrates an increased capacity to represent mathematical concepts in ways that are accessible and meaningful for students. The implementation of the GASING method encouraged teachers to organize learning experiences progressively, beginning with concrete representations before moving toward abstract concepts and mental arithmetic (*mencongak*). This instructional sequence reflects the essence of PCK, in which teachers adapt subject matter to students' cognitive characteristics and learning needs rather than merely transmitting mathematical procedures.

These findings are consistent with previous studies showing that improvements in PCK are closely associated with teachers' ability to adapt instructional strategies that are contextual and responsive to students' needs (Depaepe et al., 2013). Similarly, Habiyaremye et al. (2022), who emphasized that teachers' professional development is reflected in their ability to design meaningful learning experiences that actively engage students in constructing mathematical understanding. Likewise, Deng (2018) argued that instructional innovation contributes to teachers' pedagogical transformation by encouraging greater flexibility in selecting teaching strategies that respond to diverse classroom contexts. This perspective is reinforced by recent evidence showing that sustained pedagogical change is achieved when teachers continuously implement, reflect upon, and refine their instructional practices through ongoing professional learning experiences (Jones, 2026). The present findings support these studies, as teachers increasingly shifted from teacher-centered instruction toward facilitative learning environments that encouraged dialogue, exploration, and active student participation.

Thus, the implementation of the GASING method not only transforms teaching strategies but also strengthens teachers' pedagogical competence in effectively integrating content and pedagogy. These findings suggest that changes in instructional strategies represent an important manifestation of teachers' pedagogical transformation, as improvements in Pedagogical Content Knowledge are translated into more student-centered classroom practices. Consequently, teachers become better equipped to facilitate conceptual understanding, encourage students' mathematical reasoning, and create meaningful learning experiences. Furthermore, these findings reinforce the view that pedagogical transformation involves not only changes in instructional techniques but also the development of teachers' capacity to design learning experiences that are responsive to students' conceptual development and learning needs. Moreover, these pedagogical changes extend beyond classroom instructional practices by encouraging teachers to critically reflect on the effectiveness of their teaching, thereby laying the foundation for continuous professional reflection and improvement.

Teachers' professional reflection as the core of pedagogical transformation

The findings indicate that professional reflection was the most prominent aspect of teachers' pedagogical transformation. Teachers became more critical in evaluating their instructional practices and more sensitive to students' thinking processes. This is reflected in a teacher's statement:

"I now frequently evaluate whether students truly understand the material or are merely memorizing it." (Research Data, 2026). This statement demonstrates an increased level of reflective awareness in teaching practices. Teachers no longer focus solely on learning outcomes but also evaluate the learning process in a more comprehensive manner.

These findings are consistent with Transformative Learning Theory proposed by Mezirow, which positions critical reflection as the core of the transformation process (Mezirow, 1997). Through their teaching experiences with the GASING method, teachers are encouraged to reflect on their previous practices, leading to changes in both their thinking and actions in the learning process. From the perspective of Transformative Learning Theory, professional reflection enables teachers to critically examine their existing assumptions about teaching and learning before reconstructing more effective pedagogical practices. The implementation of the GASING method provided opportunities for teachers to continuously evaluate students' conceptual understanding, instructional strategies, and classroom interactions, thereby encouraging reflective decision-making and continuous professional growth.

Moreover, previous research also highlights that professional reflection is a key factor in the development of teachers' competencies and the improvement of instructional quality (Deng, 2018). These findings are also consistent with Fleming et al. (2022), who emphasized that transformative learning is strengthened through continuous critical reflection that encourages educators to reconsider their instructional beliefs and practices. Likewise, Freire (1970) argued that critical reflection is inseparable from dialogical teaching, in which teachers continuously reflect on classroom experiences to promote meaningful learning and critical consciousness. Recent evidence further suggests that sustained pedagogical transformation is fostered through ongoing cycles of classroom implementation, critical reflection, and professional learning, enabling teachers to continuously refine their instructional practices over time (Jones, 2026). In the present study, teachers' reflections extended beyond evaluating students' academic performance to examining whether learning activities genuinely supported conceptual understanding and active student participation.

Therefore, professional reflection is not merely a component of teaching practice, but also serves as a primary indicator of deep pedagogical transformation. These findings suggest that sustained professional reflection functions as the driving force behind teachers' pedagogical transformation, enabling continuous improvement in instructional practices and strengthening teachers' commitment to creating meaningful, student-centered mathematics learning environments.

Dialogic learning from the perspective of critical pedagogy

Changes in classroom interactions indicate a shift toward more dialogic and participatory learning processes. Teachers provide greater opportunities for students to ask questions, engage in discussions, and express their ideas. This is reflected in a teacher's statement:
"Students are now more active and willing to try." (Research Data, 2026). This statement suggests that learning is no longer one-directional, but instead involves active student participation in the learning process.

These findings are consistent with the concept of Critical Pedagogy proposed by Freire, which emphasizes that learning should be dialogic and emancipatory (Freire, 1970). In this context, the implementation of the GASING method fosters more equitable pedagogical relationships between teachers and students, where students are positioned as active subjects in the learning process. From the perspective of Critical Pedagogy, learning is not merely a process of transmitting knowledge but a dialogical interaction that enables teachers and students to collaboratively construct understanding. The implementation of the GASING method encouraged teachers to create learning environments in which students were actively involved in questioning, expressing ideas, and participating in mathematical discussions. Such learning experiences reflect Freire's view that dialogue serves as the foundation for developing critical awareness and meaningful learning.

Moreover, previous research indicates that dialogic learning can enhance student engagement and critical thinking skills (Fleming et al., 2022). These findings are also supported by Dewi et al. (2023), who reported that student-centered instructional approaches encourage more active classroom participation and strengthen collaborative learning experiences. Recent studies further emphasize that equitable and dialogic mathematics teaching encourages teachers to create classroom environments in which students actively participate, collaboratively construct knowledge, and critically engage with mathematical ideas (Wright, 2026). Likewise, Habiyaremye et al. (2022) emphasized that meaningful classroom interaction enables teachers to respond more effectively to students' learning needs while promoting deeper conceptual understanding. In the present study, teachers increasingly facilitated dialogue and encouraged students to actively communicate their mathematical thinking, creating a more participatory and supportive learning environment.

Therefore, the pedagogical transformation observed in this study not only affects instructional strategies but also contributes to the development of more humanistic and participatory pedagogical relationships. These findings indicate that meaningful classroom interaction constitutes an essential dimension of teachers' pedagogical transformation, as it promotes active student participation, strengthens teacher–student dialogue, and supports the creation of mathematics learning environments that are more reflective, inclusive, and student-centered.

GASING-based model of pedagogical transformation

Teachers' pedagogical transformation can be understood as a gradual and integrated process, beginning with changes in perceptions, followed by transformations in pedagogical strategies, and culminating in professional reflection as the most advanced stage of transformation. This model suggests that pedagogical transformation does not occur partially, but rather involves cognitive (perceptions), practical (strategies), and reflective (professional reflection) dimensions simultaneously (Deng, 2018). The GASING method serves as a catalyst that drives this process through contextual, simple, and meaningful learning experiences.

The proposed model aligns with Transformative Learning Theory by illustrating that changes in teachers' perceptions initiate a process of critical reflection that gradually influences instructional practices and professional development (Mezirow, 1997). Furthermore, the transformation of pedagogical strategies reflects the principles of Pedagogical Content Knowledge, in which teachers continuously adapt mathematical content into forms that are more accessible and meaningful for students (Shulman, 1986). While, the emphasis on dialogue, student participation, and reflective classroom interaction is consistent with Freire's concept of Critical Pedagogy, which positions teachers and students as active partners in constructing knowledge through meaningful dialogue (Freire, 1970).

This transformation is dynamic and continuous, emerging through teaching experiences, critical reflection, and the ongoing refinement of instructional practices that collectively support sustained professional growth (Jones, 2026). Therefore, the GASING method functions not only as an instructional approach but also as a means of ongoing professional development for teachers. Unlike previous studies that primarily examined the effectiveness of the GASING method in improving students' learning outcomes, the present study demonstrates that the method also contributes to teachers' pedagogical transformation by influencing their perceptions, instructional practices, classroom interactions, and professional reflection. This finding extends the existing literature by positioning the GASING method not only as a mathematics instructional approach but also as a catalyst for sustainable teacher professional development.

The GASING-based model of pedagogical transformation provides a comprehensive understanding of teacher change, extending beyond technical aspects to encompass cognitive, reflective, and social dimensions of learning. Overall, this model offers a conceptual contribution to mathematics education by explaining how instructional innovation can simultaneously transform teachers' beliefs, pedagogical practices, and reflective capacities, thereby supporting the development of more meaningful, student-centered, and dialogical mathematics learning environments.

Conclusion

The implementation of the GASING method catalyzes comprehensive and integrated pedagogical transformation among elementary school teachers who teach mathematics. This transformation encompasses three main aspects: changes in teachers' perceptions of mathematics learning, shifts in pedagogical strategies, and strengthened professional reflection. In terms of perception, teachers experience a shift from outcome-oriented to process-oriented learning, in which errors are understood as an essential part of conceptual understanding. In terms of pedagogical strategies, teachers demonstrate a move toward more contextual, gradual, and student-centered instructional practices. Meanwhile, in terms of professional reflection, teachers show increased reflective awareness in evaluating their teaching practices and in understanding students' thinking processes more deeply. The findings also indicate that professional reflection is the most dominant aspect of teachers' pedagogical transformation. Furthermore, the transformation that occurs is integrative in nature, with changes in perceptions, strategies, and reflection that are interconnected and collectively forming a continuous process of pedagogical transformation.

The novelty of this study lies in modeling the GASING method as a catalyst for the pedagogical transformation of elementary school teachers who teach mathematics from the teachers' perspective. The proposed model demonstrates that pedagogical transformation occurs in a gradual process, beginning with changes in perceptions, followed by transformations in pedagogical strategies, and culminating in professional reflection as the most advanced stage. Thus, the GASING method functions not only as an instructional approach but also as a means of teachers' professional development in fostering more meaningful, reflective, and student-centered mathematics learning.

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Declarations

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