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Mapping Mathematics-Specific Self-Regulated Learning Profiles to Inform Differentiated Curriculum and Instruction

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Abstract: Learner diversity in primary mathematics requires instructional decisions that account for differences in how students regulate their learning. This study aimed to map fifth-grade students' mathematics-specific self-regulated learning (SRL) profiles and examine their implications for differentiated curriculum and instruction. A qualitative study was conducted with 48 fifth-grade students at one public elementary school in Bogor City, Indonesia. Data were collected through an SRL questionnaire, classroom observations, semi-structured interviews, and documentation. The data were analyzed iteratively through deductive and inductive coding, within-case analysis, and cross-case analysis. Three recurring profiles emerged: strategic and self-directed learners, motivated but inconsistently regulated learners, and emerging and support-dependent learners. The profiles differed in monitoring, strategy adaptation, persistence, emotional regulation, and reliance on external support when mathematical tasks became challenging. The findings suggest that these profiles can inform differentiated mathematics instruction through adjustments to scaffolding, learner autonomy, formative feedback, monitoring prompts, and reflective activities while maintaining common curricular goals. Further research is needed to examine the transferability of these profiles and the effectiveness of profile-informed instructional approaches.

Keywords: Differentiated Instruction, Mathematics Learning, Primary Education, Self-Regulated Learning, Student Profiles

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INTRODUCTION

Primary mathematics classrooms are expected to accommodate learner diversity while maintaining common curricular goals. Students who work on the same mathematical task may differ in how they set goals, plan solution strategies, sustain effort, monitor understanding, respond to errors, and evaluate progress. Self-regulated learning (SRL) offers a useful lens for examining these differences because mathematics requires learners to interpret problems, select and revise strategies, persist when solutions are not immediately apparent, and judge the reasonableness of answers. Previous studies have reported that SRL relates to academic achievement across childhood and adolescence, as shown in the meta-analysis of Dent and Koenka (2016), and that SRL programs in primary education have been systematically reviewed by Olid-Luque et al. (2025).

According to Zimmerman (2002), self-regulation is a self-directive process through which learners transform their mental abilities into academic skills across forethought, performance, and reflection phases. In a review of six SRL models, Panadero (2017) described SRL as an active and cyclical process that involves cognition, metacognition, motivation, emotion, behavior, and the learning environment. Research by Gunzenhauser and Saalbach (2020) found that domain-specific self-regulation contributed to concurrent but not later mathematics performance in elementary students, which supports examining SRL within mathematics as a specific domain. Recent evidence from Ebbes et al. (2024) indicates that planning, monitoring, cognitive control, motivation or emotion control, and reflection are related yet distinguishable among elementary students, so a single total SRL score may conceal meaningful differences in how students regulate mathematics learning.

Person-centered approaches identify configurations of regulatory characteristics, recognizing that students with similar overall scores may exhibit different strengths and difficulties, as demonstrated by Heirweg et al. (2019), who identified distinct SRL profiles among upper primary students, Bednorz and Bruhn (2023), who found differences in students' evaluations of technology-enhanced mathematics learning environments, and Cleary et al. (2021), who linked mathematics-related SRL profiles to achievement and engagement. Differentiated instruction involves adapting learning opportunities to learner differences, with Deunk et al. (2018) examining its cognitive effects in primary education, Prast et al. (2018) investigating teacher professional development in differentiated mathematics instruction, and Kahmann et al. (2022) and Langelaan et al. (2024) examining professional development programs and key elements of teacher preparation, respectively. As Hasanah et al. (2022) explained, differentiated instruction uses diagnostic assessment to address differences in readiness, interests, and learning profiles, suggesting that mathematics-specific SRL may inform instructional decisions by helping teachers vary goals, checkpoints, motivational scaffolds, subgoals, flexibility, and levels of guidance while maintaining common learning objectives. This approach is supported by Wang and Sperling (2020), whose systematic review examined effective SRL interventions in mathematics classrooms, and Shao et al. (2023), whose meta-analysis investigated the effects of regulated learning scaffolding on regulation strategies and academic performance. In Indonesia, where differentiated learning is

receiving increasing attention, Hasanah et al. (2022) identified teachers' uncertainty about implementation practices, while Raharjo and Lukman (2025) examined differentiated instruction in Indonesian language learning, highlighting the need for further research on how mathematics-specific SRL can guide differentiated instruction for Indonesian fifth-grade students learning to coordinate mathematical representations, operations, and number concepts.

Previous studies have examined the association between SRL and achievement (Dent & Koenka, 2016), identified SRL profiles among upper primary students (Heirweg et al., 2019), and linked mathematics-related SRL profiles to engagement (Cleary et al., 2021). Limited research has examined how fifth-grade students' mathematics-specific regulatory configurations can inform decisions about task structure, scaffolding, pacing, autonomy, formative feedback, monitoring, and reflection. A bibliometric analysis by Farokhah et al. (2023) similarly reported a relatively limited intersection between SRL and mathematical literacy research. This aspect therefore remains underexplored, particularly within Indonesian primary mathematics classrooms.

This study addresses an underexplored aspect of differentiated primary mathematics instruction by profiling students' SRL specifically within mathematics learning. This study extends previous research on SRL profiles by examining qualitative regulatory configurations through questionnaire, observation, interview, and documentation evidence within one fifth-grade mathematics context. The novelty of this study lies in interpreting these profiles as diagnostic evidence for decisions about task structure, scaffolding, pacing, autonomy, formative feedback, monitoring prompts, and reflection, which extends differentiation from achievement and readiness toward the way learners regulate their engagement with mathematics. The aim of this study is to map fifth-grade students' mathematics-specific SRL profiles and to examine whether and how these profiles can inform differentiated curriculum and instruction.

To achieve this aim, the study addresses three research questions. 1) Which SRL profiles emerge in fifth-grade students' mathematics learning when key regulatory dimensions are examined together? 2) What regulatory strengths and support needs are represented in each profile? 3) How can these profiles inform differentiated curriculum and instruction in primary mathematics?

METHODS

Research Design and Context

This study employed a qualitative design to map fifth-grade students' mathematics-specific self-regulated learning (SRL) profiles and examine their implications for differentiated curriculum and instruction. The analysis focused on students' goal setting, planning, strategy selection, monitoring, effort regulation, help seeking, and reflection during mathematics learning. Deductive and inductive coding was used to identify patterns across the collected evidence, following the flexible approach to qualitative analysis described by Braun and Clarke (2006). The study was conducted during regular

fifth-grade mathematics lessons at one public elementary school in Bogor City, West Java, Indonesia.

Participants and Sampling

The participants were 48 fifth-grade students enrolled at the selected school. All students participated in the initial SRL mapping and classroom-based data collection. A purposive subsample was invited to participate in semi-structured interviews, with selection based on maximum variation in preliminary SRL patterns. The selection aimed to represent different combinations of planning, strategy use, monitoring, motivation and effort regulation, help seeking, and reflection. This approach was consistent with the purposive sampling principles discussed by Campbell et al. (2020). The mathematics teacher served as a contextual informant and provided information about classroom routines, instructional expectations, and students' observable learning behaviors.

Data Collection Techniques

Four complementary techniques were used to gather evidence on mathematics-specific SRL, namely a questionnaire, classroom observation, semi-structured interviews, and documentation. Table 1 summarizes the focus, evidence sources, and analytic roles of the four data collection techniques. The questionnaire statements referred to mathematics lessons and tasks, which kept the mapping specific to the target domain. The remaining techniques examined the same regulatory dimensions through observable behavior, student explanation, and written work.

Table 1. Data Collection Techniques, Focus, and Analytic Role

Technique	Focus and indicators	Evidence source	Analytic role
SRL questionnaire (mathematics-specific)	Goal setting and planning; activation of prior knowledge; selection of problem-solving strategies; monitoring of calculations and conceptual understanding; regulation of effort and frustration; help-seeking behavior; management of learning resources; self-reflection after a task	All 48 students	Student-by-dimension matrix used as an orienting device for preliminary patterns
Non-participant classroom observation	Preparation before a task; strategy selection; persistence when encountering difficulty; checking and revising answers; asking for assistance; responding to teacher feedback; reflecting on completed work	Regular fifth-grade mathematics lessons	Observable indicators of SRL for coding and cross-checking
Semi-structured interviews	How students prepared for mathematics; what they did when a problem was not understood; how they decided	Purposively selected students (maximum variation);	Reasoning behind questionnaire responses and observed behavior;

	whether an answer was correct; how they maintained effort; how they evaluated their own learning	contextual interview with the mathematics teacher	triangulation and identification of instructional practices relevant to differentiated support
Documentation	Selected student worksheets, written mathematics work, and learning artifacts available during data collection	Student work	Evidence of strategy use, error correction, monitoring, and reflection

Data Analysis

Data analysis proceeded iteratively alongside data collection across four stages. Figure 1 presents the sequence of stages. The first stage organized questionnaire responses in a student-by-dimension matrix, and the second stage coded all qualitative evidence using deductive and inductive codes. The third stage applied within-case and cross-case analysis, and the fourth stage interpreted each profile in relation to differentiated curriculum and instruction.

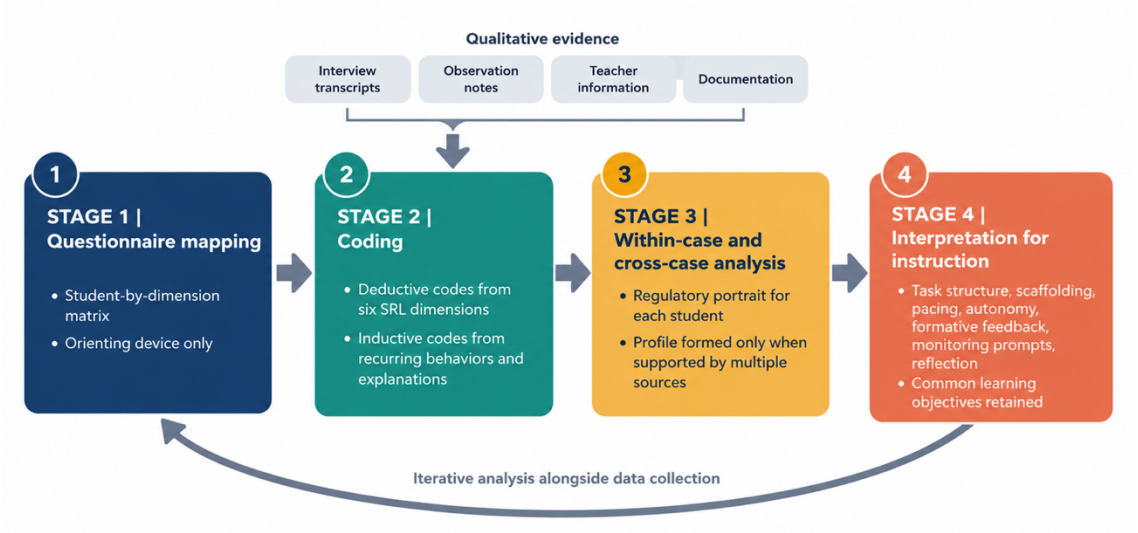


Figure 1. Four-Stage Analytic Procedure for Constructing Mathematics-Specific SRL Profiles

The questionnaire matrix served as an orienting device for identifying preliminary patterns, while profile construction relied on converging evidence from multiple sources. Deductive codes were derived from six SRL dimensions established during study planning: planning and goal setting, cognitive and strategy control, monitoring, motivational and effort regulation, help seeking or environmental regulation, and self-reflection. Inductive codes were added when recurring behaviors or explanations emerged from the data. Profile membership was determined through cross-source evidence rather than questionnaire scores alone. This decision process was documented to support the transparency of the qualitative analysis, consistent with the trustworthiness principles discussed by Nowell et al. (2017).

Trustworthiness

Trustworthiness was supported through triangulation of questionnaire responses, classroom observations, interview transcripts, documentation, and teacher information. A profile was constructed only when multiple sources supported the identified pattern. The four-stage analytic procedure provided a traceable record of decisions from data organization to profile interpretation, consistent with Nowell et al. (2017). The profiles were interpreted as context-dependent patterns of current regulation that may vary across mathematical topics, task demands, and classroom conditions. Transferability should therefore be assessed in relation to the characteristics of the research context.

RESULTS

Initiating and Sustaining Regulation in Mathematics Learning

Students generally appeared able to start mathematics learning with a recognizable purpose. Responses to goal-setting and learning-plan items suggested that many students entered a task knowing what they wanted to accomplish and with some idea of how they would study. This orientation was most visible in responses about the desire to understand mathematical material, complete tasks successfully, and organize a strategy before learning. Learning intention was therefore widely present, and the main variation emerged after learning had begun, when students had to sustain regulation and judge the effectiveness of their own actions.

Figure 2 presents the pathway from initiating to sustaining regulation during mathematics learning. The pathway integrates questionnaire responses, observation notes, interview accounts, and worksheet evidence to show the progression from initial goal setting and planning to monitoring, strategy adaptation, and persistence during mathematical tasks.

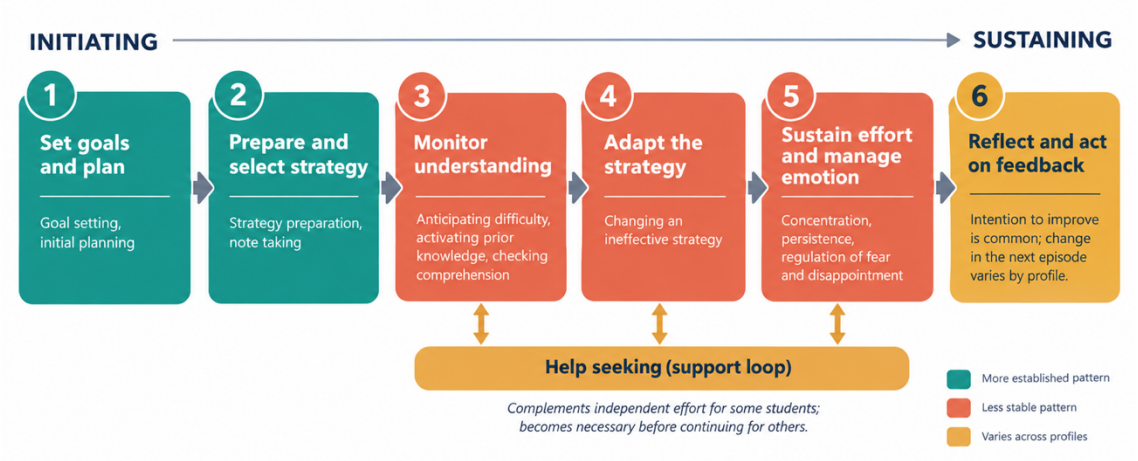


Figure 2. Pathway From Initiating to Sustaining Self-Regulated Learning in Mathematics Tasks

Cognitive and Metacognitive Regulation

Within the cognitive and metacognitive dimension, purposeful planning was more consistently visible than adaptive monitoring. Responses about establishing mathematics

learning goals and arranging a learning strategy showed a broadly positive tendency, and students recognized the usefulness of note taking and reviewing learning plans. Responses about anticipating which part of a topic would be difficult, activating relevant prior knowledge, checking whether a strategy produced understanding, and deciding when to modify a strategy were less consistently represented. In practical terms, a student might decide to read an example or practice several questions yet have difficulty determining whether the activity addressed the source of misunderstanding.

Prior knowledge use varied across students, because connecting newly encountered mathematics with previously learned ideas was not consistently automatic. Some students appeared ready to treat a new topic as an extension of earlier concepts, and others approached it as a separate set of procedures. Strategy adaptation showed a similar pattern, since students generally expressed an intention to improve while the evidence was less stable regarding what they would change when a first approach did not lead to understanding. In several response patterns, willingness to try harder was more apparent than the ability to identify why a strategy had failed, which separated effort regulation from strategic regulation in the data.

Motivational and Emotional Regulation

The motivational dimension displayed an overall constructive orientation toward mathematics. Students commonly indicated confidence that mathematical material could be understood and that assigned tasks could be completed, and they showed a strong willingness to improve after an unsatisfactory outcome. Responses about fear of poor results, disappointment after an unsatisfactory mark, and fluctuating interest showed greater variation, and some students used disappointment as a cue to increase effort while others appeared more vulnerable to anxiety or reduced confidence when confronted with difficult mathematics. Positive self-beliefs and emotional regulation therefore did not always appear at the same level within the same student, and a student could believe that mathematics was learnable while becoming hesitant or reassurance-seeking when an unfamiliar problem created uncertainty.

Behavioral Regulation and Help Seeking

Help seeking appeared as a link between emotional and behavioral regulation, because students frequently indicated that they would approach a teacher or peer when anxiety or lack of understanding arose. The response configurations differed in the timing and purpose of help seeking, since support complemented independent effort for some students and became necessary before continuing for others. Behavioral regulation was most visible in readiness to organize study time, complete tasks, ask for assistance, request feedback, and increase effort when necessary. Concentration and persistence were less uniform, as some students remained engaged when tasks became cognitively demanding and others needed prompts, reassurance, or direct guidance.

Table 2 summarizes the more established and less stable patterns identified across the cognitive and metacognitive, motivational and emotional, and behavioral dimensions. The summary highlights the regulatory behaviors that distinguished students' patterns across the three dimensions.

Table 2. Summary of Mathematics-Specific SRL Patterns

SRL dimension	More established pattern	Less stable pattern
Cognitive and metacognitive	Goal setting, initial planning, strategy preparation, note taking, intention to improve	Anticipating difficulty, activating prior knowledge, monitoring comprehension, adapting ineffective strategies
Motivational and emotional	Confidence, willingness to improve, positive orientation toward mathematics, use of support	Fear of poor results, disappointment, fluctuating interest, emotional regulation under challenge
Behavioral	Help seeking, feedback seeking, time organization, task completion, increased effort	Sustained concentration, persistence, and independent continuation when tasks become difficult

Table 2 indicates that each SRL dimension included both relatively established and less stable behaviors. Goal setting and strategy preparation were more consistently represented, while monitoring comprehension, adapting ineffective strategies, regulating emotions, and sustaining concentration showed greater variation. These patterns provide a basis for examining how regulatory strengths and needs combine within individual student profiles.

Recurring SRL Profiles

Reading the three dimensions together showed that students' self-regulation was better represented as configurations of strengths and needs than as a single continuum from low to high. The same student could show an adaptive pattern in one dimension and a less stable pattern in another, such as clear learning goals and strong motivation together with difficulty checking comprehension or changing an ineffective strategy. Another student could be relatively systematic in planning yet require reassurance to persist when an answer was uncertain. These combinations formed three recurring configurations, labeled strategic and self-directed learners, motivated but inconsistently regulated learners, and emerging and support-dependent learners, which are descriptive summaries of dominant patterns that can change across topics, task demands, and classroom conditions.

Profile 1: Strategic and Self-Directed Learners

The strategic and self-directed configuration showed alignment among cognitive, motivational, and behavioral regulation. Students with this pattern appeared to enter mathematics learning with a clear goal, select a plausible strategy, monitor progress, seek feedback when needed, and remain willing to adjust their approach. Their confidence was accompanied by learning behavior that supported continued engagement, and help seeking functioned as one resource among several. Their response pattern also suggested a readiness to change how they would study or solve a problem in the next learning episode, which linked reflection to subsequent action.

When a task became difficult, the likely regulatory response in this profile was to review the problem, inspect the strategy, obtain targeted feedback, or devote additional effort while keeping ownership of the learning process. Even students with relatively coherent self-regulation reported seeking feedback and assistance. External input

appeared integrated with self-monitoring and supported the student's reasoning. These students therefore appeared ready for greater choice and autonomy within common curricular goals.

Profile 2: Motivated but Inconsistently Regulated Learners

The second configuration combined positive motivation with uneven cognitive and metacognitive control. Students in this pattern generally wanted to succeed in mathematics, expressed confidence that improvement was possible, and showed willingness to complete tasks. They began learning with enthusiasm, yet their checking of understanding, evaluation of the selected strategy, and decisions about changing approach were inconsistent. Their main difficulty concerned the strategic regulation of effort that was already present.

This profile was most visible in the contrast between persistence and monitoring. Students could continue working or repeat a familiar procedure, yet the response pattern did not always indicate that they evaluated the quality of their understanding. As a result, additional effort could become repetitive and less responsive to the source of difficulty. These learners appeared to need explicit points at which they stopped, checked their reasoning, compared strategies, or explained why a solution step made sense.

Profile 3: Emerging and Support-Dependent Learners

The emerging and support-dependent configuration showed greater reliance on external prompts, teacher or peer assistance, and immediate feedback. Students with this pattern appeared to experience more difficulty linking prior knowledge with new mathematical ideas, anticipating what might be challenging, sustaining attention, and selecting an alternative strategy after an unsuccessful attempt. Many of them still expressed a desire to obtain better results and a willingness to learn, so motivation was present in this configuration. The transition from intention to independent action was less stable than in the other two profiles.

When uncertainty increased, these learners were more likely to depend on external direction, such as waiting for the teacher to confirm the next step, asking for help before exploring another strategy, or losing persistence when a task required several attempts. The response pattern also suggested that emotional regulation could amplify cognitive difficulty, because uncertainty about a solution combined with concern about making an error increased the need for reassurance. The configuration therefore reflected an emerging capacity for self-regulation that remained in development. The support needs indicated for this configuration included clear task sequences, worked examples, prompts for checking understanding, and structured opportunities to ask for help.

Table 3 summarizes the three recurring SRL profiles, their characteristic regulatory configurations, and their primary regulatory needs. The table links the patterns identified in the qualitative analysis to the instructional support indicated for each profile.

Table 3. Recurring SRL Profile Configurations

Qualitative profile	Characteristic configuration	Primary regulatory need
Strategic and self-directed	Goals, strategy use, monitoring, confidence, feedback seeking, and revision are mutually supportive	Opportunities to extend autonomy, justify strategies, and reflect independently
Motivated but inconsistently regulated	Positive motivation and task engagement coexist with uneven monitoring, strategy evaluation, and persistence	Explicit checkpoints, self-monitoring prompts, and guided strategy comparison
Emerging and support-dependent	Motivation is present while regulation depends more strongly on prompts, guidance, and immediate feedback	Modeling, shorter task steps, structured support, and gradual transfer of responsibility

Differences Between the Profiles

The profiles differed most clearly in how students responded after encountering difficulty. Strategic and self-directed learners appeared more likely to treat difficulty as information that guided strategy adjustment. Motivated but inconsistently regulated learners tended to respond with effort and needed stronger cues to evaluate whether that effort was productive, and emerging and support-dependent learners were more likely to require external structure before continuing. The profiles therefore represented different relationships among motivation, monitoring, persistence, and use of support, with effort present in all three.

Instructional Support Needs Indicated by the Profiles

Table 4 translates the three SRL profiles into potential instructional adjustments related to task structure, scaffolding, learner autonomy, feedback, monitoring, and reflection. The proposed adjustments maintain common mathematics learning objectives while varying the level and type of support according to the regulatory needs indicated by each profile.

Table 4. Instructional Adjustments Indicated by Each SRL Profile Within Common Mathematics Objectives

Qualitative profile	Structure and scaffolding	Autonomy and choice	Feedback, monitoring, and reflection
Strategic and self-directed	Open-ended problem solving within common goals	Choice of strategy; gradually reduced teacher support	Targeted feedback; justification of strategies; independent reflective extension
Motivated but inconsistently regulated	Planning prompts and progress checks embedded in the learning sequence; challenging content retained	Guided strategy comparison before independent choice	Explicit checkpoints; self-monitoring prompts; strategy-evaluation questions
Emerging and support-dependent	Explicit modeling; shorter task steps; clear task sequences; worked examples	Gradual transfer of responsibility to the learner	Frequent formative feedback; prompts for checking understanding; structured peer or teacher support

Note. All profiles work toward the same intended mathematics learning objective.

Table 4 indicates that differentiated instruction can vary the degree of structure, autonomy, and feedback while maintaining common mathematics learning objectives. Strategic and self-directed learners may be offered greater autonomy and opportunities for reflective problem solving. Motivated but inconsistently regulated learners may benefit from explicit monitoring prompts and strategy-evaluation checkpoints. Emerging and support-dependent learners may require more structured scaffolding, frequent formative feedback, and gradual transfer of responsibility. These instructional adjustments are proposed implications of the identified profiles and require further evaluation in classroom implementation.

DISCUSSION

Configurations of Regulation in Mathematics Learning

The study identified three recurring mathematics-specific SRL profiles, indicating that students may exhibit different combinations of regulatory strengths and needs across different combinations of regulatory strengths and needs. Panadero (2017) conceptualized SRL as a cyclical process involving cognition, metacognition, motivation, emotion, behavior, and the learning environment, while Heirweg et al. (2019) similarly identified distinct SRL profiles among upper primary students. These findings suggest that total SRL scores may conceal instructional differences, consistent with van Loon and Roebers (2024), who identified heterogeneous developmental patterns in elementary students' metacognitive monitoring and control. Teachers can therefore use profiles alongside achievement information to guide instructional planning and periodically reassess students' regulatory needs across tasks and topics.

The Gap Between Planning and Monitoring

Planning and strategy preparation were more consistently evident than monitoring, prior-knowledge activation, and strategy adaptation, suggesting that students' intentions do not always translate into effective regulation. Ebbes et al. (2024) found that planning, monitoring, cognitive control, motivation or emotion control, and reflection are related but distinguishable processes, while Dörrenbächer-Ulrich and Bregulla (2024) reviewed the relationship between SRL and executive functions. Within Zimmerman's (2002) phase model, this pattern may reflect a gap between forethought and performance-phase regulation. Gunzenhauser and Saalbach (2020) found that domain-specific self-regulation contributed to concurrent but not later mathematics performance, while Dignath and Veenman (2021) examined direct strategy instruction and indirect SRL activation. Teachers can embed strategy modeling and brief prompts into mathematics lessons to help students check understanding, identify errors, and adapt strategies, although the effects of these supports require further investigation.

Motivation, Emotion, and Help Seeking

Positive motivation was common across the profiles, but emotional regulation, persistence, and help-seeking patterns varied among students. Schukajlow et al. (2023) reviewed growing attention to motivation and emotion in mathematics education, while Di Leo and Muis (2020) examined cognitive-emotional strategy training for managing confusion and Losenno et al. (2020) investigated cognitive reappraisal and SRL during mathematical problem solving. These studies suggest that motivation alone may not ensure effective regulation when students encounter uncertainty or difficulty. De Ruig et al. (2023) linked high-quality teacher-student interactions and relationships to elementary students' SRL, highlighting the potential role of classroom interactions in shaping help seeking. Teachers can encourage students to explain their attempts before requesting assistance, although this strategy requires further classroom-based evaluation.

Instructional Responses for the Strategic and Self-Directed Profile

Strategic and self-directed learners demonstrated coordinated goal setting, strategy use, monitoring, feedback seeking, and reflection, suggesting readiness for greater autonomy and sustained cognitive challenge. Wang and Sperling (2020) reviewed effective SRL interventions in mathematics classrooms, Olid-Luque et al. (2025) reviewed SRL programs in primary education, and Eberhart et al. (2025) examined the effectiveness of metacognition interventions in young children through meta-analyses. These reviews provide relevant evidence for designing differentiated support while recognizing that outcomes may vary by age and intervention design. Instruction can emphasize open-ended problems, strategy comparison, alternative representations, justification, and reflection while retaining opportunities for teacher feedback. The effects of these approaches on mathematics learning outcomes remain to be tested.

Instructional Responses for the Motivated but Inconsistently Regulated Profile

Motivated but inconsistently regulated learners demonstrated positive motivation but uneven monitoring, indicating that repeated effort may not resolve conceptual errors without strategic evaluation. Oudman et al. (2022) examined self-scoring of mathematics problem solutions as a means of supporting primary students' monitoring and regulation, while Heikkinen et al. (2023) reviewed learning analytics interventions supporting SRL. These findings inform the use of structured checkpoints that ask students to identify known information, explain their strategies, evaluate progress, and consider alternatives. Panadero et al. (2023) examined the effects of rubrics on academic performance, SRL, and self-efficacy, providing a basis for incorporating explicit criteria into formative assessment. The feasibility and effectiveness of these supports in routine mathematics lessons require further investigation.

Instructional Responses for the Emerging and Support-Dependent Profile

Emerging and support-dependent learners showed motivation but relied more heavily on prompts, assistance, and feedback to translate intentions into independently regulated actions. Shao et al. (2023) synthesized evidence on the effects of regulated learning scaffolding on regulation strategies and academic performance, while Dignath et al. (2008) examined effective SRL strategy training for primary students. Cleary et al. (2021) also linked mathematics-related SRL profiles to achievement and engagement, supporting

the instructional relevance of identifying regulatory needs. Explicit modeling, worked examples, manageable task sequences, structured teacher or peer assistance, and frequent formative feedback may provide temporary external regulation, with responsibility transferred gradually to students. Because the study did not track students over time, the effectiveness of these supports and the appropriate timing for reducing scaffolding remain to be established.

Profile-Responsive Differentiation in Curriculum and Instruction

The three profiles suggest that teachers can differentiate structure, autonomy, monitoring, feedback, and reflection while maintaining shared mathematics learning objectives. Deunk et al. (2018) examined the cognitive effects of differentiated instruction in primary education, Prast et al. (2018) investigated professional development for differentiated mathematics instruction, and Kahmann et al. (2022) synthesized evidence on professional development programs. Langelaan et al. (2024) analyzed key elements of teacher preparation and development for differentiation, while Kalinowski et al. (2024) highlighted the roles of teacher self-efficacy and enthusiasm in differentiated instruction. These findings indicate that profile-responsive differentiation requires diagnostic assessment, appropriate instructional decisions, layered scaffolding, and teacher capacity to interpret evidence from observations, conversations, and student work. As this study did not evaluate teacher workload or instructional outcomes, school-based trials are needed to assess implementation feasibility and effectiveness.

Relevance to the Indonesian Context

The profiles offer a curriculum-and-instruction lens in a context where differentiated learning is receiving attention in curriculum implementation. Indonesian teachers must respond to learner diversity within a shared curriculum, making diagnostic information on regulation practically useful. Hasanah et al. (2022) developed a conceptual model of differentiated instruction based on Indonesian junior high school teachers' experiences and identified uncertainty about best practices, while Raharjo and Lukman (2025) examined differentiated instruction in Indonesian language learning; differences in subject, school level, and design mean these studies complement the present qualitative findings. Mathematics-specific regulatory information provides a subject-sensitive basis for differentiation, allowing teachers to maintain shared competencies while varying scaffolds, monitoring opportunities, feedback, and learner responsibility; this contribution also addresses the relatively limited intersection between SRL and mathematical literacy research reported by Farokhah et al. (2023), although transferability should be considered in relation to similar contexts because the study involved one school.

Theoretical and Practical Implications

Theoretically, the study extends person-centered SRL research by connecting qualitative regulatory configurations with curriculum and instructional decisions. Dent and Koenka's (2016) meta-analysis established an association between SRL and academic achievement across childhood and adolescence, while the present profiles illustrate how regulatory evidence may inform instructional responses. The findings also support a

multidimensional view of regulation, as planning, motivation, monitoring, emotion, and persistence varied independently within students, although this interpretation requires testing with larger and more diverse samples. Practically, teachers can use the profiles to plan mathematics lessons with differentiated support, curriculum designers can combine shared objectives with graded scaffolds, choice, and reflection prompts, and school leaders can facilitate the collection of regulatory evidence through observation, brief conversations, and worksheet review.

Limitations and Future Research

The study was conducted in one public elementary school and used questionnaire responses as an initial mapping source; therefore, the three profiles should be understood as context-sensitive qualitative configurations rather than universally applicable categories. Although self-report provides access to learners' perceptions, the study triangulated questionnaire findings with observations, interviews, documentation, and teacher information, consistent with the multimethod approach of Heirweg et al. (2019), who combined self-report questionnaires with think-aloud protocol analysis. Because the analysis emphasized regulatory configurations, the distribution of students across profiles was not treated as a finding; future research could incorporate process data, such as think-aloud protocols, to examine moment-to-moment regulation during problem solving. Further studies should investigate whether the profiles recur across schools, mathematical topics, and grade levels, track transitions between profiles over time, and experimentally evaluate profile-responsive instructional designs involving metacognitive checkpoints, adaptive scaffolding, formative feedback, and autonomy-supportive tasks to assess mathematics outcomes and changes in SRL.

CONCLUSION

This study identified three profiles of mathematics-specific SRL among fifth-grade students: strategic and self-directed learners, motivated but inconsistently regulated learners, and emerging and support-dependent learners. The profiles revealed differences in cognitive, metacognitive, motivational, emotional, and behavioral regulation, with planning and motivation generally more established than monitoring, strategy adaptation, persistence, and reflection. These findings suggest that students pursuing the same mathematics objectives require different instructional support. Strategic learners may benefit from greater autonomy and reflective problem solving, motivated but inconsistently regulated learners from monitoring prompts and formative checkpoints, and emerging learners from explicit modeling, structured scaffolding, and gradual transfer of responsibility. Future research should examine profile stability across schools, grade levels, and mathematical topics and investigate the effects of profile-informed differentiated instruction on students' SRL and mathematics learning.

AI Use Statement

AI-assisted tools were used for language refinement and proofreading, where applicable. The authors reviewed the manuscript and take responsibility for its content.

Author Contributions

LF: conceptualization, investigation, data collection and analysis, and initial manuscript preparation. MZ: investigation, data collection and analysis, and manuscript revision. DNAH: research methodology, data analysis, and interpretation of findings. EJBV: research methodology, interpretation of findings, critical manuscript review, and editing. All authors approved the final manuscript.

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Conflict of Interest

The authors declare no competing interests.

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