



Developing Mathematical Thinking:
The Struggle with Rounding and Estimation:
Research Insights for Educators

DMTI INSIGHTS

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THE STRUGGLE WITH ROUNDING AND ESTIMATION: RESEARCH INSIGHTS FOR EDUCATORS

(DMTI INSIGHTS)

Introduction

Rounding and estimation are essential yet often misunderstood skills in elementary mathematics. Here is why and how to teach them better, based on current research. Rounding simplifies numbers to make them more manageable, while estimation uses rounded numbers and number sense to generate approximate answers. These practices support flexible problem-solving, real-world reasoning, and error-checking. Despite frequent use, many students develop only shallow procedural fluency, leaving significant misconceptions unaddressed (Rittle-Johnson & Schneider, 2015; Siegler & Booth, 2004; Schneider et al., 2020).

Defining Rounding and Estimation

What exactly distinguishes rounding from estimation, and why does the distinction matter?

Rounding is a rule-based simplification of a number to the nearest benchmark, such as 10, 100, or a decimal place. For example, \$473 becomes \$500 when rounded to the nearest hundred. **Estimation, however, is a broader reasoning skill** that often employs rounding but emphasizes context and judgment. For instance, mentally totaling \$19.97 + \$4.82 + \$10.13 to approximate a \$35 grocery bill shows estimation at work.

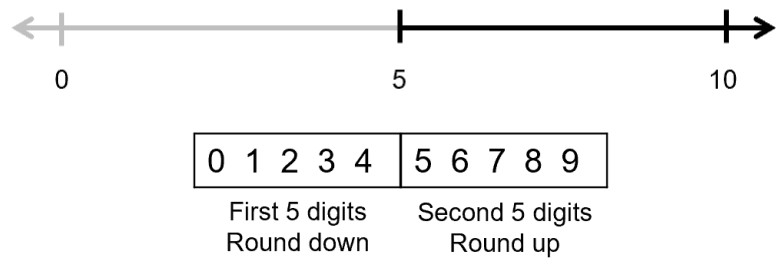
By emphasizing number sense and reasoning, teachers highlight that estimation involves contextual strategy, not mechanical steps. Students who understand this distinction are more likely to flexibly apply the correct method in different situations—for example, estimating 76×4 as approximately 300 without performing the exact multiplication first (Dowker, 2019).

Why Conceptual and Procedural Knowledge Matters

Why is it insufficient for students to know only the steps of rounding?

True mastery emerges from striking a balance between conceptual understanding (knowing why rules work) and procedural fluency (executing them accurately and efficiently). A student with conceptual knowledge can explain that 47 rounds to 50 because it is closer to 50 than 40, while one with procedural fluency can quickly follow the “look at the neighbor digit” rule.

This rule is not arbitrary; it is a logical procedure based on our base-10 number system. On a number line, any place value (like tens) is bordered by two benchmarks (e.g., 40 and 50). The midpoint between them is 45. Numbers with digits 0-4 in the target place value (like 40, 41, 42, 43, 44) fall in the first half and are closer to the lower benchmark. Numbers with digits 5-9 (45, 46, 47, 48, 49) reach or pass the midpoint and are closer to the higher benchmark. The convention of rounding "5" up is a practical agreement to ensure consistency, as 45 is exactly halfway between 40 and 50.



Instruction should deliberately connect explanations to rules. For example, pairing a number line visualization with the step-by-step rounding procedure anchors abstract rules in place-value reasoning. **The integration of conceptual and procedural knowledge enables students to be adaptable rather than rigid**, supporting deeper reasoning across mathematical tasks (Rittle-Johnson & Schneider, 2015).

Knowledge Type	What It Is	Example in Rounding
Conceptual Understanding	Rooted in place value and magnitude, knowing why a rule works	47 rounds to 50 because it is only 3 away from 50.
Procedural Fluency	Executing steps quickly and accurately	Round 347 to the nearest hundred: tens digit = 4 (<5), so the answer is 300.

When teaching rounding, it is essential to use precise language and engage students with visual models such as the number line. For example, when rounding 273, students first identify how many complete tens are present in the number; in this case, there are 27 tens, or 270. Next, they find the next largest ten, which is 28 tens, or 280. Placing these benchmarks on a number line helps students see that 273 falls between 270 and 280. Focusing on the one's digit—3, which is between zero and four, students reason that 273 is closer to 270 than to 280, so they round down to 270. Similarly, when rounding 3.98 to the nearest tenth, students consider how many tenths (39 tenths, or 3.9) and what the next largest tenth is (40 tenths, or 4.0). By locating 3.98 on the number line between 3.9 and 4.0, and noticing the hundredths digit (8), they see that it is much closer to 4.0 and thus round up. Using language that emphasizes benchmarks, proximity, and number line representations strengthens conceptual understanding and makes the rounding process visual and meaningful.

Common Misconceptions

A common error is rounding 3.98 to 3.10—evidence of procedural application without place-value understanding

(Bray, 2013). Another frequent misconception is treating estimation as rounding after solving a problem exactly, rather than as a tool for rapid reasoning and approximation. Such mistakes expose gaps in number sense that can be transformed into powerful teaching opportunities.

One approach is structured error analysis. Teachers can present incorrect student solutions and ask, “Why might someone think this is correct?” or “What is missing in this reasoning?” **By reframing errors as learning tools, misconceptions shift from obstacles into stepping stones**, encouraging metacognition and deeper understanding (Hansen, 2018; Reinhold et al., 2020).

Cognitive Perspectives

How do cognitive demands impact the way students process multi-digit rounding and estimation tasks?

These tasks demand significant working memory. Rounding 2,987 to the nearest hundred involves identifying digits, recalling rules, regrouping, and rewriting the number. Without a strong understanding of place value, students make errors like “2,987 → 2,900” instead of 3,000. **Weak place-value knowledge amplifies the cognitive load, leaving students prone to mistakes** (Siegler & Booth, 2004; Hansen, 2018).

Scaffolding strategies—such as modeling with open number lines, breaking tasks into visible steps, and using manipulatives—help offload memory demands. When the mental load is reduced, students can focus on reasoning rather than mechanics. **Instructional scaffolds make abstract processes concrete**, allowing students to build fluency with less frustration (Bray, 2013).

Research-Based Teaching Practices

Which classroom strategies most effectively cultivate a deep understanding of rounding and estimation?

Visual models, such as open number lines, anchor abstract ideas in physical representations. Asking guiding questions, such as “Is 47 closer to 40 or 50?” makes reasoning explicit. In addition, teaching estimation in authentic contexts—like budgeting, shopping, or measuring—clarifies its distinct role compared to rounding (Siegler & Booth, 2005).

Encouraging students to compare and justify methods builds strategic competence. For example, a student might explain why estimating \$473 for budgeting should be \$500, rather than \$470. **Instruction that combines error analysis, multiple models, and real-world practice develops flexible, confident thinkers** (Schneider et al., 2020).

Encouraging students to compare and justify methods builds strategic competence. For example, a student might explain why estimating a \$473 flight as \$500 for budgeting purposes can lead to a more practical decision than simply rounding it to \$470. Instruction that combines error analysis, multiple estimation models, and real-world practice develops flexible, confident thinkers (Schneider et al., 2020).

Summary

Shifting from rote tricks to reasoning-rich instruction empowers students to become confident mathematical thinkers. Traditional teaching often reduced rounding and estimation to procedural rhymes and shortcuts. Research

indicates that emphasizing number sense, scaffolds, visual models, and adaptive strategy choice fosters a deeper understanding, reduces persistent errors, and equips students with skills that transfer beyond the classroom (Bray, 2013; Hansen, 2018; Reinhold et al., 2020).

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Social Media

Are We Teaching Rounding and Estimation for the Test—or for Life?

It is easy to teach rounding rules and estimation tricks for instant results. But do these routines create true mathematical thinkers? The latest research indicates that real understanding requires more than memorized procedures. If we want our students to apply math flexibly in the real world—not just ace a worksheet—we need practices that put thinking and meaning at the forefront.

Our new DMTI Insights highlights strategies that bridge cognitive science and classroom realities:

- Why conceptual understanding (not just “circle the digit, look next door”) is the real foundation for skillful estimation and rounding.
- Powerful ways to use student errors and misconceptions as springboards for deeper learning.

- How visual models—like open number lines and hundreds charts—shift students from rote rules to lasting number sense.
- Ways to make estimation meaningful by always anchoring it in real-world, context-rich scenarios.

It is time to move beyond “five or more, let it soar”—and toward math reasoning that sticks for a lifetime.

What is your favorite strategy for helping students truly understand rounding or estimation—not just memorize it? Share your insights below.



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