METHODS FOR TEACHING THE NUMBERING OF NON-NEGATIVE WHOLE NUMBERS THROUGH CRITICAL THINKING

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ABSTRACT
Numeration of non-negative whole numbers is often taught as memorizing number names and applying place-value rules. Such teaching can produce correct reading and writing while leaving fragile reasoning in comparison, the meaning of zero, and answer checking. This thesis proposes a method that embeds critical thinking into numeration lessons: pupils state claims about number structure, test those claims with representations, and revise claims using evidence. The approach is designed for primary classrooms and for pre-service teacher education, emphasizing argumentation, error analysis, and representational coherence as routine instructional elements.

KEYWORDS: Numeration, place value, non-negative whole numbers, critical thinking, primary mathematics, methodology, formative assessment, representations.

INTRODUCTION
Numbering in the primary grades is the gateway to the base-ten system that supports multi-digit operations, measurement, and later generalization. When instruction is dominated by rehearsal and copying, pupils may treat numerals as strings of digits rather than structured quantities. Typical symptoms include digit-wise comparison (for example, judging 402 < 39 because 2 < 9), unstable reading of numbers that contain zeros, and limited ability to explain why regrouping works. Research on multiunit number concepts emphasizes that understanding develops when children coordinate unitizing, language, and written notation over time, rather than simply memorizing names and procedures.

Critical thinking offers an instructional lens for turning numeration into sense making. It is commonly defined as reasonable, reflective thinking aimed at deciding what to believe or do (Ennis), and it includes analysis, evaluation, inference, explanation, and self-regulation (Facione). In early mathematics, critical thinking is not taught as formal logic; it is cultivated through brief routines that require reasons, evidence, and revision. Embedding these routines in numeration lessons aligns with competency-based teacher education because it makes reasoning, diagnosis of misconceptions, and justification of instructional choices explicit components of methodological competence.

A design-based conceptual methodology was used to develop a teachable instructional model rather than to estimate an intervention effect size. Foundational sources were synthesized in three strands: early numeration and place-value development, reasoning-oriented mathematics instruction and formative assessment, and educational frameworks of critical thinking. The synthesis was translated into an implementable method specified through observable lesson elements: unitizing tasks (building tens/hundreds as new units), representational coherence (linking objects, expanded notation, and number lines), discourse prompts that demand justification, and coherence-oriented formative assessment that checks transfer across representations.

The method organizes numeration around three coordinated meanings developed together across lessons: quantity (how many), structure (how units compose tens and hundreds), and notation (how symbols encode that structure). Each lesson includes a brief critical-thinking cycle in which pupils state a claim, provide evidence using at least one representation, and then confirm or revise the claim. Because the cycle is short and repeated, it becomes a habitual way of working with numbers rather than an occasional "special activity."

Instruction begins with unitizing experiences in which children build and name tens as new units. Pupils represent 34 with objects, then justify why "three tens and four ones" names the same quantity as "thirty-four." The teacher elicits evidence by regrouping ten ones into one ten and asking what changed and what stayed the same. This builds a precise meaning for zero as a structural marker: in 305, "no tens" is information about missing units, which helps pupils distinguish 305 from 350 and 530 through unit language, not by guessing or relying only on memorized number names. Place-value reading is therefore treated as interpretation, not recitation: the spoken name must be supported by an explanation of units.

When pupils move to reading and writing multi-digit numerals, representational coherence is maintained by pairing every numeral with decomposition and placement. Students write 472 as 4 hundreds + 7 tens + 2 ones, then place it between 470 and 480 on a number line and explain why it is closer to 470 than to 480. Comparison is framed as argumentation rather than rule application. Pupils decide whether 560 is greater than 506 and justify the decision by referencing unit hierarchy (hundreds before tens, tens before ones) while supporting the reasoning with expanded notation or base-ten blocks. In this structure, a "correct answer" is not sufficient; the justification must be clear, relevant to place value, and consistent with a representation.

Critical thinking is strengthened through "always/sometimes/never" judgments adapted to children's language. The class evaluates claims such as "A number with more digits is always larger" by generating counterexamples (for example, 100 versus 99) and explaining why structure, not visual length, determines size. Error analysis is treated as diagnostic evidence: if a pupil compares by the last digit, the teacher returns to unit meaning, varies examples to expose invariants (including cases with zeros and different digit lengths), and asks pupils to defend a corrected conclusion with a representation and a clear reason. Formative assessment checks transfer across representations by asking pupils to match spoken number names to multiple written forms, generate numerals from decompositions, decide whether a peer's answer is reasonable, and identify which assumption should be checked when answers conflict.

The method positions critical thinking as a mechanism for building place-value structure, not as an added "soft skill." Requiring claims and evidence compels pupils to coordinate quantity, structure, and notation, directly targeting the sources of common numeration errors. This is consistent with views of teaching expertise that emphasize transforming content for learners and using student thinking as evidence for instructional decisions. For prospective teachers, the method clarifies what to plan and what to listen for: they anticipate misconceptions tied to unitizing, select representations that reveal unit structure, and use brief diagnostic prompts to decide whether to return to unitizing, strengthen language, or extend to larger numbers.

Feasibility is supported by the method's economy. The critical-thinking cycle is brief, representations are familiar, and discourse moves such as "How do you know?" and "Is it always true?" can be repeated across lessons without expanding lesson time substantially. The approach aligns with recommendations that mathematics instruction should prioritize reasoning and sense making, not only procedural accuracy. Teaching numeration through critical thinking therefore supports both conceptual understanding and metacognitive monitoring, enabling pupils to detect and correct errors more independently as numbers grow in size and complexity.

References

1. Shulman L.S. Those who understand: Knowledge growth in teaching // Educational Researcher. — 1986. — Vol. 15, No. 2. — P. 4–14. — DOI: 10.3102/0013189X015002004.
2. Ball D.L., Thames M.H., Phelps G. Content knowledge for teaching: What makes it special? // Journal of Teacher Education. — 2008. — Vol. 59, No. 5. — P. 389–407. — DOI: 10.1177/0022487108324554.
3. National Research Council. Adding It Up: Helping Children Learn Mathematics. — Washington, DC: The National Academies Press, 2001. — DOI: 10.17226/9822.
4. National Council of Teachers of Mathematics. Principles to Actions: Ensuring Mathematical Success for All. — Reston, VA: NCTM, 2014.
5. Fuson K.C. Conceptual structures for multiunit numbers: Implications for learning and teaching multidigit addition, subtraction, and place value // Cognition and Instruction. — 1990. — Vol. 7, No. 4. — P. 343–403. — DOI: 10.1207/s1532690xci0704_4.
6. Fuson K.C. Children's Counting and Concepts of Number. — New York: Springer, 1988. — DOI: 10.1007/978-1-4612-3754-9.
7. Facione P.A. Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction. Research Findings and Recommendations (The Delphi Report). — Newark, DE: American Philosophical Association, 1990. — (ERIC ED315423).
8. Ennis R.H. The Nature of Critical Thinking: An Outline of Critical Thinking Dispositions and Abilities. — Urbana, IL: University of Illinois, 2011.
9. Paul R., Elder L. The Miniature Guide to Critical Thinking Concepts and Tools. — London: Bloomsbury Publishing Plc, 2019. — 48 p. — ISBN 978-1-53813-494-8.
10. Clements D.H., Sarama J. Learning and Teaching Early Math: The Learning Trajectories Approach. — New York: Routledge, 2009. — DOI: 10.4324/9780203883389.
11. Pólya G. How to Solve It: A New Aspect of Mathematical Method. — Princeton, NJ: Princeton University Press, 1945.