Action research improves math instruction

Subtraction error patterns
Beckett teaches third grade. Although her mathematics instruction focuses on the connectedness of addition and subtraction and she uses contextual problems with models and manipulatives, her students continued to struggle with two- and three-digit subtraction involving regrouping. After reteaching the concept numerous times, using a variety of strategies, she realized that her students were still failing to grasp the idea and were also beginning to exhibit signs of anxiety when tackling this type of problem. Typical student misunderstandings included inversion errors—what Beckett calls *upside-down subtraction*—as well as basic-fact errors, adding instead of subtracting, and errors with regrouping a ten (see fig. 1).

By conducting a literature review, Beckett learned about using error patterns to assist with mathematical understanding. Error patterns are misconceptions and erroneous understandings that students make when learning new mathematical concepts. Students may incorrectly apply the procedures for one mathematical concept to another. For example, when multiplying fractions, students might approach the problem by finding a common denominator because that was the process for adding fractions with unlike denominators (van de Walle, Karp, and Bay-Williams 2010).

Beckett found numerous articles on error patterns but little existing research that focused on the use of error patterns as a means of instruction. For the purpose of her action research project, she wanted to investigate whether this approach might help her frustrated students develop a rich comprehension of subtraction with regrouping.

The action research process began with some background readings about common error patterns in subtraction, and Beckett began formulating ideas about how error patterns could be used when working with third graders. Initially, she administered a twenty-problem
Among the common errors for third graders learning subtraction are basic fact errors, errors with regrouping a ten, inversion, and adding instead of subtracting.

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research project allowed her to collect data to determine its effectiveness. McIntosh had recently read about an instructional approach in which students would invent strategies and look for patterns when learning different multiplication facts. For example, students could use the double-your-twos strategy for learning the fours facts. Specifically, when students encountered a problem such as $4 \times 2$, they would think $2 \times 2 (= 4)$, then double the product (8). As a class, McIntosh's students invented different strategies for learning the basic multiplication facts (see fig. 2). McIntosh was trying to develop within her students a conceptual understanding of the multiplication facts apart from relying solely on instant recall.

McIntosh administered a pretest involving 100 problems, which she required students in her two classes to complete in three minutes. The assessment results were evaluated according to the number of problems attempted and the number of facts solved correctly. Pretest scores for the first class showed an average of 49 problems attempted (range: 12–84 problems) and an average of 96 percent correct (range: 86–100 percent). The second class averaged 34 problems attempted (range: 14–95), with an average of 80 percent correct (range: 14–100 percent).

Classes then spent the next four weeks learning the facts by looking for patterns and connections among them. Students used index cards to make multiplication flashcards. At the top of each card, they included the individual strategy that would help them determine the product. Students were required to practice daily with the flashcards: with their peers for ten minutes and for at least ten minutes at home. Their home practice had to be confirmed by a parent; the teacher required daily written validation.

After four weeks of study, McIntosh administered the posttest. Results showed significant gains. The first class attempted an average of 23 additional problems, jumping from an average of 49 to 72 attempted (range: 36–100), while also improving the average percentage correct from 96 percent to 99.7 percent (range: 98–100 percent). The second class attempted an average of 29 additional problems, jumping from an average of 34 to 63 attempted (range: 26–100), while improving the average percentage correct from 80 percent to 95 percent (range: 81–100 percent). An added bonus was that the students really enjoyed practicing their facts in this way.

Because these results were so promising, McIntosh plans to continue using the flashcard production and practice as an instructional strategy for cementing conceptual understanding and recall of multiplication facts. She also decided to have her students use the strategy to help them understand and recall their science vocabulary. Students illustrated, defined, and noted special strategies for each vocabulary term and were held responsible for practicing with them in class and at home. McIntosh even came up with writing assignments, sorts, and other activities that use both sets of flashcards.

**Physical activity and math learning**

Byrd's class of second graders is quite active, and their attention span is best described as short. To address such needs, Byrd's mathematics instruction had to be student centered and hands on. With this in mind, Byrd based her research on the use of physical activity games in the math classroom. Would such games help students...
learn basic mathematical skills that they need to progress to third grade? Computer games that focus on specific skills are now the norm, but what about those good, “old-fashioned,” energetic games involving physical movement?

The second-grade Standards of Learning, Virginia’s expectations for student learning and achievement, require students to round one- and two-digit numbers to the nearest ten. Byrd planned her research around this objective and the use of physical mathematics activities. The primary research question for the investigation was whether mathematics instruction involving physical activity games increases student achievement in rounding to the nearest ten.

Byrd organized her research using a pretest-posttest design. She created an assessment instrument similar to the Standards of Learning test. Byrd first administered the pretest and then proceeded to teach students—through physical activity games—the skill of rounding. These games included Rounding jump (students jump on a floor-sized number line to the multiple of ten to which the given number rounds); Beanbag-toss rounding (students throw a beanbag onto a floor-sized number line, run to pick up the bean bag, and continue to the multiple of ten to which the number rounds); and Flyswatter rounding (students “swat” the multiple of ten using different forms of locomotion, such as skipping and hopping).

Byrd’s students played the games for three 50-minute sessions, then Byrd administered the posttest. Analysis of the collected data indicated a mean score of 16.9 percent on the pretest and 89.2 percent on the posttest, a mean difference of 72.3 percent. Clearly, these physical games motivated students to actively participate in the learning process, addressed their different learning profiles and readiness levels, and assisted them in mastering the concept of rounding.

The literature review that Byrd had endeavored to complete before conducting her action research was a task she had looked forward to but was ultimately the most challenging of the three topics. Unlike her colleagues’ topics, limited research was available that concentrated on physical activity involving body movement as a means to learn math. Byrd proceeded to review the literature focusing on games and different content areas, as well as the influence of games on student learning in general.

Thoughts on action research
Reflecting on the entire research process, these teachers realized that action research is a beneficial process for improving instruction and can be tailored to specific student needs. The process allowed all three instructors to target particular issues in their classrooms and investigate and improve their own instruction while involving their students. It also allowed Beckett, McIntosh, and Byrd to stay current with the vast research resources related to their areas of instruction. Accessing this research can spur teachers to try new ideas and can discourage them from using methods that have been found ineffectual. The authors encourage all their colleagues to take part in some sort of action research endeavor, perhaps by taking a class at a local university or college or by participating in a professional development opportunity offered through the school system. In this way, action research may become a larger part of every teacher’s constant pursuit of new, improved, effective ways of reaching students.

Action research addresses specific student needs, targets classroom issues, keeps teachers current, and discourages ineffectual methods.

REFERENCE

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