NC COLLABORATIVE FOR MATHEMATICS LEARNING

NC$^2$ML Research-Practice Brief #68

# The Limitations of Keyword Strategies

## WHAT IS A KEYWORD STRATEGY AND WHAT ARE ITS LIMITATIONS

"More means add. How many more means we subtract." Students who are taught a keyword strategy to solve word problems cling to isolated words in story problems, interpreting the word instead of the problem's context. A keyword strategy is a method taught to students to dissect a word problem, locating single words that signal an operation. For example, students may be taught that "total, more, in all" are for addition and mean that you should add numbers. Or they may be taught that "how many fewer, less, difference" always signal subtraction. The fault in this system is that students are trained to automatically jump to an operation or procedure without first making sense of what is being asked of them.

Take for example this problem (Clement & Bernhard, 2005): *Susan collected 6 rocks, which was 4 more than Jan collected. How many rocks did Jan collect?* If students are using a keyword strategy, they may incorrectly assume that "more" means add and then take the numbers out of context to mis-perform an operation. 6 + 4 would give an answer of 10, but Jan actually collects 2 rocks. Utilizing the keyword strategy or another procedural set of steps does not equip students with the understanding of how to begin solving problems, persevere when faced with problems, or assess the problem-solving process and outcomes for reasonableness.

**Figure 1. How would using a key word strategy in these problems mislead students?**

- Charlie had some rocks in his collection. He found four more rocks. Now his collection has 12 rocks. How many rocks did Charlie start with?
- Each classroom at a school has 24 children. The school have 12 classrooms. How many children are at the school altogether?
- Jyzear divided up his pieces of candy evenly with two friends. Each of the three boys got 15 pieces of candy. How many pieces did Jyzear start with?
- Maria baked 3 dozen cookies. She ate four and gave the rest for the bake sale. What was the total number of cookies Maria gave to the bake sale?

In addition to key words being misleading, some problems do not have key words, leaving a student taught to rely on key words with no strategy. Further, when students have used key words to solve simpler problems, they can become confused when asked to solve more complex, multi-step problems (Van de Walle & Lovin, 2006). Instead, students need to understand that mathematics is about reasoning and making sense of situations.

George Polya first presented the problem-solving process in his 1945 publication, *How to Solve It* (See Figure 2). In this process, students are taught to first take time to understand the problem before moving to devising a plan, followed by carrying out the plan, and then looking back to check and interpret. While it provides a nice structure to think about problem solving as a process, it can often be taken as a linear procedure. "Good problem solvers spend a bulk of time on Step 1 of Polya's method (understanding the problem and all the relevant relationships) while novices rush to try a plan without really thinking through the plan's effectiveness" (Chapin, O'Connor, & Anderson, 2009, p. 97).

## VERTICAL VIEW OF REASONING & PROBLEM SOLVING

Our NC mathematics standards require students to be sensemaking problem solvers instead of executors of rote steps and procedures. Practice 1 of the Standards for Mathematical Practice states that mathematically proficient students *make sense of problems and persevere in solving them.* Table 1 highlights the progression within the NC Standard Course of Study that shows what students should be able to do if they are making sense of problems.

**Figure 2. Polya's Problem-solving Process**

- Understand the problem
- Devise a plan
- Carry out the plan
- Look back to check and interpret

**Table 1. NC Standard Course of Study Practice 1: Vertical Progression**

**Kindergartners** begin to develop effective dispositions toward problem solving, make sense of problems, and assess their own thinking for reasonableness.
**1st graders** should make sense of task-type problems, find an entry point or a way to begin the task, and are willing to try other approaches when solving the task.
**2nd graders** examine problems and tasks, can make sense of the meaning of the task and find an entry point or a way to start the task.
**3rd and 4th graders** explain to themselves the meaning of a problem and look for ways to solve it. They may use concrete objects or pictures to help them conceptualize and solve problems.
**5th graders** seek the meaning of a problem and look for efficient ways to represent and solve it. They are able to ask themselves metacognitive questions to reason through various strategies.

## SENSEMAKING STRATEGIES

In order to help students become proficient in reasoning and problem solving, teachers must utilize strategies and create experiences that help students to learn how to decontextualize problems. Several instructional tools and styles can be used to support sensemaking strategies including Cognitively Guided Instruction (CGI; Carpenter, Fennema, Franke, Levi, & Empson, 2014), children's literature as a problem context, noticing and wondering, and 3-Act Tasks. To learn about these strategies, read the NC²ML brief **The Power of Sense Making Strategies.**


References

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Van de Walle, J. & Lovin, L. (2006). *Foundations of student centered instruction: Teaching Student centered mathematics grades 3 - 5* (1st Ed). Upper Saddle River, NJ: Pearson.


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