Getting Students to Do the Sense-Making: Teaching without Telling

Planning a lesson with a procedural goal, like getting the kids to see how to add fractions with like denominators or to understand the laws of exponets? The following process can assist with a lesson so the students figure out the procedure and then construct an argument for the reason it works that way.

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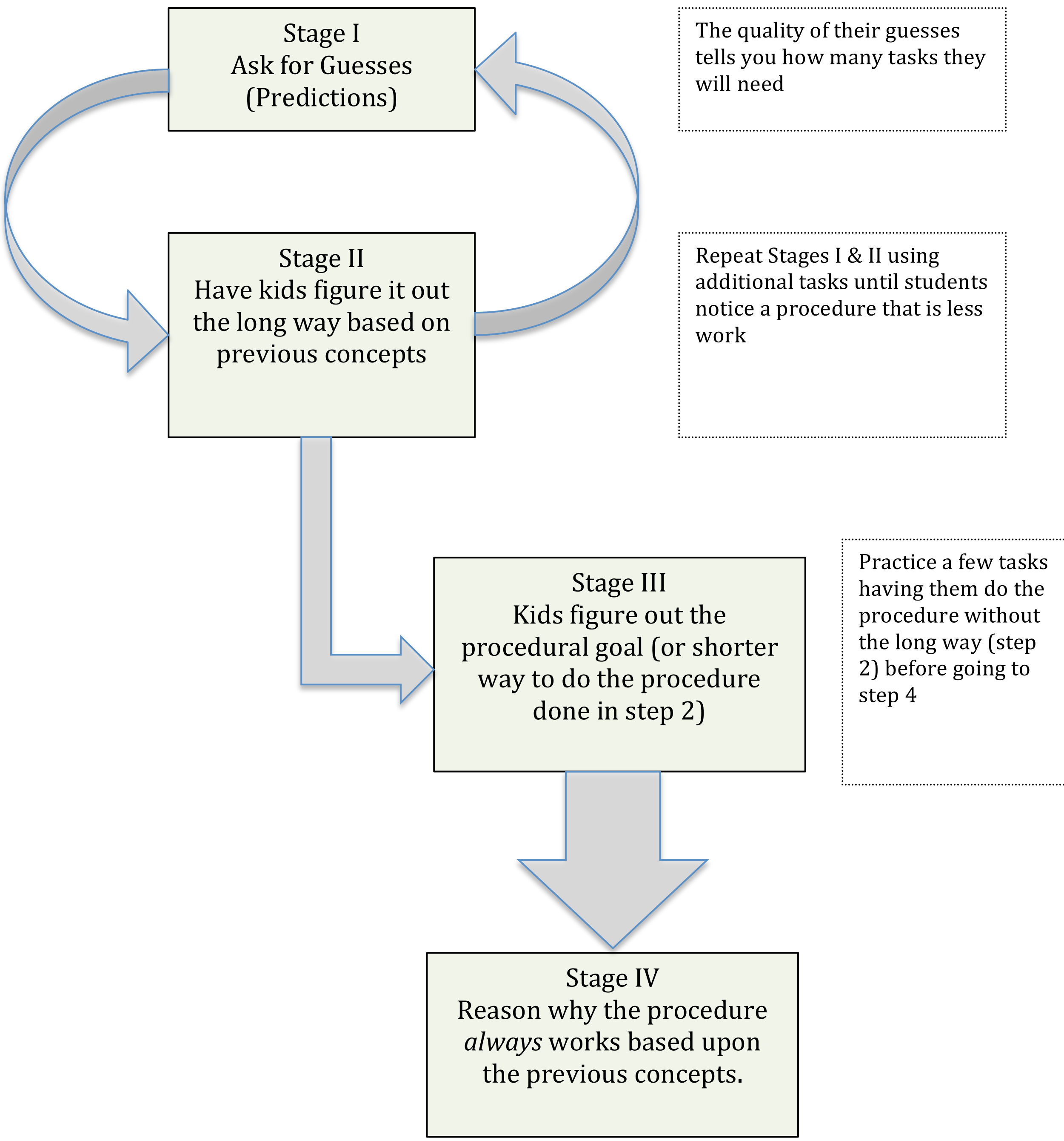
4 Stages of a Teaching Cycle t_ G___ t___ K____ T__ F_______ I__ O___



California Mathematics Project at Sacramento State
http://www.sacramentomathproject.org

When planning a lesson using a cycle TGTKTFIO please consider:

1. What is the procedural goal, the thing you want the kids to notice?
2. Figure out how the kids can do the task using previous concepts
3. Choose few tasks (3-5ish) for students to do while they are trying to figure out the shorter procedural goal.
    a. Identify some examples *not* to use (like $3^2 \cdot 3^2 = 3^4$ because there are two ways to get the exponent of 4, which could lead to some confusion.)
    b. Have some examples for students the time when part of the class sees the shorter procedural goal, and part doesn't.
    c. Prepare a task that is *backwards* from the original, to use when some of the class sees the procedure and some don't (i.e. giving the students a final answer for an exponent problem like 4^{10}, and asking them to come up with quantities involving exponents that could be multiplied to come up with that.)
4. Once students figure out the procedural goal, ask a question (or 2) so they know they've got it—so *they* recognize they figured something out. It is useful to control the size of the numbers at this stage. For example, perhaps you ask them to figure out how to express the following product using an exponent: $3^{40} \cdot 3^{60}$.
5. Once students figure out the procedural goal, they may ask themselves why that is (because the math might be surprising) which would be ideal. Determine a task and/or prompting questions that allows them access to figuring out why it works for themselves, and for making an argument for why that works. Tie this back to the previous concepts used in Stage 2 of the cycle.
6. What questions can you have in your back-pocket to
    a. help shine a light (spotlight or wide beam) to guide kids to notice the shortcut
    b. or to support them in seeing and discovering how stage 2's conceptual way explains why this works all the time?
7. Would the use of a **deliberate misteak** be a good way to have students reason about why this works, and focus them on the critical parts of the reasoning?

Things to think about as you teach:

1. To begin, ask the larger question, or ask for a guess (prediction).
2. Watch what the students are guessing to know how many examples you will need to do before they are able to figure out the shorter procedure.
3. When you get done with the long way, ask, "I wonder if there is a way to figure this out without doing all this work?"
4. Sometimes, you can control the size of the numbers in your example to provide them some motivation to find a shorter procedure, or to get them to reason why the shorter procedure will work all the time.

Possible tasks to consider as you begin thinking about using this cycle:

Primary:

- ☐ Get the kids to figure out how to determine how many lengths of 10 on the number line it would take to get out to 37 on the number line.
- ☐ Get kids to figure out that in order to add 9, you could add 10 and then subtract 1.

Intermediate:

- ☐ Get the kids to figure out that in order to add 123 + 42 they need to line up the ones, tens, hundreds.
- ☐ Get kids to figure out the shortcut for multiplying a single digit number by a power of 10 like 100 or 10,000 or…. [Or dividing by those numbers.]
- ☐ Get kids to figure out a way to do problems like $20 \times \frac{1}{5}$ is to just divide the 5 into the 20.
- ☐ Get the kids to figure out how to add decimals without telling them they need to line up the decimal points.

Middle:

- ☐ Get the kids to figure out the role of m and b on the graph in the equation: $y = mx + b$
- ☐ Get the kids to figure out that equivalent ratios, when graphed will form a line through the origin and why that must be the case
- ☐ Get the kids to figure out that any base (except 0) raised to the power of 0 power must be 1.

Potential lessons with a procedural goal to which I could apply this Teaching Cycle:

Notes:

Support for the use of Teaching Cycle:

"The old transmission teaching model (which succeeded for some and left many more behind) is not adequate for a knowledge-based society that increases the cognitive requirements of most employment and of life in general."

--Linda Darling Hammond

Darling-Hammond, L. (2012). *Powerful Teacher Education: Lessons from Exemplary Programs*. Jossey-Bass.