C-R-A ASSESSMENT

What is it?

Students’ mathematical understanding occurs at three different levels of mathematical understanding, - concrete, representational, and abstract. It is assumed that through CRA Assessment, evaluation of student mathematical understanding should also consider these three levels of understanding. Many math educators agree (Kennedy & Tips, 1994; Mercer & Mercer, 1998; Van de Walle, 1994). However, despite the logic of such an approach, most assessment in mathematics occurs solely at the abstract level of understanding. This situation is especially true for standardized math assessment instruments.

The teacher who implements C-R-A Assessment provides students the opportunity to demonstrate their knowledge of a mathematical concept/skill at any of the three levels of mathematical understanding. If the assumption is that a student should be able to demonstrate an abstract level of understanding (e.g. using only numbers and math symbols; problem-solving "in their head"), then the teacher may initially assess the student at that level. However, when the student does not demonstrate proficiency at the abstract level, the teacher then provides students the opportunity to demonstrate their understanding using objects (concrete understanding) or through drawing and use of pictures (representational understanding). This process is used because the teacher may discover that the student does indeed have a concrete understanding, or even a representational understanding of a math concept/skill. The teacher can then provide specific instruction that will enable the student to move to an abstract level of understanding. While the C-R-A Assessment process described above assumes that assessment begins at the abstract level and moves "down", the process may also begin at the concrete level or representational level and move "up."

How do I do it?

The following steps provide a framework for implementing a C-R-A Assessment effectively:
1. Determine the specific concepts/skills to be assessed.

2. Write down on a piece of paper the major components of the concepts/skills to be assessed (Ask yourself, "What would I do and think to describe or perform the concept/skill?"). This will provide you a reference when evaluating a student’s performance, particularly if the concepts/skills are ones you have had little experience teaching.

3. Based on previous assessment information and other knowledge you have about the student’s abilities (prior teaching experience with the student), decide at what level of understanding you think the student should be performing – concrete, representational, or abstract. Also be prepared with appropriate items/tasks that allow the student to demonstrate their understanding at the other two levels of understanding. For example, if you decide to begin your assessment at the abstract level, then have prepared items/tasks that reflect concrete (objects, math manipulatives) and representational (pictures or opportunities to draw) understanding.

4. Prepare assessment items that accurately reflect the math concept/skill to be assessed. For example, if you are assessing multiplication of fractions, then including items that require division of fractions is not appropriate.

5. Provide a sufficient number of items or tasks so that you can determine a pattern of performance. Too few items (e.g one or two items) may provide inaccurate information because both successful and unsuccessful student performances may be random (e.g. careless mistakes). With this said, time and potential student fatigue precludes the inclusion of a large number of items. A good rule is to include at least three to five items/tasks for each concept/skill to be assessed.

6. Explain to the student the purpose of the assessment and the process you will use. It is important to create as comfortable and non-threatening atmosphere as possible. For example, tell the student, "I’m interested in understanding how you solve math problems. I might ask you to solve them using objects, like these unifix cubes, or I might ask you to draw pictures that show me what you know. I also may ask you to try solving problems in your head or with paper and pencil. Today we’re going to see how you solve _________________. Do you have any questions?"
7. Based on the student’s performance, decide whether a change in level of understanding is needed. For example, if the student is having difficulty solving items at the abstract level, have them solve them by drawing pictures or by using concrete objects. Conversely, if it is obvious to you that the student understands the concept or skill at the concrete or representational level, move to the abstract level (using only numbers & math symbols). There are no hard and fast rules for what percentage of items the student must answer accurately in order to demonstrate mastery. Your teaching experience and the specific things you observe while the student performs are your best guides. However, a helpful rule of thumb might be that the student should demonstrate proficiency on at least two of three items, three of four items, or four of five items, depending on the number of items included for each concept/skill.

8. When you have determined at what level of understanding the student understands the concept or skill, then begin instruction at that level of understanding (with the intent of moving to the next level in the sequence of concrete-to-representational-to-abstract). If the student does not demonstrate understanding of the concept/skill at any of the three levels of understanding, then determine whether they have the prerequisite skills to understand the pertinent concept/skill. If not, teach those prerequisite skills.

Why is this approach helpful to students who have learning problems?

*C-R-A Assessment* is helpful to students who have learning problems and those teachers who teach them because the information attained through this assessment pinpoints the level of mathematical understanding at which the student can perform the particular math skill. Students who have learning problems too often are assessed only at the abstract level of mathematical understanding. This situation can lead to misinformation about the student’s true mathematical understanding. When students do not perform successfully at the abstract level, then it is often assumed that they do not understand the particular mathematical concept being assessed. While the student may not be able to perform the skill at the abstract level, they may indeed understand the underlying concept and/or procedures for a particular problem-solving situation at the concrete or representational level of understanding. The teacher underestimates the student’s knowledge base in
this situation, leading to student frustration and affirmation of the student’s negative academic self-concept. Instead of spending additional instructional time re-teaching the math concept, the student may actually need specific direct teacher instruction and practice for performing the abstract computation (understanding the procedure for solving the problem).

On the other hand, "apparent" student demonstration of understanding at the abstract level may also misinform the teacher. Due to the cognitive processing difficulties of some students who have learning problems, they may have never really understood the math concept that underlies the particular math operation/algorithm. In this case, the teacher may assume the student has truly mastered the math concept/skill and move ahead with instruction. This creates the situation where the student’s lack of conceptual understanding will prove an insurmountable obstacle for future math success. If the teacher suspects that the student may have "procedural proficiency" but possibly lacks true understanding of the math concept, then assessing the student at the concrete level of understanding is warranted.

Take for example, the student who is able to memorize and correctly write his multiplication facts. We might logically assume that he understands the multiplication process. However, when we ask that student to demonstrate multiplication using unifix cubes or counting blocks, the student may not be able to do it. He may never have learned what multiplication really means. Without this conceptual understanding, the student will encounter much difficulty as they move through the math curriculum. Because the multiplication process is an important component to many future math skills (e.g. multiplication of fractions), the student will be at great disadvantage and at risk for future math failure.

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