A Conversation with John Van de Walle, author of Elementary and Middle School Mathematics: Teaching Developmentally (Sixth Edition)(2006)

Since John Van de Walle will be our Keynote Speaker for the CCTM Fall Conference – 2006, I thought that our membership and readers would value the opportunity to become more familiar with his extensive body of knowledge. John very graciously agreed to a conversational interview, which will be offered in this article.

Catherine: *"After working with you at NCTM over the past three years and using your very popular mathematics text for elementary and middle school teachers in my mathematics methods classes, I believe that the Colorado mathematics community could derive great benefit from hearing your thoughts on mathematics teaching and learning."*

Catherine:

John, based on your extensive background in mathematics education, where do you see mathematics teaching and learning, K-8, in the United States today?

John:

My guess is that most mathematics leaders and perhaps 20% of teachers are committed to or are using a standards-based approach to teaching mathematics. That means that a large majority of teachers in K-8 schools are still using a show-and-tell approach similar to what they themselves experienced as students and what has been the norm in the U.S. for decades. Since the publication of the 2000 NCTM *Standards* document (and actually much before) the position of most mathematics educators is that the best way to teach mathematics is to "allow the subject to be problematic" for students. This is a difficult concept for teachers as it is generally not a familiar topic for them. Most teachers seem to be reluctant to allow students to struggle, even though the research evidence suggests, however, that this is the best approach we know for helping students develop real understanding of mathematics.

Catherine:

Describe the biggest benefits that you believe beginning teachers derive from using your suggested "before, during, and after" approach to mathematics lesson planning.

John:

I've gotten way too much mileage out of that three-part lesson model. I only wanted something that was simple and easy to understand with no jargon. For example, the Connected Mathematics approach of *launch, explore, summarize* is equally good if not essentially the same thing.

What is important in this model is the middle phase (during, *explore*) in which students are working on a problem or task without having been directed by the teacher in how to solve the problem. Here is where the teacher must "let go" and really allow the students to make mistakes and develop their own ideas.

In my opinion, good lessons must have this time for students to develop ideas while attempting to solve a problem – the during phase. However, if this is not followed by a rich discussion this approach will almost certainly fail. Too many teachers fail to reserve time for discussion. There is also a skill in developing a classroom atmosphere where students talk to each other, evaluate other responses, and truly discuss ideas. The development of a mathematical community of learners is the key to allowing students to struggle with mathematical ideas.

Catherine:

Why do you propose this method and what are the key aspects that seem to make a difference to deeper mathematics learning?

John:

As Jim Hiebert puts it in the NCTM books *Teaching Mathematics Through Problem Solving*, "problem solving leads to understanding" and understanding should be the ultimate goal every day. Contrast a show-and-tell approach with a problem-based approach. With the former, the teacher is dependent on students paying attention to her wonderful explanation or the one in the book. Even if the student is paying attention, almost certainly the focus is on the directions or rules that the teacher is giving and not on the core mathematical concepts involved. Even the good students know that there is a page of exercises to be done as soon as the explaining is over.

With a problem-based approach the student has nowhere else to turn other than his or her own ideas relate to the problem. As a result, rather than looking for rules, students attempt to make sense of the relevant ideas imbedded in the problem or task. Even if the problem is not solved, their own relevant ideas have been engaged. The class discussion that follows will be meaningful and interesting. Ideas are developed and integrated with each learner's existing understanding.

For me it is also extremely important to consider what each approach is saying every day to students. With teacher-directed, wonderful explanations students often view mathematics as a collection of rules that often become confused and have little meaning. Imagine sitting every day in a classroom and trying to acquire a set of rules that really make little sense to you. How boring! In the problem-based classroom students daily experience the most basic fact of mathematics: math makes sense. Further, they come to realize that they are the ones who are capable of making sense of mathematics. Learning mathematics is fun!

Catherine:

For several years, a major concern has been guiding girls to be more involved in mathematics and now, national media attention is moving toward boys and learning. How do you think that this might translate in the study of mathematics?

John:

This really is not my area. I do not think we are as concerned as we once were that girls were being ignored in math class. Nor are girls told as they once were that mathematics, science, and engineering are male domains. In fact, girls are beginning to outperform boys in the upper grades.

At the K-8 level I think we should simply be encouraging all students to solve problems and make sense of mathematics.

Catherine:

John, please talk about the role of language in learning mathematics; that is, why should teachers be concerned about teaching mathematics vocabulary in their lessons? What are the implications?

John:

Language, both written and spoken, is the way that we, as humans, express our own thoughts and experience the thoughts of others. In a problem-based classroom the important language is not that of the textbook but that which reflects students' ideas. By expressing their thoughts students communicate with one another authentically, without being concerned about the right word or the correct way to write the symbolism. This reflective discussion about ideas is where learning occurs.

Do not take this to mean that vocabulary is not important. As with any discipline, mathematics has its own vocabulary and labels for important ideas and conventions. It is important that students acquire this vocabulary so that they can communicate effectively and can read mathematics as they progress through school. But, most importantly, teachers need to allow the ideas to develop first. Only when an idea is clearly developed is it time to apply conventional labels and use mathematical terms and symbols. Students in the fourth grade can slice a 38 by 24 rectangle into two or more parts so as to easily determine how many squares are inside. Only after this approach is well established and makes sense is it reasonable to label the process an application of the distributive property.

Catherine:

In your opinion, what might the impact of written language be in the mathematics classroom?

John:

I've come to believe that students should write in mathematics classes every day, even in kindergarten and certainly in the upper grades. Writing should be an integral part of solving the problem – words, pictures, and numbers that show how the problem is solved and why the solution makes sense. There are three good reasons for requiring writing as part of solving daily problems. First, writing requires reflective thinking about the ideas involved and thus it enhances learning. Students refine and clarify their ideas and often correct their own errors. Second, writing provides the teacher with a record of student thinking since it is impossible to listen to every student every day. This written record of what is going on in each student's mind is a key to helping students who need assistance and challenging those who are capable. It is the information teachers need to reflect on today's lesson and correctly plan the task for tomorrow. Written work that is occasionally kept can be used to talk with parents and even create grades. Finally, writing is a rehearsal for the discussion phase of the lesson. When all students have been writing about their solutions there is no reason to ask for volunteers to share, a practice that always results in the same three students giving the answers that tend to shut down further discussion. When students have written, any student can be called upon to share what they have been thinking about or how they solved the problem. The written work serves as a script of sorts so that they are not fumbling for words or ideas.

Catherine:

John, with your vast experience with problem solving, talk about what you perceive to be the best ways to present problems to student.

John:

I don't know that there is any "best" way to present problems. My usual lesson goal is to get to the problem as soon as possible and not waste time with homework or preliminary activities. Sometimes it is useful to get students prepared for a problem by engaging in some whole-class discussion of a simpler but related task. But that needs to happen quickly so that time is not taken from the real task of the day.

I have found that a written version of the problem is useful. In the first grade I am working with now we often print a simple story problem on a narrow strip of paper. The kids use their glue stick to paste the problem to a half sheet of newsprint. Problems can also be printed on full sheets with space to work and write provided. Problems can be written on the board or overhead. Whatever the mode, simply be certain the problem is understood and then let go – let students work on the problem. Become an observer.

Catherine:

John, please describe how you would encourage teachers to introduce and use manipulatives/tools/models in the classroom.

John:

Although the term "manipulatives" is currently the word of choice for tangible materials, I prefer the term "models" to manipulatives. Rather than talk about when they are most valuable, I think the more appropriate issue is to understand what they can and cannot do to help children learn. First, we need to understand that kids' learning is a product of reflective thought, not working with their hands. That means that we cannot judge the value of an activity by the presence or absence of a physical model. I think there are lots of excellent activities that are best done without a model. For example, comparing two fractions to decide which is larger: if done with a model, all that is done is to make each fraction and look at them. No thinking occurs about the numbers involved, relationships to 1/2 or 1, the relative size of fractional parts, etc. That is because the model removes the need for such thinking.

Models for various numbers (small whole numbers, multi-digit numbers and decimals, fractions and percents, integers) should be introduced to students early on in the development of these number systems. Models are simply pedagogical conventions that have been invented to represent numbers. They make sense to us because we already understand the ideas that the model represents. For someone beginning to learn about these numbers, their emerging concepts can be tested against these models in the same way a student might ask a teacher if he or she has found the correct answer. If the model fits with the student's ideas, then there is reason to proceed.

For most activities, once models have been introduced and are familiar to students, they should simply be available for student use as the student desires. Of course there are activities where models should be "off limits" as in the fraction comparison example. There also are times when the teacher might require students to use a particular model because it fits best with the activity.

The greatest danger with models, and I believe it is significant, is to directly guide students in the use of a model for getting a computational result. Base-ten blocks for addition and subtraction are one example where we overly direct students so that there is more student attention placed on how to use the blocks than on developing a useful computational procedure. Another example might be showing students how to use two-color counters to model integer computation. In both cases, once it is understood how these models represent the numbers involved, students should work at developing their own procedures so that the thinking is on the procedures involved, not on the models.

Catherine:

What about virtual or electronic manipulatives? How and when should teachers use these tools?

John:

Tool software is finally getting quite good. By this, I mean software that provides students with a model that can be manipulated or changed easily on the screen but provides no questions for students and does not evaluate responses. This is in contrast to computer assisted instruction or drill software. Good virtual manipulatives exist for simple counters, base-ten blocks, and assorted fraction models. In the area of geometry, the computer excels with variations on pattern blocks, tangrams, and most significantly dynamic geometry drawing programs such as *The Geometer's Sketchpad*. Probability, statistics, and graphing tools have been around for some time and new programs provide students with ever more power to explore mathematics.

To date these computer tools are much more valuable at the middle and high school levels. However there are real advantages to tool software at the elementary level as well. For example, virtual base-ten blocks are available free if the computer is on line. A student can model four place values with essentially endless quantities of blocks. Exchanges can be made electronically (a ten can be "broken" into 10 singles and 10 tens can be "glued" to make a hundred.) Odometers that show the value of the representation can be turned on and off. Students can print out pictures of their work to show what they have done. These attributes do not exist with physical blocks. And, that is the criteria that should be applied: does the virtual version offer something that cannot be gained in the physical world. With programs such as *Sketchpad*, *TinkerPlots*, or *Fathom*, the advantages are staggering and make it almost unthinkable to not use them. While there are advantages at the K-4 level, they are not at this point in time nearly as profound.

The other problem at the K to 8 level is the availability of the computer for every student. At minimum I would like to see classrooms at all levels have a computer connected permanently to a projector or monitor for class discussion purposes. Since much of the nice software is free on the Web in the form of applets, these computers should also have web access. I would prefer this form single classroom computer to a school lab where students focus is not so much on making sense of mathematical ideas but on "doing computers." I think a computer for every student is not that far away (10 years?) but then that is just my guess.

Catherine:

What about calculators – when should they be used and when are they over-used?

John:

My books have always said, "A calculator should be in or on the desk of every student, every day, from kindergarten through high school." I think of a calculator first as a model for numbers. Imagine skip-counting 100 by steps of 0.1 and then by steps of 0.01. The relative value of these decimal fractions is inescapable.

Of course the calculator can and should be used as a computational tool, primarily to allow for realistic computations that no sane person outside of school would do without a calculator. Students should never be asked to do by hand computations that are more tedious than typical adults would attempt without a calculator.

Of course calculators can be misused. But this is the same issue as manipulatives. The teacher is in control and can decide when students may and may not use them. Why is this so difficult?

It has been said that computational facility should not be an indicator or mathematical thought or sophistication. That means that we should allow all capable children to use calculators to access mathematical ideas without being held back due to weak computational skills.

What I've said mainly applies to four-function and fraction calculators. The value of the graphing calculators is, like computer software, so compelling that it seems to me ethically wrong to not begin using them at least by 8th grade and I believe much earlier than that.

Catherine:

How should teachers be assessing student knowledge to gain a true picture of deep learning? Best tools? Best formats?

John:

In the early 1990s there was much talk about performance assessment. This was good for education and for mathematics education in particular. However, what I find to be amazing is that teachers continue to make some distinction between a performance assessment and an instructional problem or task that requires students to think, struggle, and to develop ideas. Of course there is a place for summative assessment. However, when teachers teach through problem solving there is an almost continuous stream of information coming from students that tell us what it is they understand and how they understand it. I see no distinction between assessment tasks and tasks designed for learning. When students are required to make sense of a problem, show their thinking, and defend the validity of their results, no test that I know of can give the teacher a better picture of what the student knows.

The 1989 standards document from NCTM said that we should shift away from assessments that can only tell us what students do NOT know and toward assessments that tell us what they DO know. A test that looks only at answers, no matter if in open-response format or multiple choice, can only tell us what students do not know. Problem-based, student-centered teaching is a daily form of performance assessment. Use it!

Catherine:

How might administrators and teacher leaders or mathematics coaches be involved in guiding teachers in high-quality math teaching?

John:

We are still looking for the silver bullet that will solve all of our professional development problems. As a result we search for PD materials, exemplary videos, and expert presenters, and the effects are negligible at best.

As a profession we need to understand that learning about teaching must be ongoing and life long. Second, we must understand that teachers must think deeply and analytically about teaching and reflect on what they are doing in some form of structured mode that is built into their weekly schedules. Leaders and coaches have the task of orchestrating this reflective activity in partnership with other teachers. The common goal of everyone must be student learning.

To this end some form of joint planning involving two or more teachers and a leader or coach if possible should take place regularly. Mutually planned lessons should be taught and then looked at by all involved – via video or live observation or both. Analysis should be on the lesson and not on the teacher.

Ongoing reflection of this sort can take many forms. Lesson study is the complex end of the spectrum with one-to-one coaching at the other. Grade-level meetings can be arranged for teachers to work on a lesson even without a coach. What is most difficult is for a teacher to be self-reflective without anyone to use as a sounding board or a different view of what just went on in the classroom.

Orchestrated reflective activity about planning and teaching is about learning how to learn about teaching. It is not about creating super lessons for the file.

Catherine:

John, what do you see as the key intervention techniques when working with students having trouble grasping mathematics concepts and ideas?

John:

I think the answer to this varies considerably from grade to grade and also with the topics involved. If there is one constant across all situations it is that the first thing that must be done is to find out what the child does know about the topic under question. This might be done by observation or by a short interview or simply by periodically stopping to ask, "Tell me what you are thinking about this problem." All intervention must begin where the child is or it will be superficial, threatening, and possibly demeaning.

Put yourself in place of a struggling student who hears, "It's easy! Let me show you." Since for the student it is NOT easy, the first sentence may as well have been, "You are stupid." And then the second sentence demeans the child by indicating that they are not capable on their own of making sense of mathematics. These two phrases and their equivalents should be stricken from our teaching vernacular.

So, while I don't have a definitive or specific answer to your difficult question, all methods should begin by finding out where the student is and building on his or her ideas, not on ours.

Catherine:

With the 2000 revision in the standards from NCTM, what do you believe has been the biggest impact?

John:

Unfortunately, my personal perspective is that there has not been any significant impact of the 2000 standards. It is important that it was published since it has kept the revolution begun in 1989 alive. It helped the Council clarify its positions on basic skills that was misunderstood in the original document. It provided curriculum developers and school leaders with a better understanding of a possible K to 12 curriculum by organizing all content into five strands across the grades. These are all important effects. I believe that we are ever so slowly moving in the direction of a problem-based approach to teaching but it is difficult to see yearly progress and it is nearly impossible to point to the 2000

Standards as a cause – only a necessary shot in the arm 11 years after the revolution began.

Catherine:

John, if you could suggest one key element for teachers of mathematics to concentrate on, what would it be and why would you suggest it?

John:

I believe that any teacher who develops a clear understanding that true student growth will come from confronting difficulty rather than providing students with solutions will make significant progress. This is the leap that must be made to move from “wonderful explanations” provided by the book and the teacher to student-centered, problem-based methods.

Catherine:

Will you guide our Colorado mathematics community by making a few recommendations for new teachers of mathematics?

John:

Believe in kids! Give them the opportunity to solve problems and make sense of mathematics. You do not need to tell them everything. Kids are amazing! Given the chance they will develop ideas that you could never have thought of – ideas much more interesting and just as valid as those found in your textbook. Students who are engaged in making sense of mathematics will be less engaged in disrupting your class. In short, <u>let the kids do the mathematics.</u>

Catherine:

Finally, John, where do you see the teaching and learning of mathematics going from here?

John:
Two things:
First, we must continue to support and encourage teachers to make the leap to problem-based, student-centered teaching. We are not yet close to making that the norm in our schools.
Second, we need to push our schools and districts to find ways to provide teachers with time that is not with students, either daily or weekly. Without this time, the necessary ongoing reflective thought about teaching that is so necessary for growth is less likely to happen.

There are so many good examples of real teachers teaching with problems and getting tremendous results that it is just hard for me to believe that this is not the best approach we have. It is hard – but it is fun and rewarding for both kids and teachers.

Let’s believe in our kids! Let’s give them the opportunity to think!

Footnote:
The author would like to extend sincere gratitude to Dr. Van de Walle for taking time out of his very busy schedule to complete this interview.