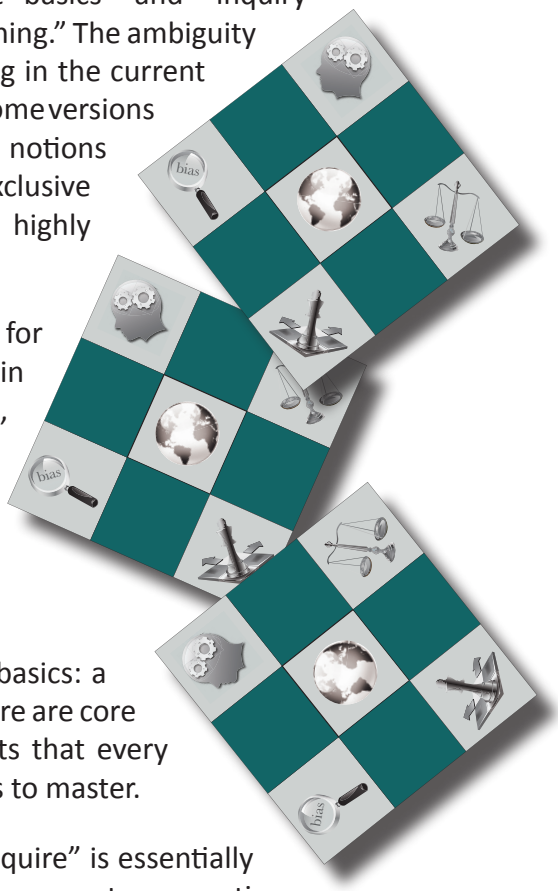
Reconciling learning the 'basics' and inquiry teaching

— Staff of The Critical Thinking Consortium

There is concern in some circles that scores on standardized mathematics and literacy tests are declining.[2] This fear has raised questions about the importance of teaching the basics and the impact of inquiry learning. Some critics attribute the perceived negative test results to the recent emphasis on "inquiry teaching."[3] Media reports frequently present a polarized debate between two camps: "back to basics" versus "inquiry or discovery learning."[4] The resulting impression that educators must chose between one or the other is the kind of exaggerated position that often propels the educational policy pendulum to oversimplify and overreact. In this article, we seek to explain how learning the basics and inquiry teaching can be reconciled, and to document the effects of doing so.

Clarifying options

In education we frequently get ourselves into difficulty by treating complicated concepts as though they are "black or white" labels.[5] Given the diversity of interpretations of most educational concepts, we should be careful to clarify the version we are considering. Otherwise we risk lumping together significantly varied options without appreciating that the results from some versions may be much different from others. This is true of the diverse approaches to "teaching the basics" and "inquiry teaching and learning." The ambiguity is especially telling in the current debate because some versions of these two notions are mutually exclusive while others are highly complementary.



Before looking for the diversity within these notions, let's agree on the defining features of each of these terms:

- Teaching the basics: a belief that there are core ideas and facts that every student needs to master.
- Inquiry: "to inquire" is essentially to pursue an answer to a question that is not already known by the individual. In other words, students' answers to an inquiry question will require some examination or investigation on their part.

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[1] Prepared by Roland Case, Garfield Gini-Newman, Laura Gini-Newman, Usha James and Sherry Taylor.

[2] According to the 2012 PISA results, mathematics scores are declining in several Canadian jurisdictions. However, results from the Pan Canadian Assessment Program for 2013 indicate that scores for grade 8 students in math and reading are on the rise across the country.

[3] Caroline Alphonso. Why discovery-based learning doesn't add up, Globe and Mail, September 20, 2013, L3. New math equals trouble, education expert says. CBC News, September 21, 2011.

[4] David Staples. The top nine reasons why Education Minister Jeff Johnson is in such hot water. Edmonton Journal, May 16, 2014. Available at: http://blogs.edmontonjournal.com/2014/05/16/the-top-nine-reasons-that-education-minister-jeff-johnson-is-in-such-hot-water/

[5] See Roland Case. 1994. Our crude handling of educational reforms: The case of curricular integration. Canadian Journal of Education, 19(1), 80-93; and Roland Case. 1992. Educational reform in British Columbia: Bold vision/flawed design. Journal of Curriculum Studies, 24(4), 381-387.

This is an expanded version of a previously published article, R. Case et al., The 'basics' and inquiry teaching: Can they be reconciled? *Education Canada*, 56(4), 40-43.

The Critical Thinking Consortium
www.tc2.ca

Two approaches to learning the basics

Although some versions of learning the basics and inquiry may conflict, there is nothing inherently contradictory about these two approaches. Let's consider a non-educational example to see how this may be the case.

Imagine two methods of practising the slap shot—one of the "basics" in hockey.

- ***Method one:*** Coaches show their players exactly how they should stand, hold their stick, shift their weight, swing back the stick and follow through. The players practise identical actions exactly as instructed hundreds, if not thousands, of times until they master "the" way to execute a slap shot. The coach's role throughout is to review the technique with players and adjust the technique whenever it deviates from the "correct" approach.

- ***Method two:*** Coaches introduce players to the principles of the slap shot and suggest various techniques. Players are expected to practise slap shots repeatedly. But instead of mimicking one prescribed way, they are asked to test out variations. What happens if they bring their stick farther back? What do they need to do to keep the puck on the ice or to lift it a few centimeters or even higher? What difference does it make to approach the shot from a standing position or on the move? The coach's role throughout is to suggest options and to exhort players to try different techniques when the current one isn't working.

We'll call the first method a rote practice approach to the basics. There is no inquiry—merely countless repetition or drill of the same gestures; whereas the second method—a critical inquiry approach to practice—involves mindful repeated testing of options. Repetition and instruction are evident in both approaches. But how these are used differ significantly. With the rote practice method, students repeat an action time-after-time exactly as before without necessarily understanding why each gesture must be done as directed. Instructions are offered as recipes to follow verbatim. This is how many of us may have learned the standard algorithms for most mathematical operations. A teacher we work with recently recounted that she was taught to divide fractions by memorizing the phrase "Tis not for me to question why, just invert and multiply."

With an inquiry approach, instruction is intended to provide a platform from which students can explore options and variations. The repetition is mindful in that students are imagining possibilities, observing the effects of each trial and making further critical adjustments as needed. If hockey players can improve their game by asking thoughtful questions as they experiment in practice, surely we can do the same in mathematics and other highly skill-based subjects. This is especially true when we are striving to empower students with the "basics" for a 21st century "arena" where conditions are changing and unpredictable, where creativity and innovation are key to success, and high levels of complex performance are needed.

One of our earliest documented experiences of the different results of these two approaches occurred while working with mathematics teachers in India. By grade six, students in one of the schools we were assisting had had two previous years of memorizing the formula for calculating profit and loss, and applying the formula as prescribed in countless problems. Despite repeated drill, many students were unsuccessful with the problems and most didn't really understand what they were doing as they applied the formula. With support from our team, teachers created several scenarios of simple commercial operations where the profit or loss was to be calculated. Working in groups, students were asked to figure out the answers as best they could, and then to formulate a sentence using as few words as possible (or only symbols if they were able) to represent all of the elements they needed to consider and the relationship among the variables. Students tested their draft "formulas" with various problems to see if they worked in each case, and shopped their version around to the other groups to see if they could arrive at more complete, reliable and concise formulations. In reflecting on this experience in a learning log, one student remarked that while this was the third time he had been exposed to the topic, for the first time he understood what he was doing. He wasn't worried that he would forget the formula at exam time, because now that he understood it, the formula was more memorable to him. He went on to explain that even if he did happen to forget the formula, he was confident he could reconstruct it because of the recent learning experiences.

Criticisms of inquiry approaches

While this example suggests that students can figure out some formulae on their own, critics will counter that student can't possibly discover everything we want them to learn. We agree that expecting students to invent everything for themselves is inefficient and unrealistic. In fact, this is where our approach differs from "discovery learning." If the teachers in the situation described above thought that solving the profit and loss problems and generating original formulae would be too difficult or time consuming for their students, they could have shifted the focus of the inquiry by providing students with possible formulae to consider. In this case the inquiry would be to determine which version of the supplied formulae would be the best to recommend for use by students at this particular grade level. As this modification suggests, inquiring into a topic does not require that students re-invent everything for and by themselves. On the other hand, inquiry learning does require some investigation; students can't simply be expected to accept answers.

A second criticism leveled against inquiry approaches is the suggestion that many of the basics can be acquired only through drill and memorization. While we agree that students should be expected to master and remember many basic facts, it is important to recognize that drill is one form of practice, and memorization is one way to remember something. In our view, the issue is not whether students need to remember and master basic facts but how best to help them satisfy this need. It is well known, that students are more likely to remember something if they understand what they are being asked to learn. Consider the following sentences:

- My best friend is Peter Pan.
- Ym tbse rfdnei si Rtpee Npa.

Most will agree that the first sentence would be easy to remember, whereas the second sentence would be very difficult. This is true even though all the letters are identical and there is the same number of words. The point being made here is the same one that the student from India was making about remembering the formula for profit and loss. He had struggled to remember the formula that he had been exposed to (and was expected to memorize) over the two previous years because he didn't understand what he was learning. Yet, as soon as he understood the formula, he became more confident in his ability to remember it. The more we help students comprehend what we want them to remember, the less students need to learn by memorization.[6] Before expecting students to memorize number facts such as "5 + 5 = 10" we should ask them to visualize this fact, manipulate objects to demonstrate it and predict the result to help them understand its meaning.

Not only must students remember many basic facts, there is much that students need to learn that can be mastered only by repetition. But what is the best way to structure repetition? Recognizing that drill is but one form of practice helps to address this question. Some drill may be useful from time to time, but without meaning, repetition is unlikely to increase understanding and fluency. On the other hand, as we saw with the second method of developing a slap shot, mindful practice guided by ongoing questioning and testing is a more effective and engaging form of repetition. Instead of "drill" worksheets where students rotely solve multiple problems involving a basic operation, a more productive strategy is to ask students to detect the various kinds of problem types present in the worksheet (for example, distinguishing subtraction problems involving regrouping of none, one or more placeholders) and to solve one example of each type. Students would repeat this process with other worksheets until they could quickly identify a wide range of problem types across all of the four basic arithmetic operations. This kind of mindful practice conducted in a spirit of inquiry is more likely to develop genuine mastery in mathematics.

As we hope these examples make clear, "learning the basics" and "inquiry," properly understood, can be complementary components of a successful educational program.

[6] *Robert Sternberg*. 2008. Assessing what matters. *Informative Assessment*, 65(4), 23.

Documenting effectiveness

Adopting the kind of robust inquiry described above that nurtures and builds from the basics (what some call moving "forward with the basics") can lead to improved and often spectacular results. We base these conclusions on 20 years of experience working with approximately 80 districts and 200 schools involving over 125 000 teachers worldwide.

Our work with teachers ranges from a few face-to-face sessions over the course of a year to ongoing sustained professional learning programs. Our efforts are generally focused on helping teachers problematize the content of the curriculum using a critical inquiry approach. We support teachers in embedding critical thinking questions into every aspect of their teaching, and then model how to systematically introduce and practise the "tools" needed to successfully complete each task. While qualitative data and anecdotal evidence suggest positive results in most cases, the benefits have been documented on standardized test results in only of few of these situations. Here we present results drawn from five sites in Ontario and Maryland. These include a family of four elementary schools in one district, and multiple classrooms in four individual schools in various jurisdictions.

These results are from studies not conducted by us. Three are based on reports in mathematics, reading and writing from the EQAO (Ontario Education Quality and Accountability Office). The reports are based on province-wide literacy and mathematics achievement tests and questionnaires administered yearly to grades 3 and 6 students. In one case, results on student engagement are provided. Other results are based on EQAO tests administered by the school and on unit tests.

As you will see, schools experienced increased achievement in mathematics, reading and writing ranging from 6.7% to 233%, and increases in student engagement running as high as 168% over the previous year. In each location, educators attribute the improved achievement, in large measure, to our work with them. Typically they credit our approach with deepening student understanding and increasing student engagement. Significantly, our approach has shown positive results with students from across the spectrum of ability.

Family of elementary schools

An area superintendent confirms that embedding critical inquiry into the daily practice of their teachers in four elementary schools contributed to a significant increase in student engagement and achievement in mathematics. The following is a comparison of 2013 to 2014 EQAO results:

- an increase of 15% in the number of grade 3 students achieving levels 3 (grades B or B+) or 4 (grades A- to A+) in mathematics;
- an increase of 36% in the number of grade 6 students achieving levels 3 or 4 in mathematics.

School A

Our team worked with the entire staff from pre-Kindergarten to grade 8 at this independent school. Between 2012 and 2013, this school enjoyed significant improvements in the percentage of students who scored at or above the provincial standard in EQAO tests administered by the school.

- a 54% increase in combined grade 3 reading and writing (from 48% to 74% of students);
- a 26% increase in grade 3 mathematics-open response questions (from 58% to 73% of students);
- a 75% increase in grade 6 mathematics in procedural and conceptual understanding
- (from 32% to 56% of students);
- a 16% increase in grade 6 mathematics in open response questions (from 51% to 59% of students).

School B

This school is located in an impoverished area with traditionally poor test results. Students had failed to meet the state standards for two years and the school was under review when we began our work. They adopted our critical thinking framework school-wide and the following year the school soared past state standards and was removed from the under-review list. The school reports the following comparative results for multiple unit tests administered across four grade 6 mathematic classes between 2010 and 2011:

- average 32% increase in the number of students successfully meeting the expected unit indicators (from 34% to 45% of students);
- average of 167% increase in the number of students exceeding the expected unit indicators (from 15% to 40% of students).

In other words, the school progressed from a situation where 51% of grade 6 students were performing below standard in mathematics to only 15% of students below standard after working with our team.

School C

We worked with teachers in this school during 2012-13, particularly in the area of literacy. The EQAO tests showed the following results:

- a 12% increase in the percentage of grade 3 students reaching the acceptable provincial levels in reading (from 74% to 83%);
- a 6.7% increase in scores in the percentage of grade 3 students reaching the acceptable provincial levels in writing (from 90% to 96%). This modest increase is to be expected given the outstanding level of student performance.

Significantly, the increases don't seem to be attributable generally to a more able cohort of students, since grade 3 mathematics scores for this group dropped (from 90% to 78%) during the same period. It is important to note that we had not yet started to work with the mathematics teachers in the school.

School D

The students at this school are considered to be at high social risk. A teacher working with multiple grades offered the following comments: "As students [in grade 3 and grade 6/7 classes] engaged in critical thinking tasks, they were able to solve problems more efficiently and effectively . . . critical thinking challenges meet the needs of all learners in a diverse classroom as there are many different entry points for each student." This teacher reported the following 2013 EQAO results over the previous year:

- a 54% increase in the number of grade 3 students reporting that they liked math most of the time (88% up from 57%);
- a 30% increase in the number of grade 3 students achieving at or above the provincial standard (65% up from 50%);
- a 168% increase in the number of grade 6 students reporting that they liked math most of the time (59% up from 22%);
- a 233% increase in the number of grade 6 students achieving at or above the provincial standard (50% up from 15%).

We believe these results confirm that properly implemented inquiry teaching is effective. However, this level of documented success has not been uniform. In many cases, the data about impact are simply not available. Other schools that we have worked with have not seen positive results on standardized tests. The following factors offer some explanation for a lack of documented success in these schools:

- We did not work with teachers at the grade levels or subject areas that were tested in standardized measures.
- Other variables overshadowed any improvement derived from our efforts.
- Our involvement with the teachers at the time of testing was too limited to expect any impact.
- It is not realistic to expect positive results in the short-term in every case. Changes in teaching habits often take time to develop and even longer to translate to improved student achievement.
- Teachers had not yet have embraced our work and implemented it in their classrooms in a regular and meaningful way.

Clearly, further research is warranted and more comprehensive data needs to be gathered. However the positive results emerging from this sampling of jurisdictions offers evidence of the potential for the approach to inquiry that we have outlined.

Concluding comments

In this article, we have tried to explain the features and document the results of a complementary approach to inquiry teaching and learning the basics. We have suggested that complaints about inquiry may stem from versions that are not robust. Consequently, it would be regrettable if the idea of inquiry per se were discredited merely because some versions are not effective. This regrettable situation would be further compounded if support for inquiry were replaced by a particular approach to teaching the basics that was dismissed in the past because it was ineffective in preparing students for an increasingly complex world. We believe that a rigorous critical inquiry that moves "forward with the basics" offers a fruitful middle ground that draws on the best of both approaches and steers clear of the less desirable extremes. While this article may raise as many questions as it hopes to resolve, we hope it will foster thoughtful debate about the role of the basics and inquiry in 21st century classrooms.