Teaching Math Classically
with Andrew Elizalde

Lesson 7: Strategies for Reforming a Math Program

Outline:

The first priority for comprehensively refining a math program (and other subjects too) must be to establish a reflective, collaborative, and professional culture at your school.

- Teachers should be ready to receive refinement or be part of reform.
- Introduce a sustainable, in-house, professional development program.
- Not only summer conferences, but regular day-to-day helps.
- Five necessary components:
    - Teachers practice regular practice of peer and self-observation.
        - Reflecting and watching other teachers, then offering feedback
        - Videotaping or recording themselves and then critiquing themselves
    - There are regular meeting for teachers to offer one another constructive commentary and criticism of ideas and sample lessons.
        - Format ideas: Critical Friends Tuning Protocol and National School Reform Council protocol
    - Teachers design a lesson collaboratively with deeper reflection.
        - Model idea: Lesson Study (Japan)
    - Have teachers reading and discussing the same books on teaching and on their specific subject areas.
    - Make sure meetings are focused, with specific "next actions" that give direction to teachers.
- If these things are established, students will notice and absorb the school ethos.
    - Quote from John Henry, Cardinal Newman's The Idea of a University: "An assemblage of learned men, zealous for their own sciences, and rivals of each other, are brought, by familiar intercourse and for the sake of intellectual peace, to adjust together the claims and relations of their respective subjects of investigation. They learn to respect, to consult, and to aid each other. Thus is created a pure and clear atmosphere of thought, which the student also breathes."

Recognize what you've inherited through your own experiences. How teachers learned math affects their pedagogy today.

- Understand the current condition of mathematics education in America. Realize the course of math education history in the past 100 years.

- You will draw students from elsewhere in later grades who have had different math experiences from your school.
- Be aware of international best practices.

Establish clear departmental goals informed by classical Christian education.

- The following are some examples of goals from Andrew's school:
  - Ensure students develop computational mastery through experiences that promote deep conceptual understanding rather than solely rote memory.
  - Mathematics should be understood as a language that describes and models natural phenomenon.
  - Develop critical thinking and problem-solving strategies through solving challenging word problems.
  - Illustrate God's eternal and unchanging attributes through contemplation of symmetry, consistency, and order of mathematics.
  - Enable students to represent and interpret mathematical functions and appreciate their strengths and weaknesses.
  - Make connections across the broader curriculum with other subjects.
- Establish your goals early in your reform efforts.
- Don't simply accept the above or other goals, but include input from your teachers to develop your school's content.

Ask: "Where are we now?" Examine your curriculum map.

- This is not necessarily your stated map, but also your implicit map that teachers are actually teaching.
- Try using an anonymous survey of mathematical topics. With the results, look for:
  - **alignment.** How do we match up with external standards (international, Common Core, formerly stated goals, other states' programs)? Are we introducing topics soon enough?
  - **internal consistency.** Do two teachers teaching the same subject align in topics covered? Are they in collaboration with one another?
  - **transitions from one grade to the next.** How smooth are these for students? Do teachers of higher grades find students from a previous grade lacking in certain areas?
- Use an Excel file to compile, compare, and map for various analytics.

Prioritize and organize the content and curriculum map by asking essential questions.

- "Essential questions" means the big questions that would synthesize and organize the curriculum. The term comes from *Understanding by Design* by Grant Wiggins and Jay McTighe, chapter 5.
- Students should be able to answer these questions at particular grade levels. Examples:

    - What makes one form of an expression any more or less simple than another?
    - Why might an understanding of inverse operations be considered a prerequisite to equation solving?
- The curriculum would be organized by the first essential question, then the second essential question, etc., for the grade level, rather than by textbook chapters.

Curriculum map refining demands that teachers invest in and master content, increasing depth of knowledge and sometimes relearning content.

- Quote from Robert Littlejohn and Charles T. Evans's *Wisdom and Eloquence*: "…We can never stop learning about the things that we teach."
    - How can we not overwhelm teachers with this requirement?
    - Rather than reforming an entire class or grade and having teachers feel targeted, take one mathematical concept the school has found an issue with and evaluate how it impacts all grades across the curriculum. This is called the practice of conceptual threading.
        - Consider how the teaching of the concept can incorporate:
            - classical Christian pedagogy
            - concrete or visual experience
            - historical narrative
            - Socratic dialect
        - Can we make the concept available to students earlier by changing the initial approach?
    - Reforming the individual teachers' pedagogy and increasing their content knowledge are absolutely essential and a commitment to that must come before something like adapting a new textbook series.
    - As you refine your curriculum map, move toward a curriculum core/non-negotiables. As teachers collaborate and consider how a concept is to be taught, they reform the curriculum map in the process. Teachers must be involved in identifying core content.
        - Quote from Jerome Bruner in The Process of Education: "…A curriculum is more for teachers than it is for pupils. If it cannot change, move, perturb, inform teachers, then it will have no effect on those whom they teach…."

Recognize that there are components of mathematics education that have been wholly absent perhaps from your experience and certainly the national experience.

- Recognize that as a classical educator, you understand the influence that historical narrative ought to have on your curriculum and its role in the teaching of mathematics.
- Realize that this idea generates debate between educational theorists and mathematicians: axiomatic ordering, or historical ordering?

    - Jerome Bruner (The Process of Education) takes a stand on axiomatic ordering.
    - Morris Kline, in *Why Johnny Can't Add*, takes a "constructivist" approach.
        - A highly formalized, logical approach seems less accessible to students.
        - The "genetic principle" recommends not a deductive but a constructive approach: students do the building of theorems and proofs themselves (re-creating them, of course, with the help of the teacher).
    - Andrew's own position is that ordering should be mostly axiomatic, but should also give attention to the historical narrative. In other words, construct a curriculum that is logical but offers opportunities to revisit and incorporate historical development of mathematical concepts.
    - Your school and teachers should decide your position for yourselves.
- Look for opportunities for historical narrative to inform the curriculum. Integrate great books that describe development of mathematical concepts, such as Petr Beckmann's A History of Pi. Let an enthusiastic teacher lead the way.

Mathematics needs to use common vocabulary.

- For example, "independent/dependent variables" versus "inputs/outputs."
- Inventory key vocabulary and establish consistency across grade and course levels.

Is the curriculum on the students' level?

- The curriculum reform should be a gradual shift—possibly two to three years.
- Establish good assessment measurements for how students are managing change.
    - Design and implement readiness tests for the next grade level. These are more or less school-standardized final exams.
    - They can determine the level of incoming transfer students.
    - The resulting data can be analyzed for specific areas.
- Change on a lesson-by-lesson level. What is the big question (or questions) the students should be able to answer after this lesson or unit, and how would students demonstrate their understanding?
    - Howard Gardner suggests replacing "learning objectives" with "performances of understanding." In a particular context, what is an appropriate and efficient method to demonstrate understanding?
    - Hold students accountable for demonstrating deep understanding on their tests.

Instead of always looking at the big picture, allow teachers to take a step back and do workshops on teaching methods or, for example, revisiting classical Christian education concepts.

After all the refining ideas are explored, ask what resources the school has to approach mathematics this way—or do we need different ones?

- Teachers should be the ones to begin to ask if new textbooks are needed. If they are necessary, consider making the change over the course of a couple of years.

Recognize that your program will be different from what students' parents experienced.

- You will need to help them understand why you are teaching this way.
- Offer workshops for working with these concepts at home.
- Recognize that it will take time for them to adjust.

Grow your "math nerd" culture.

- Find students who naturally love math.
- Feed them and give them opportunities for "recreational mathematics": brainteasers, riddles, number puzzles—just enjoying math.
- With reform, the number of "math nerds" will grow.

Reforming and refining is an ongoing process.

- In fact, it is our business. That's why we must form a school culture of reflection, collaboration, and contemplation. This will influence all subjects across the curriculum.