Teaching Math Classically
with Andrew Elizalde

Lesson 14: The Beauty of Math and Poetic Instruction

Outline:

What is the beauty of math in relation to the poetic mode of instruction?

- Modes of teaching according to the ancients were
  - gymnastic
  - poetic
  - mimetic or didactic
  - dialectic
- Usually we teach according to how we've been taught or how we'd want to be taught.
  - We don't always utilize modes that are foreign to our experience.
  - We don't always utilize modes that are contrary to our preference.
- Consider how drawing students' attention to the beauty of math can be instructive in its own right.
- The poetic mode is a "mode of instruction that draws upon the sensory, emotional, or even spiritual experience that engages the student in delightful contemplation and the use of their imagination."
  - Or what Sister Miriam Joseph in her book *The Trivium* describes as "vivid and memorable representations."

<u>Elements of Poetic Mode of Instruction</u>

- Grasping first the invisible principles via intuition.
- Wonderment might awaken students' intellect.
- Connection on an emotional level or "sympathy".
- Desire to imitate beautiful things.

H.E. Huntley in *The Divine Proportion* cites Jacob Bronowski in *Science and Human Values* in an overview of the beauty of mathematics.

- The beauty of the language of mathematics can be richer than the bare content.
- There is both a poetry and prose to math. Its poetry represents the creative process of math.
  - Math has aesthetic qualities.
  - Math allows students to wonder and imagine, and wonder awakens the intellect.

Beauty as defined by today's world is whatever pleases or satisfies subjectively.

- At a TED conference in 2010, Denis Dutton, author of The Art Instinct and philosophy professor, asserted that beauty is present to attract species together to propagate.
- Howard Gardner in Truth, Beauty, and Goodness Reframed (2011) says we should bring these ideas into our curriculum, yet there is a subjectivity to his definition.
- Most teenagers, even born-again Christians, in a variety of surveys agreed that there is no absolute moral truth.

But there is an objectivity to beauty: The Bible gives us the right to claim this by giving us a basis for assessing beauty via forms, attributes, characteristics, events, and actions:

- Creation itself (Psalm 19:1)
- Ornamentation of the temple
  - Lampstands mimicking creation
- The meek are made beautiful by salvation itself.
  - *Art for God's Sake* by Philip Graham Ryken: God transformed ugliness and degradation of the cross into beauty with the body of His Son. "He does the same for everyone who has faith in Christ. Our salvation is directed by a redemptive ascetic. The salvation of the meek is beautiful!"
- Isaiah 52:7: "How beautiful on the mountain are the feet of those who bring good news."
- Some others: physical appearance of men and women; God's chosen people; crown of precious metal; fine clothes; holiness; precious stones; gray hair; God Himself; branches of the olive tree; what He does; what His children do

There is also a classical basis for an objective standard of beauty.

- Umberto Eco gives us a medieval concept of symbolism, allegory, and metaphor in Art and Beauty in the Middle Ages:
  - *metaphysical realism:* the philosophical habit of discerning the hand of God in the beauty of the world
  - *universal allegory:* perceiving the world as a divine work of art—everything has meaning in addition to the literal
  - Thomas Aquinas: Scripture as a tool to interpret significance of natural phenomenon
  - Plato: the cave analogy—math is the starting point for the ascent of the soul
  - Aristotle's *Poetics*: archetypes to mimic beautiful works
  - Tradition of poetic knowledge: wonder and confidence in a real existence outside the knower (Dr. James S. Taylor in *Poetic Knowledge*)
  - Josef Pieper in *Leisure: The Basis of Culture*: leisure is the capacity to steep oneself in the whole of creation

We must draw our students' attention to their heritage of the definition of beauty.

How can we bring the idea of contemplating the beauty of math into the classroom?

- Consider that mathematics is an unbelievably effective universal language that describes, models, and interprets natural phenomenon.
    - Albert Einstein: "How is it possible that mathematics, a product of human thought that is independent of human experience, fits so excellently the objects of physical reality?"
    - Galileo: Philosophy is written in the universe in the language of mathematics using geometric characters.
        - We can begin to understand and marvel at God's creation through mathematics.
    - Isaac Newton in Principia: Marveling through math at how the universe (planets, solar system) is put together. This system could only come from God's intelligent and powerful governance.
    - Eugene Wigner, a Nobel-prize winning physicist in the article "The Unreasonable Effectiveness of Mathematics in the Natural Sciences": a miracle confronts us with the appropriateness of mathematical language to describe the laws of physics
- As Christians we can point out to students that we should not be surprised that the language of mathematics is reasonable and capable of helping us understand God's creation.
    - John Byl in The Divine Challenge says that mathematics exists in the mind of God. Being made in the image of God, humans can rationally discern the math of God's creation.
        - It is a key motive for scientific revolution—we must understand in order to accomplish our divine purpose.
    - The language of math is part of God's plan and a blessing to us.
- Symmetry is naturally present in creation:
    - nautilus shell
    - Fibonacci sequence
        - Golden ratio
        - Pentagons
        - Parts of the human body
            - Umberto Eco in Art and Beauty in the Middle Ages cites the Canon of Polyclitus: "harmonious proportion of the parts"
            - Fingers to other fingers, fingers to hand, etc.
- Geometric forms and relationships
    - Pythagorean description of the Platonic solids
    - Math constructions that suggest universal principles or truths
    - Teach students to pay attention to proportion and relationships.
        - Fallingwater—how Frank Lloyd Wright used the relationship between the natural setting and the house's architecture
        - Bixby Bridge in Southern California—relationship between the hills and the form of the bridge

    - Ideas have permanence.
    - Permanent ideas unite particulars.
        - Gougu in China in the 11th century
        - Pythagoras in 500 BC
        - Euclid in 300 BC
        - All were considering the same proposition (the Pythagorean Theorem), which is the same everywhere.
    - Relationships between the infinite and the infinitesimal
    - The tension between consistency and completeness
        - The resonance with the experience of constructing a systematic theology.
        - The experiences ought to lead us to ontological humility.

Mathematics is effective, yet limited and incomplete.

- As we understand God and His creation, there still remains an unknowableness of creation and indeed His revelation in Scripture.
    - Romans 11: doctrine to doxology - For who can know the mind of the Lord?
    - Romans 12: Therefore submit to Him.
    - Doctrine leads to doxology, which leads to humility and practice, just as mathematics leads to mystery, which leads to worship and obedience.
- When mathematicians think they have invented a new idea or made a new discovery, they often feel math has "happened" to them. Am I thinking God's thoughts after Him?
    - Russell Howell and James Bradley in Mathematics in a Postmodern Age: A Christian Perspective: We have not thought of anything mathematical that God hasn't already thought.
    - Sometimes we just need to marvel.
        - In the video series The Proof, Andrew Wiles (proving Fermat's Last Theorem), uses the metaphor of entering a dark mansion and finally finding the light switch.

Pay attention to historical and modern mathematics figures.

- William Dunham's *Journey through Genius*: a canon of great mathematical rhetoric in history

How does math help us understand fine and performing arts?

- ratio and proportion
- tension and relief
    - *The School of Athens* by Raphael (below)
        - Geometrics of the single-point perspective

- beat cycles of Indian classical music
  - Influenced notions of jazz
- the use of simple and complex machines/physics
  - A piano is a complex machine. We can cover the mechanics of it, but…
  - Take time to explore more than the physical—what is the Relationship between the fingers playing it and the sound Experienced by the listener?
    - Rachmaninoff's Second Piano Concerto

Challenge students to compose and present aesthetically pleasing arguments. How do we achieve true, good, and beautiful arguments? Some suggested characteristics:

- context as basis
- logical or intuitive sequencing
- legible writing
- sentences for narration
- sentences with good grammar, spelling, and punctuation
- color, space, scale
- neatness
- rhythm

Everything done in the classroom (homework, notes) should have an aesthetic - responsible, careful, respectful of math.

Ask students to make a rough draft of an argument. Then after the teacher has assessed it, have them collectively in small groups compose a single final draft.

- How can we *compose* this argument to make it more appealing?

Asking students to consider the beauty of math is in itself a huge step toward reforming math, in contrast to the national trends.

Challenge: Is there one concept that I can ask students to contemplate? Is there one universal principle I can ask them to consider? Is there any aesthetic quality I can draw students' attention to and admire?

How often do I myself stand in awe of and appreciate the content that I teach?