ClassicalU

Teaching Math Classically
with Andrew Elizalde

Lesson 15: Teaching Math as Storytelling

Outline:

According to David Hicks in Norms and Nobility, the difference between mytho-poetic pedagogy and an analytical pedagogy challenges us to consider the stories behind the concepts and introducing ideas through stories.

- International studies (particularly in Japan) show effectiveness and cohesion of the storytelling teaching style.
- How often are our lessons interrupted from beginning to end with (for example) announcements, abrupt steps from one section of the lesson to the next?
- How can we connect all ideas through a narrative?
- According to James Stigler and James Hiebert in The Teaching Gap, Japanese storytelling lessons are treated as "sacred," planned as "complete experiences" with a beginning, a middle, and an end.
    - The meaning is in the connection between the parts.
- In Kieran Egan's Teaching as Story Telling: An Alternative Approach to Teaching and Curriculum in Elementary School, storytelling needs to become part of our pedagogy.
    - Our teaching is often "inappropriately mechanistic."
    - We underuse our students' imaginations.
    - We should think in terms of stories to be told rather than objectives reached.
    - Math can be "rehumanized" by tying computational tasks back to the human reason people began to do them in the first place.
        - What is the history of how people began to use this concept?

How can math teachers be good storytellers?

- A good story has:
    - Tension to be resolved (solving a difficult problem)
    - Rhythm (tension to resolution, then repeat the cycle)
    - Beginning, middle, and an end
        - Plato's *Phaedrus*
        - Aristotle
        - George Kennedy: *Classical Rhetoric and Its Christian and Secular Tradition*

Early History of Trigonometry
Whiteboard exercise (time stamp 9:38)

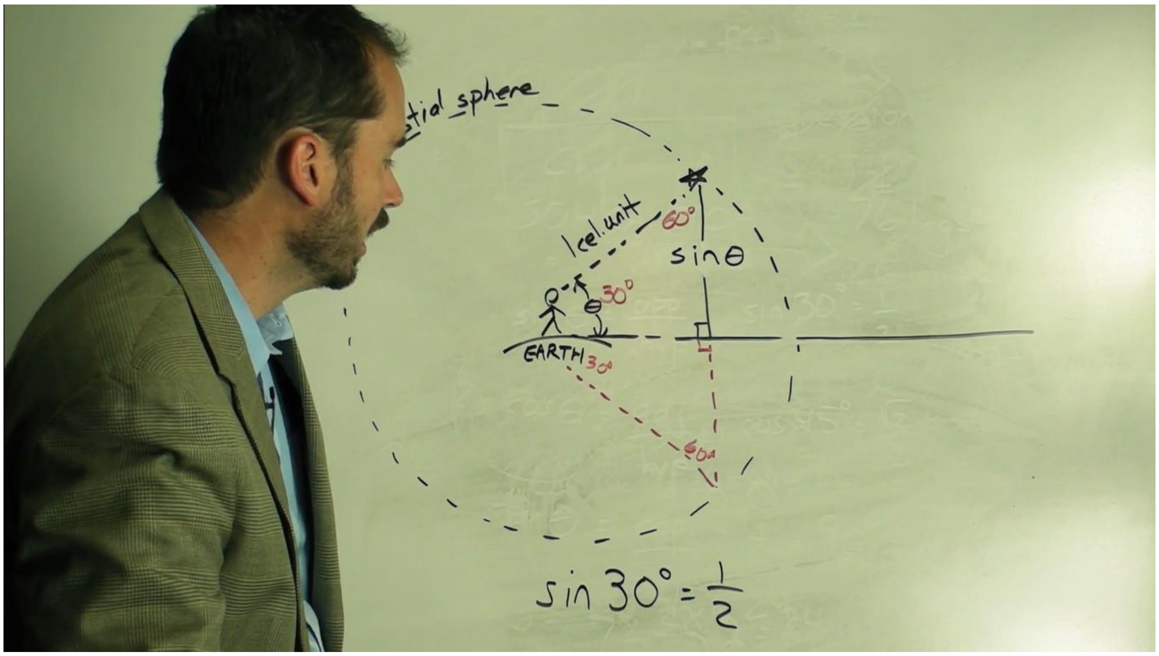
SOHCAHTOA

$\sin \Theta = \frac{opp}{hyp}$ sin 30° = ½

$\cos \Theta = \frac{adj}{hyp}$ $\cos 45° = \frac{\sqrt{2}}{2}$

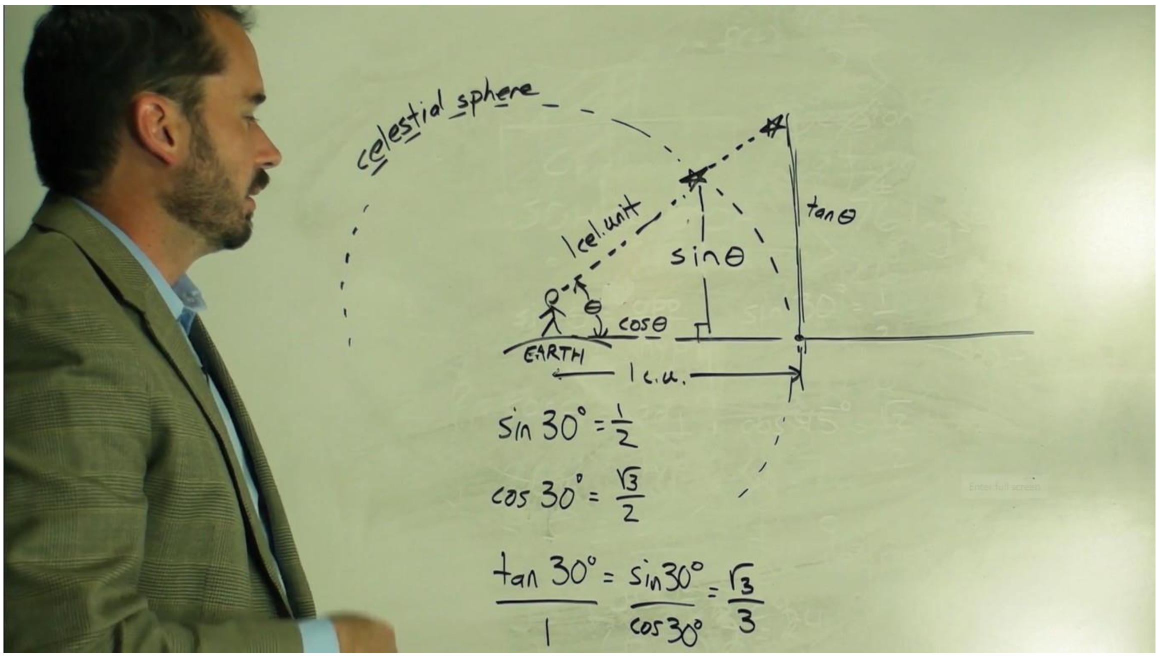
$\tan \Theta = \frac{opp}{adj}$ tan 90° = Ø *(11:28)*

- But where is the context for these ideas? What is the history of this concept?
- Let's say you are a twelfth-century astronomer. It's night and you're looking at the sky. You see the stars there. You realize the stars "shift" or rotate. The earth (at the center, of course) has a celestial sphere around it. (14:10)
    - How far away are the stars from the earth? The distance can be called a "celestial unit." (15:00)
- Orientation is defined by distance from me to horizon to star the distance above the point on the horizon = sine. (16:50)
- Sine depends on the angle you look at the star from. If the angle is Θ, and the distance is sine of Θ or sin Θ. (18:24)
    - If the Θ angle is 30° , then we can figure the other angles. (18:56) The segments extended form an equilateral triangle. (19:48)
- Half of the celestial unit = sin Θ Sin 30° = ½



- We can figure 45° and 60° from the same illustration.
- The story continues for students the next day with other portions of the triangle··· cosine or cos Θ.
- With a further star, the "shadow length" tanΘ (23:00).
- Sin 30° = ½ cos 30° = $\frac{\sqrt{3}}{3}$
- The distance from the viewer to the edge of the horizon is also 1 celestial unit. Look for similar triangles—the ratio of corresponding sides is constant. Therefore:

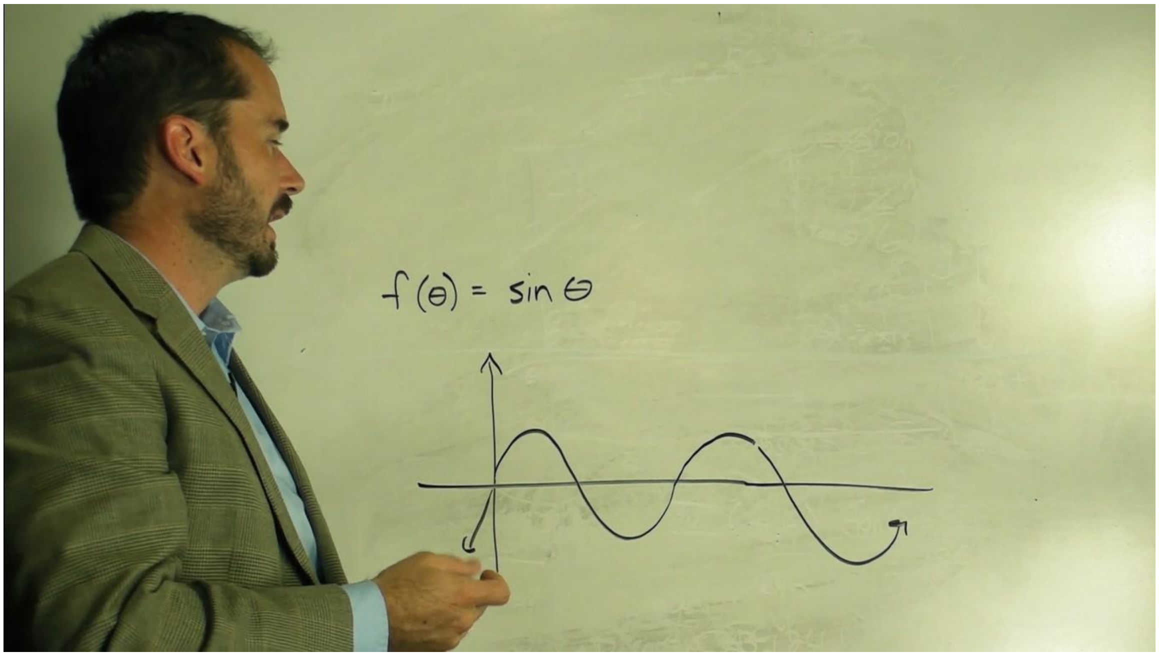
$$\frac{tan30°}{1} = \frac{sin30°}{cos30°} = \frac{\sqrt{3}}{3}$$



- The teacher can use the same picture this whole time.
- Building a new idea, but coming back to the same picture. This is the poetic rhythm of building the story.
- What if there's an even further star?
    - The hypotenuse of the new triangle
    - The side adjacent the angle = adjacent
    - The side opposite the angle = opposite *(28:30)*
    - Using ratios, we get…

$$\frac{\sin\Theta}{1 \text{ c. unit}} = \frac{\text{opp}}{\text{hyp}} \qquad \frac{\cos\Theta}{1 \text{ c}} = \frac{\text{adj}}{\text{hyp}} \qquad \frac{\tan\Theta}{1 \text{ cu}} = \frac{\text{opp}}{\text{adj}}$$ *(30:50)*

SOH CAH TOA



- This creates models for natural phenomena that we still use today, as in representations of music.
- These stories are not found in textbooks, so teachers are required to know the history and synthesize it for the students.

Challenge: Is there one concept whose history might be investigated? Could you experiment with bringing that history into your math classroom?