

**RENAISSANCE
FLORENCE:
BRUNELLESCHI'S DOME
ON THE DUOMO**



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Description

Through the use of various primary and secondary sources, students in this lesson will identify, understand and be able to explain why building the dome on Florence's Duomo presented such a daunting task and Filippo Brunelleschi's mathematical and engineering solutions to the problems. In an alternate and separate in-class activity, students will also try to replicate Brunelleschi's dome using man-made materials (sugar cubes and play-doh) to understand the challenges of such an undertaking.

Subjects

Art, Architecture, European History, World History, Science, Mathematics

Grade Level

11-12

Duration

90 minutes

Tour Links

- [Basilica di Santa Maria del Fiore, Florence](#)

Essential Questions

- Who was Filippo Brunelleschi?
- What challenges did Florentine architects face in completing the Duomo and building the dome?
- How did Brunelleschi solve the problems? What solutions and engineering techniques did he pioneer?

Academic Summary

The great cathedral had lain unfinished for over four decades. In 1418, with the Medici family poised to exert its financial and political control over Florence, the Florentine City Council announced a call for proposals on how to finish it. The Basilica di Santa Maria del Fiore stood in the center of the city, towering over the countryside. Originally designed by Tuscan artist and architect Arnolfo di Cambio, the cathedral began as a gothic style church in 1296. Over the next hundred years, architects, masons and laborers worked on the great duomo. By the beginning of the 15th century, all that remained was to cap the enormous church's altar area. That is when work ground to a halt. The problem was that, in 1400, no one knew how to build a dome big enough to cover the space, yet light enough not to collapse under its own weight. Year after year went by. Finally in 1418, an architect stepped forward with radical, untested ideas. His name was Filippo Brunelleschi.

According to Italian historian Giorgio Vasari in his 1550 book, *Lives of the Most Excellent Painters, Sculptors, and Architects from Cimabue to Our Times*, Brunelleschi won the competition by using a simple trick with an egg. When the city leaders questioned Brunelleschi on his design principles, he instead handed them an egg and challenged them to stand it on end. According to Vasari,

That whosoever could make an egg stand upright on a flat piece of marble should build the cupola, since thus each man's intellect would be discerned. Taking an egg, therefore, all those Masters sought to make it stand upright, but not one could find a way. Whereupon Filippo, being told to make it stand, took it graciously, and, giving one end of it a blow on the flat piece of marble, made it stand upright. The craftsmen protested that they could have done the same; but Filippo answered, laughing, that they could also have raised the cupola, if they had seen the model or the design. And so it was resolved that he should be commissioned to carry out this work.

Brunelleschi got the job. It would take over 15 years to complete the great dome. The technical challenge was immense. Except for the Pantheon in Rome (built in the 2nd century), no domes had survived the fall of antiquity. By the late medieval period, no one remembered nor understood dome construction, and yet Brunelleschi's design solved complex mathematical and engineering issues. First, he came up with the idea of a double shell for the dome, with a series of vertical "ribs" supporting the structure. To prevent the dome from collapsing under its own weight, a series of stone and iron chains (still in place today) would be embedded into the inner dome to provide support and stability. For the outer shell, Brunelleschi used a herringbone brick pattern to transfer the weight of the newly laid bricks to the vertical ribs and then down to the cathedral's base.

The dome was almost completed by the time Brunelleschi died in 1446. The cathedral was finally topped with a stone lantern structure in 1461 and the conical roof was crowned by a copper ball and cross, designed and built by Verrocchio in 1469. Perhaps providentially, in Verrocchio's workshop a young apprentice named Leonardo di ser Pioto (known better today as Leonardo da Vinci) helped with the ball's design and

installation, remarking years later that he was impressed and awed by Brunelleschi's use of machines and engineering techniques at the Duomo.

Through the use of various primary and secondary sources, students in this lesson will identify, understand and be able to explain why building the dome on Florence's Duomo presented such a daunting task, and Filippo Brunelleschi's mathematical and engineering solutions to the problems. In an alternate and separate in-class activity, students will also try to replicate Brunelleschi's dome using man-made materials (sugar cubes and play-doh) to understand the challenges of such an undertaking.

Objectives

1. Students will identify, analyze, understand and be able to explain why finishing the dome on Florence's Duomo took so long and what challenges the builders faced by 1400.
2. Students will identify, analyze, understand and be able to explain Filippo Brunelleschi's ideas and designs for the dome in Florence.
3. Students will identify, analyze, understand and be able to explain the mathematical challenges facing engineers in building an unsupported dome on any building.

Procedure

I. Anticipatory Set

- Writing / Question: Explain how Florence gained its wealth and prestige by 1400. (5 min)
- Handouts – Copies of the primary sources and readings from the websites listed. (5 min)

II. Body of Lesson

- Lecture / PPT – Brief overview of Brunelleschi and the Duomo. (15 min)
- Videos – Brunelleschi (20 min)
- Independent Activity – Students read the sources and articles about Brunelleschi and the Duomo in Florence (15 min)
- Suggestion: Have the students read some of the articles for homework to prepare for class discussion.
- Suggestion: Break students into groups and assign different articles to each group.
- Group Activity – Socratic Discussion: Identify and explain why building the dome on Florence's Duomo presented such a daunting task and Filippo Brunelleschi's mathematical and engineering solutions to the problems. (15 min)
- Alternate Class Activity – (make sure to watch the video on Renaissance Mathematics in Florence first) Have students build a dome out of sugar cubes so they can see for themselves the challenges Brunelleschi and the other architects faced when completing the Duomo in Florence. How can they account for the downward force trying to blow the structure apart? How did Brunelleschi account for such problems?

III. Closure

- Assessment – Essay / DBQ: Explain in detail why building the dome on Florence's Duomo presented such a daunting task and Filippo Brunelleschi's mathematical and engineering solutions to the problems.

Extension

On tour: Basilica di Santa Maria del Fiore (Duomo), Florence

While on tour, students in Florence will visit the Basilica di Santa Maria del Fiore, commonly known simply as the "Duomo" (Italian for "cathedral"), where they can see for themselves Brunelleschi's amazing dome. The Duomo dominates the Florentine landscape today, over 500 years after it was finished. They will have the opportunity to tour the duomo itself and explore the dome. Brunelleschi is buried in the crypt below the church. At the entrance to the cathedral is the following epitaph: "Both the magnificent dome of this famous church and many other devices invented by Filippo the architect, bear witness to his superb skill. Therefore, in tribute to his exceptional talents, a grateful country that will always remember buries him here in the soil below."

Web Links

- en.wikipedia.org/wiki/Filippo_Brunelleschi
Filippo Brunelleschi – Wikipedia article
- en.wikipedia.org/wiki/Florence_Cathedral
Florence Cathedral – Wikipedia article
- passports.com/group_leaders/on_the_road/italy/Florence
On the Road: Florence – from Passports Educational Travel
- passports.com/group_leaders/on_the_road/italy/florence_sightseeing
On the Road: Florence Sightseeing – from Passports Educational Travel
- www-history.mcs.st-and.ac.uk/Biographies/Brunelleschi.html
Filippo Brunelleschi (website) – from the History of Mathematics Archive (UK). Excellent site that not only tells the historical story of the Renaissance architect, but also has pictures and sketches of the dome and machines used to build it. Highly recommended for students and teachers.
- www.brunelleschisdome.com/
Florence Cathedral's dome (website)
- www.pbs.org/empires/medici/renaissance/brunelleschi.html
Filippo Brunelleschi (website) – from PBS
- journal.utarts.com/articles.php?id=2&type=paper
Filippo Brunelleschi and the Creation of Il Duomo (academic paper). From the Journal of Art History at the University of Tampa. Highly recommended for AP and Advanced students.
- www.obscure.org/~perky/uofr/fall2002/ISYS203U/Duomo_Site/index.html
Brunelleschi's Dome (website)
- www.mega.it/eng/egui/monu/bdd.htm
Florence Art Guide: The Cathedral (website)
- www.slideshare.net/telkinsey/brunelleschi
Brunelleschi (PowerPoint) – from Fran Moran, Political Science Professor at New Jersey City University
- www.ctcd.edu/communications/bcornell/documents/ThePrince.ppt
Machiavelli and The Prince (PowerPoint) – from Brenda Cornell, Professor of English at Central Texas College
- www.teachingchannel.org/videos/choosing-primary-source-documents?fd=1
Reading Like a Historian: Primary Source Documents (video). Great 2-minute video on how to incorporate primary sources into the Common Core and history classes. From Shilpa Duvoor of Summit Preparatory Charter High School in Redwood City, CA. Highly recommended for teachers.
- channel.nationalgeographic.com/channel/videos/the-mystery-of-the-dome/
Secrets of Florence: The Mystery of the Dome (video) – 5-minute video from NatGeo TV
- www.youtube.com/watch?v=9H9f2mmehZc
Renaissance 02: Filippo Brunelleschi (video) – 10-minute part of a documentary on the Renaissance in Florence. This part deals with Brunelleschi's life, including how and why he got the project for the dome.
- www.youtube.com/watch?v=q2A8Mh4UB4E

Renaissance and Math (video) – 7-minute part of a documentary on the Renaissance in Florence. This part deals with the math and engineering behind Brunelleschi's Dome on the Cathedral. Highly recommended for students and teachers.

Key Terms

- Brunelleschi
- Cupola
- Duomo
- Florence
- Medici family
- Perspective
- Renaissance

