UNIT 1 - TEACHING INVESTIGATION 0

HOW AND WHY DO INDIVIDUALS CHANGE THEIR MINDS?

Process Overview

Note: This can be treated as a one-day or two-day activity

1. **Part 1 (Day 1)**
   Explore, Read, and Analyze Texts: Establish the purpose of the Investigation, have students identify the question, and read the texts in the Investigation Library. You might make this part of one class, or assign it as homework.
2. **Part 2 (Day 2)**
   Communicate Conclusion (Investigation Writing): Give students no more than 50 minutes to complete a five- to six-paragraph essay (about two pages) responding to the Investigation question. Please make sure this is an in-class activity—do not assign it as homework. Make sure students type their responses using a word-processing application that they save as a file. They should not type directly into the Investigation 0 input form. They can copy/paste their responses into the Investigation 0 input form when they are done writing.

Purpose

Investigation 0 is the baseline writing assessment for the course. We will use it to provide you and your students with an understanding of their ability to use a range of texts to construct an evidence-based, well-structured explanation or argument. Although they should try hard to do the best they can, they shouldn't worry about their score.

Note: Investigation 0 reappears in essentially the same form in Unit 2 as Investigation 2. This will allow you to use this baseline writing as a first draft for that Investigation. When they reach Unit 2, students will have a greater familiarity with concepts such as scale, claim, thesis, and claim testing, and a deeper understanding of the roles Copernicus and Galileo—the "heroes" of this Investigation—play in changing our collective understanding of the Universe and Solar System. By returning to this Investigation question in Unit 2, students will have the opportunity to craft a far more sophisticated response than they do here, in UNIT 1. Being able to show such growth in a few weeks will undoubtedly be motivating for you and your students.

Process

Explain to students that this is a very low-stakes activity. It will not "count" toward their grade. Make them aware that they probably won't be familiar with the content, and this may be the first time they tackle such a reading and writing task. Try not to worry about the things you'd like to teach your students before they take this assessment. You'll have lots of chances to give them that information, and we will even provide some activities designed to improve their reading, writing, and thinking skills. You'll have lots to celebrate when you see the progress they've made over the year.

Tell students that they're to use the provided documents to write an answer to a big question: How and why do individuals change their minds? Let students know that this is a two-part activity.

Part 1 – Explore, Read, and Analyze Texts

First, make sure students are familiar with the Investigation question and the problem statement. Review with them the following text, which frames the assignment.

> **Framing the Problem: How and why do individuals change their minds?**
>
> In studying Big History, you will meet many people who, like you, question their own thinking and beliefs. Like you, they sometimes change their minds about things they had long thought to be true. And, on occasion, the changes in their thinking and beliefs lead other people to raise new questions, to develop new answers, and maybe to even change their minds.
>
> Many of the most important changes in the world, such as discovering cures for diseases or developing new forms of government, have happened because people came to new conclusions about what causes sickness or what is the best political system. However, it is not always easy to question your thinking or change your ideas, particularly if everyone around you believes the same thing and has done so for a very long time. And, changing one's mind might not always lead to good results. Indeed, sometimes people make mistakes or change their minds unnecessarily.
>
> So, this Investigation asks you to consider this important question: How and why do individuals change their minds?
>
> To help you think about this question, we are providing you examples of two people who changed their views on the structure of the Universe and our place in it: Copernicus and Galileo. Both men questioned beliefs that had existed for over 2,000 years. And both men contributed to a new way of thinking about the Earth's place in the Universe.
>
> Throughout history, most people thought that the Earth was at the center of the Universe and that it did not move. This is called the geocentric view of the Universe. Copernicus and Galileo questioned that view and argued that the Earth and the other planets revolved around the Sun. This is the heliocentric view.
>
> So, why did Copernicus and Galileo change their minds? Can their cases help you develop an argument for when people should change their minds? How? Or do you think that their stories are not very helpful in answering this question?

Now that students are familiar with the question and problem statement, have them read the texts in the Investigation Library. Explain to the students that they should use the texts, and the story of Copernicus and Galileo, to create an explanation about how and why individuals change their minds.

Part 2—Communicating Conclusions

Give students no more than 50 minutes to complete a five- to six- paragraph essay responding to the Investigation question. Please do not assign this as homework. This must be an in-class activity. Make sure students type their responses using a word processing application, and that they save the file. They should not type directly into the Investigation 0 input form. They can copy/paste their essays into the Investigation 0 input form when they're ready to submit.

Also, please remember the purpose of this baseline assessment. This task frustrates teachers because it frustrates students. The urge to ease their frustration will be great. Please fight the urge to teach! Continue to remind students that they are to do the best they can and not worry if they are having difficulties.

UNIT 1 - INVESTIGATION 0

HOW AND WHY DO INDIVIDUALS CHANGE THEIR MINDS?

Purpose

Why give you a writing test so early in a course? What kind of course begins with a writing test? Well, in the BHP course we are so confident that you're going to not only enjoy yourself and learn lots of "stuff," you are also going to really get better at reading, writing, and thinking. And to prove that to you, we're going to ask you three times over the course to send the BHP team some writing. And today is one of those days. This activity—Investigation 0—is the baseline writing assessment for the course.

Process

All Investigations in the course (there are 10, if you include this one!), are two-part activities. In Part 1, you will spend time exploring, reading, and analyzing what's called the "Investigation Library." The Investigation Library consists of a bunch of primary and secondary documents. In Part 2, you'll use what you learned from the texts in Part 1 to write an answer to the unit driving question (for example, this unit's driving question is: How and why do individuals change their minds?). Since this is the first time you'll do this activity, think of it as a trial run. Do the best job you can, but don't sweat it, because what you do here will not "count" toward your grade. No one is making any judgment about you or your teacher based on this assignment.

Part 1 – Explore, Read, and Analyze Texts

Investigation question: How and why do individuals change their minds?

Framing the Problem: How and why do individuals change their minds?

In studying Big History, you will meet many people who, like you, question their own thinking and beliefs. Like you, they sometimes change their minds about things they had long thought to be true. And, on occasion, the changes in their thinking and beliefs lead other people to raise new questions, to develop new answers, and maybe to even change their minds.

Many of the most important changes in the world, such as discovering cures for diseases or developing new forms of government, have happened because people came to new conclusions about what causes sickness or what is the best political system. However, it is not always easy to question your thinking or change your ideas, particularly if everyone around you believes the same thing and has done so for a very long time. And, changing one's mind might not always lead to good results. Indeed, sometimes people make mistakes or change their minds unnecessarily.

So, this Investigation asks you to consider this important question: How and why do individuals change their minds?

To help you think about this question, we are providing you examples of two people who changed their views on the structure of the Universe and our place in it: Copernicus and Galileo. Both men questioned beliefs that had existed for over 2,000 years. And both men contributed to a new way of thinking about the Earth's place in the Universe.

Throughout history, most people thought that the Earth was at the center of the Universe and that it did not move. This is called the geocentric view of the Universe. Copernicus and Galileo questioned that view and argued that the Earth and the other planets revolved around the Sun. This is the heliocentric view.

So, why did Copernicus and Galileo change their minds? Can their cases help you develop an argument for when people should change their minds? How? Or do you think that their stories are not very helpful in answering this question?

Now that you are up to speed on the question and problem statement, read the documents in the Investigation Library. You'll use them to figure out why Copernicus and Galileo changed their minds, and decide whether their cases can help make an argument for when and why people should change their minds.

Part 2 – Communicating Your Conclusions

Write a five- to six-paragraph essay explaining when and why people change their minds and whether Copernicus and Galileo are relevant examples. Make sure you type your responses using a word processing app and save it as a file. Do not type directly into the Investigation 0 input form. You can copy/paste your essay into the Investigation 0 input form when you're ready to submit.

0

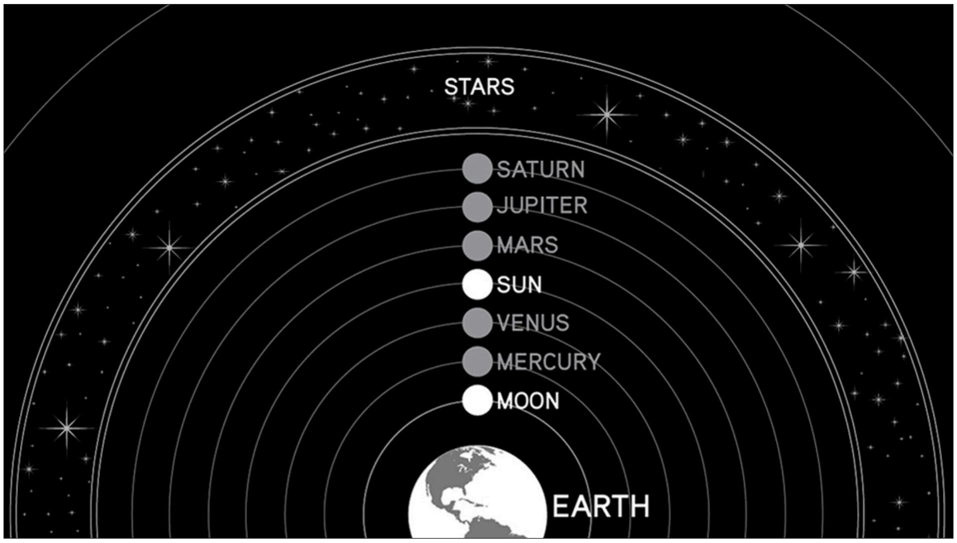
INVESTIGATION LIBRARY

TEXT 01
THE GEOCENTRIC VIEW

How did the Universe appear to our ancestors before the invention of the telescope? Most people thought the Earth was the center of the Universe. For them, the Earth did not move in the sky and it did not rotate on its axis. Rather, all the planets and stars rotated around the Earth. Historians and scientists call this Earth-centered view of the Universe *geocentric* ("geo" referring to the Earth and "centric" meaning in the center) and *geostatic* ("static" meaning unmoving).

The Greek astronomer Ptolemy (ca. 90–168 CE) described the geocentric view of the Universe in the *Almagest*, a book he wrote in about 150 CE. For more than 1,500 years, people accepted this view (pictured below) as the correct one. Why would an astronomer like Ptolemy hold a geocentric and geostatic view of the Universe? Why did so many of our ancestors accept this view? In the excerpt below, Carl Sagan, an American astronomer and cosmologist, explains.

> Ptolemy believed that the Earth was at the center of the Universe and that the Sun, Moon, planets and stars went around the Earth. This is the most natural idea in the world. The Earth seems steady, solid, immobile, while we can see the heavenly bodies rising and setting each day. Every culture leaped to the geocentric hypothesis.



THINGS TO THINK ABOUT

Why would most of our ancestors have believed in this view of the Universe? Can you figure out why their model of the Universe did not include Neptune and Uranus?

Sources
Carl Sagan, *Cosmos* (New York: Ballantine, 1985) 38–39.

Illustration by the Big History Project.

TEXT 02

PATH OF THE PLANETS

With only their eyes, our ancestors observed the heavenly bodies moving across the night sky. The Greeks called these heavenly bodies "planets," which means wandering stars.

They also noticed that sometimes the planets appear to go backward in the sky and even to do loop-de-loops. The picture below, a composite photo of shots taken of Mars from the same spot on the Earth once a week from early autumn 2009 to late spring 2010, shows how Mars appeared to reverse its course and then circle back on track.

From the first picture, taken on October 2, 2009, Mars is the white dot on the far right-hand side of the photograph. About three months later (December 22, 2009), Mars appears to go backward in the sky and moves in that direction until about mid-March, when it looks as if it is going forward again.

Scientists call this movement of the planets "retrograde motion." "Retrograde" means backward. What do you think explains this unusual motion? How would our ancestors explain it?

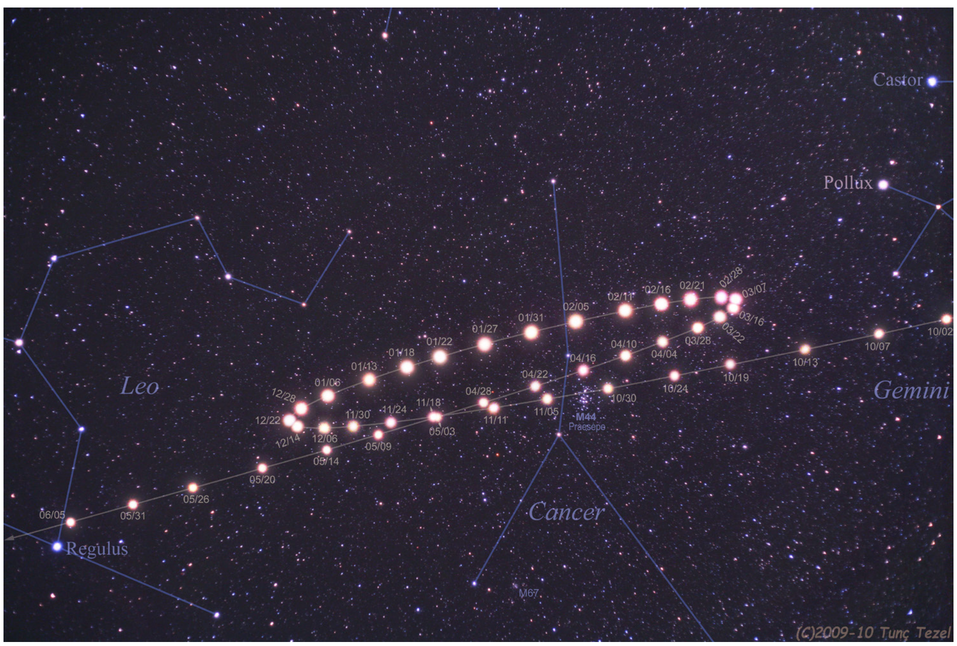


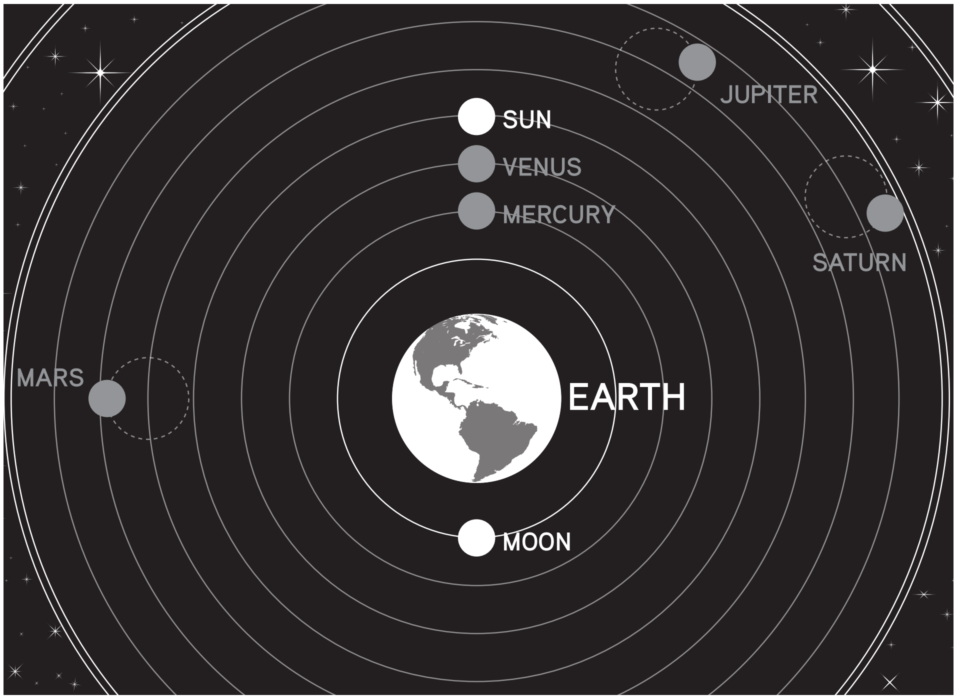
Image credit
Tunç Tezel (TWAN), http://apod.nasa.gov/apod/ap100613.html

TEXT 03
EPICYCLES

If you accepted the geocentric view of the Universe, how would you explain the backward and forward motion of Mars and the other planets? Would this motion cause you
to change your view of the Universe?

Ptolemy's explanation in the *Almagest* was that, as Mars and the other planets moved around the Earth, they also made smaller orbits called "epicycles." Epicycles were mini-orbits that planets took around imaginary centers as they also orbited the Earth.

The picture below shows the epicycles of Mars, Jupiter, and Saturn as imagined in the geocentric theory of the Universe.



Source
Illustration by the Big History Project.

THINGS TO THINK ABOUT

Can you see how adding epicycles helped to explain why planets seemed
to move backward in the night sky. How do epi-cycles explain retrograde motion of the planets?

TEXT 04

COPERNICUS'S HELIOCENTRIC VIEW

In 1543, Copernicus (1473–1543) published a revolutionary book that challenged the geocentric view of the Universe. The texts below explains some of what we know about why Copernicus changed his mind and suggested that the heliocentric view was better than the geocentric view.

Cynthia Stokes Brown, an educator and historian who taught at Dominican University of California at San Rafael, writes:

> In 1492, Copernicus went to study at a university. He was 19 years old. At school, he began to question what his teachers were teaching. Even though his professors believed that the Earth was in the center of the Universe and did not move, Copernicus began to question those ideas. His professors also taught about Ptolemy's views of the Universe, but Copernicus found mathematical errors in Ptolemy's use of epicycles that did not allow accurate predictions about the movement of the planets. These predictions would be more accurate, he thought, if the Earth revolved around the Sun instead of the other way around.
>
> After graduating, Copernicus continued his observations of the heavens. To observe the planets, he used devices that looked like wooden yardsticks joined together. He used these to measure the altitude of stars and planets and to calculate the angles between two distant bodies in the sky. He could not use a telescope because no one had invented the telescope yet.
>
> By 1514 Copernicus wrote a short report, called the *Little Commentary*, that explained his heliocentric theory. In this report, he confidently claimed that the Earth both revolved on its axis and orbited around the Sun. For Copernicus, putting the Sun in the center of the Universe solved many of the problems he found with Ptolemy's model. He gave this book, however, to only a few of his friends.
>
> Copernicus waited over 20 years before he published his ideas on the heliocentric Universe. He was afraid of creating controversy. Finally, Copernicus agreed to have the book, *On the Revolutions of the Celestial Spheres*, published in 1543, the year he died.

Paul Murdin, an astronomer at Cambridge in the United Kingdom and the author of many books on astronomy, writes:

> Copernicus put forward the concept that planets revolved around the Sun in outwards order: Mercury, Venus, Earth, Mars, Jupiter and Saturn; while the Moon revolved around the Earth. The book is regarded as the foundation of the heliocentric (Sun-centered) theory of the solar system.... Copernicus showed that the puzzling retrograde motion of the outer planets, particularly Mars, was a natural consequence of the way that the

inner planets revolved around the Sun more quickly than the outer ones — and athlete running quickly on the inside track of a racecourse would see an athlete in front on an outer track moving ahead, but then as he overtook him he would see him apparently falling behind.

Copernicus's model asked people to give up thinking that they lived in the center of the Universe. For him, the thought of the Sun illuminating all of the planets as they rotated around it had a sense of great beauty and simplicity.

Sources

Modified from Cynthia Stokes Brown's biography of Copernicus that appears in Unit 2 of the Big History Project course.

Paul Murdin, *Mapping the Universe* (London: Carlton Books, 2011).

TEXT 05

GALILEO'S LETTER TO KEPLER

Galileo (1564–1642) explains his support for Copernicus in a letter, written in 1597, to Johannes Kepler, a fellow scientist. He wrote the letter 54 years after Copernicus had died.

> I accepted the view of Copernicus many years ago. And from this standpoint I have discovered many natural phenomena, which cannot be explained on the basis of the more commonly accepted hypothesis [that the Earth is the center of the Universe].
>
> I have written many direct and indirect arguments for the Copernican view. But until now I have not dared to publish them, alarmed by the fate of Copernicus himself, our master. He has won for himself undying fame in the eyes of a few, but he has been mocked and hooted at by an infinite multitude… I would dare to come forward publicly with my ideas if there were more people of your way of thinking.

Source
Modified from *The Portable Renaissance Reader*, ed. James Bruce Ross and Mary Martin McLaughlin (New York: Viking Press, 1953).

TEXT 06
GALILEO'S TELESCOPE

Galileo invented many things, and though he did not invent the telescope, he did, in 1609, devise a telescope that had more power than previous ones. And he was the first person to *use* the telescope to study the heavens. With it, he saw that the Moon was not smooth, observed sunspots and a supernova, and discovered the four moons of Jupiter. Did these discoveries support, extend, or challenge the geocentric or the heliocentric view of the Universe?

Image credit
Telescopes owned by Galileo © Gustavo Tomsich/CORBIS

TEXT 07

GALILEO DISCOVERS THE MOONS OF JUPITER

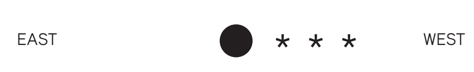
In this text, Galileo describes how he discovered the moons of Jupiter. Between January 7 and January 15, 1610, Galileo observed Jupiter and recorded his observations in his journal. At first, Galileo thought the moons were "fixed stars" and did not move, but then he changed his mind. How did he determine that these are moons that revolve around Jupiter? Do you think this discovery — that Jupiter has moons — supported Copernicus's view of the Universe? If so, how? If not, why not? Galileo published his discovery in his book *The Starry Messenger*.

On the seventh day of January of the present year 1610, I inspected the celestial constellations through a spyglass. Jupiter presented himself. I saw that three little stars were positioned near him — small but yet very bright. Although I believed them to be among the number of fixed stars, they nevertheless intrigued me because they appeared to be arranged exactly along a straight line and to be brighter than others of equal size. Two stars were near him on the east and one on the west.

FIG 1: January 7

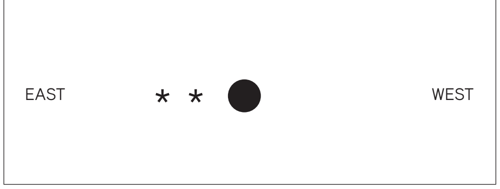
On the eighth day of January, I returned to the same observation, I found a very different arrangement. For all three little stars were to the west of Jupiter and closer to each other than the previous night, as shown in the adjoining sketch. I was aroused by the question of how Jupiter could be to the east of the fixed stars when the day before he had been to the west of two. For this reason I waited eagerly for the next night. But I was disappointed in my hope, for the sky was everywhere covered with clouds.

FIG 2: January 8



Then, on the tenth day of January, the stars appeared in this position. Only two stars were near him, both to the east. The third, as I thought, was hidden behind Jupiter. I found that change was not in Jupiter, but in the said stars. And therefore I decided that they should be observed more accurately and diligently.

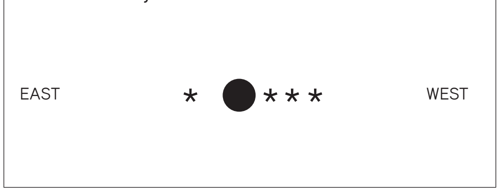
FIG 3: January 10



I therefore arrived at the conclusion, entirely beyond doubt, that in the heavens there are three stars wandering around Jupiter, like Venus and Mercury around the Sun. Also that there are not only three, but four wandering stars.

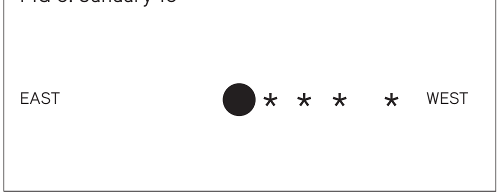
On the thirteenth day of January, three were on the west and one on the east.

FIG 4: January 13



On the fourteenth day of January, the weather was cloudy. On the fifteenth day of January, the four stars were positioned with respect to Jupiter as shown in the next figure.

FIG 5: January 15



Our vision offers us four stars wandering around Jupiter like the Moon around the Earth while all together with Jupiter traverse a great circle around the Sun in the space of 12 years.

Source

Modified from Gaileo Galilei (1610), *Sidereus Nuncius*, or the *Sidereal Messenger*, trans. Albert van Helden (Chicago: University of Chicago Press, 1989).

TEXT 08

THE HELIOCENTRIC VIEW GROWS IN POPULARITY

Before Copernicus and Galileo, most people and most powerful organizations, such as the Roman Catholic Church in Europe, thought the geocentric view was correct. Therefore, both Copernicus and Galileo were afraid to publish their new ideas and with good reason. Copernicus waited until near his death to allow his book to be published and the Roman Catholic Church eventually tried and found Galileo guilty of holding heliocentric views that went against the Bible.

As you think about why and when people should change their minds, is it important to think about social pressure? Is it easier to change your mind when others are doing so?

Take a look at this timeline below. We have included some key dates in the change in collective learning from the geocentric to heliocentric views. How does this brief timeline support, extend, or challenge your ideas about when and why people should change their minds?

1633 Roman Catholic Church Outlaws Heliocentric View
The Roman Catholic Church bans the teaching of heliocentric theories: "The proposition that the Sun is the center of the world and does not move from its place is absurd and false.... The proposition that the Earth is not the center of the world and...that it moves...is equally absurd and false...and at least an error in faith."

1661 Newton Studies Heliocentric View in College
Among the books that Isaac Newton reads at Trinity College, Cambridge is Galileo's *Dialogue*, which challenges the geocentric idea.

1686 Popular Book Promotes Heliocentric View
Bernard de Fontenelle, a French thinker, publishes *Conversations on the Plurality of Worlds*. In it he accepts the heliocentric view. The book becomes very popular and is published in many languages.

1687 Newton Publishes a Scholarly Book Improving on Heliocentric View
Newton publishes his *Principia Mathematica*, offering more proof and many corrections for Copernicus and Galileo's heliocentric view.

1758 Roman Catholic Church Drops Its Heliocentric Ban
The Catholic Church drops the prohibition of books advocating heliocentric theory.

1774 Roman Catholic Church Opens its First Observatory

1891 Roman Catholic Church Opens the Vatican Observatory

1992 Roman Catholic Church Expresses Regret for Treatment of Galileo

2008 Catholic News Reports on Roman Catholic Church Plans to Honor Galileo with a Statue in the Vatican Gardens
These plans, however, are later put on hold.

Analysis of texts in this investigation

Text Name	Lexile Measure[1]	Common Core Stretch Grade Band[2]	Mean Sentence Length	Flesch Ease[3]
The geocentric view	900	6–8	13.89	59.6
Path of the planets	890	6–8	14.3	67.2
Epicycles	970	6–8	15.5	51.1
Copernicus's heliocentric view	1040	6–8	16.7	49.2
Galileo's letter to Kepler	1150	6–8	20.14	53.2
Galileo's telescope	1160	6–8	19	41.6
The moons of Jupiter	940	6–8	14.5	69.1
The heliocentric view grows in popularity	1040	6–8	13.46	43.9

[1] Lexile measure indicates the reading demand of the text in terms of its semantic difficulty and syntactic complexity. The Lexile scale generally ranges from 200L to 1700L. The Common Core emphasizes the role of text complexity in evaluating student readiness for college and careers.

[2] We are using the Common Core "stretch" grade bands. The Common Core Standards advocate a "staircase" of increasing text complexity so that students "stretch" to read a certain proportion of texts from the next higher text complexity band.

[3] In the Flesch Reading Ease test, higher scores indicate that the material is relatively easy to read while lower scores indicate greater difficulty. Scores in the 50–70 range should be easily understood by 13- to 15-year-olds, while those in the 0–30 range are appropriate for university graduates.