

Activity 2. *Starry Messenger*: Close Reading. Teacher’s Version

Preliminary Notes

- This close reading is divided into seven sections of varying length in the left-hand column. Directed questions and explanatory text are found in the right-hand column along with focus questions that respond to CCSS.ELA-Literacy.RST.6-8.4, 7, and 9.
- The Launchpad does *not* contain the question answers or the supplementary comments. It is suggested that the student version of the questions, which appears in the Launchpad version of the handout, be distributed after the close reading of the section(s) at the discretion of the teacher.
- Academic vocabulary is bolded only in the teacher’s version; see the Teacher’s and Student version worksheets of the complete lists of vocabulary items.
- Call-outs for the handouts of Galileo’s drawings of Orion and the Pleiades are introduced in Section 5 of both the Teacher’s and student version, and in the Launchpad.

Suggested Sequence for Close Reading

Reading 1

The teacher will model a reading of the entire first section with the class. Instruct them as they read to highlight unfamiliar words or passages. For each chunk of text, have students briefly note what they think it means.

Reading 2

Read again the first section aloud to the class, modeling the types of questions that students will be answering when they read the rest of the sections on their own.

Individual Readings

If feasible, divide the class into small groups of 3 students each and have each group read aloud the six remaining passages to the class, finding answers to the focus questions (right hand column and on their graphic organizer). As students progress, review unfamiliar words in the entire passage, including the **bolded** vocabulary words (also on the vocabulary worksheets) and any other words that the students identify in their readings.

Assessment

Encourage the class to refine their own answers to the focus questions and come to consensus about the best responses for each.

Section 1

Hitherto I have spoken of the observations which I have made concerning the Moon's body; now I will briefly announce the phenomena which have been, as yet, seen by me with reference to the **Fixed Stars**. And first of all the following fact is worthy of consideration: The stars, fixed as well as **erratic**, when seen with a telescope, by no means appear to be increased in **magnitude** in the same proportion as other objects, and the Moon herself, gain increase of size but in the case of the stars such increase appears much less, so that you may consider that a telescope, which (for the sake of illustration) is powerful enough to magnify other objects a hundred times, will scarcely render the stars magnified four or five times. But the reason of this is as follows: When stars are viewed with our natural eyesight they do not present themselves to us of their bare, real size, but beaming with a certain vividness, and **fringed** with sparkling rays, especially when the night is far advanced; and from this circumstance they appear much larger than they would if they were stripped of those adventitious fringes, for the angle which they subtend at the eye is determined not by the primary **disc** of the star, but by the brightness which so widely surrounds it.

This section, though it introduces Galileo's discussion of his observations of the stars, contains information and references that are not central to student's understanding of the key concepts in this lesson. For example, in his discussion of the appearance of the stars to the naked eye refers to optical angle that an image subtends, a concept that would not be covered at this level. For this reason, it is suggested that this passage be read by the teacher to the class and used to model the process of close reading.

In this passage, Galileo refers to two kinds of stars. What are they? (*Fixed stars and erratic stars.*)

What did Galileo discuss in the passages that came before this one? (*Observations concerning the Moon's body.*)

What does Galileo mean when he refers to stars viewed with our natural eyesight? (*He means looking at stars without a telescope.*)

Did Galileo discover a difference between how a telescope magnifies the Moon and the stars? What was it? (*A telescope magnifies the Moon far more than it magnifies the stars.*)

Section 2

Perhaps you will understand this most clearly from the well-known circumstance that when stars rise just at sunset, in the beginning of twilight, they appear very small, although they may be stars of the first **magnitude**; and even the planet Venus itself, on any occasion when it may present itself to view in broad daylight, is so small to see that it scarcely seems to equal a star of the last magnitude. It is different in the case of other objects, and even of the Moon, which, whether viewed in the light of midday or in the depth of night, always appears of the same size. We conclude therefore that the stars are seen at midnight in uncurtailed glory, but their fringes are of such a nature that the daylight can cut them off, and not only daylight, but any slight cloud which may be interposed between a star and the eye of the observer. A dark veil or colored glass has the same effect, for, upon placing them before the eye between it and the stars, all the blaze that surrounds them leaves them at once. A telescope also accomplishes the same result, for it removes from the stars their adventitious and accidental splendors before it enlarges their true discs (if indeed they are of that shape), and so they seem less magnified than other objects, for a star of the fifth or sixth magnitude seen through a telescope is shown as of the first magnitude only.

How does Galileo try to get readers to understand the phenomena he explained in the previous section? (*He refers to something familiar—that as the night goes on stars appear brighter, and therefore bigger.*)

What does Galileo mean by “uncurtailed glory”? (*They appear brightest.*)

What does Galileo mean when he refers to a star’s fringe? What are some of the things that Galileo says can cut off a star’s fringe? (*Fringe is the quality of brightness that makes them more visible to us. Things that can cut off this fringe are daylight, a dark veil, colored glass, and a telescope.*)

What is Galileo referring to when he talks about a star’s “magnitude”? Find evidence for how he defines this. (*Magnitude seems to refer to brightness. The last sentence.*)

Is Galileo sure about the shape of the stars? What evidence suggests how sure he is? (*Last sentence, the phrase “if indeed they are of that shape.”*)

Section 3

The difference between the appearance of the planets and the fixed stars seems also deserving of notice. The planets present their **discs** perfectly round, just as if described with a pair of **compasses**, and appear as so many little moons, completely illuminated and of a **globular** shape; but the fixed stars do not look to the naked eye bounded by a circular circumference, but rather like blazes of light, shooting out beams on all sides and very sparkling, and with a telescope they appear of the same shape as when they are viewed by simply looking at them, but so much larger that a star of the fifth or sixth magnitude seems to equal **Sirius**, the largest of all the fixed stars.

How does Galileo describe the shape of the planets? (*“The planets present their discs as perfectly round” “little moons” “of a globular shape.”*)

How does he describe the Fixed Stars? (*“blazes of light” “shooting out beams on all sides”*)

Does a telescope change their appearance? How? (*much larger*)

What is Sirius? (*The largest of the fixed stars.*)

How does this relate to what you read in previous section? (*The stars appear bigger and are still bright, but are not magnified as much as the Moon.*)

Section 4

But beyond the stars of the sixth magnitude you will behold through the telescope a host of other stars, which escape the unassisted sight, so numerous as to be almost beyond belief, for you may see more than six other differences of magnitude, and the largest of these which I may call stars of the seventh magnitude or of the first magnitude of invisible stars, appear with the aid of the telescope larger and brighter than stars of the second magnitude seen with the unassisted sight. But in order that you may see one or two proofs of the inconceivable manner in which they are crowded together, I have determined to make out a case against two star-clusters, that from them as a specimen you may decide about the rest.

What words does Galileo use to describe the number of stars he saw through the telescope? (*Too numerous as to be almost beyond belief.*)

Galileo refers to a star's magnitude several times in this passage. How does the meaning of the term change or expand with each use? (*This question should be used for student oral reflection. When students are working in their groups, they can work on refining a definition of "magnitude" based on comparing and discussing their own interpretations.*)

What method does Galileo use to demonstrate how stars are crowded together when viewed through the telescope? (*He uses two specific star clusters as examples.*)

Section 5

As my first example I had determined to depict the entire constellation of **Orion**, but I was overwhelmed by the vast quantity of stars and by want of time, and so I have deferred attempting this to another occasion, for there are adjacent to, or scattered among, the old stars more than five hundred new stars within the limits of one or two degrees. For this reason I have selected the three stars in **Orion's Belt** and the six in his **Sword**, which have been long well-known groups, and I have added eighty other stars recently discovered in their vicinity, and I have preserved as exactly as possible the intervals between them. The well-known or old stars, for the sake of distinction, I have depicted of larger size, and I have outlined them with a double line; the others, invisible to the naked eye, I have marked smaller and with one line only. I have also preserved the differences of magnitude as much as I could.

Why did Galileo decide not to illustrate the entire constellation of Orion? (*Too many stars and not enough time.*)

How does Galileo try to make his drawing of what he has seen through the telescope as accurate as possible? (*He tries to preserve the relative size and distance of stars.*)

Why is it important that Galileo's drawing be accurate? How easy would it be for others to verify his drawings? (*His drawings need to be accurate because at the time he has written this he is the only person who has ever seen the skies through the telescope he has built. Others would have to build their own telescopes and follow his procedures to verify his findings.*)

NOTE: At Section 5, students should have the handout that includes Galileo's drawings of Orion and the Pleiades. The teacher may wish to supplement these drawings with some background information on Orion's Belt and Sword, as noted in "Preparation Instructions."

Section 6

As a second example I have depicted the six stars of the **constellation Taurus**, called the **Pleiades** (I say six intentionally, since the seventh is scarcely ever visible), a group of stars which is enclosed in the heavens within very narrow **precincts**. Near these there lie more than forty others invisible to the naked eye, no one of which is much more than half a degree off any of the aforesaid six; of these I have noticed only thirty-six in my diagram. I have preserved their **intervals**, magnitudes, and the distinction between the old and the new stars, just as in the case of the constellation Orion.

How many stars does Galileo see in the Pleiades? (*The six stars visible to the naked eye plus 40 others.*)

How do the Pleiades differ from Orion? (*Orion is a constellation; the Pleiades are part of a larger constellation, Taurus.*)

How does Galileo know that the Pleiades stars belong together? (*They lie within a very narrow defined area or precinct.*)

Of the 40 previously invisible stars, how many does Galileo include in his diagram? (36)

What do you think Galileo means by “intervals”? (*How far the stars appear apart in the sky*)

Why do you think Galileo chose to omit some of the stars he saw from his diagram? (*Not stated in text. Students might infer reasons from his explanation of why he chose to not depict the 7th star in the Pleiades or from other explanations in previous portions of the text.*)

Section 7

The next object which I have observed is the essence or substance of the Milky Way. By the aid of a telescope any one may behold this in a manner which so distinctly appeals to the senses that all the disputes which have tormented philosophers through so many ages are exploded at once by the irrefragable evidence of our eyes, and we are freed from wordy disputes upon this subject, for the Galaxy is nothing else but a mass of innumerable stars planted together in clusters. Upon whatever part of it you direct the telescope straightway a vast crowd of stars presents itself to view; many of them are tolerably large and extremely bright, but the number of small ones is quite beyond determination.

And whereas that milky brightness, like the brightness of a white cloud is not only to be seen in the Milky Way, but several spots of a similar color shine faintly here and there in the heavens. If you turn the telescope upon any of them you will find a cluster of stars packed close together. Further—and you will be more surprised at this—the stars which have been called by every one of the astronomers up to this day nebulous, are groups of small stars set thick together in a wonderful way, and although each one of them on account of its smallness, or its immense distance from us, escapes our sight, from the commingling of their rays there arises that brightness which has hitherto been believed to be the denser part of the heavens, able to reflect the rays of the stars or the Sun.

According to Galileo, what is the Milky Way made of? (*A mass of innumerable stars planted together in clusters.*)

Does Galileo believe it is possible to know the number of stars or to count them? What evidence do we have of that? (*He refers to them as innumerable. He says that the number of small ones is “quite beyond determination.”*)

According to Galileo what color is the Milky Way? How do we know? (*Galileo describes it as having the brightness of a white cloud.*)

Source: Edward Stafford Carlos, ed., *The Sidereal Messenger of Galileo Galilei* (London: Rivingtons, 1880).

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http://openlibrary.org/books/OL23650348M/The_sidereal_messenger_of_Galileo_Galilei (Note: the source is given “as is” with minor adjustments for sectioning and regularizing of British spelling, e.g., colour/color.)