# Astronomy

## Renewable Assignments

By Marisa Enos & Jonathon Miller

# Table of Contents

# Assignment 1: Make Your Own Stonehenge

Renewable Assignment

***Astronomy***

---

## OER URL

OpenStax Astronomy

## Notes to Faculty

Use with Openstax Chapters 2 (observing the Sky), 4 (Earth, Moon, Sky) or 6 (Astronomical Tools).

## Assignment Description

For this assessment, students will be asked during the unit on seasons to go find an area around where they live that could be used to mark the sun's rising position as it relates to the local landscape. Past students would try to predict using suncalc.net what buildings could be used as sun markers. Future students then would test where past students said the sun would rise and take pictures to show if it worked. Students would then try to find another area using suncalc.net to predict and future students would test. The assignment deliverable would be a picture of the building with an explanation of why or why not the prediction was correct.

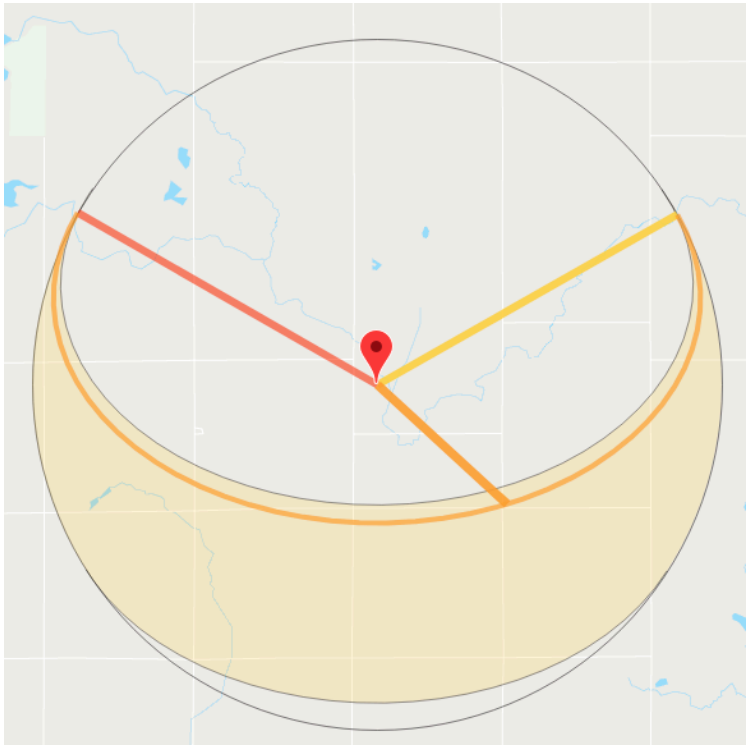
## Instructions & Student Sample

Stonehenge is a famous stone circle located on the Salisbury Plain in Southern England. The entire complex is estimated to have been constructed over a period of time between 3000 and 1500 B.C. The entire purpose of Stonehenge will probably never be known but archaeologists are very confident that one of the uses for Stonehenge was as a midsummer solstice marker. It's on this date, June 21st, that the Sun rises at its most northerly position along the eastern horizon. The inner semi-circle of stones point out to what is called the Heel Stone which lies to the northeast of the main Stonehenge complex. Observers from within Stonehenge will see the rising Sun pass right over the top of the Heel Stone. In 2017, some 1300 people visited the site in the early morning to pay witness to this sacred celestial event.

The focus of this exercise is to use the online application at suncalc.net, designed by Vladimir Agafonkin, to search for structures or natural features in your own area that could be use to

mark the rising or setting Sun on the four first days of the astronomical seasons. These northern hemisphere dates are: March 20th/21st (vernal equinox or first day of spring), June 21st (summer solstice or first day of summer), September 21st/22nd (autumnal equinox or first day of autumn), and December 21st (winter solstice or first day of winter).

The image below is of the SunCalc tool found at suncalc.net. North is to the top of the image.



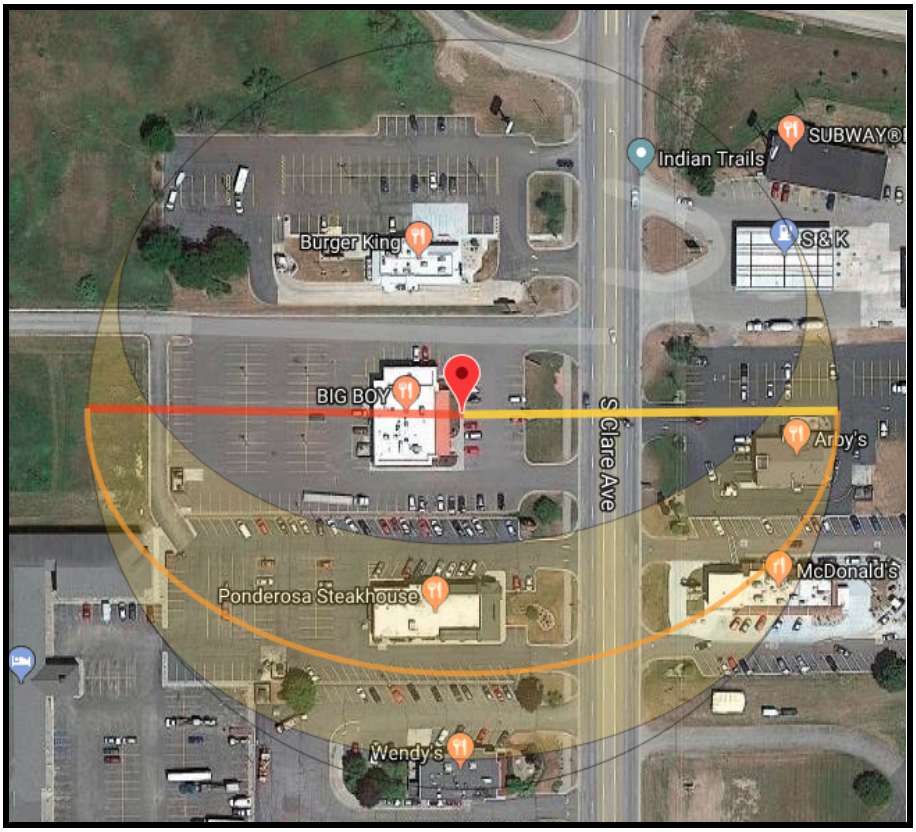
Yellow line is pointing to the position of the rising Sun for date selected.

Orange line is pointing to the position of the Sun during the daytime of the date selected.

Red line is pointing to the setting position of the Sun for the date selected.

When you enter the website, you will find the tool above projected against a simple Google Maps projection. You can toggle between map view and satellite view in the top left portion of the page. The location and date can be set along the very top of the page. The position of the Sun during daylight hours can be adjusted using the time of day scale under the location and date boxes.

Use the satellite setting to look for a structure or natural feature that would be easy to direct a person to sometime in the future. Look for a place to stand on one of the first four days of the astronomical seasons, where a selected structure or natural feature aligns with either the rising or setting Sun. Take a screenshot of the tool showing the alignment from above similar to the example show below of a location in Central Michigan. Notice in this image that a person standing in the front and center of the Big Boy Restaurant will see the rising Sun on the northern side of the Arby's building across the street on the date of the Vernal Equinox or March 20th.




Once you have selected a location and alignment from the SunCalc website, write-up a set of instructions for a student in a future semester to follow and test the accuracy of your prediction for a specified date. This student will read your instructions well before the date specified and make plans to go and stand where you instructed them. They will take a picture of either the rising or setting Sun and compare it with your screenshot of the SunCalc tool. An image testing the above prediction is shown below. The student taking a picture will write a brief report on the accuracy of the prediction, share their photo, and make a similar prediction using the SunCalc.net application for yet another student in a future semester to test.


## Assigned Dates based on Semester:

Students in the fall semester will find an alignment and make predictions for students taking the class in the semester that includes March 20th/21st. Students in the semester of March 20th/21st will test the fall semester's prediction, produce a short report, and then find an alignment and make a prediction for a student who take the class during the semester that includes June 21st. This student will again, test the previous prediction, complete a report, find a September 21st/22nd alignment and make a prediction for a student to test on September 21st or 22nd. This cycle can go on for as long as the instructor likes.

## Cloudy Skies?

It is understood that the weather conditions might not always accommodate the observer on the date specified by the previous student. Because of this students, will have a window of no more than six days (three before and three after) to check the previous semester's prediction. If weather conditions still to not allow for a quality observation then the student will take the closest day possible to make the observation and include in their report how many days difference there is and reflect on how far the Sun has drifted between the date instructed and the actual date observed. Instructors might also think about allowing or asking for both rising and setting Sun positions to increase the odds of good observational weather.

# Rubric

| Features: | Excellent 40-50 pts. | Acceptable 30-39 pts. | Poor 0-29 pts. |
|---|---|---|---|
| Creativity | Student chose a unique landmark (building, natural landmark, etc.) that would be recognizable and accessible to others. | Student chose a semi-unique landmark that is not easily recognizable or accessible. | Student chose an obscure/random landmark that is not recognizable or accessible. |
| Presentation Elements | Student created a presentation in Google Slides that includes a picture, description, and overhead SunCalc screen clipping. | Student is missing one of these elements. | Student is missing two or more of these elements. |
| Accuracy | Student captured picture on the day equinox or solstice. | Student captured picture within 3 days (before or after) of the equinox or solstice. | Student captured picture more than 7 days before or after the equinox or solstice. |
| Quality | Student gives a detailed description of where to find unique landmark and provides correct azimuth for rising sun, gives a clear image of the sunrise, uses arrows and sun clipart on the screen clipping, | Student gives a somewhat clear description of where to find unique landmark and provides correct azimuth for rising sun, the image is kind of blurry but still visible, uses arrows and sun clipart on the screen clipping. | Student gives an unclear description of where to find unique landmark, does not have/is incorrect azimuth label, the image is not visible, does not use arrows and sun clipping, |

# Assignment 2: Mission Progress Reports

## Renewable Assignment

***Astronomy***

---

## OER URL

OpenStax Astronomy

## Notes to Faculty

Use in correspondence with Chapter 6 in the OpenStax Astronomy Textbook.

## Assignment Description

Students would be tasked with updating mission progress with different satellites, including where it is, where it is going, why it is going there, etc. This could include images, links to articles, predictions, etc. Every semester students would add to the database by either updating a satellites progress or by adding a new entry. We would want to house this in OER Commons.

## Instructions

For this assignment, you will be tasked with reporting on the current status of a selected mission from NASA or another space agency.  If you are the first student for a certain mission then you'll need to choose a mission from the following websites:

1. NASA Missions (Current)
2. European Space Agency Missions (Current and Future)

You may also wish to also visit the Chinese National Space Administration website at: www.cnsa.gov.cn/

Students will choose from a list of missions to follow and essentially help create a chunk of a timeline for that mission. After students update the mission progress report, they will need to write a one page reflection discussing what have learned and predictions they have about the future of this mission. The following must be included in the mission report update:

- Name of satellite
- Where is it going?
- Where has it been?
- Current location

- Mission objectives
- Mission Progress Report
- Future mission objectives and questions for students in future semester(s)
- Images or links to articles about the satellite

## Rubric

| Features: | Excellent 40-50 pts. | Acceptable 30-39 pts. | Poor 0-29 pts. |
|---|---|---|---|
| Report | Student will report in the excel document and in a 1 page summary on what satellite they chose, where it is going, where it has been, current location, and future mission objectives. | Student report is missing one of the following: what satellite they chose, where it is going, where it has been, current location, and future mission objectives. | Student is missing two or more of the following: what satellite they chose, where it is going, where it has been, current location, and future mission objectives. |
| Reflection | Student provides a 1 page reflection that covers what they have learned and predictions they have about the future of this mission. | Student provides a ½ page summary that covers what they have learned and predictions they have about the future of this mission. | Student reflection is less than ½ a page or does not cover what they have learned and predictions they have about the future of this mission. |
| Resources | Student includes pictures or external links to assist future students in following the satellites mission report. | Student includes either pictures or external links to assist future students in following the satellites mission report. | Student does not include pictures or external links to assist future students in following the satellites mission report |

## Sample

Name of satellite: Kepler
(Mission Website: https://www.nasa.gov/mission_pages/kepler/main/index.html)

**Where is it going?**: The Kepler Observatory is stated to be in an Earth trailing, heliocentric (sun-centered) orbit that as of April of 2018, just over 94 millions miles away. I'm not sure if that is a straight line distance or the distance associated with Earth's orbital path.

**Where has it been?**

The Observatory was launched back in March of 2009 and has been in a trailing Earth orbit from the start. Over the last nine years, the observatory has been drifting further and further away from Earth. This is done for the purpose of maximizing the viewing field of the space observatory by greatly reducing the size of the Earth in those fields of view.

**Current Location**

Kepler remains 94 million miles from Earth as of April, 2018. The Kepler Observatory has been increasing its distance from Earth by a rate of about 10 million miles per year. That is just over 1,000 miles for every hour of the mission so far.

**Mission Objectives**

The Kepler Space Observatory is part of a leading edge effort in the field of astronomy to look for planets that orbit other stars, called exoplanets. The craft was designed to look at thousands of stars simultaneously and detect very slight dips in the light coming from those stars. The dip would be a result of an orbiting planet of the star passing in front, blocking a small portion of star light in the process. The event in which a planet passes in front of a star is known as a transit. Based on the amount of light blocked along with the duration of the transit, several planetary characteristics can be calculated. These would include the size of the planet and relative orbital distance from it's respective star. This transit method is the best method to date to look for the crown jewel of exoplanet searching: an Earth like planet that could possibly harbor life.

**Mission Progress Report**

According to the Mission website (https://www.nasa.gov/kepler/discoveries), Kepler has discovered more than 2,000 candidate exoplanets, over 2,000 confirmed exoplanets, and 30 exoplanets that are less than twice Earth's size and within what astronomers call the habitable zone or an average distance from their star that is neither too hot or too cold to sustain complex life.

As is the case with any space mission, mechanical failures arise that alter the mission objectives moving forward. In May of 2013, Kepler lost a guidance component that affected maneuvering abilities of the observatory. It was at this point, that the mission administrators decided to end the original Kepler mission and call the new mission, working within the new limitations of the space observatory, K2.

K2 has been searching a specific field for nearly five years now and has been able to add 480 candidate exoplanets planets and 309 confirmed exoplanets. This had been done, in large part, with the help of interested community members and google technologies that allow average citizens to comb through data collected by the K2 mission and look for data signatures that a planet had transited one of thousands of stars within the field of view.

**Future mission objectives**

As of April 2018, mission programmers have made statements that the fuel source of the Kepler observatory is running low and that the probe might finally run out before the the end of 2018. On April 18th 2018, NASA launched the TESS or Transiting Exoplanet Survey Satellite which will effectively replace the Kepler Mission in the search for Earth-like exoplanets.

**Future Students Questions:**

1. When did the Kepler/K2 probe finally run out of fuel?
2. What was the final count of candidate and confirmed exoplanets make by Kepler and K2 missions?
3. Where is the TESS probe with respect to Earth?
4. How many exoplanets has the TESS mission found?
5. Has TESS found any additional exoplanets that are Earth-like in size and within that star's habitable zone?

**Images or links to articles about the satellite**

Kepler NASA website

TESS NASA website

# Assignment 3: Follow Leading Scientists on Social Media

## Renewable Assignment

***Astronomy***

---

## OER URL

OpenStax Astronomy

## Notes to Faculty

Use throughout course on any topic that instructor wants students to spend more time exploring.

## Assignment Description

This assessment asks students to follow the trends on social media of astronomy. They will be tasked with identifying themes of conversation and research trends and create a repository of what is being discussed during that time period. Students will then be asked to make predictions or analyze trends from previous semesters.

## Instructions

Students will follow at least 4 different leading planetary scientists for 4 weeks. Students should be reading and following the interactions between different lead planetary scientists. During these four weeks, students will need to keep a list of key terms used keep track of the discussions said. By the end of the four weeks, students will need to provide at least 4 tweets per scientist on a specific topic about planetary science. A report that includes a summary of the topics covered and reflection on said topics and discussion thereafter that is collectively no less than page long will be submitted. Students will include screenshots of the chosen tweets with their reports.

## Rubric

| Features: | Excellent 40-50 pts. | Acceptable 30-39 pts. | Poor 0-29 pts. |
|---|---|---|---|
| Tweets | Student follows and provides at least 4 tweets for each of the 4 scientists on a specific topic about planetary science screenshot, name and credentials | Student follows and provide at least 3 tweets on a specific topic about planetary science. | Student follows and provide less than 3 tweets on a specific topic about planetary science or the tweets are not relevant to topic. |
| Key “hot” terms | Student provides a list of at least 3 hot (need to know) terms and definitions used | Student provides a list of at least 2 hot (need to know) terms and definitions used | Student provides less than 2 hot (need to know) terms or does not provide |

| | | | |
|---|---|---|---|
| | while following scientists. | while following scientists. | definitions used while following scientists. |
| Summary | Student provides a 1 page summary that includes who they followed and what was talked about in their tweets. | Student provides 1/2 page summary that includes who they followed and what was talked about in their tweets. | Student provides a summary that is missing who and what was talked about or student does not do summary. |
| Reflection | Student provides a 1 page reflection that includes if you agree or disagree and why, what have you learned, what would you like to know more about, and either questions or predictions for future groups to explore. | Student provides a 1 page reflection but is missing 1-2 of the following: if you agree or disagree and why, what have you learned, what would you like to know more about, and either questions or predictions for future groups to explore. | Student provides a 1 page reflection but is missing 3+ of the following: if you agree or disagree and why, what have you learned, what would you like to know more about, and either questions or predictions for future groups to explore. |

# Sample

## Planetary Scientists Followed:

1. Dr. Katharine Hayhoe (@KHayhoe): Climate / Atmospheric Scientist and Professor, Director of Climate Science Center at Texas Tech University @KHayhoe
2. Dr. Bruce Betts (@RandomSpaceFact): Chief scientist with the Planetary Society
3. Dr. Carolyn Porco (@carolynporoco): Planetary Scientist, extensive work with exploration missions.
4. Dr. Brian Cox (@ProfBrianCox): Physicist and Professor at University of Manchester

I chose to follow all four of these scientists on Twitter. The time frame that I followed and or examined their tweets ranged from February 1st to April 21st. Twitter, like many other social media forums, allows for interactions to take place online between the person of interest and anyone who is “following” said person. Twitter provides a platform for people of importance or influence to speak directly to the masses. While following the “tweets” the four scientists listed above made over a month to two month period, I noticed that each tweet could be categorized into a handful of themes. These would include: science specific tweets, retweets, or likes; statements made, retweeted, and or liked concerning social or political issues; formal “Twitter” statements related to specific events is which condolences, recognitions, congratulations,

encouragement, endorsements, opinions, etc. are shared; and miscellaneous tweets that didn't fall into one of the previous three themes. For each scientist, I have provided a summary of topics related to planetary science, bolded key terms, and offered a personal reflection over their Twitter activity.

## Summary and Reflective Report over **Katharine Hayhoe**:

Dates followed March 1st to April 1st, 2018

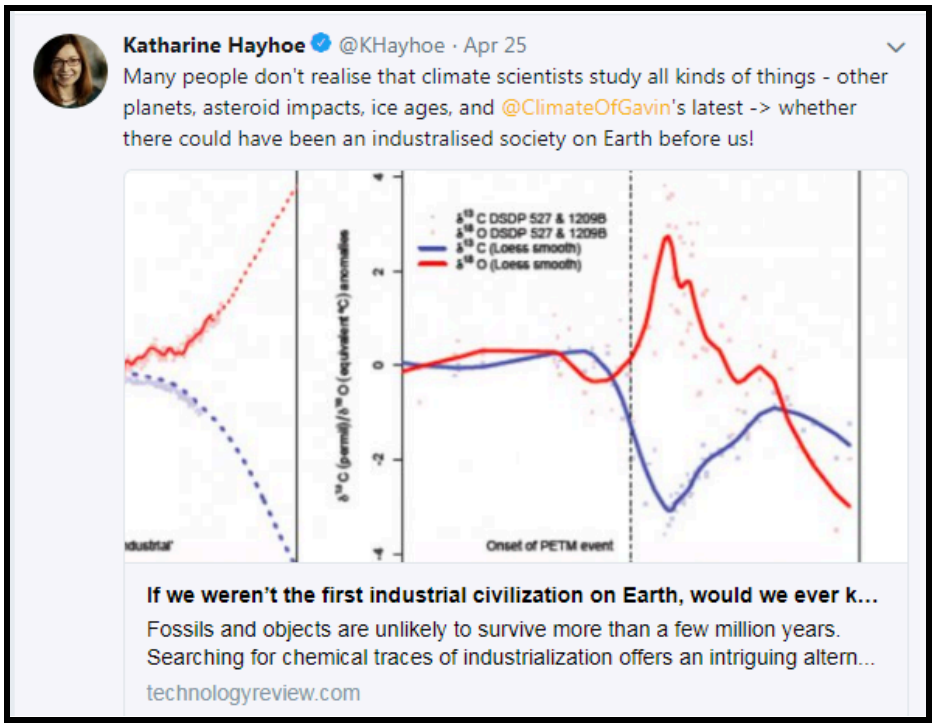
## Summary

I came across Dr. Hayhoe in following some of the back and forth that climatologists and meteorologist were having related to the issues of **global warming** and **anthropogenic climate change**. Scientists will sometimes encourage their followers to follow a specific person and I took their advice with Dr. Hayhoe. One of the themes with Dr. Hayhoe's posts that I liked was her posts sharing her video series: "Global Weirding" in which she addresses the issues and criticisms regarding this hot button issue.


## Reflection

I really respect that Dr. Hayhoe takes the time to post honest opinions and analysis on issues that are dear to her heart. She is very active on twitter, especially with sharing much of which her colleagues are posting and in the process becoming a popular source of information on climate change issues. She is also talented at explaining complicated issues in a simple

manner.  Her video series mention above seeks to correct errors of understanding and misconceptions with hard data and objective analysis.




## Summary and Reflective Report over **Bruce Betts**:

Dates followed February 1st to April 1st, 2018

## Summary

Dr. Betts did not have many tweets in the time frame I selected so I extended the time frame to two months.  With respect to planetary science, I noticed that Dr. Betts focused on the exploration of Mars.  He tweeted about **Olympus Mons** which is the largest volcano on Mars, tweeting that the landform is about the size of France.  He retweeted a NASA solar system tweet that showed a satellite image of a rover landing spot on the surface of Mars.  A post from Spirit and Oppy made mention of how long the rover **Opportunity** has been working on Mars, a total of 14 years.  Other posts or tweets related to planetary science included missions to the Moon and the launch of the **Starman** space probe by entrepreneur Elon Musk.


## Reflection:

The best qualities of Twitter is that it provides a direct path for communication, even if one way, between a person of advanced knowledge and the general public. We can share and interact with what that person feels is important at that time and place of the tweet. Followers can improve on their knowledge by reading articles that are tagged or exploring opportunities to attend online discussions or live workshops.


## Summary and Reflective Report over **Carolyn Porco**:

Dates followed February 1st to April 1st, 2018

## Summary

Dr. Carolyn Porco is a long time planetary scientist who has made a name for herself working on a few of the major solar system exploration missions such as the Cassini mission that explored the Saturn system. So many of the tweets made by the scientists I followed were comments made by others. Often a tweet would be retweeted or a link to an article of interest would be shared. This is nice as it allows followers direct access to the sources of information from which opinions and statements can be based off of.

The tweet theme that I chose from Dr. Porco was the sharing of images from the **Cassini** mission to Saturn. Her tweets often shared images and links to published reports on mission findings.


## Reflection

Dr. Porco does not tweet as often as others. She is very passionate about the environmental health of our planet and many times tweeted her opinion on specific issues related to all four system spheres of our planet: bio, geo, atmos, and hydro. I got the sense that her work with exploring other bodies within the solar system had a deeper impact on her appreciation for out home planet. She also tweeted on major political and social issues that are in the news. I tend to agree with those that are concerned with the overall health of our planet and appreciated her perspective.


## Summary and Reflective Report over Brian Cox:

Dates followed March 21st to April 21st, 2018

## Summary

To begin with, Dr. Cox is a PhD physicist, author, and a science education television personality. His science based tweets largely centered on liking or sharing tweets from others on Twitter that covered exploring the solar system, including images of **Saturn**, its rings and moons; images from **comets**; **space station** images, **mission updates**, etc.  He also posted links to programs and publications that he personally or colleagues have worked on and wanted to get the word out to his 2 million plus followers.  He retweeted from NASA's twitter feed quite often, sharing images that the space agency posted..


## Reflection

The most impressive thing I took away from this period of following were the images of the solar system that Dr. Cox shared.  There were several amazing images of Saturn and its rings along with some shots of Saturn's moons against the backdrop of the planet.  Following certain people also provides an opportunity to learn of other people who can become excellent sources of up to date information and analysis of current events.