Annotated Bibliography

Primary Sources

Books

Barbree, Jay and Martin Caidin. *A Journey Through Time*. The Penguin Group. New York. 1995. Accessed 3 Feb. 2022.

After the repair of the flawed mirror lens of the Hubble Space Telescope, scientists said the images and data collected were beyond their expectations. We learned about the many photos and data taken by the Hubble Space Telescope and were able to see how clear the images of space were. We used this source to understand how important the repair mission was to repair the mirror flaw and how much we have learned from the Hubble Space Telescope because of its success.

Hubble, Edwin. *Realm of the Nebulae*. Dover Publications, Inc., New York. 1958. https://www.aldebaran.cz/astrofyzika/struktury/galaxie/docs/Hubble-TheRealmOfTheNebulae.pdf. Accessed 6 Feb. 2023.

Edwin Hubble describes his research and observations made with telescopes on Mount Wilson and the theories about the expansion of the universe that were developed about the area of the universe populated with nebulae that could be observed with telescopes at that time. We learned that these studies were an influential part in furthering research in the field of astrology, and developing the Hubble Telescope. We used quotes of Edwin Hubble from this source on our website.

Documents

“Assessment of Options for Extending the Life of the Hubble Space Telescope” Committee on the Assessment of Options for Extending the Life of the Hubble Space Telescope Space Studies Board, Aeronautics and Space Engineering Board, Division on Engineering and Physical Sciences. National Research Council of the National Academies. 2005. The National Academies Press, Washington, D.C. https://nap.nationalacademies.org/read/11169/chapter/1. Accessed 16 Feb 2023.

This report helped us understand the top contributions the Hubble Telescope made to science and space research. This helped us strengthen our understanding of the impact the Hubble Telescope had. We used a copy of these contributions on our website.

“Hubble Space Telescope and the Space Shuttle Problems.” Hearing Before the Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Transportation. United States Senate. One Hundred First Congress, Second Session on Oversight on Recent Problems with the Hubble Space Telescope and the Space Shuttle. Washington, DC. 10 July 1990. https://www.govinfo.gov/content/pkg/GPO-CHRG-101shrg1087/pdf/GPO-CHRG-101shrg1087.pdf. Accessed 21 Feb 2023.

We were able to review the original government report outlining the Hubble problems and money issues to the subcommittee. This helped strengthen our understanding of the challenges of the Hubble Telescope that needed to be overcome. We used this information and photos of the report on our website.

"The James Webb Telescope." *Congressional Research Service*, 3 Aug. 2018. *HeinOnline*. Accessed 29 Mar. 2023.

Congress was given this report to explain how the James Webb Telescope was created as the next space telescope after the Hubble Space Telescope to see even farther into the universe. We learned it was to serve as a backup or replacement to the Hubble Space Telescope if it stopped working or was damaged. We used this source to learn more about how the Hubble Space Telescope impacted research and development of more space telescopes that followed after it.

Sen. Mikulski, Barbara (D-MD). Senate Resolution 324- 108th Congress (2003-2004). "A Resolution Expressing the Sense of the Senate Relating to the Extraordinary Contributions Resulting from the Hubble Space Telescope to Scientific Research and Education, and to the Need to Reconsider Future Service Missions to the Hubble Space Telescope." 2nd Session. 25 Mar. 2004. https://www.congress.gov/bill/108th-congress/senate-resolution/324/text?s=1&r=25&q=%7B%22search%22%3A%5B%22hubble%22%5D%7D. Accessed 28 Feb. 2023.

Senator Barbara Mikulski (D-MD) introduced a resolution to the House of Representatives recognizing the Hubble Telescope as one of the most important astronomical instruments and congratulating its results of space exploration across the past 10 years. This source helped us understand more about the positive impact the Hubble Telescope had and the public's response to it. We used this source to strengthen our understanding of the impact and legacy of our topic in venturing into a new frontier.

Morgan, Daniel. "Hubble Space Telescope: Should NASA Proceed with a Servicing Mission?" *Congressional Research Service Report for Congress*, 17 Oct. 2005. *HeinOnline*. Accessed 29 Mar. 2023.

Congress was provided this information about the troubles Hubble Space Telescope was having due to the mirror flaw. We learned that the public was upset about how much money the project cost and still was not successful. We used this source to learn more about the public's view of what many considered Hubble to be a failed mission that cost taxpayers far too much money.

"NASA: FY2017 Budget and Appropriations." *Congressional Research Service*, 6 Sept. 2016. *HeinOnline*. Accessed 29 Mar. 2023.

We learned that congress was provided research information about the budget and project costs of NASA that included the Hubble Telescope. Congress used this data to decide whether to fund the Hubble Space Telescope with appropriations from taxpayer dollars. This source helped us understand more about how the Hubble Telescope is paid for and why it is important to scientists, the government, and the public that it is a successful use of taxpayer's money.

"Report on the Eleventh United Nations/European Space Agency Workshop on Basic Space Science: the World Space Observatory and the Virtual Observatories in the Era of 10-metre Telescopes." United Nations, General Assembly, Committee on the Peaceful Uses of Outer Space. 9-13 Sept. 2002. Cordoba, Argentina. 3 Dec. 2002. https://www.unoosa.org/pdf/reports/ac105/AC105_784E.pdf. Accessed 4 Mar. 2023.

The UN held a general assembly where it discussed world space observatories, including the Hubble Telescope and the impact it has had on scientific research, its main accomplishments to date, and its objectives for the next decade of observation and studies. We learned how important the Hubble Telescope was to the entire world and the positive impact it has had on researching the space frontier. We used this information to strengthen our understanding of the impact of our topic.

Sen. Rubio, Marco (R- FL). Senate Resolution 149- 114th Congress (2015-2016). "Recognizing the Importance and Inspiration of the Hubble Space Telescope." 1st Session. 23 Apr. 2015. https://www.congress.gov/bill/114th-congress/senate-resolution/149/text. Accessed 27 Feb 2023.

The Senate resolution recognized the importance of the Hubble Space Telescope and the significant impact it has had on space research on its 25th anniversary. This source showed us how the Hubble Telescope has been a success, even though it had to overcome issues in delays, repairs, and skepticism about its cost and value. We used this source to demonstrate the long term impact and legacy of our topic.

Rep. Udall, Mark (D-CO-2). House Resolution 550- 108th Congress (2003-2004).

"**Expressing the Sense of the House of Representatives Relating to the Extraordinary Contributions Resulting from the Hubble Space Telescope to Scientific Research and Education, and to the Need to Reconsider Future Service Missions to the Hubble Space Telescope." 2nd Session. 3 Mar. 2004. https://www.congress.gov/bill/108th-congress/house-resolution/550/text?s=1&r=56. Accessed 28 Feb. 2023.**

The House of Representatives introduced the resolution to recognize and further support the efforts to service and maintain the Hubble Telescope. We learned that the government began to support and understand the importance of the Hubble Telescope and recognized it publicly. We used this to source to understand more about how the support of the Hubble Telescope improved with time and proof of results.

Rep. Udall, Mark (D-CO-2). House Resolution 251- 109th Congress (2005-2006).

"Congratulating All of the Individuals and Organizations on the 15th Anniversary of the Launch of the HubbleSpace Telescope that have Helped Make Hubble one of the Most Important Astronomical Instruments in History." 28 Apr. 2005. https://www.congress.gov/bill/109th-congress/house-resolution/251/text?s=1&r=20&q=%7B%22search%22%3A%5B%22hubble%22%5D%7D. Accessed 28 Feb. 2023.

Representative Udall (D-CO-2) congratulated the contributions of the Hubble Telescope and recognized it as one of the most important astronomical instruments in history. We learned what the public thought of the Hubble Telescope after 15 years of observation and research. We used this source to better understand the impact and legacy of our topic.

Images

Block, Herbert. “On a Clear Day.” 12 Dec. 1993. The Library of Congress, www.loc.gov/item/2012643224/. Accessed 12 Dec. 2022.

Santa Claus can be seen by the Hubble Telescope in this cartoon drawing. This source helped us understand what the public thought of the Hubble Telescope as it was repaired and became successful. We used this information to strengthen our understanding of the main event of our topic.

“Bumper V-2 Launch, NASA History Collection.” 24 July 1950. NASA, Image# 66P-0631, https://picryl.com/media/bumper-v-2-launch. Accessed 6 May, 2023.

The first rocket, Bumper 8, was launched in 1950 from Cape Canaveral, Florida. We learned more about the historical context of our topic with rocket technology and the possibility of launching into space as suggested by Obert. We used this photo on our website.

”“Father of Rocketry Hermann Oberth.” NASA. https://www.nasa.gov/audience/foreducators/rocketry/home/hermann-oberth.html. Accessed 23 Feb. 2023.

Hermann Oberth, known as the Father of Rocketry, is shown in this photo. We were able to understand some of the most influential people to the development and use of the Hubble Telescope. We used this photo on our website for background information.

"Hubble Heritage." hubblesite.org/resource-gallery/learning-resources/hubble-heritage. Accessed 16 Dec. 2022.

Several images taken by the Hubble Telescope are collected in this gallery. We learned how the Hubble Telescope is able to capture images not able to be seen from earth. We used some of the images on our website to show the amazing visuals captured by the Hubble Telescope.

“Hubble Sees First Light.”

https://hubblesite.org/mission-and-telescope/mission-timeline. Accessed 22 Feb. 2022.

“Hubble Sees First Light” is the first image captured by the Hubble Telescope. We learned that this was the image that changed everything we knew about the universe up until that time. We used this photo on our website to show how much more we could observe with the Hubble Telescope versus telescopes on earth.

“Hubble Space Telescope Images.” 21 Jan. 2015. NASA.

https://www.nasa.gov/mission_pages/hubble/multimedia/index.html. Accessed 30 Jan. 2023.

Many amazing images that the Hubble telescope took were collected on this webpage. We used this information to develop our website and understand more about the main event of our topic. We also used photos from this source for our website.

Meddick. “First Photos From the Hubble.” NEA, Inc. 1990.

https://aas.org/sites/default/files/2020-01/AAS235_Villard.pdf. Accessed 18 Feb. 2023.

A political cartoon was published to show how the Hubble Telescope’s images were distorted and the US taxpayers were upset over the mirror flaw. This source helped us to understand the adversity the Hubble Telescope had to overcome and prove itself successful. We used this image on our website to show the hurdles the Hubble Telescope overcame.

"Never Mind -- Come Back and Give the Examination to NASA". The Library of Congress, www.loc.gov/item/2012642525/. Accessed 12 Dec. 2022.

This picture shows the missions that failed trying to make the Hubble Telescope successful. We were able to see what the astronauts and Hubble team had to overcome to make the Hubble Telescope a success. We used this image to understand the work it took to make the Hubble Telescope perform correctly.

“Pillars of Creation.”

https://www.nasa.gov/feature/goddard/2022/nasa-s-webb-takes-star-filled-portrait-of-pillars-of-creation. Accessed 21 Feb. 2023.

Pillars of Creation is a photo that was taken by the Hubble Telescope. We learned what types of images were captured by the Hubble Telescope that were never seen before with the telescopes on Earth. We used this photo on our website.

Smith, Dayna. *The Washington Post*. 6 Jan. 1987.

https://www.politico.com/gallery/2015/03/barbara-mikulski-career-highlights-001936?slide=0. Accessed 15 Feb. 2023.

Senator Barbara Mikulski (D-MD) advocated for the Hubble Telescope during her reception after being sworn in at the US Capitol. This source helped us learn how Senator Mikulski supported the Hubble Space Telescope from the beginning and helped it achieve the support and funding needed to become a success. We used this image on our website.

Underwood and Underwood, New York. “May Fulfill Jules Verne's Dream--Prof. Oberth, German Inventor, to Aid Prof. Ocenasek Perfect ‘Moon Rocket’." 1930. Library of Congress. https://www.loc.gov/item/92504890/. Accessed 27 Feb. 2023.

Professor Hermann Oberth built a rocket in a laboratory in Prague, Czechoslovakia. He worked to help develop the first rocket to be shot into space. We used this photo to understand more about the history and background of our topic.

Interviews

Dr. Gallagher III, Jay (John). Personal Interview. 6 Mar. 2023 and 2 May 2023.

We interviewed Dr. Jay (John) Gallagher III, Professor Emeritus of Astronomy from the University of Wisconsin, who was a member of the Hubble Space Telescope WFPC2 instrument team. We learned the Hubble Telescope was a group effort among many different countries. We used this interview to learn more about how this effort impacted many nations and improved discovery of the universe, as well as quotes for our website.

Dr. Lattis, James. Personal Interview. 27 Feb 2023.

We interviewed Dr. James Lattis, Professor of Astronomy at University of Wisconsin. We were able to see parts that were built at the University of Wisconsin of the original Hubble Telescope that was launched in 1990. We learned how these parts were used to measure and gather information, which helped us understand how the Hubble Telescope works.

Spitzer, Lyman. Interview by David DeVorkin. 8 Apr. 1977. www.aip.org/history-programs/niels-bohr-library/oral-histories/4901-1. Accessed 4 May 2023.

Lyman Spitzer gave an interview about his background and work in astronomy. We learned that he had many ideas about telescopes in space and how they would function. We used a quote from him on our website.

Journals

Lauer, Tod R., et al. "The Core of the Nearby S0 Galaxy NGC 7457 Imaged with the HST Planetary Camera." The Astrophysical Journal. 10 Mar. 1991. Vol 369, L41-L44. The American Astronomical Society. Accessed 14 Feb. 2023.

The first published research using the data and images collected by the Hubble Space Telescope was published in this journal. We learned that the Hubble Telescope had a major impact on space research. We used an image of this document on our website.

Spitzer Jr., Lyman. "Astronomical Advantages of an Extra-Terrestrial Observatory." *The Astronomy Quarterly*. 1990. Vol 7, pp. 131-142. Pergamon Press. Accessed 22 Feb 2023.

Lyman Spitzer Jr. detailed the need for the Hubble Telescope and the advantages of having an observation instrument in space in these writings. This source helped strengthen our understanding of the benefits of this new technology. We also used a quote and photo of this journal on our website.

Roman, Nancy Grace. "Nancy Grace Roman and the Dawn of Space Astronomy." ***Annual Review of Astronomy and Astrophysics*****. Aug 2019. Vol 57:1-34. https://www.annualreviews.org/doi/10.1146/annurev-astro-091918-104446. Accessed 9 May 2023.**

Nancy Grace Roman explained how she became an astronomer and her involvement in the Hubble Space Telescope. We learned that she worked with Lyman Spitzer and led NASA in the phases and development of The Hubble Space Telescope. We used a quote from her on our website.

Magazines

Waldrop, Mitchell. "Will the Hubble Space Telescope Compute?" ***Science*****. Research News. 17 Mar. 1989. Vol 243, Issue 489, pp. 1437-1439. https://www.science.org/doi/10.1126/science.243.4897.1437. Accessed 21 Feb 2023.**

Several problems with the Hubble Space Telescope were outlined in this magazine article, and many questioned its success. This source helped us understand what many scientists and people thought about Hubble and the adversity it faced. We used an image of this article on our website to show what Hubble had to overcome.

Newspapers

The Canadian Press, Ottawa. "Hubble's Troubles Delay Research by Canadians." ***The Whig-Standard*****. (Kingston, Ontario, Canada). 23 July. 1990. https://www.newspapers.com/image/730652161/?terms=%22hubble%20telescope%22&match=1. Accessed 5 Mar. 2023.**

Hubble Space Telescope's mirror flaw had a negative impact on data projects of scientists around the world. This source helped us understand the public's disappointment of the flaw and having to wait three years for repairs to fix this problem. We used this source to understand more about the hurdles Hubble had to overcome to be successful and what the public thought of these issues.

Dye, Lee. "New Eye In the Sky: An Orbiting Telescope Will Reveal a Universe Never Seen by Humans." ***St. Louis Post-Dispatch.*** **20 Feb. 1990.** ***Los Angeles Times.*** **1990. https://www.newspapers.com/image/139939090/?fcfToken=eyJhbGciOiJIUzI1NiIsInq1R5cCI6IkpXVCJ9.eyJmcmVlLXZpZXctaWQiOjEzOTkzOTA5MCwiaWF0IjoxNjc3NTU0MzMwLCJleHAiOjE2Nzc2NDA3MzB9.Z4kVl1QcRlGCsJJoRtWHmM2tbL8MYnfIloUxORk7-vI. Accessed 27 Feb. 2023.**

Several space telescopes would be launched during the 1990s, and the Hubble Telescope was one of them. We learned that the Hubble Telescope was part of a large project to study space with telescopes beyond the earth. We used this source to strengthen our understanding of the main event and how space projects continued after the Challenger disaster.

Dye, Lee. "An Orbiting Telescope Will Reveal Universe Never Seen by Humans." ***St. Louis Post-Dispatch*****, [St. Louis], 20 Feb. 1990, p. 29. Newspapers.com. Accessed 27 Feb. 2023.**

This newspaper article introduced the Hubble Space Telescope and how it would be used to observe and research. We strengthened our understanding of how the Hubble Telescope broke the barriers of researching the space frontier. We used this article to learn more about the main event of our topic.

Leary, Warren E. "Hubble Space Telescope Finds Big Shifts in Weather on Mars." ***The New York Times*****. 21 May 1997. Newyorktimes.com. Accessed 29 Mar. 2023.**

The Hubble Space Telescope was used to understand more about the weather and atmosphere of Mars. We learned that this information helped other spacecraft and research projects successfully prepare for the conditions on Mars. We used this information to understand more about how the Hubble Space Telescope helped scientists explore and research Mars and other areas of space, using it as their eyes in space.

Laurence, William L. "Hubble Pictures Space Frontiers." ***The New York Times*****. 31 Dec. 1941. Newyorktimes.com. Accessed 29 Mar. 2023.**

We learned Edwin Hubble gave a lecture to Sigma Xi about the new 200 inch telescope being built at Mount Palomar, California. We gained historical context by understanding what Dr. Hubble anticipated for observations and discoveries through its use. We used this source to understand more about the limitations of telescopes on earth and how they were advancing prior to the Hubble Space Telescope.

Perlman, David. "Serious Doubts Raised Over Future Space Flights." ***San Francisco Chronicle*****. 29 Jan. 1986. 122nd Year, No. 11. https://www.sfchronicle.com/chronicle_vault/article/Chronicle-Covers-When-the-Challenger-explosion-6791797.php. Accessed 24 Feb. 2023.**

Serious doubts were raised after the explosion of the Challenger, and all space missions were indefinitely delayed as a result. This source helped us understand how the launch of the Hubble Telescope was one of the missions indefinitely delayed after the fate of the Challenger. We used this information and pictures of the newspaper article in our website to explain the growing concerns and challenges that needed to be overcome.

Signor, Roger. "Missourian Made Project Possible." ***St. Louis Post-Dispatch*****. 20 Feb. 1990. https://www.newspapers.com/image/139939090/?fcfToken=eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJmcmVlLXZpZXctaWQiOjEzOTkzOTA5MCwiaWF0IjoxNjc3NTU0MzMwLCJleHAiOjE2Nzc2NDA3MzB9.Z4kVl1QcRlGCsJJoRtWHmM2tbL8MYnfIloUxORk7-vI. Accessed 27 Feb. 2023.**

We learned that the Hubble Telescope was named after Edwin P. Hubble, a native of Marshfield, Missouri. Also, two University of Missouri scientists were chosen to lead the experiments on the Hubble Telescope. We used this source to strengthen our understanding of the historical context of our topic.

Wilford, John Noble. "NASA Pronounces Space Telescope Cured." ***The New York Times.*** **14 Jan. 1994. Section A, Page 1. https://www.nytimes.com/1994/01/14/us/nasa-pronounces-space-telescope-cured.html. Accessed 16 Feb. 2023.**

Scientists involved with the Hubble Telescope declared that the repairs made to the Hubble Telescope were a complete success. We learned that although the Hubble Telescope faced many early challenges, scientists overcame them and it was a successful and impactful result on space research. We used an image of this important article on our website.

Videos

"Hubble: A New Beginning." NASA News Conference. 09 Sep. 2009. NASA. https://www.youtube.com/watch?v=ZUl5oMfjq0A. Accessed 19 Jan. 2023.

NASA held a news conference to announce the improvements, repairs, and new technology of the Hubble Space Telescope, as well as the new release of images taken. In attendance were scientists, government officials, members of the press, and the public. We strengthened our understanding of the success of the Hubble Telescope and used quotes for our website.

"Hubble Satellite Repair Mission." C-SPAN.org, 3 Dec. 1993. https://www.c-span.org/video/?52685-1/hubble-satellite-repair-mission. Accessed 28 Feb. 2023.

We learned from this video about the repair missions of the Hubble Telescope and how it was designed to be serviced. This news interview helped us understand more about why the Hubble Telescope needed to be repaired and maintained and the costs involved. We used this information to understand more about the main event of our topic with the repair spacewalks.

“Hubble Space Telescope. NASA News Conference.” C-SPAN. 13 Jan. 1994. https://www.c-span.org/video/?53735-1/hubble-space-telescope. Accessed 26 Feb. 2023.

NASA held a news conference to explain the repair of the Hubble Telescope mirror flaw with experts from NASA and the US Senate. We were able to see the pictures that Sen. Barbara Mikulski (D-MD) held up to demonstrate the difference before and after the repair. Her quote, “The trouble with Hubble is over.” strengthened our understanding of the hurdles that the Hubble Telescope had to overcome and prove to be successful, and we used this quote and pictures from this news conference on our website.

"Hubble Space Telescope Problems." C-SPAN.org, 29 June. 1990. www.c-span.org/video/?12954-1/hubble-space-telescope-problems. Accessed 12 Dec. 2022.

The Senate Commerce, Science, and Transportation Subcommittee on Science Technology and Space held a hearing that discussed the oversight and issues of the Hubble Telescope and other space programs. Senator Al Gore, Jr. (D) Tennessee, subcommittee chair, spoke and questioned the NASA Scientist panel during this hearing about the Hubble mirror flaw. We used this video as a media clip for our website showing the problems and public questioning the Hubble Telescope had to overcome.

“Hubble Telescope Repairs.” C-SPAN. 18 Feb. 1997. https://www.c-span.org/video/?79117-1/hubble-telescope-repairs. Accessed 27 Feb. 2023.

This video helped us understand more about the repairs made to the telescope and hurdles the Hubble Team had to overcome. We were able to see how astronauts made repairs with a space walk. This source helped us understand more about what the Hubble Telescope was able to do and how it was maintained.

Sen. Mikulski, Barbara (D-MD). "Space, Science, and Technology Forum." C-SPAN. 12 June. 2000. https://www.c-span.org/video/?157653-1/space-science-technology. Accessed 27 Feb. 2023.

Senator Barbara Mikulski spoke about the US space program and the advancements and achievements reached. She encouraged continued support and explained the government's role in the program and appropriations process. We used this information to strengthen our understanding of how the Hubble Telescope was funded and supported as it became successful.

"STS-61 Endeavour Space Shuttle HST (Hubble Telescope) Repair EVAs, 8 Dec. 1993. UK News reports." https://www.youtube.com/watch?v=0bjhDN5b5J4. Accessed 21 Feb. 2023.

This video shows a news report of a successful mirror repair of the Hubble Telescope. We were able to understand how astronauts made repairs to the telescope in space. We used this video on our website as a media clip.

Waldrop, Mitch. "Hubble Telescope." C-SPAN Live. 3 July. 1990. https://www.c-span.org/video/?12995-1/hubble-telescope. Accessed 28 Feb. 2023.

Mitch Waldrop of Science Magazine was interviewed about the recently discovered problems with the mirror of the Hubble Telescope. This video helped us understand what issues the mirror flaw caused and how it would be fixed. We used this information to help us understand more about the main event of our topic.

"WEB EXTRA: Hubble Space Telescope Launches April 24 1990." 24 Apr. 1990. CBS Miami. https://www.youtube.com/watch?v=XqVlOP1Wuhs. Accessed 22 Feb 2023.

The successful launch of the Hubble Telescope on board the Space Shuttle Discovery was recorded on this video. We learned how the telescope was put in space. We used this video on our website as a media clip.

Websites

"For the First Time Hubble Directly Measures Mass of a Lone White Dwarf." HubbleSite.org, hubblesite.org/contents/news-releases/2023/news-2023-004. Accessed 3 Feb. 2023.

We learned about some of the amazing discoveries of the Hubble Telescope and how it has helped scientists understand more about the universe. This website gave us useful and helpful information to understand what the Hubble Telescope is, how it was created, and how it has helped us achieve research and observation of the space frontier. We used this information to enhance our website with photos, media, quotes, and to write our process paper and script for our website.

"Hubble Captures the Heart of the Orion Nebula." HubbleSite.org, hubblesite.org/contents/news-releases/1997/news-1997-13.html. Accessed 17 Jan. 2023.

Data captured of the Heart of the Orion Nebula by the Hubble Telescope was detailed on this website. We learned about the amazing information the Hubble Space Telescope is able to collect. We used this source to learn more about the main event of our topic.

"Just One More Try -- This Man is Also a Licensed Optometrist"." The Library of Congress, www.loc.gov/item/2012642605/. Accessed 12 Dec. 2022.

It took many tries to make Hubble a success. We learned about the many issues that the Hubble Space Telescope had to overcome. We used this source to learn more about the main event of our topic and how many different scientists were used to overcome scientific obstacles.

"Mirror, Mirror on the Hubble, Who is Free of Blame for Trouble?"." The Library of Congress, www.loc.gov/item/2012642528/. Accessed 12 Dec. 2022.

The Hubble Space Telescope had a mirror flaw that had to be repaired to work correctly. We learned about the problems the Hubble Telescope encountered and what the public thought about these issues. We used this source to help us understand what adversity the Hubble team had to overcome.

"Observatory - Instruments." NASA, 5 Dec. 2017, www.nasa.gov/content/goddard/hubble-space-telescope-science-instruments. Accessed 14 Dec. 2022.

The NASA website provides in depth information about the Hubble Telescope, its history of development, what it does, how it is used, and the impact it has had on science. We used this information to understand more about the parts of the Hubble Telescope and what they are used for, as well as what it has accomplished. We used this website to find information to write our script, give timelines, images, media clips, and quotes that were used on our website.

“STScI Timeline.” Space Telescope Science Institute. https://www.stsci.edu/who-we-are/our-history/stsci-timeline. Accessed 21 Jan. 2023.

The Space Telescope Science Institute is the science operations center for the Hubble Space Telescope. We were able to understand the history of the Hubble Telescope, how it was developed, what it has done, and how it continues to be impactful today. We used this source to develop our narrative and add images to our website.

Secondary Sources

Field Trip

Jerke, Darin. 2023. *Virtual Reality, The James Webb Telescope.* Center for Continuing Education. University of South Dakota, Vermillion, SD. 9 May 2023.

We visited Darin Jerke at the University of South Dakota and experienced space observations with virtual reality through the Hubble Space Telescope and the James Webb telescope. We were able to visit different parts of space, see images, and view data collected. We used this experience to strengthen our understanding of the impact and legacy of The Hubble Telescope and how everyone can learn about the space frontier from it.

Interview

Dr. Gabel, Jack. Personal Interview. 11 May 2023.

Dr. Jack Gabel is an associate physics professor at Creighton University who used data and technology from the Hubble Telescope to research black holes. We learned about the behavior and speed of black holes and how they can be seen in relation to ultraviolet light above the atmosphere. We used this source to understand more about what scientists are able to learn about our universe with the information collected from the Hubble Telescope.

Dr. Struck, Curtis. Personal Interview. 16 Feb 2023.

We interviewed Dr. Curtis Struck, Professor of Physics and Astronomy at Iowa State University. Professor Struck was able to help us understand how scientists apply for time to use the Hubble Telescope to gather data. This helped to strengthen our understanding of the impact the Hubble Telescope has on research today.

Magazines

DeVorkin, David. "How Nancy Grace Roman Shaped Hubble." ***Physics Today*****. 1 Apr. 2020. https://pubs.aip.org/physicstoday/Online/28080/How-Nancy-Grace-Roman-shaped-Hubble. Accessed 4 May 2023.**

Nancy Grace Roman, astronomer and head of NASA space astronomy was an important part of the development of Hubble Space Telescope, working with Lyman Spitzer, Jr. We learned about the key people involved in the development, creation and launch of the Hubble Space Telescope. This source was used in the background and main event sections of our website.

"Hubble Space Telescope." ***BBC Science Focus Magazine*****. www.sciencefocus.com/hubble-space-telescope/. Accessed 6 Feb. 2023.**

This article taught us about the servicing missions of the Hubble telescope and why it was important to maintain it. We used this information to develop the legacy portion of our script.

Kluger, Jeffrey. "The Story of Hubble's First Photo- 25 Years Later." ***Time*****. 19 May 2015. https://time.com/3889335/hubble-telescope-first-photo/. Accessed 23 Feb. 2023.**

The first photos of the Hubble Telescope were controversial since many were expecting much better image quality than photos taken from telescopes on earth, which was due to a mirror breaking. This source helped strengthen our understanding of the adversity Hubble Telescope had to overcome and how it proved to be successful. We used photos from this article on our website.

Siegel, Ethan. “The Most Important Image Ever Taken by NASAs Hubble Space Telescope.” *Forbes*. 13 Apr. 2020. www.forbes.com/sites/startswithabang/2020/04/13/the-most-important-image-ever-taken-by-nasas-hubble-space-telescope/?sh=7cf7829c3077. Accessed 30 Jan. 2023.

We were able to see images taken by the Hubble Telescope and learned why they are important to science. The Hubble Space Telescope was able to see farther into space than any other telescope on earth. We used this information to develop the legacy portion of our script and how the Hubble Telescope has impacted space research.

"Space, Stars, and the Beginning of Time: What the Hubble Telescope Saw." *The Horn Book Magazine*, vol. 87, no. 2, Mar.-Apr. 2011, p. 142. Gale General OneFile, link.gale.com/apps/doc/A249684575/ITOF?u=iowaec&sid=bookmark-ITOF&xid=5a7b3438. Accessed 5 Dec. 2022.

The Hubble Telescope collected images and data, and that information was used to make calculations about the universe. We learned how important the information collected by the Hubble Space Telescope is to scientists. We used this source to understand more about the impact and legacy of the Hubble Telescope.

Straughn, Amber. “Beyond Hubble: A New Era of Astronomy with the James Webb Space Telescope.” *The Library of Congress*, 21 Mar. 2012, http://www.loc.gov/item/webcast-5591/. Accessed 12 Dec. 2022.

We learned how the Hubble Telescope broke the frontier barriers of space study and paved the way for new advancements in the field of astronomy. The James Webb Space Telescope was the next space telescope that followed after the Hubble Space Telescope. We used this source to understand more about the legacy of our topic and how it has impacted current space research.

Publications

Field, George B. "Lyman Spitzer, Jr. (1914–1997)." ***Publications of the Astronomical Society of the Pacific*****, vol. 110, no. 745, 1998, pp. 215–22.** ***JSTOR*****, https://doi.org/10.1086/316135. Accessed 20 Feb. 2023.**

Lyman Spitzer, Jr. was a scientist that studied space beginning in the 1940s. This publication helped us learn more about his research and contained quotes that helped us understand his involvement in the Hubble Telescope. We used his quote in our website to convey background information.

Soter, Steven and Neil deGrasse Tyson. "Lyman Spitzer and the Space Telescope." ***Cosmic Horizons: Astronomy at the Cutting Edge*****.** ***New Press*****, 2000.** ***American Museum of Natural History*****, https://www.amnh.org/learn-teach/curriculum-collections/cosmic-horizons-book/lyman-spitzer-hubble-telescope. Accessed 9 May 2023.**

Champion of the Hubble Space Telescope project, Lyman Spitzer, Jr. was a key person in its development, creation, and gaining political support for funding. We learned about the connection between early advancements in technology and the launch of the Hubble Space Telescope. We used this source to strengthen the historical context of our project.

Videos

President Biden, Joseph. "President Biden and Vice President Harris Receive a Briefing on James Webb Space Telescope." 11 July 2022. The White House. https://www.youtube.com/watch?v=ySaIPoHisRg. Accessed 19 Feb. 2023.

We were able to see the first images captured by the James Webb Space Telescope, which followed the Hubble Space Telescope, and observed new parts of the universe. We learned that the legacy of the Hubble Telescope is its major impact on the study of the space frontier and the advancements that were later developed. We used this video on our website to show the legacy of our topic.

"Finding Our Origins with the Hubble & James Webb Space Telescopes." The Library of Congress, 22 Mar. 2018. loc.gov/item/webcast-8353. Accessed 12 Dec. 2022.

This video shows the amazing achievements of the Hubble Telescope, and what scientific data it can unlock. We learned more about the impact of our topic from this source and how it pioneered space telescope observation and paved the way for other space observatory advancements. We used this source to strengthen our understanding of how the Hubble Space Telescope broke into the new frontier of space exploration and research.

"Hubble Space Telescope Videos." NASA, 21 Jan. 2015, www.nasa.gov/mission_pages/hubble/videos/index.html. Accessed 14 Dec. 2022.

We learned how observations of supernovas recorded by the Hubble Telescope help scientists understand more about the formation of our universe. We used this information to learn more about the impact of the Hubble Space Telescope on studies of astronomy and space exploration.

Websites

“10 Fascinating Facts About the Hubble Space Telescope.” History, 24 Apr. 2020. www.history.com/news/10-fascinating-facts-about-the-hubble-space-telescope. Accessed 6 May 2023.

Several interesting facts about the Hubble Space Telescope were listed on this website, including how scientists made advancements to it while it was delayed by the Challenger disaster. We learned how they made these improvements and what the impact of the delay was on the cost of the Hubble Space Telescope. We used this information to understand more about the main event of our topic.

“About the Hubble Space Telescope.” 24 Sept. 2019. NASA. https://www.nasa.gov/mission_pages/hubble/about. Accessed 30 Jan. 2023.

NASA provides many details about the Hubble Telescope and what it has done across the past 30 years in this website. We learned more about the Hubble Telescope’s size and build, which was roughly the size of a school bus. We used this information to understand more about the impact and legacy of our topic.

Byrd, Deborah. “Edwin Hubble and the Expanding Universe”. 20 Nov 2021. earthsky.org/space/this-date-in-science-edwin-hubble-and-the-expanding-universe/. Accessed 12 Dec. 2022.

Edwin Hubble used telescopes on earth to discover the universe was expanding. We learned that through his research and further scientific studies, the Hubble Telescope was created to be able to see further into space than any telescope on earth. We used this source to learn about the background history of our topic.

"Collaborating Missions." HubbleSite.org, hubblesite.org/mission-and-telescope/collaborating-missions. Accessed 6 Feb. 2023.

The Hubble Telescope collaborates with other telescopes and space missions to gather information. We learned more about the impact that the Hubble Space Telescope has studying the space frontier. We used this source to understand the long term impact and legacy of the Hubble Telescope.

"Cosmic Wonders." HubbleSite.org, 16 Dec. 2022, hubblesite.org/science/cosmic-wonders. Accessed 30 Jan. 2023.

This article taught us that, even though decades old, Hubble still continues to amaze us in science. We learned the Hubble Telescope still collects data and images today and is used for research. We used this to strengthen the legacy section of our project.

"Did the Hubble Telescope Reach Its Goal? A Look Into What Was Once a NASA Failure." Distractify. 20 June 2020. www.distractify.com/p/what-was-the-overall-goal-of-hubble-telescope. Accessed 2 Feb. 2023.

The Hubble telescope was the first major optical telescope to be placed into space. We learned the information collected by it has helped us learn more about space than any other telescope on earth before it. We used this information to understand more about the impact of the Hubble Telescope.

“Discoveries.” 24 Sep. 2019. NASA. https://www.nasa.gov/content/discoveries. Accessed 30 Jan. 2023.

This website included videos and photos about the significance of the Hubble Telescope, what it has observed, the data captured for research, and how it has impacted discoveries of the universe. We learned many interesting facts and details about the Hubble Telescope. We used this information to learn more about the impact and legacy of our topic.

"Edwin Hubble." Encyclopedia Britannica, www.britannica.com/biography/Edwin-Hubble. Accessed 17 Jan. 2023.

Edwin Hubble is the astronomer who the Hubble Telescope was named after. We learned about his life, scientific and space research, and how he used telescopes on earth to gather information. We used this source as historical background for our topic.

Fixing Hubble’s Blurry Vision. Spaceflight Now. 23 Apr. 2015. Spaceflight Now. https://spaceflightnow.com/2015/04/23/fixing-hubbles-blurry-vision/. Accessed 30 Jan 2023.

The Hubble Space Telescope had a problem with the mirror. We learned how scientists and astronomers overcame that issue and repaired it. We used this information to understand more about the main event of our topic.

Garner, Rob. "About - Hubble History Timeline." ***NASA*****, 04 Sept. 2018, http://www.nasa.gov/content/goddard/hubble-history-timeline. Accessed 5 Dec. 2022.**

We were able to view a development timeline of the Hubble telescope from the 1940's to the 2000's. We learned about the Hubble Telescope launch and mirror flaw. We used this source to gain an understanding of the timeline of events of our topic.

Garner, Rob. "About - The Hubble Team." NASA, 3 Aug. 2020. https://www.nasa.gov/mission_pages/hubble/team/index.html. Accessed 14 Dec. 2022.

We learned about the members of the Hubble Team, what their jobs were, and how they contributed to the Hubble Telescope. We used this source to understand more about the build up and main event of our topic.

"Hubble Astronauts." NASA, 29 Apr. 2022, www.nasa.gov/content/hubble-astronauts. Accessed 14 Dec. 2022.

NASA outlined some of the Hubble repair missions and the astronauts involved in this source. We were able to learn about the legacy and ongoing use of the Hubble Telescope. We used this source to gain an understanding of the team of scientists and astronauts that make the Hubble Space Telescope a success.

"Hubble Deep Fields." 30 Sep. 2022. HubbleSite.org. https://hubblesite.org/contents/articles/hubble-deep-fields. Accessed 2 Feb. 2023.

This article showed our group how the data collected by the Hubble Telescope played an important role in science. We learned how the data collected by Hubble Space Telescope crossed into a new scientific frontier of space study. We used this information in the legacy research of our topic.

"Hubble Detects Protective Shield Defending a Pair of Dwarf Galaxies." HubbleSite.org, hubblesite.org/contents/news-releases/2022/news-2022-030. Accessed 2 Feb. 2023.

We learned that the Hubble Telescope is still collecting important information about the universe and how it operates. We used this source to learn more about the legacy of our topic and how it continues to expand our knowledge about the space frontier.

"Hubble's Exciting Universe: Measuring the Universe's Expansion Rate." HubbleSite.org, hubblesite.org/hubble-30th-anniversary/hubbles-exciting-universe/measuring-the-universes-expansion-rate. Accessed 12 Dec. 2022.

According to the data collected by the Hubble Space Telescope, the universe is expanding and getting bigger. We used this source to learn about how the Hubble Telescope continues to help us observe, learn and understand more about the endless frontier of space. This strengthened our understanding of the impact of the Hubble Telescope on modern science.

"Hubble Finds Hungry Black Hole Twisting Captured Star Into Donut Shape." HubbleSite.org, hubblesite.org/contents/news-releases/2023/news-2023-001. Accessed 6 Feb. 2023.

Our group learned more about black holes, based on the data collected by the Hubble Telescope. This telescope continues to collect data that helps scientists discover more about the frontier of space. We used this information to understand more about the impact of our topic.

“Hubble History Timeline.” 4 Sept. 2018. NASA. https://www.nasa.gov/content/goddard/hubble-history-timeline. Accessed 30 Jan 2023.

NASA provided a timeline of the creation of the Hubble Space Telescope. This source helped us understand more about how the Hubble Telescope was developed and what it has done in space. We used this source to learn more about the timeframe of our topic.

"Hubble's Mirror Flaw." NASA, 16 Mar. 2015, www.nasa.gov/content/hubbles-mirror-flaw. Accessed 14 Dec. 2022.

Hubble’s mirror flaw was caused by a break. This article explained how it broke, affecting the images it captured. This source helped us understand the long term impact of our topic and how it contributed to the creation of the James Webb telescope.

"Hubble Space Telescope." California Science Center, californiasciencecenter.org/exhibits/air-space/stars-telescopes/hubble-space-telescope. Accessed 6 Feb. 2023.

The Hubble Telescope was the first optical telescope in orbit around the earth and was designed to be repaired and fixed by astronauts. We learned about the legacy of this amazing space telescope and how it has impacted our understanding of the universe.

"Hubble Space Telescope Facts." University of Arizona Research, Innovation & Impact, 8 Mar. 2019, research.arizona.edu/stories/hubble-space-telescope-facts. Accessed 13 Dec. 2022.

We learned about some very interesting facts such as the supernova that Hubble spotted and how supernovas were made by stars exploding in outer space. We used this source to understand more about the impact of the Hubble Telescope on space discovery.

"Hubble Space Telescope Stats." HubbleSite.org, hubblesite.org/mission-and-telescope/hubble-stats. Accessed 26 Jan. 2023.

We learned about specific data of the Hubble Telescope and how it functions. This source provided useful information that helped us understand more about how the Hubble Space Telescope works. We used this information to develop and write our script for our website.

"Hubble Space Telescope Theater | Kennedy Space Center." Visit Kennedy Space Center Visitor Complex at Cape Canaveral. www.kennedyspacecenter.com/explore-attractions/shuttle-a-ship-like-no-other/hubble-space-telescope-theater. Accessed 2 Feb. 2023.

Hubble Space Telescope Theater is a place the public can visit to learn more about the Hubble Telescope. We used this source to understand more about the legacy of our topic.

Information@eso.org. "History: How Hubble Came About." ESA/Hubble, esahubble.org/about/history/. Accessed 24 Jan. 2023.

Many scientists and astronomers wanted to be part of the Hubble team, also known as the “Dream Team”. We learned background information about the Hubble Space Telescope. We used this source as main event information to understand more about our topic.

"Just a Moment..." Just a Moment.., skyandtelescope.org/astronomy-blogs/hubbles-future-in-the-webb-era/. Accessed 26 Jan. 2023.

This web article taught our group that the Hubble Telescope has surpassed scientists expectations about how long it would last and remain in orbit. We learned that the Hubble Space Telescope has been a success in studying the frontier of space. This information helped our group understand more about the legacy of our topic.

Lewis, Briley. "Meet Nancy Grace Roman, the "Mother" of the Hubble Space Telescope." Massive Science, massivesci.com/articles/nancy-grace-roman-hubble-telescope-our-science-heroes. Accessed 5 Dec. 2022.

We learned about the life and goals accomplished by Nancy Grace, "the mother of Hubble." Nancy Grace Roman's role was very important to the development of the Hubble Telescope and the Space Telescope Science Institute, which manages space telescopes and their data. We used this source to understand more about the important people involved in the Hubble Telescope.

"The Meaning of Light and Color." HubbleSite.org, 30 Sep. 2022, hubblesite.org/contents/articles/the-meaning-of-light-and-color. Accessed 2 Feb. 2023.

The data collected by the Hubble Telescope can be analyzed to create color and understand more about the universe. We learned how the images and data collected by the Hubble Space Telescope help in scientists research. We used this source to understand more about how the Hubble Telescope works and how scientists use the data.

"Mission and Telescope."

https://hubblesite.org/mission-and-telescope/mission-timeline. Accessed 1 Dec. 2022.

This timeline helped us understand how the Hubble Telescope was developed, as well as the missions, discoveries, and happenings that have occurred since launching the telescope into space. We were able to understand more about the events that led to the creation and launch of the Hubble Space Telescope. We used this information to develop a general timeline for our website.

“News.” 24 Sept. 2018. NASA. https://www.nasa.gov/mission_pages/hubble/news. Accessed 30 Jan. 2023.

We learned about the impact of the Hubble Telescope from the data and information collected, to saving lives and a space station from being hit by an asteroid. We used this NASA news release for the impact of our topic and how Hubble is being used today.

“Observatory.” 20 Feb. 2015. NASA. https://www.nasa.gov/mission_pages/hubble/spacecraft/index.html. Accessed 30 Jan. 2023.

NASA explained what the Hubble Telescope does, how it works, where it is and how fast it travels. We also learned about the Webb telescope and how it was different from the Hubble Telescope. We learned about the impact and legacy that the Hubble Telescope had on advancements in astronomy technology and used this information to write our script.

“On This Day, a Scientific Marvel: Hubble Space Telescope Was Launched." GenealogyBank Blog, blog.genealogybank.com/on-this-day-a-scientific-marvel-hubble-space-telescope-was-lanched.html. Accessed 1 Dec. 2022.

The Hubble Telescope was launched into space to provide scientists with the best view into the frontier of space. We learned how the Hubble Space Telescope was launched into space and what happened on that day. We used this source to understand more about the build up and main event of our topic.

“Orbiting Hubble Interactive.” 15 Jan 2021. NASA. https://www.nasa.gov/content/about-orbiting-hubble-interactive. Accessed 2 Feb. 2023.

This source is an interactive webpage designed to help people understand more about the Hubble Telescope and what it does. We used this information to understand more about the main event of our topic.

"Origins: Hubble: Tools: Telescopes Before Hubble (HST) | Exploratorium." Exploratorium: the Museum of Science, Art and Human Perception, www.exploratorium.edu/origins/hubble/tools/before.html. Accessed 30 Jan. 2023.

Our group learned about how some of the technology of the Hubble Telescope is credited to be built by Hans Lippershey. We learned more about the main event of our topic from this source.

Smith, Nate. "Celebrating the Hubble Space Telescope from its Beginnings to its Thirtieth Anniversary." 18 Aug. 2020. Library of Congress Blogs. https://blogs.loc.gov/inside_adams/2020/08/hubble-turns-30/. Accessed 13 Feb. 2023.

The history of the Hubble Telescope and the scientists whose research contributed to its development and creation was outlined on this webpage. We used this information for the background of our topic. We also used photos from this source on our website.

Tillman, Nola Taylor. 'Mother of Hubble' Nancy Grace Roman Led the Way for Women in Astronomy. 8 Mar. 2018. https://www.space.com/39923-mother-of-hubble-nancy-grace-roman.html. Accessed 19 Jan. 2023.

Nancy Grace Roman was considered to be the 'Mother of Hubble' and helped women to enter the field of science by breaking the norm of women being discouraged from practicing in the fields of science. We learned that many frontiers were crossed in the development of the Hubble Telescope, including women becoming involved in science. We used this information and a photo on our website.

“A Tiny, Hidden Galaxy Provides a Peek into the Past." HubbleSite.org hubblesite.org/contents/news-releases/2022/news-2022-051. Accessed 19 Dec. 22.

The information collected by the Hubble Telescope helps us understand more about the universe. We used this website to understand more about the impact of our topic on history.

"Top 5 Discoveries from the Hubble Space Telescope." CBS News - Breaking News, 24/7 Live. https://www.cbsnews.com/media/hubble-space-telescope-science-milestones/. Accessed 25 Jan. 2023.

We realized some of the great achievements of the Hubble Telescope with this webpage. We used this information to strengthen our understanding of the impact and legacy of our topic.

"Two Exoplanets May Be Mostly Water, NASA's Hubble and Spitzer Find." 2022. HubbleSite.org, hubblesite.org/contents/news-releases/2022/news-2022-048. Accessed 6 Feb. 2023.

Hubble Space Telescope has aided in the discovery of exoplanets. We learned how the Hubble Space Telescope continues to help scientists discover more about the frontier of space. We used this information to understand more about the impact and legacy of our topic.

"The Universe." HubbleSite.org, 16 Dec. 2022, hubblesite.org/science/universe. Accessed 30 Jan. 2023.

This source taught us how useful the Hubble Telescope has been in understanding more about the universe. We learned more about how the Hubble Space Telescope continues to collect data to understand more about our universe. This source strengthened our understanding of the impact of the Hubble Telescope.

"What has the Hubble Space Telescope Discovered?" Royal Museums Greenwich. https://www.rmg.co.uk/stories/topics/what-has-hubble-space-telescope-discovered. Accessed 4 Jan. 2023.

We learned about some of the amazing discoveries of the Hubble Telescope. We used this information to help write our script and understand more about the impact of our topic.

"What is the Big Bang Theory?" Space.com, 1 Feb. 2022, www.space.com/25126-big-bang. Accessed 15 Feb. 2023.

Some scientists believe the Hubble Telescope provided information about understanding The Big Bang Theory. We used this source to understand more about the impact of the Hubble Telescope.

“What is the Hubble Space Telescope?” 21 May 2015. NASA. https://www.nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-is-the-hubble-space-telecope-k4.html. Accessed 30 Jan. 2023.

NASA explained how the Hubble Telescope was created and provided some of the images it has taken. We used this source to learn more about what the Hubble Telescope does and how it works.

"Why is Hubble Important?” Education and Outreach Collections from the University of Chicago. ecuip.lib.uchicago.edu/the-story-of-the-hubble-space-telescope/01/index.html. Accessed 16 Dec. 2022.

The Hubble Telescope has been an important part of space discovery and understanding more about this unknown frontier. We learned more about the impact of the Hubble Telescope on science and our understanding of the universe. We used this source to strengthen our knowledge of the impact of our topic.