WOMEN IN ASTRONOMY COOPERATIVE CARD GAME

AT A GLANCE

- Age Group: 13-18 years old students, groups and families
- Format: Moderated discussion
- Duration: 20 minutes to 1-hour

OVERVIEW

By playing a cooperative card game, the public will discover the role of women in astronomy and recognise their contributions and their role in advancing the science of astronomy.

OBJECTIVES/AIMS

- Offer new role models to teenagers.
- Promote better representation of women in schools, science centres and museums and other informal learning settings.
- Show women's contribution to astronomy throughout history.

SUGGESTED SCENARIO

The activity can be conducted in an informal learning setting as a moderated discussion or at a school. It can take place within a broader event or as a standalone activity.

TARGET AUDIENCE

- Age: 13 - 18
- N. participants: 2 - 30
- N. facilitators: 1 or 2 depending on the number of participants
- Type of audience: Students, school groups, families, public

FORMAT

Moderated discussion.

TOPICS COVERED BY THE ACTIVITY

Women in Astronomy throughout history, the history of astronomy.

DURATION OF THE ACTIVITY

20 minutes to one hour, depending on the format and the number of participants.

MATERIALS

- Cards printed on both sides:
    - FRONT: Photo or painting of a female astronomer + name + a short text presenting them and their biggest/most famous accomplishment or discovery (don't indicate any dates on this side)
    - BACK: Photo or painting of a female astronomer + name + years of birth and death
- 30 cards (or more)
- Hooks or clothes pegs and rope to hang the cards 60 (2 per card)

SETTING

• If the activity is implemented for a group including more than 10 people: a big wall to hang the cards as the game progresses. You can also choose to place the cards on the floor or a long table.
• If there are between 2 to 10 players: several tables and chairs, each table with a small set of cards. Tables should be able to accommodate the size of the group playing the game.

GROUP MANAGEMENT

The game can be implemented either for small groups of 2 to 10, or for bigger groups of 10 or more (up to 30).

DESCRIPTION AND TIME SCALE

1. INTRODUCTION

- For a large group, 5 min to explain the game:
    - The facilitator(s) introduce themselves.
    - They show a portrait card: “We are going to travel back and forth in time to meet female astronomers and learn about their discoveries or contributions to astronomy.”
    - “Each card has information about the astronomer in the front and the years of birth and death on the back.”
    - “The goal is to place the cards in the correct chronological order, from the oldest on the left to the newest to the right.”
    - “This is a cooperative game, so you can discuss as a group to find the correct place for each discovery in the timeline.”
- For small groups: Rules of the game are printed ahead of time and left on the tables with a set of cards. A poster close by lets the public know that they can play without asking. Facilitators can stay nearby to provide any necessary explanations.
    - With this game, we will travel through time: we will meet female astronomers and learn about their discoveries. The goal of the game is to build a timeline, placing each card in ascending chronological order according to the astronomer’s year of birth. The front of the card tells us about the astronomers and their discoveries or contributions to the field of astronomy. On the back, you can see their years of birth and death. Shuffle the cards, making sure to keep all “front sides” up. The game starts with the draw of the first card; after reading about the astronomer, place it on the table with the back side of the card up (showing the years). Draw the second card, inspect the information given, and without looking at the back, decide if the card goes to the left or the right of the first card (chronologically). If you think the astronomer was born before, place it to the left. If they were born after, place it to the right. Once you have finished the deck, flip the cards and reposition them in the correct order in the timeline.

Note:

- Choose the women you want to show carefully: you need as much diversity as possible in terms of education, age, nationality, sexual orientation (when publicly stated by the woman herself) etc.

DEVELOPMENT OF THE ACTIVITY

1. After introducing themselves and the game (see into),
2. One of the facilitators reads the front of the first card out loud and hangs it with the date showing.
3. They pick another card, read its information aloud, and ask the group where it should go: before or after the first one.
4. The second facilitator (if there is one) can walk among the public to catch some thoughts and encourage the players to share them with the group.
5. Facilitators can give some clues without providing the correct answer.
6. The card is hung where the group says it should be.
7. The facilitators pick a new card (or ask one of the players to take their role).
8. Players go through the deck, taking their time to discuss where which card goes. They are free to adjust their timeline as they go, revisiting and discussing why they made the choices they made.
9. At the end, the facilitator or one of the players goes through the timeline, turning the cards over to reveal the dates and if necessary, repositioning them. Players are encouraged to discuss their decision-making process.

Note:

- The public can participate on several levels:
    - suggest the placement of the cards
    - engage and encourage others by taking the facilitator’s role,

- handle the cards and hang them,
- engage in follow-up discussion

- The facilitator (s) must be briefed on the importance of involving girls/non-binary participants in the discussion. Especially in groups that are predominantly male, as there is a risk that only boys engage in the discussion. The facilitator(s) should also be prepared to hear sexist comments and react accordingly.

CONCLUSION

1. When the game is completed or time is up, facilitators invite participants to have a look over the entire timeline and facilitate a follow-up discussion, broadening the discussion beyond gender to include other underrepresented communities. A way to start could be: “In a short time, we have seen a lot of discoveries by women throughout history.”...
    a. “Who is your favourite? Why?”
    b. “Do you know other women who are not represented here?”
    c. “Why do you think women are under-represented in astronomy?” (Prohibited from teaching, publishing, studying, access to education and tools, stigma, etc.).
    d. Access: It is worth highlighting that some known female astronomers (Mariam al-Asturlabi, Sophia Brahe, Caroline Herschel, for example) only had access to tools (knowledge, telescopes, etc.) through the man in their lives.
    e. Many of the historical astronomers featured in the deck were from affluent families: how much class was a factor in ensuring they had access to tools? How is it today?
    f. Race: include the discussion on the representation of people of colour in the history of astronomy. How many are in the deck, when do their contributions start being recognised, and when do they start having access? How is it today?
    g. If there is time, a general discussion on how to ensure better representation of underrepresented communities, including women, in STEM, can take place.
2. If the activity is done in an educational setting in which you regularly interact with the participants, you could additionally follow this game up with an assignment for each participant to do some research and make their own cards of (3?) women in astronomy/STEM they can find.
3. The game could also be made with astronomers from your own country or with other underrepresented groups: people of colour, LGBTQ+, etc.

Note: How to create a card?

- The content of the cards, including the portrait and the discovery, can be found in online encyclopaedias (Wikipedia, for example) or in books.
- Be careful when you choose the illustration/picture: it must be free to use (with or without attribution - or make sure your design includes the attribution). You can find online databases to get license-free pictures (Wikimedia commons, for example).
- Here are three examples of cards (the front page of the card is on the left, and the back side of the card is on the right)

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Text

Rules of the game

With this game, we will travel through time: we will meet female astronomers and learn about their discoveries. The goal of the game is to build a timeline, placing each card in ascending chronological order according to the astronomer’s year of birth. The front of the card tells us about the astronomers and their discoveries or contributions to the field of astronomy. On the back, you can see their years of birth and death. Shuffle the cards, making sure to keep all “front sides” up. The game starts with the draw of the first card; after reading about the astronomer, place it on the table with the back side of the card up (showing the years). Draw the second card, inspect the information given, and without looking at the back, decide if the card goes to the left or the right of the first card (chronologically). If you think the astronomer was born before, place it to the left. If they were born after, place it to the right. Once you have finished the deck, flip the cards and reposition them in the correct order in the timeline.

Cards:

Astronomer	Year	English:
Aglaonice	2nd or 1st century BC	Early astronomer from Greece. Aglaonice was incredibly skilled in predicting when and where a lunar eclipse would occur. Her ability is probably a result of her studying the Metonic cycle, a period of around 19 years, after which the lunar phases fall within the same time of the year. Many thought she was a sorceress as she used her astronomical knowledge to appear as if she was making the Moon "disappear" from the sky.
Hypatia	c. 355 - 415	Greek Neoplatonist philosopher, astronomer, and mathematician. Hypatia was recognised as one of the greatest thinkers, mathematicians and astronomers of her time. Her father was head of a prominent school and also a known astronomer and mathematician. Hypatia's contributions to these fields build on the works of Apollonius and Diophantus, including revising astronomical tables. She was a famed teacher and lecturer, and large audiences came to hear her speak. Hypatia suffered a violent death, being brutally murdered.
Queen Seondeok of Silla	c. 595 - 647	Queen Seondeok of Silla was a Korean queen who rained as the 27th ruler of Silla, one of the three Kingdoms of Korea. Her policies and investments brought about a time of great development not only in astronomy but in other scientific fields and culture. During her reign, Queen Seondeok built the Cheomseongdae Observatory. Still standing today, the 9 m high structure is the oldest astronomical observatory in Asia.
Mariam al-Asturlabi,	10th century	Lived in Aleppo, now northern Syria. al-Asturlabi was an astronomer and maker of astrolabes, an ancient astronomical instrument that was used to predict the motions of objects in the sky, like the Sun, Moon, and stars. The daughter of another astrolabe maker, Mariam mastered the design and making of astrolabes and produced instruments which were capable of making precise calculations and accurate predictions. She was employed by the first Emir of Aleppo, Syria, Saif al-Dawla, to construct these instruments.
Sophia Brahe	1559-1643	Danish scientist and writer who worked in astronomy, horticulture, chemistry, and medicine. Born into an aristocratic family, Sophia Brahe is the younger sister of the famous astronomer Tycho Brahe. She often helped her brother with astronomical observations, and her work contributed to the development of Tycho's theory of planetary orbits. She also made her own observations of comets and eclipses.
Caroline Herschel	1750 - 1848	Born in Germany, Caroline Herschel is considered the first professional female astronomer. She discovered several comets, an open star cluster and 14 nebulae. She worked closely with her brother, Sir William Herschel, including assisting him in building astronomical instruments, cataloguing stars, and executing calculations. As her brother's assistant, she received a salary from King George III of England. The Royal Astronomical Society awarded her its gold medal in 1828.
Wang Zhenyi	1768–1797	Wang Zhenyi was a Chinese astronomer, mathematician, poet, and acclaimed scholar. She authored articles on equinoxes and the relationship between lunar and solar eclipses. She researched the movement of the Sun, Moon and Earth, and developed innovative experiments to prove her theories. Wang Zhenyi was also an accomplished poet, publishing 13 volumes of poetry, prefaces and postscripts.
Caterina Scarpellini	1808 – 1873	Caterina Scarpellini was an Italian astronomer and meteorologist. She worked as her uncle's assistant at the Astronomical Observatory of Sapienza - University of Rome. She was the founder, together with her husband, and the

		editor of *Corrispondenza Scientifica*, a bulletin that published scientific discoveries from her observatory and other research institutions. She founded a meteorological station in Rome.
Henrietta Swan Leavitt	1868 - 1921	Henrietta Swan Leavitt was an American astronomer who worked at the Harvard College Observatory as a "computer", measuring and cataloguing the brightness of stars. Her wealthy background allowed her to join the team at Harvard first as a volunteer. She discovered the relation between luminosity and the period of Cepheid Variables - stars that become brighter and dimmer within a given timeframe. Her findings provided astronomers with the first "standard candle" - a way to measure galactic distances using know measurements of stars' luminosity and distance. Building on the work of Henrietta Swan Leavitt, Edwin Hubble demonstrated the existence of other galaxies outside the Milky Way.
Cecilia Payne-Gaposchkinan	1900 - 1979	Born in England in an upper-class family, Cecilia Payne-Gaposchkinan was an American-based astronomer. Her groundbreaking PhD thesis was published in 1925 under the title "Stellar Atmospheres - A Contribution to the Observational study of High Temperature in the Reversing Layers of Stars". In it, Cecilia Payne-Gaposchkin not only demonstrated that stars are composed mainly of hydrogen and helium, an idea that challenged the scientific consensus of the time, but she also showed that stars could be classified according to their temperatures. Additionally, her work on the nature of variable stars laid the foundation for the understanding of these astronomical objects.
Paris Pişmiş	1911 – 1999	Paris Pişmiş was an Armenian-Mexican astronomer with many firsts, including being the first woman to obtain a PhD from the Science Faculty of Istanbul University and the first professional astronomer in Mexico - the very first. She was one of the first astronomers to study young stellar clusters using photometric photometry. Her work in the field of galactic structure led he to catalogue over 20 Open Clusters and 2 Globular Clusters. She published over 100 papers.
Ruby Violet Payne-Scott	1912–1981	A pioneer in the field of Radio Astronomy, Ruby Violet Payne-Scott was born in Australia and was the first female radio astronomer in her country. Her research focused on solar noise, especially in relation to sunspots - areas on the Sun's surface that appear darker. Her research was central to the discovery of new types of sunbursts - energy emissions from the solar corona and laid the foundations for the mathematical research in radio astronomy. Together with Joe Pawsey, and Lindsay McCready, she demonstrated the connection between sunspots and increased radio emissions from the Sun.
Vera Rubin	1928 - 2016	The work of this groundbreaking American astronomer confirmed the existence of dark matter. Vera Rubin's research focused on the dynamics of galaxies and provided some of the first evidence for galaxy mergers. While working with Kent Ford, an astronomer who had developed an advanced spectrometer (an instrument that breaks light out into its constituting parts), Vera Rubin discovered that stars in the centre and in the periphery of the Andromeda galaxy rotate at the same speed. The fact suggested the existence of matter "holding" the rapid moving stars at the out regions in orbit. Her observations confided the existence of unseen mass in the universe - or dark matter. Her legacy was described by The New York Times as "ushering in a Copernican-scale change" in cosmological theory.
Jocelyn Bell Burnell	**1943 -**	Born in Northern Ireland, Jocelyn Bell Burnell discovered the existence of pulsars - astronomical objects that contain more mass than the sun and emanate light but are not stars. She discovered the existence of Pulsars while working on her PhD studies at Cambridge University. Despite her discovery,

		Jocelyn Bell Burnell's supervisor received much of the credit for her work and was even awarded a Nobel Prize based on Burnell's discovery. She had a prominent career as a researcher and lecturer, she was the president of the Royal Astronomical Society and of the Institute of Physics.
Mae Jemison	1956 -	American medical doctor and astronaut. Prior to her career as an astronaut, Mae Jemison was also in the Peace Corps as a medical officer in Sierra Leone and Liberia. She is known for being the first black woman in Space. She was the mission specialist aboard the Endeavour and spend nearly 8 days orbiting the Earth. Following her career at NASA, she founded various companies and the Dorothy Jemison Foundation for Excellence, a non-profit working on STEM education and sustainability. She is a member of various scientific organisations, such as the American Medical Association, the American Chemical Society, the Association of Space Explorers and the American Association for the Advancement of Science.
Wanda Díaz-Merced	**1982 -**	Born in Puerto Rico, Díaz-Merced lost her sight in her early twenties due to complications with degenerative diabetic retinopathy. Not letting this interfere with her career in astronomy, she found new ways to study stellar radiation without relying on her vision. She realised that she could use her ears to detect patterns in stellar radio data that could potentially be obscured in visual and graphical representation. Wanda is best known for using sonification to turn large astronomical datasets into sound. Wanda Díaz-Merced was instrumental in advising on and testing sonification for use in the astronomical profession.

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