Smithsonian Institution

Why STEAM Matters

THEMES: Science, Art, Collaboration, Innovation, Creativity, Design

SUMMARY: This program encourages participants to think more inclusively about the arts and sciences. Participants will learn about different individuals, programs, and fields that integrate the arts and sciences. They are encouraged to incorporate personal experiences and identify local and national figures who also employ both creative and analytical approaches to their work, often to come up with dynamic solutions or innovative designs that individuals use or encounter in their every day.

LESSON SNAPSHOT:

TIME	SKILLS	TECHNOLOGY	MATERIALS	PROJECT
1 – 1.5 hours	analytical and critical thinking, observation	A computer and projector or digital monitor to display videos	***Provided in this packet***: All instructions for leading a program on STEAM, discussion questions for two videos, and a vocabulary list. ***Additional materials needed***: A whiteboard or writing surface. A computer and projector or digital monitor to display videos. Pieces of paper. Additional items as per hands-on activities noted below.	Participants will discuss the intersections between the arts and sciences and think critically about related career fields and products that combine the arts and sciences.

LESSON OUTCOMES	Participants should understand the intersections between the arts and sciences and their importance for innovation and design.
FACILITATOR PREPARATION	Facilitators should prepare to lead this program by printing the discussion question worksheets and the vocabulary list. The facilitator should spend time reviewing the contents of this packet to become familiar with the material, especially the two videos and the famous scientists who are famous artists or artists who are scientists. Depending on local internet bandwidth, the facilitator may wish to download the two videos ahead of the program to avoid issues with streaming.

Smithsonian Institution

VOCABULARY	• **Science:** the intellectual, analytical, and practical activity that studies the structure and behavior of the physical and natural world through observation and experiment • **Art**: the expression or application of human creative skills and imagination, usually seen in forms such as painting or sculpture • **Analysis:** detailed examination of the elements or structure of something. • **Analytical:** using logical reasoning • **Creativity:** the use of imagination or original ideas, especially in the production of an artistic work • **Innovation**: the introduction of something new; a new idea, method, or device • **STEAM:** the fields of Science, Technology, Engineering, Arts, and Mathematics; a new movement that advocates for the inclusion of arts in the STEM fields • **STEM:** the fields of Science, Technology, Engineering, and Mathematics • **Technology:** the use of scientific knowledge to achieve a practical purpose • **Engineering:** the branch of science and technology that focuses on design, building, and use of engines, machines, and structures • **Mathematics**: the abstract science of number, quantity, and space *Definitions provided by: Merriam Webster and Oxford English Dictionary*

Smithsonian Institution

DETAILED LESSON PLAN:

Warm-Up (7-10 minutes)	• Before the program begins, place some objects on the participants' tables or a presentation table. Objects can include items such as tennis shoes/sneakers, Gore-Tex shoes, athletic wear (a running shirt), a guitar, a harmonica, blueprints for a building, images of fancy party/wedding cakes, a DVD of a movie that uses special effects like AVATAR, fidget spinners, slime, wooden ornaments, and other items that reflect scientific and artistic components. • Ask the participants to put the object into one of two categories: Does this object represent art or science? You may give them a few minutes to discuss and debate amongst themselves. **Facilitator Tip:** This activity will allow participants have an interactive start to this lesson. Facilitators can call on various participants around the room to have them present their ideas on the different objects. • Next, pose two true/false questions to the group to encourage analytical thinking. Read the following statements aloud: - Scientists are not creative. True or False? - Artists are not analytical. True or False? • Ask participants to write their answers to each question on a piece of paper, including an explanation of why they have come to their decision. • After participants have written down their answers to both questions, bring the group back together for a discussion about each question. Review each question and ask what participants thought about each statement. Questions could include: - Why do you think this is true or false? - Is there a way that these statements could be both true and false? **Note for Facilitator:** Participant answers will vary, and they may or may not agree on the answers to these questions. These two quick thought exercises lay the framework for introducing STEAM.
Continuing the Discussion of Scientists and Artists: *Discussion of famous scientists who are artists or famous artists who are scientists*	• Choose between five and seven of the names below to write on the whiteboard or other writable surface: - Leonardo da Vinci - Albert Einstein - Benjamin Franklin - Rachel Carson - Mae Jemison

Smithsonian Institution

(7 - 10 minutes)	- Neri Oxman - Ibn Sina - Sir Humphrey Davy - Patsy O'Connell Sherman - Samuel Morse - Maria Sibylla Merian - Santiago Ramon y Cajal - Hedy Lamarr - Carl Jung - Ibn Rushd • Ask participants if they have any ideas on what these individuals have in common. If not, select one of the individuals and encourage conversation about the careers or well-known accomplishments of that individual. Continue to do this with the list you have written on the whiteboard or writable surface. • They are all famous scientists who are artists or famous artists who are scientists. - Leonardo da Vinci: Italian Scientist and Painter - Albert Einstein: German Physicist and Violinist - Benjamin Franklin: American Inventor and Artist - Rachel Carson: American Marine Biologist and Author - Mae Jemison: American Engineer, Physician, Astronaut, Actress, and Dancer - Neri Oxman: Israeli Artist and Environmental Designer - Ibn Sina: Persian Physician, Astronomer, and Poet - Sir Humphrey Davy: English Chemist and Poet (founder of modern atomic theory) - Patsy O'Connell Sherman: American Chemist and Inventor - Samuel Morse: American Painter and Inventor - Maria Sibylla Merian: German-born Naturalist and Scientific Illustrator - Santiago Ramon y Cajal: Spanish Neuroscientist and Artist - Hedy Lamarr: Austrian-born American Actress and Inventor - Carl Jung: Swiss Psychoanalyst and Artist - Ibn Rushd: Spanish Astronomer, Physicist, and Philosopher • After identifying what each of these individuals has in common, ask participants if there are any other names they could add to the list. As participants answer, ask them to explain to the group why this individual should be included in the list.

Smithsonian Institution

	Facilitator Tip: The names provided above are suggestions to continue the conversation and lesson. If there are local well-known scientists who are artists or well-known artists who are scientists, feel free to add those individuals to the list of examples.

Introduction: What is STEAM? *Introduce participants to the idea of STEAM and the inclusion of arts in the study of science.* (7 - 10 minutes)	• Write the following two questions on the whiteboard or other writable surface:
	  - What is science?
	  - What is art?
	• Ask the group to think about and share the first words that come to mind when they think of the two questions on the board. Start with one question (science) before moving on to the second question (art). Write participants' responses on the whiteboard or other writeable surface for the group to see. Spend approximately three to five minutes on each question.
	• Give each participant a printed copy of the vocabulary list found on page 2 of this packet.
	• Ask participants to review the vocabulary list, and select one participant to read aloud the definition for **science**. Encourage the group to think about how the words on the board or their own definitions of the word compare to the definition provided on this sheet. The facilitator might ask questions, such as:
	  - Are there similarities/differences with the definitions we discussed and the ones provided on the vocabulary list? Explain.
	  - Do you agree with the vocabulary definition? Why or why not?
	• Repeat this exercise with the definition for **art**.
	
	Facilitator Tip: Encourage participants to review the vocabulary list for definitions to words they may be unfamiliar with, such as **creative** or **analytical,** before being asked the questions above.
	
	• Now that the group has worked together to clarify and better understand the definitions of art and science, the facilitator should explain the following:
	  - Write out the letters for 'STEAM' on the whiteboard or other writeable surface. Ask participants what each letter might stand for. As participants guess correctly, write each word on the whiteboard or other writeable surface. STEAM is an

	acronym that stands for **S**cience, **T**echnology, **E**ngineering, **A**rt, and **M**athematics. - It is a movement that started gaining greater recognition in 2010 in an effort to include the arts in STEM-related fields (STEM is another acronym that stands for science, technology, engineering, and mathematics). - During this program, we will be exploring why STEAM is important (and why the addition of 'arts' is especially important), where we have already seen STEAM in practice, and how STEAM can impact daily life.
Why is STEAM important? *Videos and discussions* (20-30 minutes)	• Ask participants: Do you think it is important to combine or incorporate the arts and the sciences in academic studies, careers, or hobbies? Why or why not? • Briefly explain the following to the group: - It is important to integrate the arts into the fields of science, technology, engineering, and mathematics (STEM) because the arts are important to fostering innovation. STEAM is about finding a way to incorporate artistic and design-related skills and perspectives with the creative and critical thinking process of science-related fields of study or occupations. Individuals associate science with people in white coats working in laboratories. In reality, scientists, engineers, and technology professionals often employ creativity and innovation every day to implement their projects and ideas. - To better understand these intersections of art and science, the group will watch two videos that highlight professionals who combine art and science in their careers. *Videos and Conversations* • In preparation for the following two videos, give each participant the video question handout found on **page 11** of this packet. • Review the questions for the first video by selecting participants to read each question aloud. • Watch the video with or without English language closed captions. It will be helpful to play this video more than once to allow participants to think about the discussion questions and promote English language learning and comprehension. As participants watch, encourage them to use the handout with discussion questions to take notes. - "Hugh Herr's Bionic Future" video from the Smithsonian's American Spaces video portal (run time 2:18)

	- *Summary for facilitator*: Hugh Herr lost his legs in a climbing accident at the age of 17. Because of this accident, he was inspired to create bionic limbs that function more like human limbs. This story explores where design, science, and technology are integrated to create something that looks good, and also provides important motor functions that simulate human responses as best as possible. - After the video, lead a discussion with the group using the following questions as a guide: - Where do we see specific scientific aspects in this video? - Where do we see specific artistic aspects in this video? - How do they intersect or work with one another? - What role does art and creativity play in invention? - Is this a good example of STEAM at work? Why or why not? • If time allows, watch the second video as a group. Repeat the same process of watching the video twice before leading a discussion around the questions found on the video discussion handout. - "Why Scan a 3-D Dinosaur?" video from the Smithsonian's American Spaces video portal (run time 2:26) - *Summary for facilitator*: Members of the Smithsonian's National Museum of Natural History and the Smithsonian Digitization Program Office worked together to create a digital archive of the entire Dinosaur Hall in the museum. This video emphasizes the intersection of design and innovative technology with promoting scientific interest and awareness, aiming to digitally archive the exhibit and also make it more accessible to online audiences by providing a digital version of the Dinosaur Hall. - Discussion questions: - Where do we see specific scientific aspects in this video? - Where do we see specific artistic aspects in this video? - How do they intersect or work with one another? - What role does art and creativity play in inspiring further scientific research or interest? - How can science and art be combined to make information more accessible to the public?

Smithsonian Institution

	Facilitator Tip: The facilitator can adapt the above discussion questions. In addition to these questions, the Smithsonian has also put together a list of suggested conversation questions for each video. These questions could be used in combination with the discussion questions above. - Conversation Club questions for Hugh Herr's "Bionic Future" can be found here in PDF and Word. - Conversation Club questions for "Why Scan a 3-D Dinosaur?" can be found here in PDF and Word. • After the videos and discussions, explain to the group that these are only two examples showing individuals and teams combining art and science. Ask the group to identify other examples of jobs or products/projects that combine art and science – incorporating the "A" in STEAM. - Some examples include: - Space and airplanes: You need to use science and art to design and create useful but aerodynamic models that will fly. - Health and medicine: Bionic limbs, art therapy. - Photography: Use of light, lenses, and chemicals to create images.
Conclusion and Final Activity (5-10 minutes)	• Encourage participants to think back to the beginning of the program and to the definitions and word associations that were written on the board for **art** and **science,** as well as the true/false statements (Can scientists be creative? Can artists be analytical?). • Ask participants if the addition of "A" into STEAM is important. Is it necessary for invention and innovation? What happens to science/technology/engineering/math (STEM) WITHOUT art? • Ask participants if their feelings have changed about any of these after the discussions and videos. Why or why not? Would they make any edits to the definitions of these words on their vocabulary list? Give participants two to three minutes to work with a partner or in groups to discuss these questions. • Ask participants to share any changes or updates they've made to the definitions as a result of this program. • Conclude the program with the following idea: Incorporating the arts into the sciences – the "A" in STEAM – is critical for supporting creativity and innovation. The arts and the sciences intersect in many ways, and you may be surprised to see these intersections in many things that influence your daily life.

Smithsonian Institution

Optional Lesson Extension and Additional Resources	**OPTIONAL LESSON EXTENSIONS** **Facilitator Tip:** Depending on time and the age level of participants, facilitators can consider adding the following activities and lesson extensions: • **Creation Activity:** Give participants creation challenges on different tables. The creations will be judged on effectiveness as well as design (the design is a key part of the former but also makes something more attractive). Creation tables could include materials for making the following items WITHOUT instructions: a marble run, fidget spinners, a sound effects table, a spaghetti bridge, etc. • **Research and Presentation Activity:** Encourage participants or groups of participants to select one of the scientists/artists discussed during the program to research. Participants could then present their research to the group during the next program. • **Comic Activity:** You may also consider asking participants to develop a short comic about the individual they have selected. Instructions for developing a comic are here (the video is especially helpful) and downloadable templates for creating comics can be found here and here. • **Warm Up Activity Extension:** As an extension to the warm up activity, have participants look around their home, school, neighborhood and reflect where art and science intersect. They can present their observations and reflections during the next program. This may be an interesting activity for younger participants as they explore their local surroundings, ranging from the tennis shoes they are wearing to musical instruments to city design, such as where trees are planted. • **Maker Activities:** In "Hugh Herr's Bionic Future" Programming Guide, developed by Casa Thomas Jefferson, an American Space in Brasília, there are suggestions for three maker activities: - Build a Model Robotic Hand - Make an Articulated Hand - Create Prosthetics Using a 3D Printer **ADDITIONAL RESOURCES FROM THE SMITHSONIAN** • Spark!Lab Facilitator Manual, developed for American Spaces: https://americanspaces.state.gov/wp-content/uploads/sites/292/spark-lab-facilitator-october-2015.pdf • Stories and Blogs of featured inventors from the Smithsonian's National Museum of American History's Lemelson Center for the Study of Invention an Innovation:

	http://invention.si.edu/search/inventors%20stories • *From Innovation to Market* Video provides step-by-step instructions on the process of invention: http://amhistory.si.edu/american-enterprise/innovation-to-market/ • Ready, Set, Design! Activity from the Smithsonian's Cooper-Hewitt National Design Museum: https://www.cooperhewitt.org/2011/09/09/ready-set-design/ • Cooper-Hewitt National Design Museum's *Access+Ability* Online Exhibition highlights 70+ innovative designs developed in the last decade that assist people with a wide range of physical, cognitive, and sensory abilities: https://collection.cooperhewitt.org/exhibitions/1141959921/ • Smithsonian Science Education Center features free educational resources, including videos, games, and activities: https://ssec.si.edu/explore-our-curriculum-resources?f[0]=field_is_free%3A1 • Articles from Smithsonian.com about Women Who Shaped Science: https://www.smithsonianmag.com/science-nature/women-science-180967866/ • Smithsonian's National Air and Space Museum Educator Resources: https://airandspace.si.edu/educator-resources

Smithsonian Institution

Discussion Questions: Hugh Herr's Bionic Future

1. Where do we see specific scientific aspects in this video?
2. Where do we see specific artistic aspects in this video?
3. How do they intersect or work with one another?
4. What role does art and creativity play in inspiring further scientific research or interest?
5. Is this a good example of STEAM at work? Why or why not?

Discussion Questions: Why Scan a 3-D Dinosaur?

1. Where do we see specific scientific aspects in this video?
2. Where do we see specific artistic aspects in this video?
3. How do they intersect or work with one another?
4. What role does art and creativity play in inspiring further scientific research or interest?
5. How can science and art be combined to make information more accessible to the public?