Lesson Plan
Ben Barres:
Neurobiology Pioneer and Champion for Equity in STEM

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Neurobiologist Ben Barres, before his death in 2017.
Photo credit to Timothy Archibald, from the journal Nature.

Grade Level(s): 11-12, General College	**Subject(s): History, Social Activism, Equity in STEM**

In-Class Time: 50 min – 1 hour	**Prep Time: 15 min – 20 min**

Materials

- Lesson Plan
- Copies of: (See Supplemental Materials)
  - "Ben Barres (1954 – 2017)"
  - "Ben Barres - gender champion"
  - "Does gender matter?" and Discussion Worksheet
- Classroom internet access

Objective

This two-part lesson is about introducing students to Ben Barres (1954 – 2017), a successful neurobiologist and gender equity activist. Students will learn about his life and experiences as a female-to-male transgender scientist through excerpts and a review of his posthumously published book, *The Autobiography of a Transgender Scientist* (2017). Additionally, students will read his famous

commentary in *Nature*, titled "Does gender matter?," and discuss Barres' arguments for why women are not advancing in science as quickly as men. Students can also explore the *Queer in Stem* online research project to collect information about LGBTQ+ scientists' career experiences. The teacher should be prepared to discuss the importance of diverse representation in academic leadership and role models in science, issues such as *subtle discrimination*[1], as well as how students can be allies in cultivating an equitable learning community.

The guide is divided into two parts, which can be used together or as independent lessons: (1) an introduction to Ben Barres' life as a scientist and activist, and (2) resources for understanding LGBTQ+ experiences in STEM and increasing their visibility in the scientific community.

Introduction

Ben Barres was born in 1954 and raised in West Orange, New Jersey. Barres decided when he was very young that he was going to be a scientist, even though he "did not know any scientists and hardly had any concept of what science was."[2] From this age on, Barres also recognized that, although he was born "Barbara" and was assigned the gender of "girl" at birth, internally he felt strongly that he was a boy.[3] He writes:

> "From junior high school on, I had increasingly strong feelings of *gender dysphoria*, difference, and confusion. I felt very embarrassed and ashamed about my gender incongruity, but was totally unable to express what I was feeling to anyone."[4]

He found public school moved at a "very slow pace," and sought many outside opportunities to supplement his education, including astronomy courses at Rutgers University and a Science Honors Program at Columbia University funded by NSF.[5] He even secured an entry-level position at Bell Laboratories immediately following his high school graduation. Although Barres was the strongest science and math student in his class and had nearly perfect SAT scores, he was advised to not apply to MIT (his dream school) and instead to local, less competitive schools.[6] He applied anyway, and was accepted into MIT beginning in the fall of 1972. Barres graduated in 1976 with a neurobiology major (which he himself designed).

In the early 1970s, only about 5 percent of MIT students were women. Although the institution was making an concerted effort to admit more women, according to Barres, "we were in some respects not receiving the same education as men."[7] Barres had trouble finding a laboratory at MIT that would accept him, despite equivalent male students finding ample research opportunities. He quite often experienced instances of *gender discrimination*, even though he did not feel that he was a woman. The following is an oft-cited example:

[1] See our teaching guide, titled "Subtle Discrimination," for additional materials on this topic.
[2] Barres, *The Autobiography of a Transgender Scientist*, 3.
[3] Ibid., 9.
[4] Ibid., 10.
[5] Ibid., 5-6.
[6] Ibid., 13.
[7] Ibid., 16.

> "In the artificial intelligence course I took at MIT, I was the only student to solve a very difficult question on the take-home final exam whose solution involved constructing a LISP program with nested subroutines that recursively called on each other. The professor announced in class that since no one had solved it, he was not counting it toward our grades. After class I went up to the professor to show him that I had solved the question. To my dismay, he sneered at me and said that my boyfriend must have solved it for me. I was offended because he was unfairly and wrongly accusing me of cheating. It was many years before I realized that his meaning was deeply sexist—he just couldn't believe a woman had solved the problem when so many men had been unable to."[8]

Barres continued his education after MIT at Dartmouth Medical School from 1976 to 1979, and became more deeply interested in *neuroscience* and *neurology*, the science of the nervous system. Barres then pursued a one-year medical internship, followed by a neurology residency at the Memorial Sloan Kettering Cancer Center in New York. Following his medical training, which he notes was when he "found that the barriers for women starting to become more glaring than they were at MIT," Barres pursued his PhD in neuroscience at Harvard Medical School.[9] While a PhD candidate, Barres rotated through several neurobiology labs, and found a research interest in *glial cells*: the most abundant type of cell in the nervous system, they surround *neurons* and provide support for and insulation between them. After seven successful years at Harvard Medical School, making several discoveries along the way, Barres earned his PhD in Neuroscience and pursued post-doctoral work for several years at University College London before becoming a professor at Stanford University.

Barres built and ran his own successful laboratory at Stanford, and often said that the best part about being a scientist was "mentoring young students."[10] It wasn't until several years into his professorship when he first learned about transgender people and visited a local clinic to learn more about the process of transitioning from female to male. Barres was initially hesitant, and worried for several weeks about possible repercussions to his career. He writes:

> "Even though I was already tenured and so did not have to worry about being fired—a frequent outcome for transgender people in other professions at the time (in many states, transgender people are still not legally protected from being fired)—there was much to consider."[11]

He decided to reach out for advice and found immediate support from his family and colleagues. At the age of 40, he began his transition from "Barbara" to "Ben." He wrote often about his unique perspective cultivated from experiences as a woman and man in science—he realized after his gender transition the extent to which women still frequently experience barriers that hinder their STEM careers. For the rest of his life, he was a relentless advocate for women in STEM, authoring articles and giving presentations about the startling level of gender discrimination that persists today. An infamous example is Barres' response to comments made by Larry Summers, a previous president at Harvard University who claimed that women are inherently less talented than men at science, which is explored in this lesson. You can find examples of Barres' advocacy work in the "Additional Resources" section.

[8] Ibid., 17.
[9] Ibid., 19.
[10] Ibid., 1.
[11] Ibid., 54.

Ben Barres was the first transgender scientist elected to the National Academy of Science in 2013. He is remembered for his groundbreaking neurobiology research, as a pioneering advocate for women in science, and his tireless service as a dedicated mentor to many graduate students. He passed away from cancer in December 2017.

He concludes his autobiography with the following:

> "As I have described, I believe that my different experiences in life as an LGBT person helped provide me with diverse perspectives and with the fortitude that I needed to persevere in a competitive world. Growing up transgender in a time of universal ignorance and hate has been difficult and emotionally painful. I believe that most or all of this pain is preventable in a future world where people are less ignorant, more supportive, and more understanding. I have tried my best to help others by being open about my transgender identity and by being a good scientist, mentor, and human being as I have been able to be. It has been a very great privilege to have had such an enjoyable academic career."[12]

Terminology and Definitions

Gender Discrimination: unequal or disadvantageous treatment of an individual or group of individuals based on gender
Gender Dysphoria: a condition where a person experiences discomfort or distress because there's a mismatch between their biological sex and gender identity
Glial Cells: Supportive cells for neurons, surround neurons and make up the insulation between them
Neurons: Transmit information throughout the body
Neuroscience: Field of study to understand the structure and function of the nervous system
Pipeline Leak: Significant loss of talented individuals in science due to environmental factors
Transgender: denoting or relating to a person whose sense of personal identity and gender does not correspond with their birth sex.

Instructions/Activities

Part 1: Ben Barres, Neurobiologist and Equity Activist
Engage: 5-10 minutes

Students will watch the video titled "Neuroscientists You Should Know: Ben Barres."	
What is the teacher doing? The teacher is playing the video. Ask students to write down short notes about Barres' work. After the video ends, take a few minutes to ask students several short follow-up questions about neuroscience, glia cells, and basic information about Barres shared in the video.	**What are the students doing?** Students will watch the video and write down introductory facts about Barres' life, research, and advocacy. Students should also make special notes of the following vocabulary: neurons, glia cells, and pipeline leak.

Explore: 15 minutes

[12] Ibid., 115.

The class will be divided into groups of 3-4 to read and discuss "Ben Barres (1954-2017)" and "Ben Barres – gender champion." Each article can be found in the **Supplemental Materials** and each group should be provided with one copy (if group of 3) or 2 copies (if group of 4) to be shared.

What is the teacher doing?	**What are the students doing?**
The teacher will pass out copies of "Ben Barres (1954-2017)," "Ben Barres – gender champion." Ask the students to spend time reading each article, making notes of significant life events. Ask each group to **write a short biography** of Barres' life (~10 sentences). Be sure to discuss his research interests and accomplishments, scientific research positions, aspects of his gender discordance, and advocacy. When finished, each group should share their biography, while the teacher takes note of the common experiences each group wrote about in their biographies.	The students are individually reading the short articles, "Ben Barres (1954-2017)" and "Ben Barres – gender champion," highlighting life events and preparing to work with their group to write a short biography of his life. Once each group member has finished reading, write a short biography of Barres, drawing on the significant experiences that each group member highlighted in her or his reading.

Explain: 5-10 minutes

The teacher will now discuss the controversial statements made by Larry Summers, former president of Harvard University, about why there are less women in STEM fields.[13] This incident inspired Barres to write his famous article "Does gender matter?" for *Nature* magazine.

In January 2005, at a Conference on Diversifying the Science & Engineering Workforce, Larry Summers spoke on the issue of underrepresentation of women in science, and made the following comment:

> "It does appear that on many, many different human attributes – height, weight, propensity for criminality, overall IQ, mathematical ability, scientific ability – there is relatively clear evidence that … there is a difference in the standard deviation, and variability of a male and female population."[14] – Larry Summers

Summers argued that women were underrepresented in science because they are biologically less able to perform successful scientific research, and discrimination was no longer a barrier to women's academic careers. He also argued that women were reluctant to work long hours because of childcare responsibilities. According to The Guardian, the number of tenured jobs offered to women fell from 36% to 13% during Summers' Harvard presidency.[15]

Ben Barres responded to Summers' claims in his article "Does gender matter?" published in *Nature*. In it, he writes:

> "I am suspicious when those who are at an advantage proclaim that a disadvantaged group of people is innately less able. Historically, claims that disadvantaged groups are innately inferior have been based on junk science and intolerance."

[13] See also Dillon, "Harvard Chief Defends His Talk on Women," *The New York Times*.
[14] Excerpt from "Neuroscientists You Should Know: Ben Barres."
[15] Goldenberg, "Why women are poor at science, by Harvard president," 2005.

This article received wide-spread media attention after its publication and, according to Google Scholar, has since been cited over 250 times.

What is the teacher doing?	**What are the students doing?**
The teacher is providing background information about Larry Summers' controversial statements about underrepresentation of women in science.	Students listen to the background introduction to Summers' controversial statements.

Elaborate: 25 minutes

Students will read Barres' article "Does gender matter?" from *Nature* magazine.	
What is the teacher doing? The teacher is passing out copies of the "Does gender matter?" article and accompanying worksheet to individual students. Instruct students to read the article and work together to answer the questions on the provided worksheet in **Supplemental Materials**.	**What are the students doing?** Student will read the article and work together to answer the questions on the worksheet provided in the **Supplemental Materials**.
After groups have completed the worksheet, initiate a discussion with the entire class about their groups' answers.	Students will discuss their answers on the worksheet, as well as their own thoughts and reactions to Summers' comments.

Evaluate: Take-Home Assignment or In-Class Discussion

Students should choose one of the following sections of Barres' book and write a 2+ paragraph response to it, summarizing the major aspects of Barres' advocacy work and addressing the provided Sample Questions. See "Additional Materials" for the excerpts.

"Advocacy" (103-115)
Sample Questions:
[1] How does Barres' describe the experience and importance of mentoring young scientists?
[2] Describe two of the biases and barriers that women face in the pursuit of science that Ben Barres discusses.

"Transitioning from Barbara to Ben" (53-62)
Sample Questions:
[1] What were some of the potential repercussions that Ben Barres worried about if he were to undergo a gender transition? Why was he worried?
[2] Describe one way that transgender people have received more public support that Ben Barres mentions, as well as one change that still needs to be made.

Part 2: LGBTQ+ Experiences in STEM

Engage: 5-10 minutes

Begin the class by dividing the students into discussion groups of 3-4 students. Introduce the 500 Queer Scientists project, a visibility campaign for LGBTQ+ people and their allies working in STEM and STEM-supporting jobs.	
What is the teacher doing? The teacher divides the class into groups of 3-4 students and asks them to discuss the following: (1) What are the goals for this project? (2) Why do you think a collection LGBTQ+ scientists' stories is important?	**What are the students doing?** Students are introduced to the 500 Queer Scientists Project. In their groups, students browse the 500 Queer Scientists project website while discussing the questions posed by the teacher.

Explore: 15-20 minutes

Students will read "Proud to be different in STEM: LGBTQ+ scientists and engineers are coming out and being visible to support the next generation" from *Science News for Students*.	
What is the teacher doing? The teacher is passing out copies of "Coming out: the experience of LGBT+ people in STEM" and the supplemental worksheet for each individual student, but students should remain in their groups. Instruct students to fill out the worksheet from Supplemental Materials in their groups.	**What are the students doing?** Students will take time to individually read "Coming out: the experience of LGBT+ people in STEM," making note of similarities and differences between the interviewee's experiences. Students are completing the accompanying worksheet with related questions.

Explain: 10 minutes

The teacher should now play the video including along with the article, "LGBTQ in STEM: Advice from LGBTQ scientists | Science News for Students."	
What is the teacher doing? The teacher is playing the video. After the video, the teacher will ask students to share their answers to the worksheet.	**What are the students doing?** Students are watching the video. Students share answers to the discussion questions on the provided worksheet.

Elaborate: 15 minutes

Students will then explore the Queer in STEM project. Managed by Allison Mattheis, Joey Nelson (from previous article and video), Daniel Cruz-Ramirez de Arellano, and Jeremy Yoder, the Queer in STEM project is a series of two systematic, nationwide surveys of LGBTQ+ people in STEM careers.	
What is the teacher doing? Instruct the students to browse the Queer in STEM project website. Student should work	**What are the students doing?** Students are browsing the Queer in STEM project.

together to summarize the motivations of the survey, structure of the survey, and several main results.	Students will work together to summarize the motivations, structure, and main results of the survey.

Evaluate: Take-Home Assignment (Can also be substituted for the Queer In STEM in-class activity)

Students will read "Coming out: the experience of LGBT+ people in STEM" and write a response about similarities and differences between the interviewee's experiences as LGBTQ+ scientists. Encourage students to write about reasons why it is important that scientists share their experiences as researchers and academics and ask them to reflect on what they learned from the readings, discussions, and website explorations during class or lecture period.

Required/Recommended Reading and Resources

- Barres, B. (2006). Does gender matter? *Nature*, *442*, 133–136. Retrieved from:
- Barres, B. (2018). *The Autobiography of a Transgender Scientist*. Cambridge, Massachusetts: MIT Press.
- Barres, B., Montague-Hellen, B., & Yoder, J. (2017). Coming out: The experience of LGBT+ people in STEM. Genome Biology, 18(62).
- Dillon, S. (2005, January 18). Harvard Chief Defends His Talk on Women. *The New York Times*.
- Freeman, M. (2018). Ben Barres: Neuroscience pioneer, gender champion. *Nature*, *562*, 492.
- Goldenberg, S. (2005, January 18). Why women are poor at science, by Harvard president. *The Guardian*. Retrieved from:
- Nelson, B. (2019, May 14). Proud to be different in STEM: LGBTQ+ scientists and engineers are coming out and being visible to support the next generation. *Science News for Students*.

Further Reading and Additional Resources

- **Ben Barres' Advocacy:** "Ben Barres (Stanford) 2: Women in Science."
- **Additional Resources about Women in Science**
  - *The Madame Curie Complex* by Julie Des Jardins (2010).
  - *The Science Education of American Girls: A Historical Perspective* by Kim Tolley (2003).
  - "Reflections on women in science -- diversity and discomfort: Jocelyn Bell Burnell at TEDxStormont." Jocelyn Bell Burnell (2013).
- **Additional Resources about LGBTQ+ People in Science**
  - See our lesson plans "Alan Turing" and "Sally Ride: To Space and Back"

Extensions

Each lesson plan can be used independently or can work together as a pair. Additionally, the resources from this lesson can be mixed and matched – most of the activities involve reading short articles and discussion and deal with the broader issue of gender discrimination in STEM as well as increasing LGBTQ+ visibility in the sciences.

Ben Barres life and work can easily be incorporated as part of science curriculum about the brain and nervous system. His research on glia cells was groundbreaking in the neurobiology field and was incredibly influential in how neuroscientists think about glia cells' role and relationship to neurons. Incorporating his work in this regard is a helpful way present science as an inclusive, diverse community.

Common Core Standards

For more information on Common Core Standards, visit http://www.corestandards.org/.

Speaking & Listening	
CCSS.ELA-LITERACY.SL.11-12.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CCSS.ELA-LITERACY.SL.11-12.4	Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
History/Social Studies	
CCSS.ELA-LITERACY.RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
CCSS.ELA-LITERACY.RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
Science & Technical Subjects	
CCSS.ELA-LITERACY.RST.11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
CCSS.ELA-LITERACY.RST.11-12.6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
Subject Writing	
CCSS.ELA-LITERACY.WHST.11-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
CCSS.ELA-LITERACY.WHST.11-12.9	Draw evidence from informational texts to support analysis, reflection, and research.

Next Generation Science Standards

For more information on the Next Generation Science Standards, visit http://www.nextgenscience.org/.