

Lesson Plan

Lise Meitner, Austrian Nuclear Physicist



Image courtesy of the AIP Emilio Segré Visual Archives

Grade Level(s): 6-12

Subject(s): History, Physics

In-Class Time: 60-120 Minutes

Prep Time: 15-45 minutes

Materials

- A/V equipment
- Photocopies of research worksheets (available in Supplemental Materials)

Objective

Students will learn about the professional and personal challenges faced by Lise Meitner and other female physicists in the mid-20th century.

Introduction

Lise Meitner is one of the most famous female physicists. She is often remembered for contributing theories that made the atomic bomb possible and for being snubbed by the Nobel Prize committee. However, there is much more to this pioneering physicist; Meitner herself would have objected to the controversy being her main legacy. This lesson will teach students about Meitner's dedication, accomplishments, and struggles. This lesson plan can be used in conjunction with AIP's "Fair or Unfair: Should these women have received the Nobel Prize too?" teaching guide, which allows students to study this controversy.

Instructions/Activities

Before class:

Assign the supplementary research worksheet on Lise Meitner. This assignment can be completed as homework before class or become an in-class assignment depending on the availability of research resources. Some resources are listed in the biographical materials section of “Further Reading and Additional Resources” later in this lesson plan.

Engage: 5-10 minutes

The lesson will begin with a short discussion of the research worksheet. Ask the students what they learned and what questions they still have about the Nobel Prize and women scientists.

What is the teacher doing?

Facilitate students in a short discussion of answers of the worksheet questions. Students’ answers should be based on factual information, but the questions are written to be relatively open-ended, and multiple answers are expected for each question. Encourage comments on aspects of Meitner’s life that were surprising or unexpected.

What are the students doing?

Engage in the conversation and share answers for each question. All students should have the opportunity to participate in the discussion.

Explore: 25 minutes

Show chapter 11/12 of NOVA’s *Einstein’s Big Idea* (2005) (located approximately 1:24:00-1:44:00). This video can be found at <https://www.youtube.com/watch?v=B4vDGTYTCLo>

What is the teacher doing?

Encourage students to actively consider the ways in which Meitner and her collaborators are depicted in the video as compared to their research before class.

What are the students doing?

Take notes on the ways Meitner is depicted in the video versus their research.

Explain: 25 minutes

Have a discussion of student observations of the NOVA video versus their biographical research. This discussion should focus on both similarities and differences in content, as well as a comparison of the two different types of media (video and internet/book sources).

What is the teacher doing?

Lead a conversation that compares aspects of the video’s depiction of Meitner to the facts that students found in their prior research. Possible discussion questions include:

1. How do Meitner’s biographies compare to her depiction in the video?
2. How did her obstacles as a girl growing up in turn-of-the-century Vienna affect her growth as a scientist?

What are the students doing?

Participate in answering questions and critically comparing the video to the readings and worksheet answers.

<ol style="list-style-type: none"> 3. What challenges did Meitner face in the workplace? 4. What sacrifices did Meitner make for her work? 5. How would you characterize Meitner's relationships with her male collaborators, namely Otto Hahn and Otto Frisch? 6. What factors prevented Meitner from achieving the same level of recognition as her colleagues? 7. What are the possible reasons behind Otto Hahn's Nobel Prize not being jointly awarded to him and Meitner? 8. What effects did World War II have on Meitner's career? <p>Possible answers are available in the Supplemental Materials to this lesson.</p>	
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Elaborate: 10-60 minutes

<p>Extend discussion of video topics. For a longer lesson, utilize this time to complete a laboratory activity related to Meitner's work.</p>	
<p>What is the teacher doing?</p> <ol style="list-style-type: none"> 1. If any important aspects of Meitner's life were left out of the discussion of the video, use this time to bring them up and include them in the discussion. 2. Good sources for examples of class activities (middle and high school) related to nuclear physics and radiation <ul style="list-style-type: none"> • The Society of Physics Students created an activity to explain nuclear fission using marbles, mousetraps, and ping pong balls: Lesson 3: Nuclear Fission • Also, http://www.nuclearconnect.org/in-the-classroom/for-teachers/classroom-activities has several activities designed to teach about atomic interactions and nuclear fission. 	<p>What are the students doing?</p> <ol style="list-style-type: none"> 1. Continue to participate in a discussion of overlooked aspects of Meitner's life or listen attentively to the teacher adding information to the discussion. 2. Active participation in a hands-on activity related to Meitner's work.

Evaluate:

<p>There are several ways to evaluate participation in this lesson, including:</p> <p><u>Graded research worksheet:</u> Students turn in their research worksheet for grading.</p>
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Write-up on Meitner:

From information taken in from initial research assignment as well as in-class activities, have students write a 1 or 2-page summary of the information they have gathered about Meitner and her importance.

Lab report:

If a scientific activity is incorporated into the lesson, students can submit either individual or group lab reports on the completed activity.

Required/Recommended Reading and Resources

Video:

NOVA's *Einstein's Big Idea* (2005): Chapter 11 of 12 (located approximately 1:24:00-1:44:00)
<http://www.pbs.org/wgbh/nova/physics/einstein-big-idea.html>

Discussion Questions

1. How do Meitner's biographies compare to her depiction in the video?
2. How did her obstacles as a girl growing up in turn-of-the-century Vienna affect her growth as a scientist?
3. What challenges did Meitner face in the workplace?
4. What sacrifices did Meitner make for her work?
5. How would you characterize Meitner's relationships with her male collaborators, namely Otto Hahn and Otto Frisch?
6. What factors prevented Meitner from achieving the same level of recognition as her colleagues?
7. What are the possible reasons behind Otto Hahn's Nobel Prize not being jointly awarded to him and Meitner?
8. What effects did World War II have on Meitner's career?

Possible answers are available in the Supplemental materials to this lesson plan.

Further Reading and Additional Resources

Meitner and Frisch's first publication regarding fission:

- Meitner, Lise, and Otto Robert Frisch. "Disintegration of uranium by neutrons: a new type of nuclear reaction." *Nature* 143, no. 3615 (1939): 239-240.

Articles on Meitner's personal views of women and academia (both of these articles are included in the supplemental materials):

- Meitner, Lise. "Looking Back." *Bulletin of the Atomic Scientists* 20 (1964): 2-7.
- Meitner, Lise. "The status of women in the professions." *Physics Today* 13 (1960): 16-21.

Articles regarding the Nobel Prize controversy:

- Crawford, Elisabeth, Ruth Lewin Sime and Mark Walker. "A Nobel tale of wartime injustice." *Nature* 382 (1996) 393-395. (found at: <http://www.nature.com/nature/journal/v382/n6590/pdf/382393a0.pdf>)

- Crawford, Elisabeth, Ruth Lewin Sime and Mark Walker. "A Nobel tale of postwar injustice." *Physics Today* 50, no. 9 (1997): 26-32. (found here: <http://scitation.aip.org/content/aip/magazine/physicstoday/article/50/9/10.1063/1.881933>)

Biographical materials:

- Byers, Nina and Gary Williams, eds. *Out of the Shadows: Contributions of Twentieth-Century Women to Physics*. Cambridge, UK: Cambridge University Press, 2010.
- Frisch, Otto Robert. "Lise Meitner." *Biographical Memoirs of Fellows of the Royal Society* 16 (1970): 405-420. (biography written by her nephew and colleague)
- AIP Oral History interview of Otto Frisch by Charles Weiner, 5/3/1967: (discusses his relationship with Lise Meitner) <https://www.aip.org/history-programs/niels-bohr-library/oral-histories/4616>
- Aczel, Amir D. *Uranium Wars: The Scientific Rivalry that created the Nuclear Age*. New York: Palgrave Macmillan, 2009.
- Hahn, Otto. *Otto Hahn: A Scientific Autobiography*. Translated and edited by Willy Ley. New York: C. Scribner's Sons, 1966.
- McGrayne, Sharon Bertsch. *Nobel Prize Women in Science: Their Lives, Struggles, and Momentous Discoveries*. Washington, DC: Joseph Henry Press, 2001. (Chapter 2)
- Rife, Patricia. *Lise Meitner and the Dawn of the Nuclear Age*. Boston: Birkhaeuser, 1999. pgs 357-376.
- Shearer, Benjamin and Barbara Shearer. *Notable Women in the Physical Sciences: A Biographical Dictionary*. Westport, CT: Greenwood, 1997.
- Sime, Ruth Lewin. "The Discovery of Protactinium." *Journal of Chemical Education* 63 (1986): 653-657.
- Sime, Ruth Lewin. *Lise Meitner: A Life in Physics*. Berkeley, CA: University of California Press, 1996.
- Sime, Ruth Lewin. "Lise Meitner and the Discovery of Nuclear Fission." *Scientific American* 278 (1998): 80-85.
- Sime, Ruth Lewin. "Lise Meitner's escape from Germany." *American Journal of Physics* 58 (1990): 262-267.

Extensions

Related AIP Teacher's Guides on Women and Minorities in the Physical Sciences:

- Fair or Unfair: Should these women have received Nobel Prizes too?
- Outcasts and Opportunities: World War II and Women

Related Resources from the Society of Physics Students' 2011 Science Outreach Catalyst Kit:

- [Lesson 3: Nuclear Fission](#) (Explains how nuclear fission works using marbles, mousetraps, and ping pong balls)

Common Core Standards

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

Speaking & Listening	
<u>CCSS.ELA-LITERACY.SL.9-10.1</u>	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse

	partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
<u>CCSS.ELA-LITERACY.SL.9-10.2</u>	Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.
<u>CCSS.ELA-LITERACY.SL.9-10.4</u>	Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
<u>CCSS.ELA-LITERACY.SL.11-12.1</u>	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.
<u>CCSS.ELA-LITERACY.SL.11-12.2</u>	Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
<u>CCSS.ELA-LITERACY.SL.11-12.4</u>	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	
<u>CCSS.ELA-LITERACY.RH.9-10.1</u>	Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.
<u>CCSS.ELA-LITERACY.RH.9-10.2</u>	Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text.
<u>CCSS.ELA-LITERACY.RH.9-10.4</u>	Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.
<u>CCSS.ELA-LITERACY.RH.9-10.9</u>	Compare and contrast treatments of the same topic in several primary and secondary sources.
<u>CCSS.ELA-LITERACY.RH.11-12.1</u>	Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.
<u>CCSS.ELA-LITERACY.RH.11-12.2</u>	Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.
<u>CCSS.ELA-LITERACY.RH.11-12.7</u>	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

<u>CCSS.ELA-LITERACY.RH.11-12.9</u>	Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.
Science & Technical Subjects	
<u>CCSS.ELA-LITERACY.RST.9-10.1</u>	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
<u>CCSS.ELA-LITERACY.RST.9-10.2</u>	Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
<u>CCSS.ELA-LITERACY.RST.9-10.4</u>	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to <i>grades 9-10 texts and topics</i> .
<u>CCSS.ELA-LITERACY.RST.9-10.5</u>	Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., <i>force, friction, reaction force, energy</i>).
<u>CCSS.ELA-LITERACY.RST.11-12.1</u>	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
<u>CCSS.ELA-LITERACY.RST.11-12.2</u>	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.
<u>CCSS.ELA-LITERACY.RST.11-12.4</u>	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to <i>grades 11-12 texts and topics</i> .

Next Generation Science Standards

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

<u>Dimension One: Practices</u>	<ol style="list-style-type: none"> 1. Asking questions (for science) and defining problems (for engineering) 6. Constructing explanations (for science) and designing solutions (for engineering) 8. Obtaining, evaluating, and communicating information
<u>Dimension Two: Crosscutting Concepts</u>	<ol style="list-style-type: none"> 2. Cause and effect 3. Scale, proportion, and quantity 5. Energy and matter
<u>Dimension Three: Disciplinary Core Ideas</u>	Core Idea PS1: Matter and Its Interactions