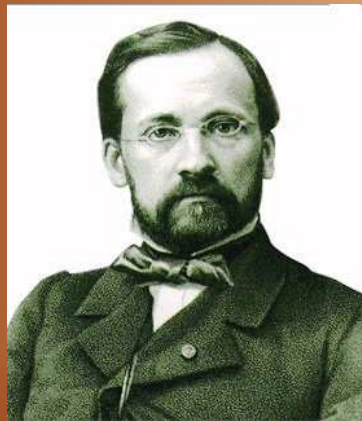
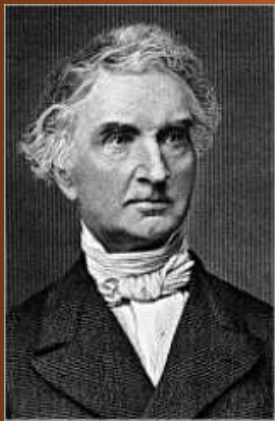
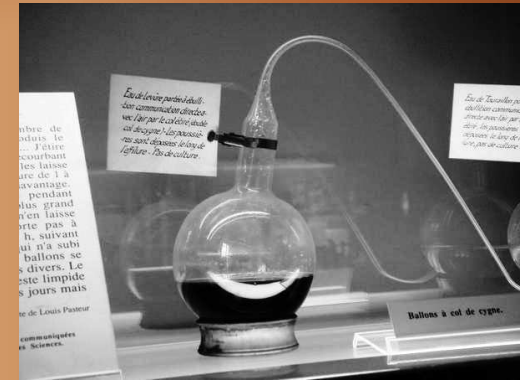
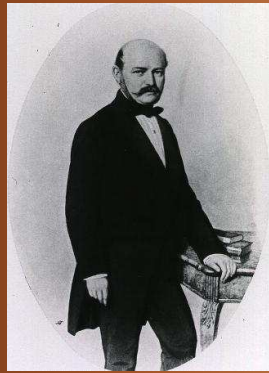


Cases and controversies from the history of science for learning about the nature of science



Foundations

- ✓ The history of science (HOS) as a good resource to address nature of science (NOS) issues in science class.
- ✓ A set of stories of the cases and controversies is ready to implementation in preservice science teacher training (2600 - 4300 words).
- ✓ An explicit and reflective instructional approach is promoted.
- ✓ A holistic view of NOS: attention is given to both epistemic and non-epistemic aspects of NOS in the analysis of the stories.
- ✓ Class sessions are based on teamwork and whole-class discussions.

Semmelweis and childbed fever

Acevedo, García-Carmona, and Aragón (2016b)

- Q1. What differences do you think exist between observation and inference in scientific research?
- Q2. What do you think are the main features of the Semmelweis' research method?
- Q3. Do you think that Semmelweis was original and creative in his research? Why?
- Q4. Do you think that the Semmelweis' hypothesis became a theory? Why?
- Q5. Do you think that the procedure followed by Semmelweis influenced on the acceptance of his findings? Why?
- Q6. Why do you think the Semmelweis' findings took a lot of time to be accepted?
- Q7. Do you think that the Semmelweis' skills for scientific communication influenced on the acceptance of his findings? Why?
- Q8. Do you think that the Semmelweis' personality affected it? Why?
- Q9. Do you think that political issues influenced it? Why?
- Q10. Which of those factors do you think were most decisive?

Tesla vs Edison: The war of the currents

Acevedo and García-Carmona (2016b)

A controversy in the history of technology to learn about the nature of technology that is different from the nature of science.

Q1. What individuals, collectives and social actors do you think were involved in the Tesla-Edison controversy? Why?

Q2. Which characteristics do you think that best define technology?

Q3. Do you think that technology must be identified with applied science? Give your reasons.

Q4. What elements do you think characterize the technological knowledge? Why?

Q5. Do you think patents are important in technology? Why?

Q6. Two examples of technological values are the technical rationality and the contribution of technology to social welfare. Can you quote and justify other values of technology?

Pasteur vs Liebig: The fermentation

Acevedo-Díaz and García-Carmona (2016c)

Q1. Why do you think that there might be important differences in scientific interpretations of a natural phenomenon, as in the case of Pasteur and Liebig regarding fermentation?

Q2. According to what you have read in the text, how would you explain what a scientific theory is?

Q3. According to what you have read in the text, to what extent do you agree that scientific research develops mainly through successive processes of experimentation and testing?

Q4. From what you have read about the scientific controversy on fermentation, how important for the development of science do you think the mistakes that scientists make are?

Q5. According to what you read in the text, what role do you believe scientists' creativity and imagination have in their research?

Q6. For what reason do you think Pasteur's ideas on fermentation had more success than Liebig's at their time?

Q7. How do you think the sociocultural, political, economic, etc. contexts of each age can influence the development of science? Explain it for this case of fermentation.

Q8. What interest do you think there can be for the advancement of science in the existence of disputes or disagreements among scientists about a research problem?

Pasteur vs Pouchet: The spontaneous generation

Acevedo-Díaz, García-Carmona, and Aragón (2016a)

Q1. What do you think was the role of theoretical beliefs in the interpretation of the observations? Why?

Q2. What role do you think the experimental designs had on the results obtained? Why?

Q3. Do you think the controversy was solved with a crucial experiment? Why?

Q4. Do you think that there was subjectivity in the controversy? Why?

Q5. Do you think that the procedure of the scientific community to judge the controversy avoided subjectivity? Why?

Q6. Do you think religion influenced on the controversy? Why?

Q7. Do you think politics influenced on the controversy? Why?

Q8. What procedures do you think were employed to communicate the research findings to other colleagues and the public concerned in they?

Q9. What factors do you think were most influential for solving the controversy? Why?

Rosalind Franklin and the DNA structure

Acevedo and García-Carmona (2016a)

Q1. It is very common to read that “the scientific method” is a step-by-step process whereby the scientific knowledge is built. Do you agree with it? Give reasons.

Q2. Do you think that all scientists involved in research about DNA worked towards the same objectives? Give your reasons.

Q3. What are the main strengths of the Watson and Crick model of DNA in your opinion?

Q4. Rosalind Franklin was not the first scientist to elucidate the structure of DNA. What epistemic and non-epistemic factors could influence it in your opinion?

Epistemic aspects of NOS addressed (I)

Nature of the science processes

- ✓ Observation and inference.
- ✓ Scientific methodologies.
- ✓ Role of hypotheses.
- ✓ Creativity and imagination.
- ✓ Role of experimentation in science.
- ✓ Role of errors in the development of science.
- ✓ Influence of the scientists' beliefs, attitudes and skills.
- ✓ Role of classification schemes.
- ✓ Interest of the scientific controversies for the advancement of science.
- ✓ Research designs and experimental results.
- ✓ Influence of the scientific specialisms of scientists in the planning and development of scientific research.
- ✓ Research question and aims pursued.
- ✓ Models and modelling in science.

Epistemic aspects of NOS addressed (II)

Nature of the scientific knowledge

- ✓ Characteristics of a scientific theory.
- ✓ Differences between scientific laws and theories.
- ✓ Differences and relations between science and technology.
- ✓ Differences in scientific interpretation of the same phenomenon.
- ✓ Tentativeness of scientific theories.
- ✓ Dominance of some scientific theories over others.
- ✓ Tentative and dynamic nature of scientific knowledge.

Non-epistemic aspects of NOS addressed (I)

Internal factors to the scientific community

- ✓ Role of scientific communication.
- ✓ Professional relationships in the scientific community.
- ✓ Scientists' personality.
- ✓ Personal relationships among the scientists.
- ✓ Role of scientific community in the acceptance of scientific theories.
- ✓ Rhetorical skills and semantic strategies to persuade through own ideas.
- ✓ Scientific cooperation.
- ✓ Scientific competitiveness.
- ✓ Moral and ethical issues.
- ✓ Gender influence.

Non-epistemic aspects of NOS addressed (II)

External factors to the scientific community

- ✓ Political influences in science.
- ✓ Role of patents.
- ✓ Historical, social and cultural context.
- ✓ Influence of nationalist patriotism.
- ✓ Political support for scientific research.
- ✓ Economic support for scientific research.
- ✓ Influence of society on science.
- ✓ Influence of science on society.
- ✓ Impact of science on socioeconomic issues.
- ✓ Science and religion.
- ✓ Role of media in science dissemination.

References

- Acevedo-Díaz, J. A., & García-Carmona A. (2016a). Rosalind Franklin y la estructura del ADN: un caso de historia de la ciencia para aprender sobre la naturaleza de la ciencia. *Revista Científica*, 27, 162-175.
- Acevedo, J. A., & García-Carmona A. (2016b). Una controversia de la Historia de la Tecnología para aprender sobre Naturaleza de la Tecnología: Tesla vs. Edison – La guerra de las corrientes. *Enseñanza de las Ciencias*, 34(1), 193-209.
- Acevedo-Díaz, J. A., & García-Carmona A. (2016c). Uso de la historia de la ciencia para comprender aspectos de la naturaleza de la ciencia. Fundamentación de una propuesta basada en la controversia Pasteur *versus* Liebig sobre la fermentación. *Revista Iberoamericana de Ciencia, Tecnología y Sociedad*, 11(33), 203-226.
- Acevedo-Díaz, J. A., García-Carmona, A., & Aragón, M. M. (2016a). La controversia Pasteur vs. Pouchet sobre la generación espontánea: un recurso para la formación inicial del profesorado en la naturaleza de la ciencia desde un enfoque reflexivo. *Ciência & Educação*, 22(4), 913-933.
- Acevedo, J. A., García-Carmona, A., & Aragón, M. M. (2016b). Un caso de Historia de la Ciencia para aprender Naturaleza de la Ciencia: Semmelweis y la fiebre puerperal. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*, 13(2), 408-422.