



Teaching Ethics Through the History of Science: A Case-Based Jigsaw Activity

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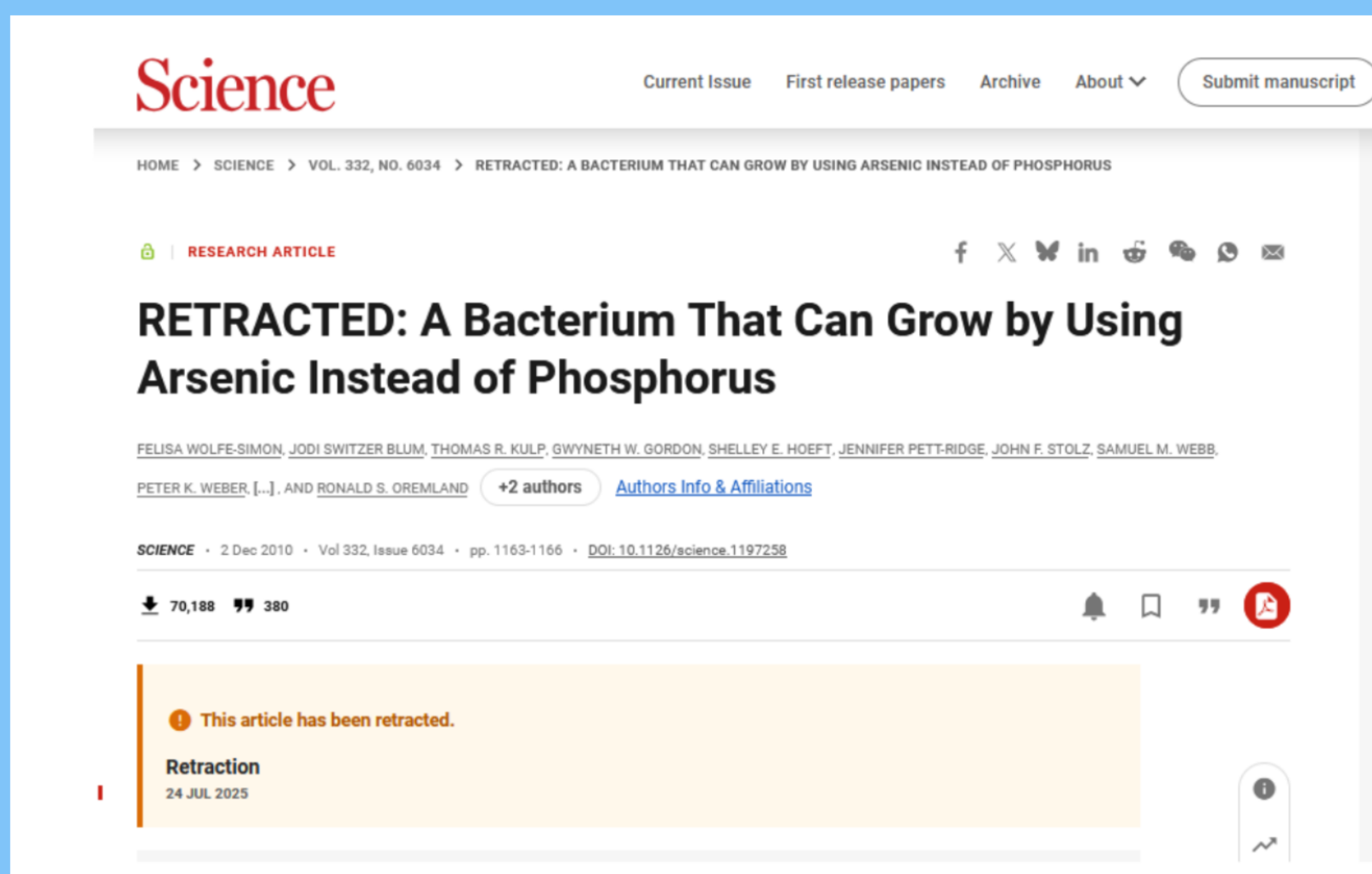


Introduction

Introductory science courses that examine what science is and how it is practiced can benefit from incorporating ethics as a core component of scientific understanding. Ethics not only supports the development of higher-order critical thinking but also serves as a foundational element in training future scientists [1]. However, the scope and implementation of ethics instruction remain subjects of ongoing discussion among educators. Here, we define ethics as the “principles for conduct that distinguish between acceptable and unacceptable behavior” [2].

To support ethics instruction, we implement a discussion-based, case-study activity in which students analyze and reverse engineer five anonymized, real-world examples of scientific conduct—ranging from unethical to exemplary—using a two-round jigsaw format [3]. This activity introduces first-year students to responsibility and professional conduct across both routine and complex scientific contexts, while fostering critical thinking in the classroom.

Step 1: Identify n case studies of interest.



Step 2: Formulate a short anonymized paragraph for each case + a common set of guiding questions.

A geomicrobiology team published a major-journal study claiming a bacterium could grow by substituting arsenic for phosphorus, reporting growth in arsenate-rich media and proposing arsenic incorporation into biomolecules such as DNA. The paper drew significant attention, and multiple labs initiated replication attempts. One microbiologist's team repeated the cultivation and molecular assays and reported that the organism required trace phosphorus and did not show arsenic incorporated into DNA. Follow-up biochemical studies examined protein binding and reported selective affinity for phosphate rather than arsenate. The original paper got retracted years later.

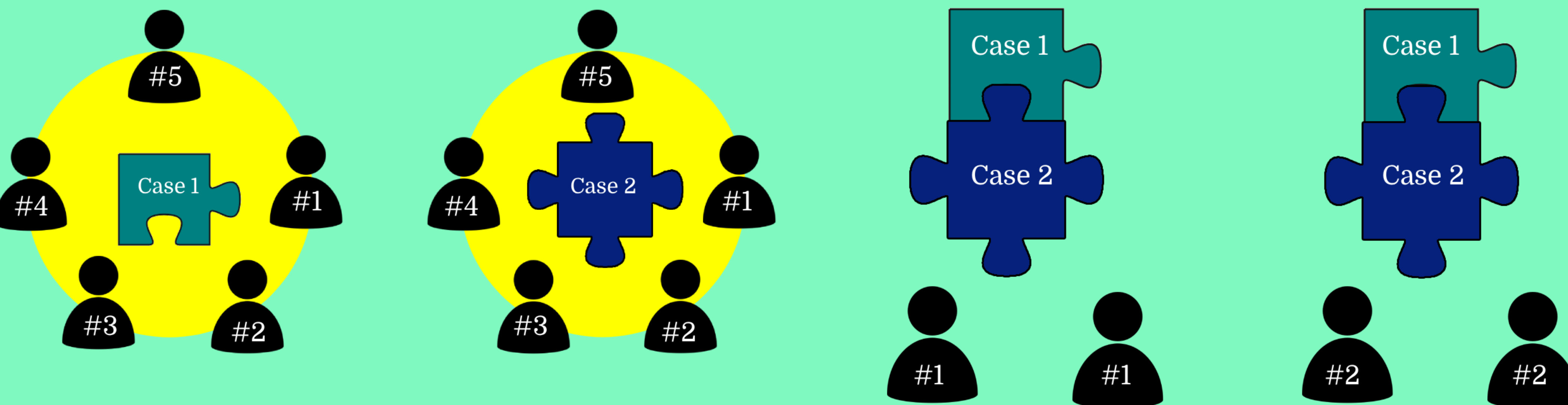
- 1) In your own words, what's the main problem here?
- 2) What would acting with integrity look like in this situation?
- 3) What are the possible consequences of this situation for the research, the researchers involved, and the broader community?

Step 3 (first half): Divide the class into five groups, assigning one case study per group.

Within each group, assign each student a unique identifier (i).

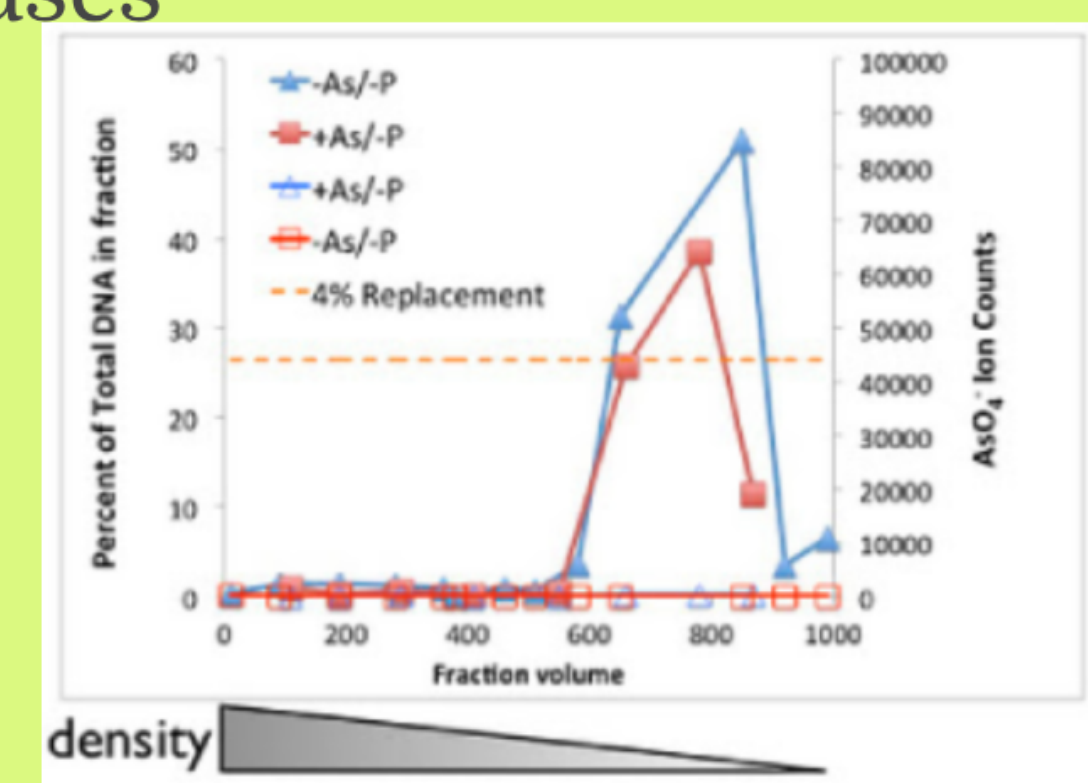
Step 4 (second half): Regroup students by their identifiers: all students labeled i form a new group.

Each newly formed group now contains one representative from each original case study.



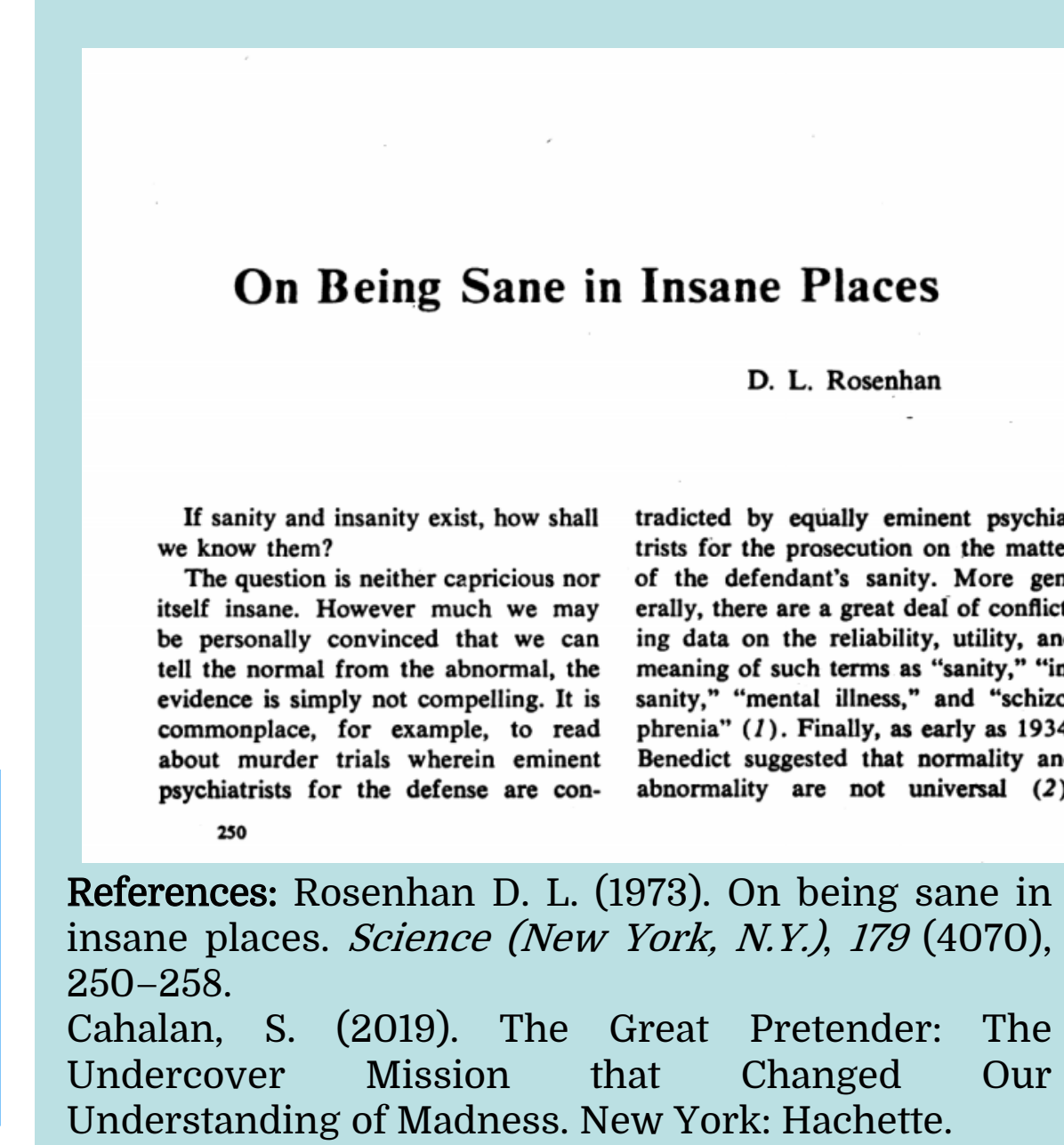
Step 5: Whole-class debrief with deanonymization of cases

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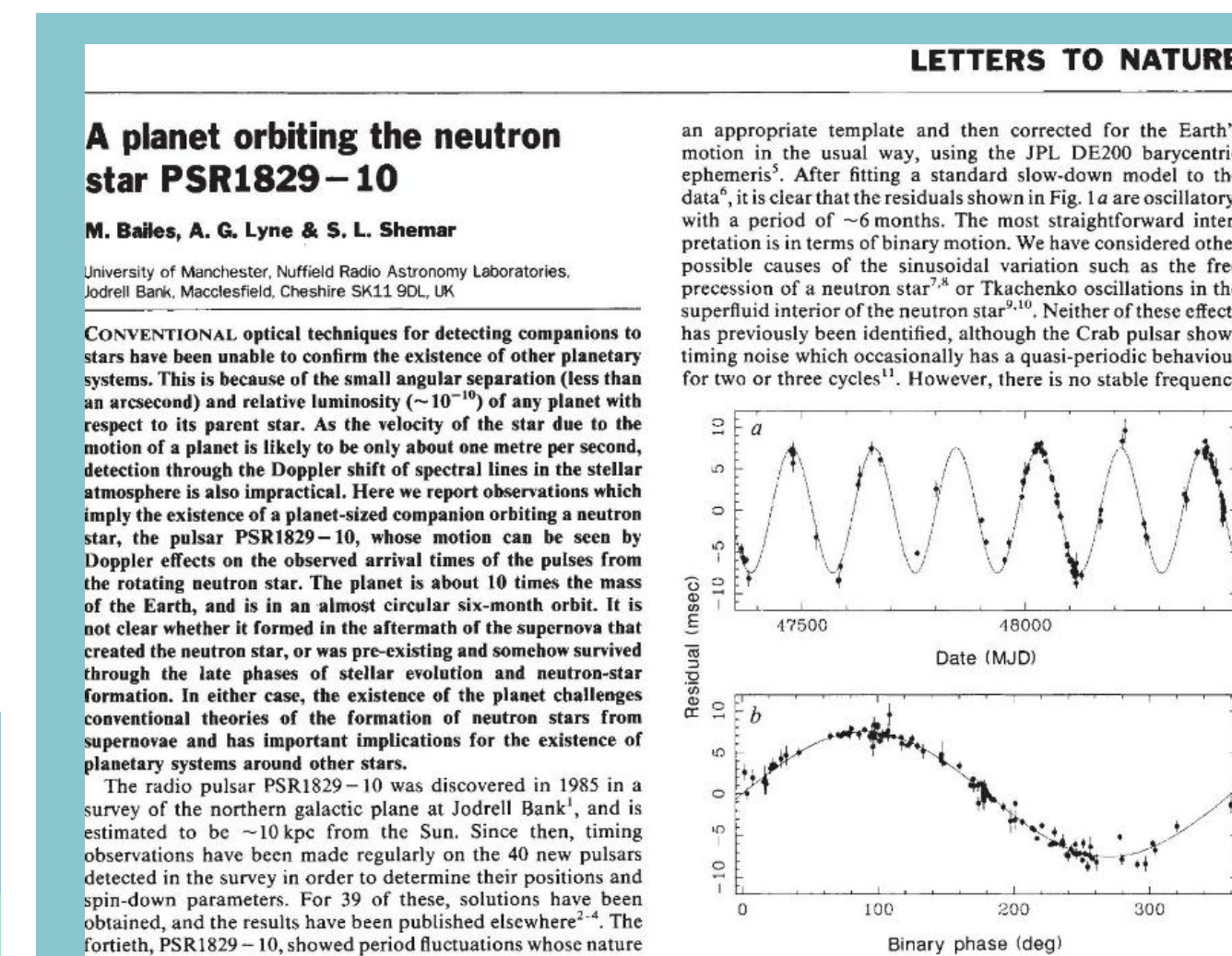
Example of selected case studies

The case studies below are a subset of those designed by the authors and implemented in the Ethics component of the Scientific Thinking and Literacy course within the Science One program at UBC.



In 1973, a psychologist published a paper describing how he organized eight volunteers (including himself) to present hallucination symptoms at 12 psychiatric hospitals. After admission, the participants stopped feigning symptoms and behaved normally, while staff documented ordinary behavior as pathological. He reported that most participants remained hospitalized for days or weeks and concluded that diagnostic practices could not reliably distinguish health from illness. Decades later, a journalist reviewed the psychologist's notes, interviewed participants, and checked archival records. She reported mismatches between the published account and the underlying materials, could independently identify only two pseudopatients, and found records that diverged from the psychologist's narrative, including a participant he excluded who reported a more positive stay. Her investigation questioned how the study was documented and presented.

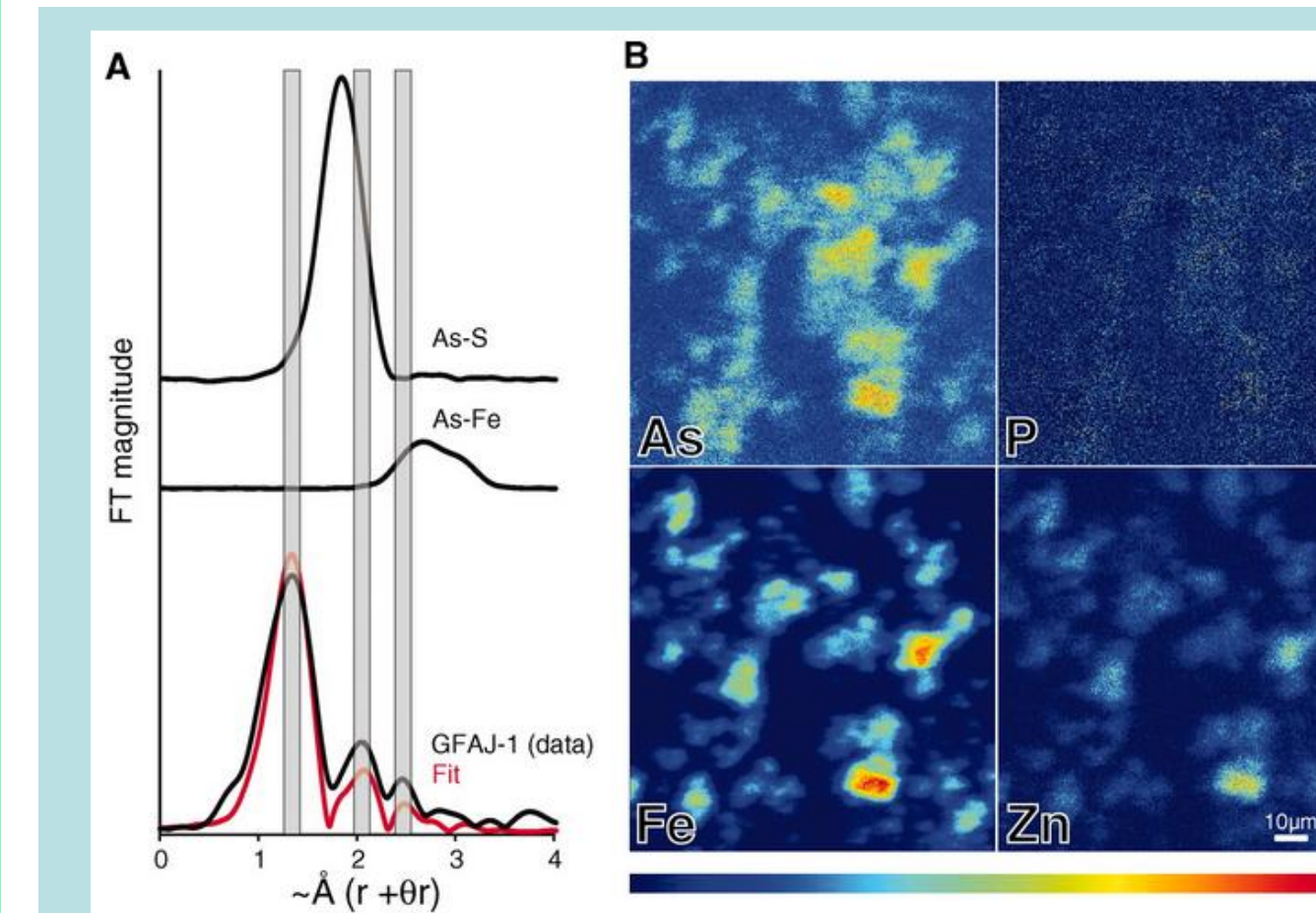
Case 1. Case of ethical misconduct: data falsification and the drawing of unsupported conclusions for publicity, prestige, or other personal gain.



An astronomer was a coauthor of a 1991 paper published in Nature reporting what was believed to be the first direct evidence of a planet outside the solar system. While later revising the analysis for a presentation at a meeting of the American Astronomical Society, he identified an error in the original calculations. As a result, the original conclusion could no longer be supported. At the conference, he informed the audience that the research team's earlier result was incorrect and that the published findings were not reliable.

References: Bailes, M., Lyne, A. & Shemar, S. (1991). A planet orbiting the neutron star PSR1829-10. *Nature* 352, 311-313.
LYNE, A., BAILES, M. (1992). No planet orbiting PS R1829-10. *Nature* 355, 213.

Case 2. Case of no ethical misconduct: honest errors are identified and subsequently corrected by the authors. The case highlights shared scientific values in the pursuit of truth, including transparency, honesty, and evidential rigor.



References: Fellisa Wolfe-Simon et al. (2011). RETRACTED: A Bacterium That Can Grow by Using Arsenic Instead of Phosphorus. *Science* 332, 1163-1166.
Redfield, Rosemary (2012). CSCL: Mass spectrometry data. RRResearch. Retrieved April 22, 2026.

In 2010, a geomicrobiology team published a major journal study claiming a bacterium could grow by substituting arsenic for phosphorus, reporting growth in arsenate rich media and proposing arsenic incorporation into biomolecules such as DNA. The paper drew significant attention, and multiple labs initiated replication attempts. One microbiologist's team repeated the cultivation and molecular assays and reported that the organism required trace phosphorus and did not show arsenic incorporated into DNA. Follow up biochemical studies examined protein binding and reported selective affinity for phosphate rather than arsenate. These replication efforts re-evaluated the original interpretation and narrowed what the data could support.

Case 3. Case of no ethical misconduct: original work is apparently of standard quality; community members attempt to replicate findings reveal methodological flaws. The case highlights the scientific community's role in the ongoing review process of scientific claims.

Acknowledgements

We are grateful for the support of the Science One program director, Dr. Costanza Piccolo, and Associate Director, Dr. Jonathan Massey-Allard, in the implementation of this class.

References

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- [2] National Institute of Environmental Health Sciences. (n.d.). *What is ethics in research & why is it important?* Retrieved April 22, 2026.
- [3] Aronson, E., & Patnoe, S. (2011). *Cooperation in the classroom: The jigsaw method* (3rd ed.). London: Pinter & Martin, Ltd.