

Ethics of Chemistry: From Poison Gas to Climate Engineering

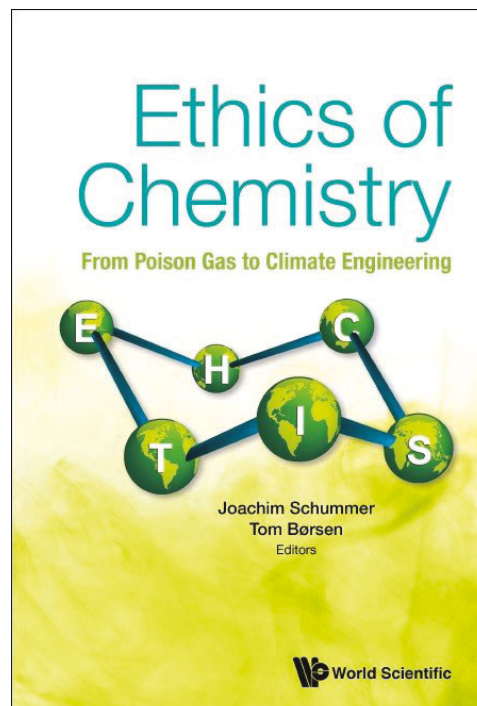
Joachim Schummer and Tom Børsen, editors
World Scientific Publishing, 2021, 559 pages
(<https://doi.org/10.1142/12189>)

reviewed by: Peter Mahaffy, Leah Martin-Visscher, and Cassidy VanderSchee (Professors at The King's University, Edmonton, Alberta, Canada), Cindy Slupsky and Heather Starke (Laboratory Instructors), and Jonathan Barwegen, Rio Bouwers, Jared Faulkner, Audrey Jenkinson, Tristan Loewen, Jadeyn Lunn, Ikenna Onyeagolu, Erin Pederson, and Sydney Visser (Chemistry Senior Seminar Students)

Imagine yourself a chemist confronted with the use of chemical weapons during World War IO. Or a citizen living in Bhopal, India, perhaps having negotiated the siting of the plant in your city as a politician or an employee bringing home a good wage working at Union Carbide's methyl isocyanate plant. Or perhaps you are a student in 2023 needing to make informed choices about climate engineering or the rapid full-scale extraction of rare-earth materials to mitigate the climate crisis. What is the right thing to do in each of these scenarios? How can the study of the moral values, norms, judgments, and virtues relevant to chemistry equip students to deeply reflect about the practice of chemistry and guide them to make informed and responsible choices about their behaviour as professionals?

Ethics of Chemistry, edited by Joachim Schummer and Tom Børsen, is a helpful collection of ethical case studies written by a diverse group of authors. This compilation is meant to introduce and help university chemistry students wrestle with questions of ethics, and provides resources to help fill a significant gap in the education of many scientists who don't receive formal training in ethics in their chemistry courses and programs.

Rather than simply providing *Chemistry International* readers with the thoughts of faculty who have read the collection, we thought it would be helpful to describe the experiences of a group of 3rd and 4th year chemistry undergraduate students as we piloted various chapters of this book in a weekly one-hour seminar course in the Fall (September – December 2022) academic term at the King's University, a small undergraduate university in Edmonton, Alberta, Canada. We describe the topics we worked on together, some approaches we took in



using active-learning strategies to introduce this material to students, and summarize some of the student's thoughts about what they found helpful about the book and their suggestions for what could be improved.

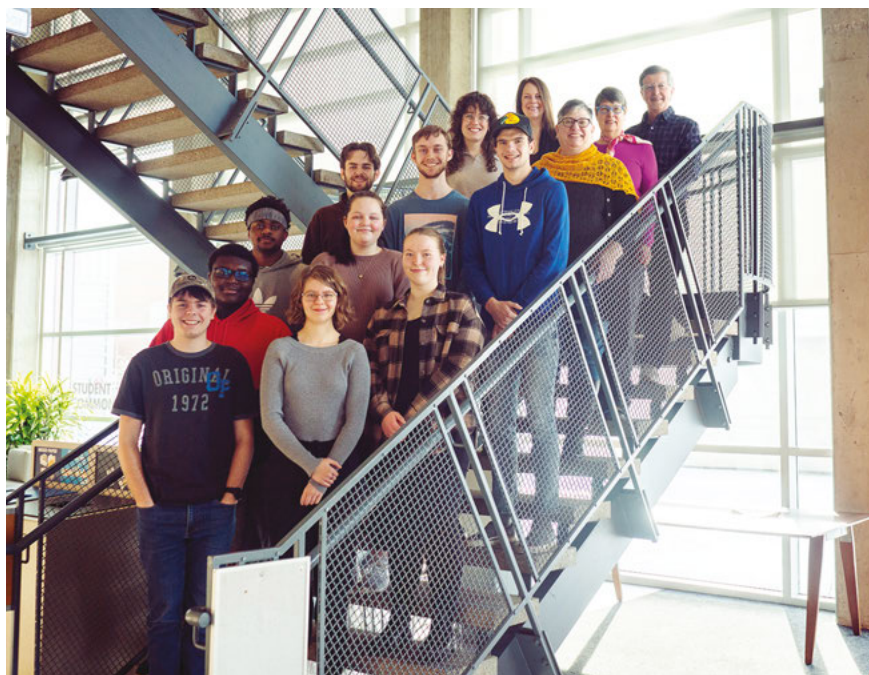
After an introduction to the topic, the book helpfully categorizes the 19 chapters into five large parts that collectively give a rich and comprehensive overview of ethical issues of relevance to chemists:

- I. Misuse and Misconduct;
- II. Unforeseen Local Consequences;
- III. Global and Long-Term Influences and Challenges;
- IV. Challenging Human Culture; and
- V. Codes and Regulations.

Our seminar group worked through the chapters described below:

Introduction: Students and faculty had a group discussion of the purpose of this new book and identified other places in the curriculum at our liberal arts institution where ethics is already introduced. We discussed the potential value for students who were nearing the end of their undergraduate education to dig more deeply into some additional ethical case studies. Students wrestled with the author's distinction between ethics **in** chemistry and ethics **of** chemistry, and discussed how the book's approach provided a complementary fit with students' previous introductions to philosophical ethics in other courses they had taken as part of our university general education requirement.

Ethics of Chemistry: From Poison Gas to Climate Engineering



King's University students and faculty who used Chemistry of Ethics in a senior undergraduate seminar.

From bottom left: Jared Faulkner, Audrey Jenkinson, and Erin Pederson (behind Audrey). Behind Jared is Josh Olisa and behind him Ikenna Onyeagolu, and to Ikenna's right is Sydney Visser. Then from left to right are Tristan Loewen, Rio Bouwers, and Jonathan Barwegen; Standing on the second row from the top from left to right are Cassidy VanderSchee and Heather Starke. In the very back are Leah Martin-Visscher, Cindy Slupsky, and Peter Mahaffy.

Chapter 3: Ethics of Chemical Weapons Research: Poison Gas in World War One (From Part I on Misuse and Misconduct). Students were asked to imagine themselves as chemists during WWI and to think about the ethical struggles and questions they might be grappling with as they became aware of, or perhaps even asked to participate in, the development of chemical substances designed to kill military or civilian populations. They then worked in small groups to frame an ethical response to this story from either the perspective of utilitarianism or deontological ethics, terms defined in the Introductory chapter.

Student Reflections on Chapter 3 (poison gas). Students applauded the communication of different "excuses" (using the author's term) to validate chemical weapons research, but they felt that it put forward a somewhat stark and uncompromising stance about the ethics behind them. Students would have liked to see more consideration of the various pressures that chemists felt during that time and the consequences that they would face if they turned away from chemical research. They pointed to modern day examples where the choices to participate in such work are sometimes mandated by the military of national scientists and it would be very difficult for a scientist to say no. They would have also liked to see more elaboration of the environmental impacts that were created with the use and disposal of chemical weapons during and after the war and the long term effects on wildlife and surrounding populations.

Chapter 5: Corporate and Governmental Responsibilities for Preventing Chemical Disasters: Lessons from Bhopal (from Part II: Unforeseen Local Consequences) After reading the ethical analysis of the 1984 Bhopal industrial disaster at the Union Carbide isocyanate plant in central India, students came to the seminar having written down their thoughts on what went wrong, who was at fault, what ethical rules were violated, and how future disasters could be prevented.

Student Reflections on Chapter 5 (Bhopal). Students described this case study as an insightful reflection of ethical indignities within chemistry, and a lesson to prevent future chemical disasters. They felt the authors demonstrated the consequences of corporate and political greed as well as neglect of chemical safety and lack of moral responsibility. They appreciated the comprehensive presentation of the potential causes of the disaster, highlighting the multiple failings of the plant. Students commented on the value of analyzing this case study using philosophical principles of ethics such as the golden rule and the precautionary principle, offering insight to the potential moral development within chemistry, and relevance to present industrial issues. Some felt that such strong attribution of corporate greed oversimplified the situation, where local decision makers welcomed the major economic boost the plant brought to their community. It was interesting and important for students to speculate on why this plant was sited in India and whether

differential environmental regulations played a role in that decision. The reputational damage to the company and chemical industry in general was evident because of bad ethical decisions. Through additional research activities, students explored how this widely publicized industrial disaster led to important global initiatives by industry to take responsibility, including the introduction of the Responsible Care and other programs.

Chapter 12: The Ethics of Rare Earth Elements (REE) Over Time and Space (from Part III: Global and Long-Term Influences and Challenges). To create greater engagement from each member of the class, the instructors divided the students into two groups and assigned each to take one side of a debate on the proposition: *“Be it resolved that, in light of the climate crisis, society should move as quickly as possible to extract rare earth elements to support energy transitions.”* Using the chapter as a starting point, and doing additional research, each side was asked to frame their position on the debate with consideration of ethical issues related to both intergenerational and environmental justice. Students found the debate format to be particularly lively and engaging. Following the debate, the class took the discussion further by reflecting on the ethical tensions created by needing to consider the REE needs of both present and future generations, while living within our planetary boundaries for climate change. Students considered the urgency of the climate crisis and the requirements for REE for rapid transitions from fossil fuel combustion to electrification of energy supply. They also did further research to explore the scarcity of REE and debated how large-scale exploitation of REE now might leave future generations without ongoing supplies, but how failure to extensively use REE now may leave future generations at or beyond a climate tipping point. They noted that REE resources are concentrated in only a few countries at present, and that rapid extraction of those resources creates ethical issues related to equitable access and can create unsafe and unfair working conditions for those who extract them for use in other countries.

Student Reflections on Chapter 12 (REE): Students found this chapter to be solid, readable, and interesting, providing a comprehensive evaluation of REE technology and the ethics of this practice as it is today. They valued the insights that came from applying lenses of environmental and intergenerational justice to the ethical questions about REE use and commented that these aren't the only ethical lenses that could be

applied. One student summed up the way we covered this topic this way: *“The debate format was a great way to discuss this chapter. It was very enjoyable to take part in, and provided far greater motivation to actually dig into the chapter compared to our standard format. Also, as we talked about today, a chapter on ethics really does lend itself to the idea of a debate.”*

Overall Student Reflections on Using Ethics of Chemistry. Students journaled after each of the sections described above and also reflected at the end of the academic term on what they had learned, what they found helpful, and areas that might have been stronger or more balanced in the provision of resources. Overall, their experience was positive in using resources to help them explore more deeply ethical case studies, and to focus their attention on a more formal application of the relevant ethical issues. They appreciated the historical narratives, diversity of expertise, voices, and perspectives of the author teams for each chapter. The complexity of choices facing the players in each story was appreciated and they commented on the integrity with which this complexity was usually presented. As seen in their reflections about each of the chapters above, they also offered several examples of where they felt the ethical issues were presented with too much generality and perhaps a bit of oversimplification.

The instructor team felt that the fact that the constructive and substantive critique by students of the approach and of the individual case studies, in itself is a positive reflection on the way the book equipped them to apply ethical considerations to complex cases in chemistry. We recommend this resource to other instructors in separate ethics courses and in similar seminar courses to the one we offer. It is perhaps most suited to upper-level students, but with appropriate scaffolding would also make a helpful introduction to ethics to beginning chemistry students. By using a case study approach, where chemistry, historical context and questions of ethics are woven together, this book provides numerous, accessible starting points for chemistry instructors who wish to enrich the content and context of their lectures and courses. We were pleased to note that the relatively high price of the print book, which would significantly limit its accessibility, is mitigated by the offering of a reasonably priced e-book. 📖

Submitted for the co-authors by Peter Mahaffy, member of IUPAC's Standing Committee on Ethics, Diversity, Equity, and Inclusion. Email: peter.mahaffy@kingsu.ca; <https://orcid.org/0000-0002-0650-7414>