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Teaching philosophy of science that matters

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1 Introduction

The topical collection to which this is the introduction, is an outlier in this journal. Most philosophers of science will read the *European Journal for Philosophy of Science* when teaching tasks are done and when they have found time (finally!) to catch up on research. This collection, however, takes you – dear reader – back to teaching matters. Your first reaction may well be that this presents a mismatch between topic and outlet. The *EJPS* is a research journal whose stated aim is to publish "groundbreaking works that can deepen understanding of the concepts and methods of the sciences" (EJPS, Aims & Scope statement). Why would the *EJPS* publish a collection on *teaching* philosophy of science? Shouldn't a collection of this kind be published in a journal devoted to research on teaching and learning? We will explain why we think not, and we are grateful to Federica Russo & Phyllis Illari – Editors-in-Chief of *EJPS* when we started working on this collection – for agreeing with us and for providing the opportunity to publish this collection in *EJPS*.

To explain our perceived need for this collection, let us start with a recent perspective on *research* in philosophy. In his short but compelling book, *What is the Use of Philosophy?*, Philip Kitcher (2023) laments the current state of academic philosophy in the Anglophone world. In recent decades, many areas of ethics, epistemology and metaphysics have become hyperspecialized. They have turned into "industries of busywork" that obsess over the minutiae of problems that are only recognized as worth laboring over by a handful of specialists who count it as their cherished domain of expertise. But if even professional philosophers from neighboring areas have a hard time seeing the point of the debates that preoccupy their

Introduction to the Topical Collection 'Teaching Philosophy of Science to Students from Other Disciplines'.

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close colleagues, it becomes hard to conceive of plausible scenarios in which philosophical research will produce anything of value for science or society. Yet, Kitcher argues, that is what we can and should expect from philosophy – especially in times like ours. Academic philosophy should reform and recalibrate itself to the values and needs of science and society. In Dewey's memorable words, philosophy can and should aspire to more than being "a sentimental indulgence for a few" (Dewey, 1916; cited in Kitcher, 2023, p.4).

Kitcher's diagnosis of the sorry state of Anglophone philosophy does not apply equally to all its subfields. As he himself points out, philosophy of science appears to be in a relatively healthy state. We think that this rings particularly true for the area of practice-oriented philosophy of science, or philosophy of science in practice (PSP), which has grown into a vibrant and fruitful approach to studying the sciences (Ankeny et al., 2011). More than anything, it has reduced the distance between philosophy of science and the practice of science, and between philosophers and scientists. What used to be the exception is nowadays common: philosophers collaborating closely with scientists, publishing in science journals, and contributing actively to (meta)scientific discussions. Moreover, many of the same philosophers of science are starting to contribute to more 'broadly engaged', socially relevant philosophy of science endeavors. Until recently, it would have been unthinkable to encounter conference sessions on how to engage with stakeholders from NGOs or government agencies as a philosopher of science. It is no longer. And so, we believe that practice-based and socially relevant philosophy of science may be showing the way forward for other areas of philosophy.

But what about teaching? One would expect that the avant-garde role of philosophy of science in bringing philosophical research closer to science and society has left its marks on teaching too. However, a look at some of the most popular textbooks in philosophy of science today shows this not to be the case. With some notable exceptions, philosophy of science textbooks still tend to focus on the 'core topics' that we inherited from the twentieth century. Treatments of empiricism, methodology, rationality, frameworks, revolutions, explanation, realism, and the like dominate their pages, often only leaving room for a brief discussion of 'current issues' in the final pages.

We are not blind to the many good reasons for why this remains the dominant approach. For one thing, philosophical reflections on the currently 'hot topics' are often too transient or unsettled to use them as the backbone for a textbook. Moreover, a proper philosophical understanding of current issues often requires an appreciation of 'core' topics and debates in philosophy of science. To give just one example: to separate hope from hype in debates about 'big data' science, students will profit from having learned about induction, empiricism, and the theory-ladenness of observation. And yet, we think that the "theory-first" approach of many textbooks is unsuitable for introducing students to philosophy of science in the present day and age.

This holds especially true for students that have not chosen to study (or major in) philosophy. Science, engineering, and medical students, among others, can profit immensely from taking a 'backstage' view on the methods, principles, and practices that are the topic of their other degree courses. Moreover, philosophy of science courses can open students' eyes to complex questions about relation between expertise, democracy, and policy that they can profit from in a future career outside academia. But teaching material and teaching strategies developed with philosophy students as the intended reader will often not engage this group. Thus, introducing science students[1] to philosophy of science in a manner that resonates with their training and engages them in learning requires effort. It calls for reflection on the didactical strategies, teaching materials, expectations, and learning goals that benefit this audience.

This topical collection takes a step in this direction. We entitled this collection "Teaching philosophy of science to students from other disciplines" to encourage reflections on the contrast with teaching philosophy students. We were positively surprised by the interest following our open call for papers, counting more than 40 submissions, and we believe that the published collection offers many valuable reflections on this topic.[2] In the remainder of this introduction, we will highlight some of these insights on the *why*, *who, what*, and *how* of teaching philosophy of science to science students.

2 Why do we teach philosophy of science?

The answer to this question might be obvious to philosophers of science, but the aims and benefits of philosophy of science teaching will be less clear to educators or students from other disciplines. As teachers, one of the reasons (and rewards) for teaching philosophy of science to science students can be to inspire a select few students to change course and pursue graduate studies in the philosophy of science. Another motivator will often be to challenge and overcome the widespread prejudice that philosophy of science is esoteric and irrelevant. Taking inspiration from the famous line, often attributed to Richard Feynman, that "philosophy is about as useful to science as ornithology is to birds", we will refer to this as the 'ornithology-for-the-birds' challenge in what follows. We can think of many other reasons. What these have in common, is that they assume an institutional context in which opportunities for teaching philosophy of science exist. It is worth reflecting on these institutional arrangements for offering philosophy of science teaching to undergraduate students in the sciences.

Green et al. (2021) point out that in Denmark it is written into the law that undergraduate students need to pass a course in philosophy of science related to their area of study. Only a few other European countries have similar national requirements, but sometimes there are university-level requirements regarding philosophy of science

[1] Henceforth, we will understand science students in a broad sense, including students of the social sciences, (pre-)medical students, engineering students, and other students in application-oriented sciences. In the present context, we (and the contributors to the collection) do not discuss teaching of philosophy of science to students in the humanities.

[2] The complete list of contributions is included at the end of the article. It can also be viewed at: https://link.springer.com/journal/13194/topicalCollection/AC_4af936723283319dcffff881293afbfc/page/1

education. For example, Kleinhans (2021) points out that Utrecht University (in the Netherlands) has a course requirement for philosophy of science-related teaching for science students, and MacLeod (2021) and Boon et al. (2022) offer reflections on the compulsory courses in philosophy of science for engineering students at the University of Twente (also in the Netherlands). Lusk (2022) provides a perspective from a residential college of Michigan State University in the U.S., where students can fulfill some of their course distribution requirements by taking a sequence of four HPS courses.

The aims and goals for offering philosophy of science teaching to science undergraduates range from the very general to the very specific. Starting again with Denmark: their national requirements can be traced to a Humboldtian ideal of *Bildung*, according to which universities should not just offer pre-packaged skills training and disciplinary knowledge, but also ought to foster self-cultivation, introspection, and reflection on the role of science and society. In one form or another, the more specific goal for philosophy of science courses to contribute to 'critical thinking' skills is also present in other arrangements. But the proximate impetuses vary. As Kleinhans (2021) notes, in Utrecht the course requirement in philosophy of science teaching was a direct consequence of concerns about research integrity that followed the Stapel affair of fraud in social psychology.

At the course level, there is a range of more specific learning goals that philosophy of science courses aim to meet. Several authors discuss the differences between the objectives of teaching philosophy of science to philosophy students and to science students. De Regt and Koster (2021) point to the importance of engaging students in reflections on the role of (their) science in society. Kleinhans (2021) highlights that students benefit from a deeper understanding of the implications of their field, which can aid in the transition from *learning* technical skills to *applying* them in their professional careers, while getting conceptual tools to discuss topics such as causation in complex systems, model building, field work, science communication, scientific norms, and integrity. Green et al. (2021) emphasize that their philosophy of science courses do not just aim for students to be better scientists, but also aim at helping them become better informed and more critically engaged citizens, science teachers, consultants, or other types of professionals. Lusk (2022) shows that tailoring philosophy of science teaching to the interests and (career) perspectives of science students along these lines can help overcome the ornithology-for-the-birds challenge. He presents data from a survey that shows that STEM students dropped their initial resistance to HPS courses after experiencing the course material was directly relevant to them. Finally, Jaksland (2021) draws attention to a potential role for philosophy of science in fulfilling specific educational requirements. He gives the example of the EU goal to nurture innovation and creative thinking in science education, which he argues, philosophy of science courses are especially well-equipped for.

3 Who do we teach?

The contributions to this collection include reflections on teaching philosophy of science for students from a broad variety of educational programs and backgrounds. These range from focused perspectives on teaching students in particular (sub)disciplines – such as the earth sciences (Kleinhans, 2021), geography, biology, chemistry, sports science, mathematics, computer science (Green et al., 2021), electrical engineering, or civil engineering (MacLeod, 2021), to broader perspectives on teaching aspiring medical professionals from a variety of educational backgrounds (Bursten & Strandmark, 2021), to general reflections on teaching students from the (social) sciences at large (e.g. Grüne-Yanoff, 2022; De Regt & Koster, 2021; Lusk, 2022). Closely related to the question of the home discipline (or major) of the students, is the question of how much experience students (should) have acquired in the home discipline when they take an introductory philosophy of science course. Again, the contributions showcase a range of institutional arrangements and requirements that affect what and how philosophy of science is taught. For example, Kleinhans (2021) reflects on the drawbacks of teaching students in the first year of their bachelor studies. Since these students have only just begun developing lab and data analysis skills and have not done any fieldwork yet, there is limited room to engage them in philosophical reflections on methods and practices they are already familiar with. If curriculum design allows for it, teaching students later in their education would be preferable. Ideally, Kleinhans would like to see philosophy of science elements being 'spot-welded' into the earth science curriculum, as modules within other courses, culminating in a specialized capstone course at the end of the bachelor. Lusk (2022) presents an institutional context that approaches this ideal to some extent: at Lyman Briggs College (a residential college affiliated with Michigan State University) students follow a sequence of (typically) four HPS courses at different stages of their undergraduate studies. This arrangement obviously shapes different opportunities for diversification and targeting of philosophy of science teaching to different phases of competence and experience. MacLeod (2021) presents an interesting case of teaching philosophy of science at the final stage of a bachelor study, in parallel with students planning and preparing their thesis. This can be challenging, as students may already be entrenched in a way of working and thinking that makes them resistant to engage in reflection in the final leg of their education. On the flip side, it is an advantage of offering philosophy of science training at this stage that it allows for engagement with an actual scientific (thesis) project, which can be improved by inviting students to reflect, for example, on assumptions about their methodology.

Apart from the question of who we teach, it also merits mentioning that some contributions offer reflections on who *does* the teaching. Most of the contributors will self-identify as philosophers (of science). Kleinhans (2021) is an exception in being first and foremost a physical geographer (with a successful research career in his home discipline) who keeps up with, and has contributed to, research in philosophy of science on the side, out of a conviction that earth scientists can profit from it. His combined expertise in the earth sciences and philosophy allows him to reach a level of integration of discipline-specific practices and concerns into his philosophy of science teaching that will be hard to emulate for many professional philosophers of science. A more realistic scenario for most of us will be to co-teach with scientists who have an interest in philosophy of science. For example, at our own institution, the University of Copenhagen, the philosophy of science course for chemistry students is co-taught by a philosopher and a faculty member in chemistry. The dynamic in teaching collaborations between philosophers and scientists is often that the philosopher provides the more general background concepts and methods, which the scientist illustrates with examples from the scientific discipline. However, teaching collaborations do not always and only serve to fill knowledge gaps. Bursten and Strandmark (2021) present an interesting example of a different kind of collaboration, aimed more at bringing together complementary methodological and practical competences. Their own collaboration is one between a philosopher of science and an educational archivist. This is not an example of just 'tacking on' the archivist to unlock some files and make sure that they aren't mishandled. As the authors explain, philosophically fruitful collaboration requires deep integration and collaboration.

4 What do we teach?

As we noted above, using a traditional textbook written for philosophy students as a set text is often limiting if the aim is to tailor the teaching to students with other disciplinary backgrounds, interests, and concerns. Several contributors to this collection also showcase their approaches to going 'beyond the canon' in teaching philosophy of science to science students.

Grüne-Yanoff (2022) makes a case for moving beyond the 20th-century normative claims by the likes of Carnap or Popper about a supposedly universally applicable methodology of science. Yet, he argues that the widespread recognition of the disunity of the sciences should not lead us to dispense with making (and teaching) normative claims about methodology. Instead, disunity and normativity can be reconciled by teaching students about heuristic reasoning from exemplars. Using cases that involve significance testing, randomization, and massive simulation modeling, Grüne-Yanoff shows how science students can be taught to think about (fallible) justifications for and against using a particular method, given the particular aims and context of the research.

Jaksland (2021) gives an example of a different approach to going 'beyond the canon'. Instead of discarding a component of a traditional philosophy of science course altogether, he shows how such a component could be co-opted and repurposed for a discussion that is perhaps more pertinent to science students. More specifically, he shows that a traditional course component on Kuhn's notions of normal science, puzzle-solving, and scientific revolutions can be used as a stepping stone for reflecting on various kinds of innovation and creativity in science.

Young (2022) argues for a more radical reorientation of philosophy of science teaching away from its traditional focus on theoretical reasoning and towards a concern with practical reasoning. In teaching science students in particular, the emphasis should be less on conceptual analysis and 'pure' epistemic issues and room should be made for reflecting on the uses of knowledge for and in policy environments. For example, Young suggests exploring with students "how the recommendations of advisory reports require different forms of justification than those utilized in support of theoretical conclusions in scientific research" (p. 2). He also contends that the linear model of science advising is challenged by philosophical research that shows the irreducible role of non-epistemic values in scientific reasoning.

De Regt and Koster (2021) also see an important role for such courses in challenging the value-free ideal in philosophy of science teaching, since most science students will unreflectively accept it as the appropriate ideal for science. More specifically, they reflect on the different approaches one might take in teaching this topic to philosophy students vs. science students. Philosophy students, they think, would be more interested in analyses of objectivity and in analyzing the different ways in which the distinction between epistemic and non-epistemic values can be carved and interpreted. For science students, on the other hand, it will often be more relevant and interesting to reflect on cases from within their own area of expertise in which values can be seen to enter at various 'stages' of research practice.

Another topic that can profit from being tailored to the particular audience of science students is scientific modeling. Vaesen and Houkes (2021) make a convincing case for the need to adapt and extend philosophical work on modeling to resonate with students in the engineering sciences. In these research contexts, philosophical perspectives on models as representational tools in hypothesis-driven research practices cover only part of the uses and needs for models. In addition, models need to be framed and understood as creative tools in application-oriented or design-driven activities. Vaesen and Houkes discuss how they addressed this need by developing a complementary philosophical approach to 'modeling scientific modeling' for application-oriented epistemic activities. Apart from having resulted in an elegant teaching tool, we think that their work shows how novel philosophical research can be prompted by a teaching need.

5 How do we teach it?

Discussions of pedagogical and didactical challenges and strategies are part of many of the contributions. Many of these tie in with the considerations about what to teach. For example, Green et al.'s (2021) focus on teaching philosophy of science through discussions of subject-relevant topics and controversies goes hand in hand with a case-based teaching approach. Cabrera (2021) likewise advocates for a case-based approach, which he develops into a more comprehensive 'second philosophy' approach to teaching science students. A key feature of this approach is to discuss topics that emerge from scientific practice itself and that engage scientists *qua* scientists, rather than being imposed by philosophers "from the outside". As Cabrera points out, this strategy can even be fruitfully applied to traditional philosophy of science topics. For example, the demarcation problem can be introduced to students by presenting them with articles from *Scientific American* and *Nature* in which physicists debate whether string theory counts as science. Cabrera also highlights the benefits of the strategy in overcoming the ornithology-for-the-birds challenge: dismissive attitudes to philosophy of science are best tackled by deferring to physicists who see a need for asking philosophical questions.

Bursten and Strandmark's (2021) archive-based learning activities present another example of a case-based approach (in the more specific medical sense) that excels at engaging students. They describe a teaching format developed for pre-medical students in a healthcare ethics class, where students engage with archival material on a historical

US clinical trial. The students are given the opportunity to engage with archival material to answer both questions about the design of the study and ethical concerns about the trial. In addition to anchoring ethics teaching in real-world cases, Bursten and Strandmark highlight the benefit of this teaching strategy in imitating important aspects of historical research, including the excitement of identifying and connecting pieces of information in complex historical sources. Abstract questions in medical ethics are made concrete by inviting students into the archives and letting them examine old documents with (confidential) information about people from the region they live in.

De Regt and Koster (2021) zoom in on the importance of engaging students in dialogue to foster critical and reflective thinking skills. They present a dilemma-oriented learning model as an example of a teaching format that promotes these skills, by guiding students through a discussion of ill-structured problems at the interface of science and society. Danne (2021) offers another perspective on the role of dialogue in teaching. He presents an exercise of “persona writing” that requires students to step into the shoes of figures they are familiar with and construct a contrived dialogue between them. He illustrates this with an exercise for engineering students on conjuring up an imagined exchange on ethics in science between Henri Poincaré and Pope Francis. As background, students are introduced to Poincaré’s 1913 essay *Ethics and Science* and Pope Francis’ (humanist) call for environmental action against consumerism in his second encyclical *Laudato si*. Danne points out that introducing engineering students to Poincaré’s views on ethics can be particularly helpful in addressing the ornithology-for-the-birds challenge. Since his name graces many of the students’ mathematics and physics textbooks, showing that he was also a respected philosopher of science (who even spent time discussing ethics!) can pique the interest of those who are skeptical about the relevance of philosophy.

MacLeod (2021) reflects on the ‘how?’ question at the level of educational programs. He argues that perceived problems about the relevance of philosophy of science are best addressed by securing tighter integration into courses of study. He offers an illustration of how such integration has been achieved in the educational program for civil engineering students. This involved carefully selecting topics that align with the problem-solving focus of application-oriented sciences, tailoring them to the context of study, and securing a proper overall embedding of philosophy of science courses in study programs.

Apart from contributions that reflect on innovative pedagogical tools and approaches to improve philosophy of science education, the collection also includes two papers that reflect on influences going in the opposite direction, from philosophy of science to pedagogy/didactics. Boon et al. (2022) and Reydon (2021) show that contemporary philosophy of science has produced insights that are relevant for the theory and practice of science education. Boon et al. (2022) discuss how problem- and project-based learning approaches can profit from philosophical reflection on the role of facilitators in group discussions. They point out that science educators often take for granted that students’ project work should be supervised by non-expert facilitators. Boon et al. conjecture that this didactic strategy is informed by assumptions about the character of scientific knowledge and of research practices that are rooted in an outdated empiricist epistemology of theory-neutral observation and rule-governed hypothesis testing. Boon et al. make a case for jettisoning this empiricist epistemology and for adopting a “constructivist epistemology”. On the latter approach, students are encouraged to start addressing scientific problems by constructing a (theory-laden, practice-informed, fallible) conceptual model of the problem at issue. But this is no easy task. Hence, students will need to be scaffolded by experts in creating such tools.

Reydon (2021) shows the relevance of a philosophy of science take on a topic of lasting importance in the science education literature: conceptual change. It is widely recognized in science education circles that students do not get a grasp of scientific concepts by building cumulatively on prior knowledge, but rather through a transformation of pre-existing, sometimes inchoate (mis)conceptions. What is less widely recognized, Reydon points out, is that the concept that is targeted in science education need not always be a single, correct notion, but can itself be a plurality of closely related ones. Reydon illustrates this in detail for the concept of fitness in evolutionary biology. ‘Fitness’ has acquired a plurality of meanings in biological research communities, past and present. This is no news to philosophers of biology, but as Reydon points out, they may fail to appreciate that using philosophical work on mapping and analyzing this conceptual pluralism can be used to create reflection tools for didactical purposes.

6 Concluding remarks

We have sampled just a few of the many insights that the contributions to this topical collection have to offer. We hope that the collection can serve as an inspiration for teaching philosophy of science that matters in practice, and will prompt further reflections on the challenges that lie ahead. Among these challenges is the observation, made by several contributors, that philosophy of science literature often is inaccessible to science students. This signals a need for writings and outlets that facilitate more engagement across disciplines. Making philosophy of science courses more practice-oriented also requires efforts to develop good cases for teaching. All this is easier said than done; it takes effort to get to know areas of scientific study (and associated study programs) well enough to develop cases that are relevant, engaging, and have philosophical depth. It also takes efforts to nurture productive collaborations with co-teachers across disciplines. These efforts are, however, in alignment with the increasing practice orientation of philosophy of science, which may help to stimulate synergies between teaching and research activities. We see the publication of this topical collection in EJPS as an important step in this direction.

That said, we should stress that we do not consider the contributions as representative of philosophy of science teaching in general. The experiences reported are predominantly drawn from North American and European institutional contexts, which are not necessarily representative of needs, norms, and practices elsewhere. For future discussion, it will be important to explore how teaching of philosophy of science is done in wider geographical and cultural contexts. So, rather than presenting comprehensive guides to how teaching should be done, we hope that the contributions to this topical collection can be seen as starting points for exploring the benefits of community engagement in teaching development in philosophy of science.

Data Availability Not applicable.

References

Ankeny, R., Chang, H., Boumans, M., & Boon, M. (2011). Introduction: Philosophy of science in practice. *European Journal of Philosophy of Science*, *1*(303). https://doi.org/10.1007/s13194-011-0036-4

Boon, M., Orozco, M., & Sivakumar, K. (2022). Epistemological and educational issues in teaching practice-oriented scientific research: Roles for philosophers of science. *European Journal of Philosophy of Science, 12*, 16. https://doi.org/10.1007/s13194-022-00447-z

Bursten, J. R. S., & Strandmark, M. (2021). Better learning through history: Using archival resources to teach healthcare ethics to science students. *European Journal of Philosophy of Science, 11*, 89. https://doi.org/10.1007/s13194-021-00406-0

Cabrera, F. (2021). Second philosophy and testimonial reliability: Philosophy of science for STEM students. *European Journal of Philosophy of Science, 11*, 67. https://doi.org/10.1007/s13194-021-00392-3

Danne, N. M. (2021). A dialogue on the ethics of science: Henri Poincaré and Pope Francis. *European Journal of Philosophy of Science, 11*, 62. https://doi.org/10.1007/s13194-021-00385-2

De Regt, H. W., & Koster, E. (2021). The Hows and whys of philosophy of science teaching: A comparative analysis. *European Journal of Philosophy of Science, 11*, 106. https://doi.org/10.1007/s13194-021-00421-1

Dewey, J. (1916/2001). *Democracy and Education. An introduction to the philosophy of education*. The Pennsylvania State University.

Green, S., Andersen, H., Danielsen, K., et al. (2021). Adapting practice-based philosophy of science to teaching of science students. *European Journal of Philosophy of Science, 11*, 75. https://doi.org/10.1007/s13194-021-00393-2

Grüne-Yanoff, T. (2022). Overcoming Frege's curse: Heuristic reasoning as the basis for teaching philosophy of science to scientists. *European Journal of Philosophy of Science, 12*, 22. https://doi.org/10.1007/s13194-022-00452-2

Jaksland, R. (2021). Teaching scientific creativity through philosophy of science. *European Journal of Philosophy of Science, 11*, 110. https://doi.org/10.1007/s13194-021-00427-9

Kleinhans, M. G. (2021). Down to Earth: History and philosophy of geoscience in practice for undergraduate education. *European Journal of Philosophy of Science, 11*, 81. https://doi.org/10.1007/s13194-021-00402-4

Kitcher, P. (2023). *What is the use of philosophy?* Oxford University Press.

Lusk, G. (2022). Is HPS a valuable component of a STEM education? An empirical study of student interest in HPS courses within an undergraduate science curriculum. *European Journal of Philosophy of Science, 12*, 19. https://doi.org/10.1007/s13194-021-00433-x

MacLeod, M. (2021). Integrating philosophy of science in civil engineering: An integrative course design strategy. *European Journal of Philosophy of Science, 11*, 105. https://doi.org/10.1007/s13194-021-00422-0

Reydon, T. A. C. (2021). Misconceptions, conceptual pluralism, and conceptual toolkits: Bringing the philosophy of science to the teaching of evolution. *European Journal of Philosophy of Science, 11*, 48. https://doi.org/10.1007/s13194-021-00363-8

Vaesen, K., & Houkes, W. (2021). A new framework for teaching scientific reasoning to students from application-oriented sciences. *European Journal of Philosophy of Science, 11*, 56. https://doi.org/10.1007/s13194-021-00379-0

Young, M. T. (2022). From epistemology to policy: Reorienting philosophy courses for science students. *European Journal of Philosophy of Science, 12*, 26. https://doi.org/10.1007/s13194-022-00454-0