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Virtues and vocation: An historical perspective on scientific integrity in the twenty-first century

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ABSTRACT

According to the Dutch chemist Gerrit Jan Mulder (1802–1880), the principal aim of university education was character building and moral edification. Professional training was of secondary importance. Mulder's ideas about the vocation and moral mission of the university professor can serve as a historical counterpart to later Weberian, Mertonian, and contemporary ideas on the ethos of science. I argue that a revaluation of the moral precepts that Mulder saw as defining the life of an academic is helpful in dealing with the problems of late modern science, such as the replication crisis and research misconduct. Addressing such problems must start in the university classrooms. To empower students to internalize the principles of responsible conduct of research, we need an updated version of Mulder's idea of the university professor as a moral agent.

Introduction

The Dutch chemist Gerrit Jan Mulder (1802–1880; Fig. 1) championed a deeply conservative view of the purposes of university education. For him, being a professor was a calling rather than a job, and the university's *raison d'être* was not to contribute to the growth of knowledge, but to educate the next generation of *Bildungsbürger*. Mulder articulated his ideas on the meaning of academic education in a number of polemical writings that provide insight into what he perceived as the moral mission of the university professor. I shall sketch his ideas in some detail here as a historical counterpart to later Weberian, Mertonian, and contemporary ideas on the ethos of contemporary science. In his *The Scientific Life* (2008) Steven Shapin contends that, because of the fundamental uncertainties inherent in late modern science and technology, the personal and moral virtues of its practitioners are of central significance. In line with this argument, I aim to show that a revaluation of the moral imperatives that according to Mulder defined his professorial duties is helpful in dealing with the problems contemporary science is facing, such as the replication crisis, perverse incentives ("publish or perish"), questionable research practices, and research misconduct. For an important part, these problems are indicative of shortcomings of the current science system, and systemic problems require systemic solutions. However, fostering responsible conduct of research among students and researchers is just as indispensable to remedy what has gone wrong in contemporary science. I will argue that reflection on what it means to act with integrity must start in the university classrooms, and that we need an updated version of Mulder's idea of the university teacher as a moral agent.

Gerrit Jan Mulder was one of the architects of the revival of the Dutch universities in the middle decades of the nineteenth century. After the period of French dominance (1795–1813), the universities had entered a period of financial hardship. Professors complained that they were overburdened with teaching duties. They lacked the elementary tools and instruments to keep their teaching up to date, and facilities for research were lacking altogether. It was only around the middle of the century that the situation began slightly to improve and that a number of Dutch university professors found the time and means to engage in academic research. The first signs of recovery were seen in Utrecht, where professors such as Mulder, the zoologist Pieter Harting, and the physiologist Franciscus Cornelis Donders created a vibrant community of scholars seeking to reform academic education and research. Following German examples, they established teaching laboratories for their students, and they worked hard to regain a position in the international world of research. Whereas, in the early nineteenth century, the Dutch universities had almost exclusively been teaching institutions, by 1900 they had developed into teaching and research institutions. Utrecht University is customarily seen as the breeding ground of this transformation.

Thus one might be inclined to think that, in the Netherlands, the first initiatives toward adding research to the principal tasks of the university

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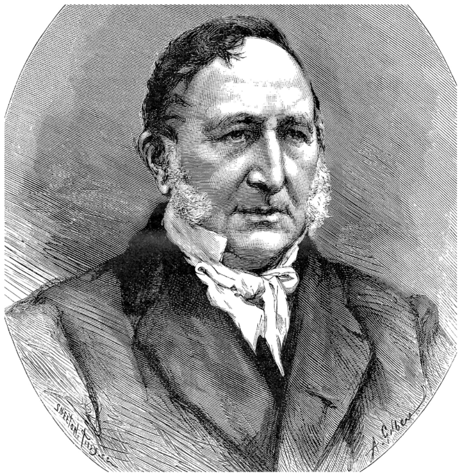

Fig. 1. Gerrit Jan Mulder, by A. Gilbert, in *Eigen Haard: Geïllustreerd Volkstijdschrift*, 1880, p. 181. Source: Wikimedia Commons. Public Domain.

professor were taken in Utrecht. This would be a mistake, however, because just like their colleagues elsewhere in the country the Utrecht reformers continued to believe that the university's principal purpose was to educate the future elite, citizens of "*Bildung*" whose high moral character, knowledge, and judgment were indispensable for safeguarding the nation's identity and its social and moral order and prosperity. Students might opt for a professional or an academic career, yet it ought to be their moral character that defined them, rather than their scientific expertise. Accordingly, university professors first and foremost had to be educators, and their scientific ambitions should never interfere with their principal obligations as teachers. There was general agreement that academic education was about much more than acquiring expert knowledge and research skills. Some professors even doubted whether science education contributed to the students' *Bildung* at all. The idea of the university as an institution for both education and research, that began to gain prominence in the final decades of the nineteenth century, was definitely not envisaged by the Utrecht reformers. Gerrit Jan Mulder, whose ideas we will now turn to, was the most zealous and vociferous of these reformers.

Professorial duties

Mulder became professor of chemistry and pharmacy in Utrecht in 1840. Through his close contacts with leading chemists such as Jöns Jacob Berzelius in Sweden and Justus von Liebig in Germany, he succeeded in reconnecting Dutch chemistry to international developments in the field, in which elemental analysis played a central role at the time. Mulder established a laboratory for chemical analysis in Utrecht, where he would educate the first generation of Dutch chemists. He wrote chemistry handbooks, launched several scientific journals, and also wrote extensively for a general audience to popularize his field and illustrate its practical relevance.[1]

It should be emphasized that Mulder's chemical laboratory was a teaching laboratory, intended for his students to gain practical experience. Chemistry, Mulder professed, should be taught hands-on: "giving a thousand lectures is not as effective as offering students a single opportunity to practice with the material" (Mulder, 1833–1834, I: 17). This pedagogical approach was not aimed at raising a new generation of scientific researchers, but at providing future chemists and pharmacists with the practical know-how they needed in their occupations. This was the most important innovation that Mulder and his colleagues introduced in Utrecht. An earlier generation of university professors had not considered it their task to give their students practical training. They were charged with transferring their theoretical knowledge to the students; the practical aspects were left to instructional training on the job.

Mulder and his colleagues felt that this would no longer do: students had to graduate as competent professionals, theoretically as well as in the practical sense. Mulder did not strive to create a chemical research school; most of his pupils became physicians, pharmacists, or secondary school teachers. Eight of them were appointed as professor of chemistry and helped to disseminate the Utrecht teaching philosophy across the Dutch universities. They did not make their mark as researchers, however. Mulder's laboratory did of course offer him and some of his graduate students the opportunity to conduct research, and they made good use of it. Yet this is not to say that, in Mulder's perception, scientific research was part and parcel of his professorial duties.

This also transpires from the way in which he legitimized his field in his academic speeches and popular writings. As Mulder considered alleviating the needs of society to be the principal aim of knowledge production, he decried research that lacked any connection to useful applications as a waste of time and effort. Scholarship for its own sake, he scoffed, was for pointy-headed intellectuals living meaningless lives (Mulder, 1830, p. 39). Both academic education and academic research served to enhance the prosperity and wellbeing of the nation, by training competent professionals and by producing useful knowledge. Mulder did not go so far as to insist that university research should focus entirely on finding solutions for practical problems. Saying that academic research should never lose its connection to the material needs of society did not imply that scientific investigation should always result in practical applications or concrete answers to practical questions. More often than not, academic research was applicable in principle rather than applied, meaning that it contributed to the knowledge base needed to solve the practical issues faced by, for instance, physicians, agriculturists, navigators, and engineers. Thus there was room for pure science in academia—research that solely aspired to find truth—provided that investigators always kept an eye on the eventual uses of their efforts and refrained from indulging in the accumulation of idle scholarship (Mulder, 1849a). Mulder was not alone in harboring this sense of duty toward society. Ad Maas has aptly characterized the Dutch academics of the late eighteenth and early nineteenth century who shared Mulder's conviction of the social usefulness of science as "civil scientists" (Maas, 2010, p. 75).

In his own research, Mulder lived by the precepts of the civil scientist. His chemical research was always connected, directly or indirectly, to practical problems in agriculture, medicine, or industry. In his lectures and addresses to students, however, he emphasized the pure aspect of scientific research, or, in his own terms, the quest for "what is true, what is beautiful, what is good" (Mulder, 1849b, p. 11). This was not because, at the end of the day, Mulder's real interest was in pure science, his insistence on useful knowledge being merely a rhetorical strategy to justify his work to the outside world. Mulder was dead serious about useful knowledge and in his rejection of scholarship for its own sake. Rather, the difference in emphasis in his academic lectures derived from Mulder's ideas about higher education, which cannot be directly inferred from his statements expressing his commitment to the idea of useful knowledge.

For Mulder, receiving an academic education was not the same as being instructed how to produce useful knowledge. Even though it was the university's responsibility to educate competent professionals, this was not what defined the core of its mission. If the university's only task was *Ausbildung*, aimed at meeting society's need for skilled pharmacists, chemists, physicians, and other professionals, it might as well be called a school for occupational education. The crucial difference with occupational education was that universities molded their students' character and prepared them for membership of the *Bildungsbürgertum*, the elite

[1] The analysis of Mulder's views in this paper is mainly based on Theunissen (2000), Chapter 4. See Snelders (2008) for a concise biography, and van Raak (2001) for Mulder as a conservative public figure. Throughout the paper, all quotations from Mulder's works have been translated by the author.

group of upstanding citizens who had learned to recognize and value what was eternally true, good, and beautiful (Mulder, 1849b).

Thus Mulder, like most of his Dutch contemporaries, deployed a more traditional interpretation of the term *Bildung* than German philosophers such as Herder and, particularly, von Humboldt, whose names are commonly associated with the term. For Wilhelm von Humboldt, the emphasis in higher education should be put on the development of the personality and the specific proclivities and talents of the individual, thus creating an intellectual aristocracy of independently thinking citizens. Mulder did not share this liberal notion of the autonomous *Bildungsbürger* (educated citizen). He rather strove to pass on the eternal and timeless values of the classical man of virtue to his students, expecting them to become part of a like-minded elite that helped to safeguard the moral, religious, and political cornerstones of the nation (Biesta, 2019, Chapter 2; Labrie, 1986; Rothblatt, 1993).

Professorial virtues

Mulder's prioritizing of *Bildung* in academic education is best understood against the background of the transformation of the Dutch universities in the 1860s and 1870s, a changeover that Mulder was to deplore and even condemn until the end of his life.

As a young man, Mulder had been a conservative royalist. By the time he retired, in 1868, he had become a reactionary, even though (or because) he never changed his political outlook. The watershed event in his life was the liberal revolution of 1848, which put an end to the Dutch monarch's sovereignty and replaced it with ministerial responsibility for government policy. Liberalism, in Mulder's view, "did away with love and replaced it with interests and benefits" (Mulder, 1883, I: 8). The notion of "love" (or "charity"), in this context, referred to a universal and unchanging virtue, just like prudence, temperance, and justice, which defined what Mulder called "men of character" (Mulder, 1879, p. 247). The liberals' vices, as he perceived them, were the exact opposites of these virtues: the liberal higher education laws introduced a notion of science as an enterprise geared toward making discoveries, careers, and money. As a result, academic life was destroyed, because "where so-called interests, personal glory, personal benefits, leisure, opulence are put first, there can be no society, no salvation, no communality, even no peace" (Mulder, 1883, II: 29).

The higher education acts that Mulder campaigned against were introduced for medical education in 1865, and for university education as a whole in 1876. They defined the purpose of academic teaching as preparing students for a profession or for conducting research. They no longer required all students to first absorb a *studium generale* including courses in philosophy, history, classical languages, and the arts. While professors had formerly been appointed in one of the university's faculties (of theology, law, medicine, arts, and sciences), they were now appointed in a particular field, such as physics or chemistry, and the requirement that they should be able to teach different fields in their faculty was dropped. More and more, they were regarded as specialists in a specific area of knowledge (Baggen, 1998; Maas, 2001; Theunissen, 2000; Wachelder, 1992; Willink, 1991).

In Mulder's view, these reforms unveiled the ugly face of liberal ideology. Apparently, utility was all that mattered in this new definition of the university's purpose. The ideals of *Bildung* and of moral edification were done away with and replaced by the utilitarian goals of professional education. This, Mulder argued, amounted to the destruction of the idea of the university as an institute of higher education. Higher learning, he detailed, required students to engage in the study of the classics, religion, ethics, and a generous sprinkling of the *artes liberales*. The aim was to build their character and personality in such a way that they would develop into virtuous public servants. In contrast, the new education laws reduced academics to mere specialists (Mulder, 1865a, 1865b).

Whereas Mulder, in his younger years, had maintained that the natural sciences were among the disciplines that contributed to the students' *Bildung*, he became more extreme in his views at an older age, denying that the acquisition of scientific knowledge, as such, contributed anything to the students' character. Science was organized knowledge; character building was something else entirely. Fostering his students' moral edification, Mulder declared, had been his calling as a university professor. As a chemist, he had merely been a professional complying with the demands of his social responsibility to alleviate the needs of society. The only part of science that might claim to contribute to *Bildung* to some degree, was its pure core, that represented what was eternally true, good, and beautiful, the classical triad of which the *Bildungsbürgertum* should naturally be cognizant (Mulder, 1876, 1879).

Mulder's infamous altercation with the German chemist and entrepreneur Justus von Liebig (1803–1873) over the chemical nature of protein in the 1840s provides a vivid example of his conception of the moral habitus of the university professor (Glas, 1975; Glas, 1976; Mulder, 1846). Liebig ignited the debate by publicly questioning Mulder's claim to have succeeded in experimentally isolating "protein," which he believed to be the basic building block of all proteins. The ensuing dispute between the two men derived its acerbity from Mulder's unveiled attack on Liebig's moral character, which he denounced as unworthy of a university professor. Liebig was successful as a discoverer of new chemical facts and as an entrepreneur: he pioneered the use of artificial fertilizers and established a company for the sale of beef extract, for instance. But all this spoke against him, in Mulder's view, when it came to judging his trustworthiness and righteousness as a man of science and a university professor. A virtuous man of *Bildung*, Mulder expounded, would never chase discoveries the way Liebig did, let alone try to make money out of them. Ambition and avarice had made Liebig famous, yet disinterestedness was a precondition for trustworthiness, and Liebig's glory-hunting disqualified him as a truth seeker:

> Liebig's laboratory in Giessen has taught us what can be accomplished by ambition and money making. I do not want to detract from Liebig's talent, but without his ambition and avarice, and without his efforts to instill these traits in his students, he would not have been able to shine or win over as many students for chemistry as he did (Mulder, 1883, I: 249–50).

His ambition made Liebig equally unsuitable as a university professor, who should focus on the education of his students, not on seeking recognition through making discoveries. A professor should be an educator and an exemplar, and "if he is a specialist, he should be rejected as a Professor" (Mulder, 1876, p. 498). For Mulder, unchanging moral values and norms of behavior defined the virtuous academic. The university professor's "love" warranted both the truthfulness of his scientific work and his dependability as an educator of the future elite of like-minded *Bildungsbürger*. As indicated, the elder Mulder even disagreed with many of his contemporaries that the pursuit of scientific knowledge was a virtuous enterprise in itself and thus contributed to the academic's *Bildung*. It was rather the other way around, he argued: it took a virtuous man to grasp the truth. The facts of nature did not present themselves to the observer unmediated. It was through his innate, God-given moral judgment that the researcher was able to separate truth from falsehood and to glean what was true, good, and beautiful. Thus it was not the nature or the methods of scientific inquiry that guaranteed the veracity of scientific facts, but the moral character of the man of science (Mulder, 1883, I: 3).[2]

Mulder fought a hopeless rearguard action against the liberal reform of the Dutch universities in the second half of the nineteenth century. Although academic discussions about the importance of *Bildung* were far from over (Baneke, 2008), the ideal receded into the background for all practical purposes. By the early twentieth century most university

[2] In other words, Mulder emphasized non-epistemic virtues. See van Dongen (2017), van Dongen and Paul (2017), Maas (2017), and Paul (2018) for the role of epistemic virtues in the (Dutch) sciences and humanities.

professors in the Netherlands had become teachers and researchers who no longer had their students' moral elevation as their primary objective. Instead, they aimed to prepare the students for academic research and professions for which a scientific education was required.

Max Weber (1864–1920) articulated this new conception of the role of higher education in his 1917 lecture "Wissenschaft als Beruf" (Weber, 2002; see also Shapin, 2019). In a disenchanted world, Weber famously declared, scientific knowledge did not convey moral meaning. Scientists made their name as specialists and discoverers of new facts. It was fallacious to say that what is true is also and necessarily good and beautiful—scientific facts might be highly inconvenient, and the truth was not always beautiful. Academic professors were teachers, not moral leaders or seers pretending to be able to instruct their students how to live and what to do. Lest teachers become prophets or demagogues, there was no room for religious or political convictions in academic teaching: "in the lecture rooms of the university no other virtue holds but plain intellectual righteousness" ("daß innerhalb der Räume des Hörsaals nun einmal keine andere Tugend gilt als eben: schlichte intellektuelle Rechtschaffenheit"; Weber, 2002, p. 511).

Weber also distanced himself from the notion of the professor as a civil scientist. The social value of science was in its technical and commercial uses, and in advancing rational understanding and clarity of thinking. Practical usefulness, however, was not what motivated or legitimized the scientific quest for knowledge; scientists did their research for its own sake, not with an eye on practical uses or gains.

The ethos of science

Weber did not problematize the notion of intellectual righteousness or integrity, seemingly suggesting that it was part and parcel of the scientist's devotion to the quest for knowledge. Still, as Shapin (2008) has argued, the identity of the scientist as a morally righteous person was irrevocably destabilized by the redefinition of science as an ordinary job. Whereas the high moral standing of university professors had long been self-evidently implied in their mission to build their students' character and in the moral value of the quest for truth, the virtuousness of university teachers who were no longer moral leaders was not an incontestable given. It would take until after the Second World War for this notion of—in Shapin's words—the "moral equivalence" of scientists to the rest of humanity to become the default view, but the argument that scientists were ordinary humans, not a morally superior type, was voiced by several authors from the late nineteenth century onward. So, if it was not the scientists' singular moral standing, what was it that warranted the trustworthiness of science?

In his 1942 essay "Science and Technology in a Democratic Order," later republished as "The Normative Structure of Science," sociologist Robert K. Merton (1910–2003; Fig. 2) reversed the argument (Merton, 1973; Shapin, 2008, Chapters 2–3). It was the ethos of science, he claimed, that warranted the credibility of the researcher. Merton, too, started from the premise that scientists were vulnerable to all human frailties; assuming special motives distinguishing the scientist, such as a passion for knowledge or an altruistic concern for humanity, was misguided. Thus the question presented itself, Merton continued, as to how one was to explain the virtual absence of fraud and deceit in science when compared to other human activities—an exceptionalist assessment he apparently regarded as unproblematic.

The four norms of scientific inquiry—communism, universalism, disinterestedness and organized skepticism—captured by the acronym CUDOS, for which Merton's name is still widely remembered, formed the core of his answer to the question. Scientific facts or laws are not owned by the person who discovered them but commonly owned by all scientists (communism); the validity of a scientific claim does not depend on the socio-political and personal status or attributes of the researcher (universalism); the scientific enterprise fosters the growth of knowledge and is not meant for personal gain (disinterestedness); and scientific results and methods must be presented to peers for critical

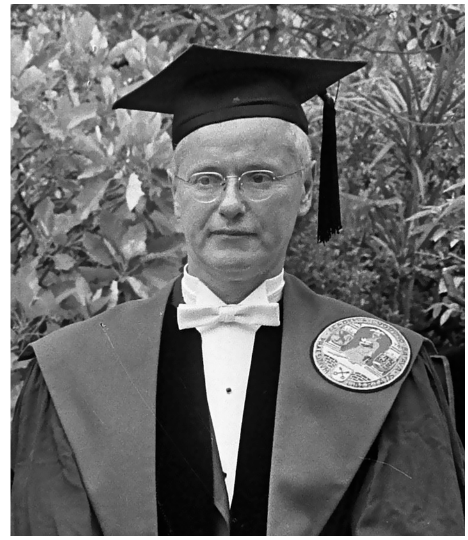

Fig. 2. Robert K. Merton in Leiden, 1965. Photograph by Eric Koch/Anefo (National Archives, The Netherlands). Source: Wikimedia Commons. CC0 1.0 Universal License.

scrutiny (organized skepticism). These were not personal norms, but the norms of the scientific enterprise as an institutional activity; they were constitutive of the nature of science as the organized quest for truth. Students internalized the four norms during their academic education, Merton believed, and researchers conformed to them not only "on pain of psychological conflict," but also because rigorous internal policing by the scientific community enforced them. Whoever violated the norms was going to be held accountable by his or her peers "to a degree perhaps unparalleled in any other field of activity" (Merton, 1973, p. 276).

Thus what Weber had called the "plain intellectual righteousness" of the academic became, in Merton's rendering, a quality that might distinguish the scientist from other professionals after all. Fraud in science was rare because scientists internalized and zealously guarded the norms of science as an institution. Admittedly unexceptional as moral beings, as researchers they were bound in a unique manner to adhere to the imperatives that characterized the ethos of science.

Obviously, much of the cogency of Merton's reasoning derived from his premise that fraud in science was rare. But here, of course, is the catch. Since the 1960s, the moral equivalence of scientists has more and more been taken to imply that scientific autonomy and self-regulation need to be balanced by public accountability (Baldwin, 2018; Strathern, 2000). In 1989, investigations of what the public press called a crime wave in scientific research resulted in the establishment of the US Office of Scientific Integrity, the first governmental agency to oversee and direct the detection, investigation, and prevention of research misconduct, especially in health (Anderson et al., 2013; ORI, 2023). Since then we no longer say easily after Merton that breeches of scientific integrity are rare, or that science's internal policing mechanisms are singularly effective in preventing them.

Much of what Gerrit Jan Mulder feared would happen to the ethos of science in a liberal world has come true. Seen from his perspective, the ill-fated consequences of liberalism are indeed upon us. The science system suffers from perverse incentives. The "publish or perish" mentality and the increasing dependence on external funding severely test academic researchers' resilience to improper behavior. Since the 2000s, we have a replication crisis, epitomized by the title of John Ioannidis' *PLOS Medicine* paper "Why Most Published Research Findings are False" (Ioannidis, 2005). Ioannidis's claim was later extended from biomedicine to other fields (see, e.g., Baker, 2016), and despite criticism of his alarmist tone and allegedly problematic use of the terms "false" and "most," the paper has been highly influential as a wake-up call, generating a vast body of critical literature on the shortcomings of the current science system.[3]

The need for more thoroughgoing methodological and statistical scrutiny of scientific results is widely recognized. The peer review system, while it is supposed to function as an objective, rigorous, and impartial check on the validity of scientific claims, is under attack not only for allowing too much room for biased, sloppy, and partisan evaluations, but also for its alleged conservatism, that is said to hinder innovative research (see, e.g., Campanario, 1998a; Campanario, 1998b; Siler et al., 2015). Finally, political diatribes about fake facts and frequent newspaper reports on scientific misbehavior give us every reason to worry about the general public's trust in the Credibility of Both Scientists and the Knowledge They Produce. "Scientific Research has Changed the World. Now it Needs to Change Itself," *The Economist* editors headlined in the October 19, 2013 issue (The Economist, 2013).

The grey zone of scientific integrity

Today, the focus is not only, or even mainly, on major cases of misconduct such as those of physicist Jan Hendrik Schön at Bell Labs in the early 2000s and social psychologist Diederik Stapel at Tilburg University in the early 2010s. Indisputably, they have had an injurious impact on the image of science and scientists, but deliberate falsification, fabrication, and plagiarism—the cardinal sins in scientific research—are relatively rare. In anonymous surveys, some 2 % of the participating scientists admitted to such major integrity violations. Yet up to 34 % said to have been involved in much smaller, everyday transgressions, variously called sloppy science or questionable research practices (Fanelli, 2009).[4] These much more widespread practices are difficult to police and prevent by the traditional self-correcting mechanisms of science such as peer review and replication, the more so because these instruments are themselves considered to be part of the problem.

Studies in the history, philosophy, and sociology of science have impressed on us that there is no unfailing scientific method to guide us to the truth. Knowledge production is fraught with uncertainties, and knowledge claims must always be provisional. Research is a social activity, and the human factor cannot be neutralized. More and more, we realize that the values and norms promulgated to safeguard scientific integrity need to be actively fostered by researchers. Yet it now seems naïve to assume, as Merton did, that students will automatically internalize these principles and guidelines during their academic training as scientists and scholars. The current crisis of the science system rather prompts the cynical suspicion that students are internalizing the wrong "values" altogether and are taught to turn means—publications, citations, grants—into ends.

While it might be argued that Merton's norms still hold in principle, they are hard to live up to in a system that puts a heavy emphasis on output and impact and that is increasingly dependent on public-private partnerships for its funding. Merton felt that some of the precepts of scientific research in industry were irreconcilable with the CUDOS norms of academic science: "The communism of the scientific ethos is incompatible with the definition of technology as 'private property' in a capitalistic society" (Merton, 1973, p. 275; Shapin, 2008, pp. 111–13). The reality of our times, however, is that the boundaries between science and business are increasingly difficult to draw, and it now sounds inane to suggest that the principle of communism should suffice to forestall issues with respect to intellectual property rights or secrecy. Similarly, as much as we expect scientists to be disinterested and skeptical with respect to the outcomes of their investigations, the reward system that fuels their careers counts positive rather than negative results, because they translate much more easily into publications and successful grant applications. So for students to learn how to conduct scientific research with integrity in a highly competitive and output-oriented working environment, positing such principles is not enough, not even if they are converted into concrete guidelines specifying do's and don'ts.

A cardinal point here is that many issues of scientific integrity that scientists encounter in their day-to-day work have no solutions of the black and white kind and cannot simply be solved by an appeal to norms or rules. While falsification, fabrication, and plagiarism (FFP) are the most serious forms of scientific misconduct, they are obvious "don'ts" and, in this respect, fairly unproblematic. The real challenge is in dealing with the vast grey area of concerns and dilemmas that present themselves in daily practice and that derive as much from the inherent uncertainties of knowledge production as from the fact that scientists are human. More often than not, codified norms and guidelines do not provide clear-cut solutions here, for instance because integrity issues may involve a conflict between scientific and personal or social values. The context in which an issue arises may be all-important in figuring out a solution. Many problematic situations that are routinely referred to as "questionable research practices" or "sloppy science" should rather be categorized as challenging issues in the grey zone, because it is far from obvious what constitutes appropriate behavior in such cases (van den Hoven & Theunissen, 2021). The following quotations from a paper by Raymond de Vries et al., aptly titled "Normal Misbehavior" and based on discussions with fifty-one scientists, illustrates the kinds of problems that occur frequently during the everyday routines of scientific work:

> One respondent noted: "I think that [FFP is] a really small part … I think those kind of ethical issues we actually don't deal with very often. But there are a lot of daily things that go on …" Another respondent described a successful colleague who is not "terribly ethical," pointing out that this person's misconduct included only a "little bit of FFP;" she believed that the more troublesome behavior involved: "… abusing … post docs, claiming things that—taking like credit, you know, like credit for lots of things that aren't yours." Often we heard, "In my area, FFP is not the issue, it is …" followed by a description of a more mundane, everyday problem in the lab or with the research team. These more common, everyday problems fall into four categories: (1) the meaning of data, (2) the rules of science, (3) life with colleagues, (4) the pressures of production in science. As we analyzed our focus group data, we came to realize that the everyday problems of scientists are often associated not just with ordinary human frailties, but with the difficulty of working on the frontier of knowledge. The use of new research techniques and the generation of new knowledge create difficult questions about the interpretation of data, the application of rules, and proper relationships with colleagues. Like other frontiersmen and—women, scientists are forced to improvise and negotiate standards of conduct (de Vries et al., 2006, pp. 44–45).

Some concrete examples of these four categories of grey-zone issues mentioned by de Vries et al. are: How much data should I collect for my results to be truly robust? Can I be sure that some of my data can be discarded as outliers? Can I claim authorship of a paper? As a student, should I share my data with a senior staff member? Should I help a fellow student who is competing with me for a job? Should I tell on a fellow student who is obviously cutting corners? How much overwork is acceptable for a graduate student? How much time can I afford to spend on improving the quality of my paper? Such examples can easily be expanded to all areas of scientific activity, such as dealing with sponsors (How do I deal with the pressure to produce positive results?), peer review (Can I be an objective reviewer of a paper that criticizes my own

[3] See Wikipedia Contributors (2023) on the replication crisis for a useful overview of the main issues.

[4] A recent Dutch survey reports higher incidences than previous estimates, with one in twelve researchers admitting to having committed a serious form of research misconduct within the past three years, and one in two admitting to engaging in questionable research practices (National Survey on Research Integrity, 2020; see also de Vrieze, 2021). However, the survey's set-up and methodology have been questioned, and ten out of fifteen Dutch universities declined to participate for this reason (de Vrieze, 2020).

work?), or publishing (How should I deal with dubious requests from journal editors, such as citing their own papers?).

Incriminating notions such as "sloppy science" and "questionable research practices" seem to suggest that there is in fact a correct way to act. Multifarious efforts are being undertaken to remedy the shortcomings of the current science system and to introduce more rigorous statistics, more openness with respect to data, better editorial policies, more transparency concerning funding and conflicts of interest, and so on. All this is much needed, yet removing perverse incentives, making methodological improvements, and tightening rules and regulations do not provide answers to the ethical conundrums that may underly integrity issues in the grey zone. What is the best way to act in complicated real-life situations is context-dependent and requires ethical deliberation.

Given that the values and norms that come into play in such deliberations are not automatically internalized, and, moreover, that rule-following behavior does not suffice, it follows that there is a need for education on how best to handle integrity dilemmas in daily practice. Currently, more and more university boards do indeed acknowledge that research integrity training, or training in "responsible conduct of research" as it is customarily conceived (Steneck, 2007; Steneck & Bulger, 2007), is an essential aspect of academic education.

Research integrity and science as a calling

The concept of responsible conduct of research (RCR) provides a useful baseline for such training. The gist of this approach is that it is better to focus the students' training on how to do things right than on avoiding scientific misconduct. Research ethicist Michael Kalichman has argued that RCR education should aim for a "positive disposition towards RCR, with a sense that there are things [students] can do in the face of concerns, and with a belief that they are part of a culture that takes RCR seriously." Integrity training should "empower [students] to continue those conversations with peers, mentors and their future trainees" (Kalichman, 2014, p. 71).

Students' own experiences, in their particular field of study, offer a useful starting point. Alternatively, integrity cases such as those provided by, for instance, the Erasmus Dilemma Game or the Embassy of Good Science can be used (Erasmus University Rotterdam, 2023; The Embassy of Good Science, 2023). The important thing is to focus on the many issues in the grey zone, which students can discuss in a way that enhances their awareness of potentially problematic issues. They should develop a critical attitude toward their own practices and learn how to proactively maintain a responsible research culture in their own environment. A group discussion of an integrity dilemma may be structured by means of a simple method for ethical case deliberation, such as the ones provided on the website of the Embassy of Good Science. Scientific codes of conduct, such as the ALLEA (2023), can be used to check which norms are at stake and which rules might apply. The discussion can be concluded by showing students which procedures are in place to help them and which persons they can turn to for advice, such as a student advisor or an integrity counsellor. In many cases, finding solutions for integrity issues will prove anything but easy, but students should know they do not have to find such solutions on their own. Knowing where to go for help is an important first step (van den Hoven & Theunissen, 2021).

There is much more to be said about integrity training, yet for present purposes it is particularly apposite to draw attention to what, in my view, is presupposed in the RCR approach. This is that integrity training is an indispensable part of—in Gerrit Jan Mulder's terms—a student's *Bildung* to become a virtuous academic. Today, we might prefer to say that students have to become "streetwise" about the scientific arena and, starting from its basic values and norms, need to be taught responsible coping and decision strategies. Yet while all current codes of scientific conduct agree that research integrity involves values and norms, the latter do not provide unfailing guidelines. We can no longer consider such values to be the timeless and universal principles that will guide us to discern what is true, good, and beautiful (Mulder) or that will guarantee our allegiance to the ethos of science (Merton).

Scientific values, and the norms that derive from them, are culture-dependent, and they always have been. Mulder's notion of virtuous "men of character" had obvious masculine and Christian overtones. Merton's CUDOS norms reflected his liberal view of the autonomy of science (Turner, 2007). And today's scientific codes of conduct, by emphasizing values such as responsibility, accountability, and transparency, reflect the demise of the ivory tower image of science as well as our awareness of the uncertainties of knowledge production. Moreover, we have come to realize that such values may be in conflict with each other and with other, personal or societal values. More often than not, integrity dilemmas in the grey zone involve exactly such discords between values or norms, and becoming a responsible scientist includes acquiring competence in dealing with them. Thus compliance with integrity codes is not simply a matter of ticking the boxes of the rules that follow from the basic research values. Rather, future researchers should learn how to handle moral dilemmas, both as members of a team and as individuals. What do we, as investigators, consider responsible conduct of research to entail in this or that particular situation? And what do I, as an individual, consider the right thing to do in a particular case? Put differently, what kind of scientist do I want to be?

While scientific values and norms do not provide ready-made answers, they remain indispensable as cornerstones of such ethical deliberations. For Mulder, building the students' character did not just come down to teaching them how to do things right, but also to do the right things. As Weber stressed, however, professors should not be prophets or demagogues, and we no longer share Mulder's apodictic intuitions about what is right or wrong. Still, even though being a scientist is a job, a commitment to its institutional values is crucial for the scientific enterprise to function properly or even to make sense. As Shapin concluded in *The Scientific Life* (2008), the realization of the radical uncertainties of knowledge production has highlighted the centrality of personal virtues in scientific work even more. Trust in science can only be maintained if its practitioners commit to basic principles variously described as honesty, accountability, responsibility, independence, and so on—in short, if they act with integrity.

I would add that, as academic teachers, we therefore have an obligation to teach and empower our students how to do so. If there is still something special about being an academic, both as a researcher and an educator, it resides in this commitment and obligation. One might counter that learning how to become a responsible researcher is just another part of a scientist's *Ausbildung*. Or one might even feel that compliance with the rules of codes of conduct is just another bureaucratic imposition to ensure accountability. Yet Gerrit Jan Mulder's reasons for adamantly opposing a merely professional and instrumental perspective on academic education still make sense. Mulder's true scientist was driven by "love," a calling to live a virtuous life. *Mutatis mutandis*, I would say that the scientist of today should be driven by an internal calling to act with integrity. The crisis of the science system shows that such a vocation does not come naturally to all. Moreover, adhering to norms and rules is not enough; scientists must be able to deal responsibly with integrity dilemmas, which requires ethical deliberation. Learning how to do this should start during university education, and this imposes a responsibility on teachers that goes beyond professional instruction. Since the late nineteenth century, the university has considered teaching and research as its dual task, and according to Mulder this was the root of all evil. One can think differently about whether teaching should be given priority over research again at our universities, yet I think Mulder was definitely right in contending that professors, as educators, should be moral agents, because instilling a vocation for acting with integrity in students is an essential precondition for making right what has gone wrong in science.

CRediT authorship contribution statement

Bert Theunissen: Writing – original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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