Articles

Teaching Good Scientific Practice: Results from a Survey and Observations from Two Hundred Courses

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In 2009, a good scientific practice curriculum was developed and published on behalf of the "Ombudsman für die Wissenschaft". Soon after we had started giving courses for doctoral students that follow this curriculum, we listened to many stories about scientific misconduct – related by the participants. Since these stories were far more numerous than we had expected from the published literature, we decided to ask the participants about their experience with malpractice with the help of a short explorative survey.
387 doctoral students returned our questionnaire after participating in a two-day good scientific practice course between November 2011 and December 2012. 76 students – about one in five – admitted to have been involved in one of six forms of severe scientific misconduct with consequences upon their work: plagiarism; data manipulation, fabrication or theft; honorary authorship; duplicate publication.
More than half of the respondents stated that they were involved in, or had witnessed problems with unclear data ownership or honorary authorship. In the courses, many participants told us that data management and authorship issues had never been addressed thoroughly prior to the course, although they are important aspects of the scientific process. This leads to several unsolved questions concerning the supervisors' role in the fostering of good scientific practice, and to an assumption of "inherited unawareness" and systematic non-communication. We suggest that the issue should be tackled by educating all members of the scientific institutions, accompanied by structural changes.

1 Introduction

In 1997, a case of misconduct in biomedical research rocked the German scientific community.[11] In its aftermath, the Executive Board of the Deutsche Forschungsgemeinschaft (DFG), Germany's largest public funding organization, appointed an international commission with "the mandate, to explore causes of dishonesty in the science system, to discuss preventive measures, to examine the existing mechanisms of professional self regulation in science and to make recommendations on how to safeguard them."[2] One of the outcomes of their efforts was a set of sixteen recommendations, which, if consciously observed, should be "the best preventive measure against dishonesty."[2] A particularly important recommendation states that rules of good scientific practice (GSP) "shall be made known to, and shall be binding for, all members of each institution. They shall be a constituent part of teaching curricula and of the education of young scientists and scholars."[2] Consequently, the DFG insisted on the implementation of GSP rules and regulations for dealing with scientific misconduct in those public German research institutions that wished to apply for DFG funding.[3] In 2009, the 'Curriculum "Good Scientific Practice" for Courses in Science and Medicine' was developed and published on behalf of the "Ombudsmann für die Wissenschaft", an English translation followed in 2011.[20] A new version of the curriculum that applies to all fields of

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science was published in 2012. One year later the DFG issued a second edition of the recommendations that contains a chapter about whistleblowing.[6]

Since 2009, we gave more than two hundred GSP courses for doctoral students that follow this curriculum. Their structure and method are mainly based on our experience with similar seminars in bioethics, research, medical and nursing ethics that we (GS and MG) had been conducting and evaluating since the late 1980s at Ulm University and other institutions. Real-life case studies, in which the participants reflect and discuss ethical aspects, are at the core of these seminars.[13, 19]

After we had started conducting and evaluating the GSP courses, we realized that more and more participants reported their experience with scientific misconduct. As we always ask the participants to remain strictly confidential about everything they hear in the course, many of them confessed their own troubles. The narrated stories appeared to be far more numerous than we had expected from the published literature.[9] Also, most surveys reported findings from the US, and none focused exclusively on doctoral students at the beginning of a possible research career. The extent of misconduct that young scientists, especially those at the beginning of their research career, are confronted with in Germany, is yet unknown. We therefore decided to ask the participants of our courses anonymously about their involvement in various forms of misconduct in science. The survey was designed as exploratory, so no hypothesis was to be tested.

2 Materials and Methods

Between November 2011 and December 2012, we conducted thirty-five two-day GSP courses at sixteen universities and research facilities in Germany that were attended by 411 doctoral students. 387 questionnaires were returned (94%). Table 1 and 2 give more information about the respondents.

To simplify completion after an exhausting GSP course, we presented only ten forms of scientific malpractice with three degrees of involvement to choose from on the reverse side of our standard evaluation questionnaire. The quality of these forms listed in Table 3 ranges from minor misdemeanors to severe research misconduct.[8, 15, 16] In choosing these ten forms we took into account what the participants of about twenty courses had told us prior to the start of the survey, particularly concerning severe misconduct. To create awareness for the seriousness of these transgressions, all six forms of severe misconduct included in the questionnaire were discussed in the workshops. Inventing and manipulating data was the subject of two case studies, and several examples were given for data theft. Plagiarism was always a topic due to the highly publicized cases involving several politicians. From the vast field of publication misconduct, we decided to include only two forms: duplicate publication, as the undisclosed re-publication of a scientific text with the sole intention to extend one's publication list; and "honorary" authorship. The latter encompasses all forms of fake authorships (guest authors, authorship cartels, author doping, default authors) that are among the most harmful distortions of the scientific record and are therefore "generally not considered to be acceptable under any circumstances." (DFG Recommendation, p. 83).

The purpose of our survey (obtaining information about doctoral students' experience with scientific misconduct and publishing anonymous results) was explained to all participants prior to distributing the questionnaires. We always underlined that completing it would be voluntary and anonymous, and implicit consent was therefore assumed by returning a completed questionnaire. No identifying information was requested, and we asked the participants to make sure that they did not add any information on the questionnaire that would give away their identity.

Table 1: Information about our course participants and the respondents.

Number of participants	411
Returned questionnaires	387 (94%)
Female	190 (49%)
Male	193 (50%)
No answer	4 (1%)
Years of experience in scientific research	Mean: 2.9 years Median: 3 years (Range: 0-30 years)

Table 2: Information about the fields of graduation of the respondents.

Field of graduation	Number of questionnaires
Science	269
Engineering	46
Medicine	34
Humanities/Art	24
Other	13
No answer	1

Table 3: Absolute numbers of positive answers for every item of misconduct

Item	I have been involved (e. g. as a victim) with consequences upon my work	I have been a witness without any direct consequences upon my work	My colleagues told me about it
Sloppy work	126	142	121
Bad mentoring	99	85	151
"Honorary" authorship*	57	121	120
Unclear data ownership	41	53	82
Data manipulation*	21	45	113
Salami publication	12	53	119
Duplicate publication*	9	36	79
Data theft*	8	13	105
Data fabrication*	6	9	67
Plagiarism*	6	36	105

*The six forms of misconduct that we assumed to be severe are marked with an asterisk. The instruction given on the form was: "Have you ever had any experience with the following forms of questionable research practice/scientific misconduct, and if yes, to which extent? Multiple answers in one line are possible." The positive answers were collected from 387 questionnaires.

All participants who returned a questionnaire complied. The only voluntary personal information we asked was about gender, scientific background and research experience. Institutional review board (IRB) approval was not necessary because surveys of this kind do not require IRB consultation or approval in Germany. The directors or coordinators of all sixteen graduate programs gave us their permission to use the data for publication, provided we do not disclose their origin.

3 Results

76 out of 387 doctoral students (= 19,6%) admitted to have been involved in at least one of six severe forms of scientific misconduct with consequences upon their work: plagiarism; data manipulation, fabrication or theft; honorary authorship; duplicate publication. Honorary authorship was by far the most prominent form, followed by data manipulation (see Table 3). One in four doctoral students admitted to have been involved in bad mentoring. More than half of the students (198 = 51,2%) experienced any kind of misconduct with consequences upon their work.

Why did our survey yield so many positive answers? One possible reason could be that our participants had a clearer understanding of the meaning of the wrongdoing because we had discussed it thoroughly in the two preceding days. For them, "data manipulation","honorary authorship" and "data fabrication" were not expressions with half-guessed meanings, but concrete scientific practices for which they had heard and discussed numerous examples in real-life case studies.

Since our course groups were usually small (3 to 18 participants, mean 11), and many stories of malpractice were shared, we excluded questions of self-confession ("have you ever fabricated data?"). Also, our chosen statements pointed to a more passive experience: have you witnessed, been told or involved? without the need to admit one's own wrongdoing. This might also have lead to more students giving positive answers. Other factors lowering or raising admission rates, like social expectation, forgetfulness, representativeness or anonymity are discussed in literature.[9]

Almost 51% of the respondents indicated that they had witnessed or been involved in "honorary" authorship and/or unclear data ownership. This mirrors an observation from our courses: numerous students reported that these two central aspects of the research process – ownership, storage and retention of data, materials and sources; the question who can and who cannot be an author – had not yet been addressed thoroughly during their undergraduate studies and their dissertation research. This is alarming because the various recommendations and guidelines clearly state that a data management policy is part of an institution's professional standard, and that authorship issues should be discussed as early as possible in a project.[2, 14, 21] It may or may not be a coincidence that both aspects are directly connected with science's recognition system.

Many students told us that they had not been aware that certain occurrences are considered misconduct, and that they had assumed them to be ordinary scientific practice ("The head of our department is always the last author on every paper, even if he does not know the topic"). Talking about issues of good and bad scientific practice seems to occur rarely in everyday science, and many participants told us that they had never done so before the course. It is also disturbing that only 17 of 118 participants (14%) we asked knew about the existence and the role of ombudspersons.

4 Further Observations and Unanswered Questions

In every single one of our 200 GSP courses we heard a variation of one or more than one of the following questions for which we do not (yet) have answers:

- "Why didn't our supervisors tell us about the GSP regulations?"

- "Do our supervisors also know about the GSP regulations?"
- "Are there GSP workshops for our supervisors?"

The DFG's and the institutions' primary approach is to qualify young researchers. This is stated in the GSP regulations of hundreds of research institutions in Germany. These three questions contain one critical assumption: they indicate that it is not sufficient to educate young researchers about GSP – their supervisors should also be trained.
Since 2009, our focus has been educating young researchers in GSP. The request for our courses increased sharply after several highly publicized cases of plagiarism.[7, 18] We therefore started working on a concept for training GSP teachers. Between 2013 and 2014 we conducted four teachers' trainings for supervisors and senior researchers. Two more trainings were planned for 2014 and 2015, but they had to be cancelled due to low interest. We received informal requests from about a dozen more scientific institutions so far, but without further consequence. Two trainings are scheduled in 2016.
Coming back to the first and second of the unanswered questions, we can imagine several answers:

- Supervisors know about the GSP regulations and the topics covered in them, and they assume that the doctoral students know them as well, so they never discuss them.
- Supervisors know about the GSP regulations and the topics covered in them, and they assume that the young researchers will learn them implicitly without discussing them.
- Supervisors are not aware of the existence of GSP regulations and/or the topics covered in them, so they are never discussed.
- Supervisors know about the GSP regulations, but they do not think them important, helpful, or necessary, so they are never discussed.
- Supervisors experience so much stress (writing applications, publishing articles, lecturing, etc.) that they have no time to discuss GSP issues with young researchers.
- Supervisors know about the GSP regulations, but they are oblivious to their importance.
- Supervisors know about the GSP regulations, but they do not want to discuss them with young researchers.

Although we can only speculate, we strongly believe that the reason for many doctoral students' unfamiliarity with the GSP regulations is "inherited unawareness" or systematic non-communication, rather than the consequence of malign neglect or deception.
Discussing these issues with doctoral students and coordinators of graduate schools and programs, we are often confronted with insinuations of reluctance, as though it were unnecessary or shameful to get GSP training as a supervisor or senior faculty. A major problem appears to be the time load for further education: participants of our teachers' trainings tell us how difficult it is to free six days for the three modules within one semester. Some of our program coordinators ask us occasionally if the GSP course cannot be done in one day because the supervisors do not want the doctoral students to be "out of the lab" for too long (the workload of the minimum curriculum for empirical/experimental researchers is 16 academic hours which can be managed in one and a half days). Course participants tell us frequently that there is very little time to discuss anything beyond how long it will take to get the necessary results for the next publication, and some participants told us that they have hardly anyone at all for discussion. We sometimes hear that talking about GSP or other ethical considerations is too time consuming or even useless, or an impediment to research, usually with a reference to the alleged freedom that science needs to function properly.
The solution for overcoming these constraints can certainly not be to force all supervisors and senior faculty into GSP trainings. We have experienced that obligatory GSP workshops for doctoral students are not always met with enthusiasm, and we can safely assume the same for senior researchers. Besides, there are not nearly enough GSP teachers available for qualifying several hundred thousand researchers.
There are more issues to consider. The feedback at the end of our courses and the graduate programs' evaluations indicate that the courses' content is considered relevant, important and useful. Yet we do not know if the acquired insight into good practices survives a transfer into everyday science. To encourage young researchers to engage in good scientific practice, the research environment must allow, foster and reward these practices. Good scientific practice needs time and occasions for reflection, doubt and self-criticism. In a culture of competition for money, of deadlines and publication pressure, this seems hard to achieve. On the contrary: our current system of evaluating scientific "output" in a highly competitive environment tends to reward questionable practices and even severe misconduct.[17]
At the beginning of our courses we have the participants collect values, norms and principles of what they think is good scientific practice. These collections show that young researchers have a keen sense of what is good scientific practice. Our survey and the countless stories about their own experience show that they also grasp what misconduct in science is – and that far too many young scientists are involved in it (we assume more often as victims than as perpetrators). We also learned from the stories that they are very much aware of the dilemma they are facing: should they fight, leave, look away or comply?
We do not clearly know how we can foster good practice in the different realms of science, but we know that we have to try – at least for the sake of science's credibility and the researchers' integrity. The more scandals science experiences, the more difficult will it be to uphold society's (and the taxpayers') confidence in the self control of science.[12]

When we look at the recent explosion of retractions and exposures, it is likely that the worst is yet to come.[10] Science may understand its independence as one of its innate and indispensable pillars, but we should never take it for granted. Independence is a privilege that we must not squander. It comes with the obligation for professional self-regulation, and that means that no one is permitted to engage in scientific misconduct and can get away with it. Those who give us their money and let us work with it as we see fit have the right to expect that we do our best to ensure that it is invested into real science – and not into science fiction.

The GSP regulations of the German research institutions and universities may show us a way to achieve this high degree of scientific integrity: supervisors and academic teachers have to create an environment that makes it easy to engage in good scientific practice and act as role models. Young researchers must become acquainted early in their studies with values and norms of good scientific practice, and be educated continually in a way that allows integration into their everyday work. The necessary competencies have to be trained. Knowledge concerning the role of ombudspersons must be disseminated. A growing number of mandatory dissertation agreements and graduate programs try to give more structure and reassurance to the young scientists' education. To prevent questionable practices from developing into serious misconduct, early intervention systems may be useful.[1]

Structural changes are also necessary, particularly concerning rewarding systems and quality assessment.[17] Some efforts were made in the past years, namely by the DFG, after a scandal involving fabricated citations.[4] In an attempt to check the "publish or perish" madness, the number of publications that can be listed in funding submissions is now limited to a few.[5]

It is likely that none of these steps alone will guarantee immediate success. We think it reasonable that the problem of scientific misconduct should be tackled on the structural, the institutional and the personal level.

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