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PhD Education: Lack of Ethical Values or Lack of Commitment?

Introduction

The level of trust that has characterized science and its relationship with society has contributed to a period of unparalleled scientific productivity. But this trust will endure only if the scientific community devotes itself to exemplifying and transmitting the values associated with ethical scientific conduct (On being a scientist 1995). As scientists, our own responsibility is to find ways to transmit these values to future generations.

After four centuries of the dominance of the Cartesian paradigm, it is becoming unrealistic that humans remain mere objective observers of nature. Since scientists are humans, subject to the same fears and worries as other human beings, and are not in an isolated community, society strongly impacts scientific practice. Integrity and trust is essential to the well being of science. However, the most difficult ethical problem of scientists is not merely to avoid choosing evil, but to realize when a moral choice is being made.

As promoted by social movements such as 'Science, Technology and Society', it needs to be accepted that the production of scientific knowledge is a process related to interests, values and compromises with society. It is our responsibility to educate future generations so that they do not experience value-blindness. Scientists must know when to apply moral judgment, and ask themselves the relevance of their work, as well as their responsibility as researchers.

This work represents a preliminary survey asking PhD students to explore 1. whether the formal education received in History and Philosophy of Science and Scientific Ethics (HPE) is perceived as enough to ensure the good practice of science; 2. if witnessing misconduct in research has consequences in young scientists' career, either on their perception of the quality of science or on their intention to continue in research; and 3. how PhD students perceive their participation in the future impact of research, and what are their responsibilities in promoting values that guide scientific research.

Methods

Using a 21 item questionnaire, PhD students were asked to 1. evaluate their knowledge about HPE, and 2. evaluate the perception of the responsibilities that science and scientists share. The questionnaire (available at http://www.catalitza.info/dynamon/menu/survey.doc) was divided into four sections. Questions 1 to 8 were designed to make a description of the population surveyed. From question 9 to 13

the aim was to evaluate the perception of HPE knowledge. Questions 14 to 17 were related to the witness of science misconduct, whereas questions 18 to 21 referred to values and responsibilities of scientists. The questionnaire was sent via e-mail to PhD students, members of 'Federación de Jóvenes Investigadores' (www.precarios.org), which is a nationwide organisation of Spanish young researchers. In addition, we sent the survey to all PhD students from University Pompeu Fabra, and also to others from Universitat Autónoma de Bellaterra, Universitat de Barcelona and Universitat Politècnica de Barcelona (Barcelona, Spain). The questionnaire was sent as an attached file, and a presentation letter was included inviting everybody to forward the e-mail to people who might be interested.

Questions 1, 2, 4-17 and 19 were analysed by giving each answer a different number code in order to facilitate the statistical analysis. For question number 3, related to the degree area, we set the following classification:

1. Natural Sciences: including Biology, Environmental Science and Marine Sciences
2. Exact Sciences: including Chemistry, Physics and Mathematics
3. Biomedical Science: including Pharmacy, Biochemistry and Medicine
4. Engineering and Computing Technology
5. Social Sciences

In items 18, 20 and 21, participants were asked to enumerate in decreasing order of importance 10-12 different options. All these enumerated options were analysed; however, in the results section we only reported the most relevant ones, which were: for question 18, the first three most chosen options and the least chosen one; for question 20, the first three most chosen options, and for question 21, the first four most chosen options. After these classifications, all data were statistically analysed by using the statistical program SPSS (SPSS Inc.), where descriptive statistics and correlations were performed.

Results

Description of the population surveyed

120 e-mails were received with the answered test as an attached file, among them three were received unanswered. Thus, the final population surveyed was 117 students. The mean age was 27.33 ± 0.43 years, with 44.7% being men and 55.3% being women.

The analysis of their current PhD stage revealed that 20.7% were in their first year of thesis, 25% in the second, 25% in the third, and 16.4% in the fourth year. 12.9% of the people surveyed were in their fifth year of PhD or beyond. The mean PhD stage of the students surveyed was 2.8 years.

66.4% of the students intended to continue in research after finishing the PhD, whereas 19.8% had decided not to continue and 13.8% did not know what to do after the dissertation.

Regarding the different University degrees characterizing the sample, Natural Sciences was the most represented, followed by Exact and Biomedical Sciences (*Figure 1*).

Figure 1. Classification depending on University degrees

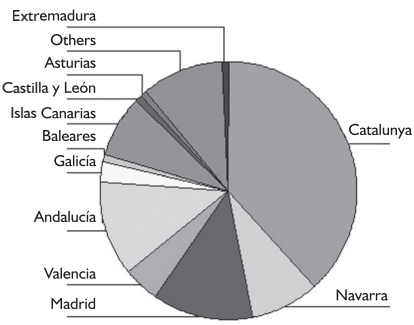
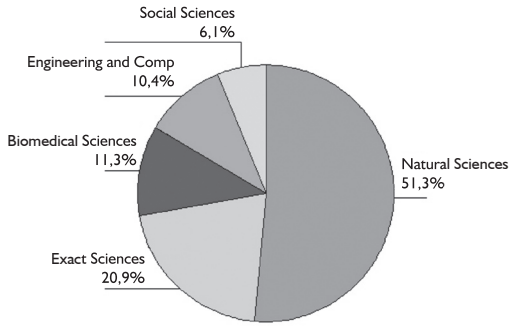


Figure 2. Classification depending on geography

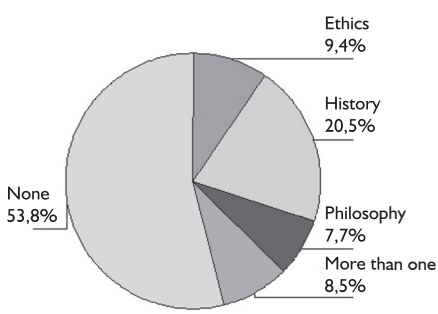


As shown in *Figure 2*, 10 of the 17 Spanish autonomic provinces were represented in the sample: 38.5% of the people answering the questionnaire were from Cataluña, 12.8% from Madrid, 12.0% from Andalucía, 8.5% from Navarra, 7.7% from the Canary Islands, 4.3% from Comunitat Valenciana, 2.6% from Galicia, 0.9% from the Balearic Islands, 0.9% from Extremadura, 0.9% from Asturias, and finally there was 10.3% that did not study in Spain, but in other countries such as Italy, France, Colombia, Uruguay or Argentina.

Formal education received

When students were asked about the education in HPE received during their degree, 47% answered to have taken a subject related to HPE. The results are expressed in *Figure 3*.

Figure 3. Subjects during the degree



Among the people surveyed, 57.9% had HPE courses as mandatory credits, 24.5% as optional credits and 17.5% as elective credits.

The results of the self-evaluation about HPE knowledge, performed by the participants, are summarized in *Table 1*. No differences in the appreciation of this knowledge were

found between those people who received formal education in the university in comparison to those who did not have any formal education. No gender differences were found in any of the answers.

Table 1. Self-evaluation of knowledge about History and Philosphy of Science and Scientific Ethics

	History	Philosophy	Ethics
1-bad	16.2%	39.7%	12.9%
2-average	55.6%	41.4%	29.3%
3-good	23.9%	13.8%	37.9%
4-very good	4.3%	5.2%	18.1%
5-excellent	0%	0%	1.7%

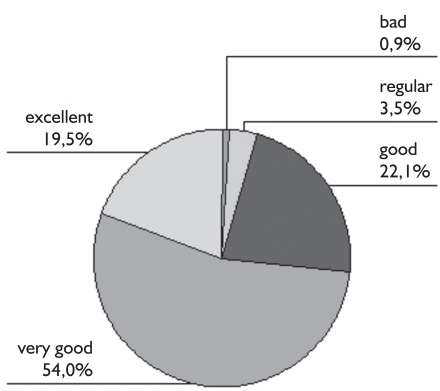
Regarding the origin of HPE knowledge, 33.3% of the people reported to have acquired it from university courses, 33.6% from their own initiative, 16.53% from discussions with other people at the laboratory, 10.2% from seminars, and finally 6.26% from other sources.

The students were asked their opinion about including these courses in the science degrees. Whereas 50.4% of participants considered it very important and thought it should be mandatory, 44.4% of people thought it can be good but in an optional way, and 3.4% considered it unnecessary.

Ethics at work

When students were asked to self-evaluate, on a scale from 1 (bad) to 5 (excellent), their own ethics in their scientific work, 54% of the people described them as very good. This data is controversial since the mean score obtained in the self-evaluation about Scientific Ethics knowledge was 2.66 ± 0.09 and only 9.4% of students reported to have received formal education in their degree about Scientific Ethics.

Figure 4. Self-evaluation of own ethics



When people were asked to evaluate, on a scale from 1 (bad) to 5 (excellent), the 'health' of science in terms of scientific quality, 42.2% of people found that it was good, whereas 33% of people said it was average, and 3.7% considered it bad. 17.4% of people found it very good and 3.7% excellent. The fact that people had witnessed an unethical behaviour in their work environment had a negative impact, since we found a significant positive correlation between those people who reported that the quality of science was average or bad with those people that had witnessed unethical behaviour in their work environment.

49.6% of the students surveyed agreed about including new courses related to HPE topics, and also considered that this would improve scientific quality in future generations. However, 23.9% was not in agreement, and 22.2% did not answer or did not know.

Responsibilities and values

One of the aims of this survey was to investigate the opinion of Spanish PhD students about their responsibilities as scientists. We asked them to enumerate in decreasing importance different responsibilities, and we evaluated the three first options chosen. These were:

- Trying to find the truth and objectivity in research, 76%
- Attending the needs of society to focus the topics of research, 62%
- Working in science and technology for developing peace, social equality and sustainability, 56%

The least chosen option within the 10 provided was 'to set a link with the mass media to popularise science in a proper way' (9%).

Then we asked subjects to choose one among 7 options (see below) regarding the influence that science will have in the future. The results were:

- Science will help to improve human quality of life, 64.68 %
- Science will be in equilibrium between humanity and nature, 7.76%
- Science will generate ethical questions with difficult resolution, 6.86%
- Science will not have an important influence in the future, 3.43%
- Science will contribute to increasing natural disasters, 1.71%
- Did not know or did not answer, 5.14%
- Other, 10.39%

Further, we asked students to enumerate by decreasing importance different challenges which researchers will have to face in the 21st century, and we evaluated the three first options chosen. These were:

- Discovering new types of renewable energies, 83%
- Ending diseases by using individualised drugs and genetic therapy, 69%
- Abolishing world hunger, 33%

Finally, we requested them to make a choice about the main values which are now guiding the practice of science. Once again, 12 options were given and we asked subjects to enumerate them by decreasing importance, and we evaluated the first four positions chosen. These were:

- Profitability, 70%
- Media impact, 53%
- Political interests, 53%
- Applicability, 50%

Discussion

The responsible conduct of research should be viewed as an integral part of good science, and thus as an integral part of educational programs (Integrity 2002). The results of this preliminary survey raise several points that should be taken into account when developing strategies to improve PhD education. 1. Formal education about HPE and/or integrity in research received at the university appears to be ineffective and not appropriate. 2. Approximately half of the PhD students surveyed reported to have witnessed a scientific misconduct during their degree. 3. A discrepancy between the responsibilities of scientists and the values that are now guiding science was found, indicating that the next generation of scientists will probably still be isolated from society.

Only half of the population surveyed had HPE courses during their degree, and this did not correlate with their self-evaluation of HPE knowledge, since more than 50% of the people scored between bad and average, except for Ethics, where they scored between average and good. This reveals that the education given at universities is apparently far from being effective and useful. Moreover, even though 42.2% of people reported to have average or bad knowledge about Scientific Ethics, 73.5% confirmed to work with very good or excellent Ethics. These results suggest that Ethics knowledge is not related to formal education received at the university. However, the possibility that the question had directly affected the answer cannot be ruled out, since Ethics is socially seen as a positive value.

A code of ethics is not a complete guide to decision-making, since our more difficult choices are among alternatives that arise when we cannot act strictly according to our professional code (Leys 1952). Thus, education in responsible conduct is important and critical, but it must be done appropriately and in a creative way. If not, as observed in the survey, the actual theoretical education given at universities may be ineffective. This is supported by the fact that only 33% of the HPE knowledge comes from university. One way that this situation could change is to modify the teaching techniques of integrity in research by including practical courses and/or seminars about HPE. Interactive lessons with discussions of specific cases will provide abilities to young scientists that give rise to responsible conduct. New and more challenging scenarios are needed to make students aware of the rights and responsibilities of their profession while participating in their graduate training.

Another important issue of this survey is the fact that 50.4% of people asked had witnessed a case of unethical behaviour in their work environment. Furthermore, the correlation with the year of PhD reveals that the probability of observing misconduct in the late years of graduate work is higher (33.3% in the first year, 44.8% in the second, 62.1% in the third, 42.1% in the fourth and 80% beyond the 4th year of PhD). This result might suggest that through the course of the PhD degree, students acquire different skills which make them able to better recognize when a misconduct is happening. However, other issues arise as to the types of misconduct that students refer to in their answers, or as to the action that a student takes when confronted with unethical behaviour. Unfortunately, we are not able to define the types of misconduct observed, since the questionnaire failed to ask about them. A main concern is the fact that the students experiencing such misconduct do not count on a supportive board that helps them in

this situation, and sometimes they do not know that they exist. The main question to deal with is if the scientific community can respond adequately when fraud or misconduct are happening. Do we need 'watchdogs of science'? Certainly, well-defined procedures for handling accusations of misconduct should be developed and implemented (HAMNER 1992). One possible solution could be the establishment of ethics committees that exist not only for implementing rules of conduct but also to ensure their accomplishment. Thus, creating an organization which evaluates such conducts, guaranteeing at the same time the rights of the requester would be a first step. Although this can be a risk for science of losing its supposed autonomy and self-regulation, society must be able to trust their scientists. Thus, collaboration between scientists, policy-makers and educators is needed to handle this problem.

Finally, some questions related to responsibilities and values of scientists were asked in the survey. Several contradictions were observed when the results were analysed, suggesting that scientists perceive themselves as isolated from society. The first incongruity was that whereas 'attending the needs of society' was judged as one of the most important responsibilities for a scientist, 'opening a debate about science and technology issues with society' or 'setting a link with the mass media to popularise science in an appropriate way' were the least cited options. Thus, if scientists are not closely in touch with society, how can they ensure that science will meet its needs? The second disagreement is related to the fact that while the great majority considers that profitability, media impact, political interests and applicability are the main values which are now guiding scientific research, 76% of people surveyed considered their main responsibility as scientists to be 'to search for the truth and objectivity in research'. This also contrasts with the fact that 'to improve the quality of life' was the option chosen by a great number of students surveyed. More than 65% of students considered that 'ending with diseases by using individualised drugs and genetic therapy was one of the main challenges that research will face in the future'. Therefore, the following questions can be raised: If profitability, media impact, political interests and applicability are the values which guide science, is 'looking for the truth and the objectivity' the main responsibility of a scientist? And also, with these values guiding scientific practice, will science improve the quality of life? For whom?'

Taken together these results show that PhD students are well aware that science is now being influenced by social values such as profitability, media impact or politic interests. However, they only consider themselves responsible for producing true and objective knowledge and do not seem to feel engaged with the decisions about the uses or consequences that this knowledge can bring up. Thus, the point is not that PhD students suffer from value-blindness, but that PhD education does not provide enough tools for engagement in the process of decision-making on science and technology issues.

Science and technology have become such integral parts of society that scientists can no longer isolate themselves from societal concerns (On being a scientist 1995). Scientists are increasingly called upon to contribute to public policy and to the public understanding of science. They play an important role in educating non-scientists about the content and processes of science. Thus, among their responsibilities, scientists must take time to relate scientific knowledge to society in such a way that members of the public can make an informed decision about the relevance of research.

In summary, this preliminary survey evokes three main issues to be considered for implementing tools which improve the quality of PhD education. First, the introduction of new practical approaches in the scientific integrity education of PhD students is a crucial step to attaining this goal. An example of this is an optional subject, called 'Science and Technology for Peace', which was included in the curriculum of Universitat Autònoma de Barcelona. In the framework of the 'Science, Technology and Society Movement', this course aims to make students think carefully about the effects of Science and Technology in the development of societies, setting a debate around Peace and Environmental topics. Second, it is necessary to create a mechanism to channel the witness of scientific misconduct, such as an international and impartial organization which acts as Ethics Committee. Finally, there is a vast requirement for introducing activities that promote the interaction between science and society. One such action is the 'Science Shop', which provides independent, participatory research support in response to concerns experienced by civil society. Another example is 'The Dynamon Project' that, through investigating the social perceptions that people have on science and technology, aims to achieve social engagement in science and technology issues. In conclusion, the challenge is to develop alternative strategies to promote the interaction between education, science and society.

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