



Educating and Training in Research Integrity (RI): A Study on the Perceptions and Experiences of Early Career Researchers Attending an Institutional RI Course

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Abstract

Research integrity (RI) is defined as adherence to ethical principles, deontological duties, and professional standards necessary for responsible conduct of scientific research. Early training on RI, especially for early-career researchers, could be useful to help develop good standards of conduct and prevent research misconduct (RM).

The aim of this study is to assess the effectiveness of a training course on RI, by mapping the attitudes of early-career researchers on this topic through a questionnaire built upon the revised version of the Scientific Misconduct Questionnaire and administered to all participants at the beginning and at the end of the course.

Results show that after the course, participants reporting a high understanding of the rules and procedures related to RM significantly increased (pre-course: 38.5%, post-course: 61.5%), together with the percentage of those reporting a lack of awareness on the extent of misconduct (pre-course: 46.2%, post-course: 69.2%), and of those who believe that the lack of research ethics consultation services strongly affects RM (pre-course: 15.4%, post-course: 61.5%). Early-career researchers agree on the importance to share with peers and superiors any ethical concern that may arise in research, and to create a work environment that fosters RI awareness.

As a whole, results suggest the effectiveness of the course. Institutions should introduce RI training for early-career researchers, together with research methodology, integrity and ethics consultation services to support them. Senior scientists should promote RI into their research practices, and should stimulate engagement in peer-to-peer dialogue to develop good practices based on RI principles.

Keywords Research integrity · Research misconduct · Training · Survey · Early career researchers

Introduction

Research integrity (RI) is defined as adherence to ethical principles and values, deontological duties, and professional standards necessary for responsible and proper conduct in the pursuit of scientific research and related activities. Implementing RI standards also means conducting research in such a way that the scientific community and the general public can have confidence in the methods used in and the findings of the research. Moreover, when we talk about RI we do not only refer to the quality of the research itself, but also to the researchers' personal and professional integrity (Tauginienė et al., 2018; Poff, 2014).

The relevance of RI issues has been internationally recognised in recent years, and several initiatives have been promoted to raise awareness among the scientific community, policy makers and the general public.

Since the early 1990s in the United States, the growing number of cases of *research misconduct* (RM) led to the formulation of a number of recommendations, which included the introduction of specific training for young researchers on these issues, in order to improve their ability to identify problematic aspects and to know how to deal with them (Commission on Research Integrity, 1995). As training activities have increased, a broad reflection has also developed concerning the objectives, methods and effects of such activities, as well as the perceptions and attitudes of students and researchers in relation to RM issues (Katsarov et al., 2022; Shaw & Satalkar, 2018).

More recently, in Europe, fundamental principles of RI, that guide researchers in their work and engagement with the practical, ethical and intellectual challenges inherent in research, have been listed in the *European Code of Conduct for Research Integrity* (ECoC), which also includes the notion of RM (ALLEA - All European Academies, 2023).

Although there is a broad international consensus on what are the basic principles of good scientific conduct - clearly stated in several documents, including the ECoC (Mejlgaard et al., 2020), in particular on the principles of reliability, honesty, respect and responsibility, it seems that a widespread internalisation of these principles has not yet been achieved (Xie et al., 2021; Mejlgaard et al., 2020).

It is also worth noting that, although research misconduct is a widespread phenomenon, involving researchers of all ages and at all career levels (Fanelli & Tregenza, 2009), according to recent studies, PhD students and junior researcher are involved in questionable research behaviour in a significantly higher proportion than associate or full professors. (de Vrieze, 2021; Gopalakrishna et al., 2022). Early-career researchers may frequently engage in some forms of research misconduct - even serious, such as fabrication or falsification of data -, and often dishonest behaviours are inhibited only by the fear of being caught by supervisors, colleagues, or peer reviewers. These behaviours are generally related to the intense pressure to publish, but are also closely related to extreme competition, need for recognition, inadequate mentoring, lack of RI policies adopted at the institutional level, lack of knowledge or preparation about the realities and challenges of a scientific career, as well as lack of awareness of the rules and standards for the responsible conduct of research (Fanelli et al., 2015).

Although the causes of research misconduct are manifold and are often to be related more to organisational and institutional inadequacies than to individual researchers' attitudes, many of them concern, directly or indirectly, the lack of training on the subject, and the consequent inability to recognise and deal with the problems associated with it.

For this reason, a well-designed and structured training on RI and RM may be of fundamental importance (Anderson et al., 2007), especially for PhD students and early-career researchers. Engaging young researchers in early training on methodology, integrity and the ethical conduct of research can help them understand the ethical principles of good research conduct, which ultimately lays a solid foundation for the creation of a healthy research environment that adheres to shared moral principles.

Against this background, this study aims to assess the effectiveness of an online course on academic and RI through a virtue ethics approach, and to map the perceptions and attitudes about RI and RM in a sample of early-career researchers, with the ultimate goal of proposing the introduction of educational modules on RI within PhD courses.

The course was proposed as part of the PhD course in *Clinical and Experimental Medicine and Medical Humanities* at the University of Insubria, but other early-career researchers interested in the topic were also allowed to attend. Data related to the participants' perceptions and attitudes about RI and RM was collected through a questionnaire administered before and after the course.

Materials and Methods

Study Design and Setting

The intensive training course was provided by three of the authors (FG, SC, and SM), as a part of the Horizon 2020 VIRT²UE project¹, a train-the-trainer program for RI trainers and researchers (European Commission - CORDIS, 2018). The 12-hour course was offered to students enrolled in the PhD program in *Clinical and Experimental Medicine and Medical Humanities* at the University of Insubria in Varese (Italy) but was open to all early-career researchers interested in the topic. According to the aims of the VIRT²UE project and in accordance with the principles outlined in the ECoC, a training approach based on virtue ethics was adopted to address the issues of RI and RM. Participants received an overview of virtue ethics approach and RI and RM issues. Practical real-world examples of ethical dilemmas regarding academic research and study/work environment were discussed to stimulate reflection and insight. Participants were strongly encouraged to actively contribute to the course, by sharing personal opinions, experiences, and ideas.

The course consisted of two sessions: the first session (4 h) was carried out independently by each participant and consisted of consulting introductory materials on the topic (which included articles and videos), provided and available from the Embassy of Good Science website (The Embassy of Good Science, 2020); the second session (8 h) consisted of a face-to-face online training, which was delivered on the 26th and 27th of January 2022.

Questionnaire and Survey Procedure

A questionnaire was built upon the revised version of the Scientific Misconduct Questionnaire (SMQ-R)(Broome et al., 2007; Mabou Tagne et al., 2020) and adapted to an online course with a limited number of participants, with the integration of RI concepts. It consists

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of five macro investigation areas which allow collection of data on respondents' preconceptions and experiences, specifically concerning:

- research and ethical climate at the work environment;
- perceived prevalence of scientific misconduct in the workplace;
- attitude and beliefs about RI and scientific misconduct;
- behavioural influences on RI and scientific misconduct;
- personal involvement in scientific misconduct.

Demographic data and research background data were also collected through the survey.

The questionnaire was administered the first time at the beginning of the training course, after the participants had independently conducted the initial 4-hour session. The same questionnaire was administered the second time at the end of the 8-hour online course, as the concluding task of the course. In both cases, the questionnaire was administered via the Microsoft Forms application.

Participation in the course was voluntary and all gathered data was pseudonymised for statistical analyses. All information shared by the course participants was destroyed after the course was completed, in line with VIRT²UE standards, keeping only anonymised data for further analyses. In administering the questionnaires during the course, the same numerical code was assigned to the participants so that pre- and post- questionnaires could be matched.

Before the start of the course, participants were asked to fill a confidentiality agreement to maintain the confidentiality of the information discussed by all participants and researchers during the face-to-face on-line session.

Consent to Participate in the study was given implicitly by completing and returning the questionnaire. The survey was conducted according to the Italian Code regarding the protection of personal data and all participants consented to the use of the information, provided in anonymous form, for the purposes of the present study. Since no identifiable data was collected, the study did not require any ethical approval.

Data Analysis

Data was processed with Microsoft Excel and analysed through a descriptive approach by comparing the participants' aggregate response percentages and cross-checking them between the two administered questionnaires. The impact of the course on the distribution of different response patterns was also assessed through a χ^2 test conducted via MS Excel, where the pre-course answers were used to set predicted distributions. Pre-course answers by participants who did not provide post-course answers were excluded from our analyses to avoid inserting any bias in pre-course vs. post-course comparisons.

A value of p lower than 0.05 was considered statistically significant. In any case, this value is only intended to discriminate between large correlations in the sample and does not imply any inferential significance.

Results

Demographic Characteristics

The number of trainees attending the course was 16 (n=16), and they were all enrolled doctoral students at the University of Insubria. The academic background of the course participants appeared to be diverse, presenting academic degrees in anthropology (n=3, 18.75%), biology (n=3, 18.75%), philosophy (n=2, 12.5%), and medicine/surgery (n=8, 50%). Participants also differed in age (range: 24–39), and the median years passed since graduation was 4 (range: 0–13).

Pre- and Post-Course Questionnaire Responses

The results are shown in thematic tables regarding individual questions administered to participants before and after attending the course, and the answers are represented as percentage (%) of responses for each item (Tables 1, 2, 3, 4 and 5).

All course participants (n=16) completed the pre-course questionnaire, while the post-course one was returned by 13 of them. The 3 participants who did not answer the post-

Table 1 Research and ethical climate in your work/study environment. In your immediate work environment, how would you rate the following?

	Pre-course					Post-course					p
	Very low	Low	High	Very high	Don't know	Very low	Low	High	Very high	Don't know	
Your own understanding of the meaning and value of research integrity	0	46.2	46.2	7.7	0	7.7	23.1	53.8	15.4	0	0.2635
Researchers' understanding of the meaning and value of research integrity	7.7	46.2	38.5	0	7.7	0	15.4	53.8	7.7	23.1	0.0372
Your own understanding of rules and procedures related to scientific misconduct	15.4	38.5	38.5	7.7	0	7.7	15.4	61.5	15.4	0	0.1646
Researchers' understanding of rules and procedures related to scientific misconduct	7.7	38.5	38.5	0	15.4	0	30.8	30.8	15.4	23.1	0.5934
The effectiveness of your institution's rules and procedures for reducing scientific misconduct	15.4	38.5	23.1	7.7	15.4	7.7	38.5	30.8	7.7	15.4	0.9334
Severity of penalties for scientific misconduct	15.4	30.8	15.4	15.4	23.1	7.7	53.8	7.7	0	30.8	0.2325
Researchers support of rules and procedures related to scientific misconduct	7.7	23.1	30.8	0	38.5	7.7	30.8	23.1	15.4	23.1	0.7094
Chances of getting caught for scientific misconduct if it occurs	0	53.8	23.1	7.7	15.4	7.7	23.1	15.4	15.4	38.5	0.0436

Table 2 Perceived prevalence of research misconduct in the workplace. How frequently do you believe the following occur in your work/study environment?

	Pre-course					Post-course					<i>p</i>
	Never	Rarely	Occasionally	Frequently	Don't know	Never	Rarely	Occasionally	Frequently	Don't know	
Selective dropping of data from "outlier" cases	7.7	7.7	30.8	7.7	46.2	15.4	15.4	30.8	15.4	23.1	0.3425
Plagiarism	30.8	46.2	23.1	0	0	30.8	38.5	15.4	7.7	7.7	0.7788
Data falsification	15.4	23.1	30.8	15.4	15.4	23.1	23.1	23.1	7.7	23.1	0.7816
Falsification of biosketch, abstract, reference list	15.4	15.4	30.8	0	38.5	15.4	23.1	30.8	7.7	23.1	0.7291
Pressure from study sponsor to engage in unethical practices	23.1	23.1	0	7.7	46.2	23.1	15.4	30.8	15.4	15.4	0.2614
Intentional protocol violations related to procedures	23.1	38.5	7.7	0	30.8	15.4	53.8	15.4	0	15.4	0.3715
Intentional protocol violations related to subject enrolment	23.1	38.5	0	0	38.5	15.4	61.5	7.7	0	15.4	0.1399

Table 3 Personal involvement in research misconduct. Have you or one of your colleagues ever been directly involved in one of the following:

	Pre-course					Post-course					<i>p</i>
	Never	Rarely	Occasionally	Frequently	Don't know	Never	Rarely	Occasionally	Frequently	Don't know	
Disagreement about authorship	38.5	23.1	15.4	7.7	15.4	38.5	23.1	15.4	7.7	15.4	1
Selective dropping of data from "outlier" Cases	30.8	23.1	15.4	0	30.8	38.5	15.4	23.1	0	23.1	0.7212
Intentional protocol violations related to procedures	46.2	23.1	0	0	30.8	46.2	30.8	0	0	23.1	0.7470
Plagiarism	53.8	23.1	0	0	23.1	46.2	23.1	15.4	0	15.4	0.7881
Pressure from study sponsor to engage in unethical practices	53.8	7.7	0	0	38.5	46.2	15.4	15.4	7.7	15.4	0.2295
Data falsification	38.5	30.8	7.7	0	23.1	38.5	30.8	15.4	0	15.4	0.7212
Intentional protocol violations related to subject enrolment	53.8	7.7	7.7	0	30.8	38.5	30.8	0	0	30.8	0.0142
Falsification of biosketch, abstract, reference list	38.5	15.4	0	0	46.2	30.8	38.5	0	7.7	23.1	0.0450

course questions had the following characteristics: (a) all had educational background in medical sciences; (b) age 27, 34 and 37; (c) years since graduation 2, 6 and 13, respectively.

Research and Ethical Climate in the Work/Study Environment

Table 1 reports the results for each item regarding research and ethical climate in participants' work/study environment. Before the course 53.9% of the participants rated their own understanding of the meaning and value of RI as high or very high, whereas after the course this percentage rose to 69.2%. Interestingly, before the course none of the participants rated their own understanding as very low, whereas after the course 7.7% of participants gave this answer. The participants also rated their own understanding of the meaning and value of RI differently than researchers' understanding in general: before the course, 38.5% of the respondents rated it as high or very high and after the course the percentage rose to 61.5%.

In terms of understanding of rules and procedures related to scientific misconduct, before the course, 46.2% of the respondents rated their own understanding as high or very high, a percentage which rose to 76.9% after the course. Again, the participants gave different answers regarding the researchers' understanding of rules and procedures related to scientific misconduct, rated as high or very high by 38.5% before the course, and by 46.2% after the course.

As for the presence of any statistical significance between the pre- and post-course questionnaires, the χ^2 test reports values of $p < 5\%$ for the items "Researchers' understanding of the meaning and value of research integrity" ($p = 0.037$) and "Chances of getting caught for scientific misconduct if it occurs" ($p = 0.043$). The p values from the χ^2 test for the section "Research and ethical climate in the work/study environment" are reported in Table 1.

Perceived Prevalence of Research Misconduct in the Workplace

Table 2 shows the respondents' opinions on the frequency of cases of RM in their workplace.

Participants seem to believe that RM occurs to a considerable extent in their working environment. However, their perception regarding the frequency of such practices changed significantly after the course. Notably, data falsification was rated as occasional or frequent by 46.2% of the participants before the course and by 30.8% after the course. As for selective dropping of data from "outlier" cases was evaluated as occasional or frequent by 38.5% of the respondents before the course and by 46.2% after the course. Lastly, plagiarism was perceived as an occasional or frequent practice by 23.1% of the respondents, a percentage that remained unchanged after the course. Data in Table 2 also shows a high percentage of participants who answered 'don't know' to many questions, both before and after the course. The χ^2 test didn't report any significant result for this section's items (Table 2).

Personal Involvement in Research Misconduct

Coming to personal involvement of study participants in RM (Table 3), the percentage of participants who thought RM to occur occasionally or frequently was overall increased after the course, for all items except for disagreement about authorship and intentional protocol violations related to procedures, for which there was no change, and intentional protocol violations related to subject enrolment, which reported decreased percentages.

Table 4 Attitude and beliefs about research integrity and scientific misconduct. Please indicate which option best represent your views and beliefs about research integrity and scientific misconduct

	Pre-course			Post-course			<i>p</i>
	Agree	Disagree	Don't know	Agree	Disagree	Don't know	
All professional education programmes should include information about standards of research ethics	92.3	0	7.7	100	0	0	0.2979
All academic and/or research institutions should establish research ethics consultation services to support researchers	92.3	0	7.7	100	0	0	0.2979
I am concerned about the amount of misconduct	30.8	30.8	38.5	61.5	7.7	30.8	0.0397
I am concerned about the lack of awareness among researchers about the amount of misconduct	46.2	15.4	38.5	69.2	7.7	23.1	0.2465
I think the responsibility for the scientific integrity of a study lies with the principal investigator only	0	69.2	30.8	15.4	69.2	15.4	0.3173
I feel uncomfortable talking with other researchers about ethical behaviour	23.1	38.5	38.5	15.4	84.6	0	0.0018
I feel uncomfortable not being able to talk with my colleagues/supervisors about ethical behaviour and research misconduct	30.8	46.2	23.1	38.5	53.8	7.7	0.4168
Dishonesty and misrepresentation of data is common in society and doesn't really hurt anybody	7.7	76.9	15.4	23.1	76.9	0	0.0497

In this section, the χ^2 test reported a statistical significance for the items “Intentional protocol violations related to subject enrolment” ($p=0.014$) and “Falsification of biosketch, abstract, reference list” ($p=0.045$). These results can be explained away by the fact that different experiences in the research journey were exhibited during the course, especially regarding participants’ different academic backgrounds, so instances concerning misconduct during the execution of scientific protocols were discussed and led to confrontation also with participants from a philosophical background who had never encountered such experiences. The values of p from the χ^2 test for this section are reported in Table 3.

Attitude and Beliefs About Research Integrity and Scientific Misconduct

Table 4 reports participants’ opinions and beliefs about RM. Overall, after the course the percentage of respondents who said they were concerned about the amount of misconduct almost doubled (61.5% post vs. 30.8% pre), as did the percentage of those who said they were concerned about the researchers’ lack of awareness of the amount of misconduct (69.2% vs. 46.2% pre-course).

Notably, 92.3% of all pre-course and 100% post-course respondents agreed that all professional education programmes should include information about standards of research ethics and that all academic and/or research institutions should establish research ethics consultation services (RECSs) to support researchers.

Table 5 Behavioural influences on research integrity and misconduct. How much do you think each of the following influences scientific misconduct?

	Pre-course			Post-course			<i>p</i>		
	Not at all	Moderately	Strongly	Don't know	Not at all	Strongly		Don't know	
Need for publications	0	23.1	69.2	7.7	0	7.7	92.3	0	0.1888
Pressure for external funding	7.7	7.7	69.2	15.4	0	23.1	69.2	7.7	0.1386
Need for recognition	0	46.2	46.2	7.7	0	46.2	53.8	0	0.5580
Financial conflict of interests	7.7	46.2	23.1	23.1	15.4	38.5	46.2	0	0.0667
Low interest of principal investigator in study, enrolment, and outcomes	23.1	46.2	15.4	15.4	23.1	30.8	30.8	15.4	0.4459
High interest of principal investigator in study, enrolment, and outcomes	23.1	46.2	7.7	23.1	15.4	53.8	15.4	15.4	0.6077
Pressure for tenure	15.4	38.5	0	46.2	15.4	23.1	30.8	30.8	0.4803
Insufficient censure for misconduct	15.4	46.2	23.1	15.4	15.4	30.8	30.8	23.1	0.6822
A belief that the level of risk to subjects is quite low in a given study protocol	15.4	38.5	7.7	38.5	7.7	38.5	30.8	23.1	0.0161
Insufficient involvement of principal investigator in enrolment of subjects	15.4	53.8	7.7	23.1	23.1	30.8	23.1	23.1	0.1225
Number of research protocols principal investigator is responsible for	15.4	23.1	7.7	53.8	0	46.2	23.1	30.8	0.0162
Strong involvement of principal investigator in enrolment of subjects	23.1	23.1	15.4	38.5	23.1	30.8	15.4	30.8	0.9115
Unclear definition of what constitutes misconduct	23.1	53.8	15.4	7.7	30.8	53.8	15.4	0	0.7212
Lack of training of researchers on standards of research ethics	23.1	30.8	30.8	15.4	7.7	61.5	30.8	0	0.0619
Lack of research ethics consultation service within the institutions	23.1	30.8	15.4	30.8	15.4	23.1	61.5	0	4.93E-05

When it comes to responsibility, most of participants disagree (69.2%) in thinking that the responsibility for the scientific integrity of a study lies with the principal investigator only.

Before taking the course, 38.5% of the participants could not say whether they felt uncomfortable talking about ethical behaviour with other researchers, and only 38.5% disagreed with this statement; after the course, no participant answered “don’t know” and the percentage of respondents who disagreed rose to 84.6%.

In this section, the χ^2 test reported the majority of items with a statistically significant difference (Table 4). These were “I am concerned about the amount of misconduct” ($p=0.039$), “I feel uncomfortable talking with other researchers about ethical behaviour” ($p=0.0018$) and “Dishonesty and misrepresentation of data is common in society and doesn’t really hurt anybody” ($p=0.049$).

The significant result obtained on this item can be interpreted as the fruit of discussions which participants developed over the course, during which various experiences, both directly and indirectly experienced by the participants, were reported about episodes of misconduct that occurred during scientific research.

Behavioural Influences on Research Integrity and Misconduct

Table 5 shows the extent to which behaviours listed in the study questionnaire are perceived as contributing to RM. After taking the course, 92.3% of respondents believe that the need for publications strongly influences RM (vs. 69.2% pre-course), together with pressure for tenure (a value which was not considered before the course and that eventually rose to 30.8% after attending the course). Other causes deemed relevant (both before and after attending the course) by most participants were need for publications and the need for recognition. After the course, participants also believe that unclear definition of what constitutes misconduct and lack of training of researchers on standards of research ethics can moderately influence RM (53.8% and 61.5% respectively).

It is worth noting that, consistent with the data reported in Table 4, the percentage of participants who believe that the lack of training of researchers on standards of research ethics influences (moderately or strongly) scientific misconduct also increased significantly after the course (61.6% vs. 92.3%), as did the percentage of those who believe that it is also influenced by the absence of RECSs within research institutions (46.2% vs. 84.6%).

In this last section, the χ^2 test reported interesting results regarding “A belief that the level of risk to subjects is quite low in a given study protocol” ($p=0.016$), “Number of research protocols principal investigator is responsible for” ($p=0.016$), and “Lack of research ethics consultation service within the institutions” ($p<0.0001$).

These results allow us to emphasize the usefulness of the investigated course concerning the awareness and unanimity in agreeing that there is a lack of research ethics consultation services within institutions and a lack of training for researchers on standards of research ethics, a finding that brings to mind how indeed there is a need to implement a course of this kind. The values of p for the χ^2 test for this section are reported in Table 5.

Discussion

RI can be understood, on the one hand, as a summary of responsibilities for the research community and for individual researchers and, on the other hand, as a reassurance of society's trust in the outcomes of research (Dhakal, 2018).

In this context, the purpose of this study was to understand whether and to what extent early-career researchers are aware of the integrity and ethical issues that may arise in academic research and, in particular, of the concepts of RI and RM, so that they can conduct reliable, honest, respectful and responsible research. In fact, it is essential for researchers not only to master the technical and methodological aspects of their disciplines, but also to be able to address the integrity and ethical issues that may arise at all stages of their research. Failure to comply with good research practices also constitutes a breach of professional responsibilities, harms the research process, undermines relationships among researchers and trust in research and its credibility, causes resources wasting, and may expose the actors and users of research, society, and the environment to avoidable harm (ALLEA).

The educational background of the course participants was predominantly scientific, with some exceptions of participants with a humanistic background. This is representative of the multidisciplinary nature of the doctoral course in *Clinical and Experimental Medicine and Medical Humanities* at the University of Insubria.

In the first session of the course, participants were able to independently consult the introductory material on RI and RM, which was provided by the Embassy of Good Science. Based on this information, the trainers developed the second (face-to-face) part of the course, constantly involving the participants in the discussion of the topics.

The administration of the revised version of the Scientific Misconduct Questionnaire (SMQ-R) at the beginning of the course allowed for the assessment of the participants' knowledge and awareness about principles, values, and standards of conduct in research, as well as their awareness on RM issues. Re-administration of the same questionnaire at the end of the course helped assessing the impact of the course on participants' awareness and understanding of RM.

Clearly, the participants' general lack of knowledge of RI and RM at an early stage of their research career, posed a major challenge in developing the course. However, the VIRT²UE project made available (online) to the trainers developed specific tools for the training of non-experts in RI and RM, and provided the necessary support to address this issue through a virtue-based ethics approach.

Based on collected data and on direct feedback from participants - which provided significant added value to the course -, it seems possible to argue that, even among early-career researchers, a certain degree of awareness about the importance of RI and the relevance of RM in the academic context was present.

It is worth mentioning that, despite participants' fairly limited research experience (the median number of years since graduation was 4), they reported that they had personally found themselves in ethically challenging situations or had even been involved in (or had direct knowledge of) RM practices. They also consciously indicated the main causes that can lead to these behaviours (need to publish, need for recognition, etc.), which are consistent with what has been reported in the literature on the subject (Pradhan & Kumar, 2023; Gopalakrishna et al., 2022; Martinson et al., 2010).

A further relevant finding was the value acknowledged by early-career researchers to the possibility of sharing with their peers and superiors any ethical dilemmas which may arise in research. Before taking the course, only 38.5% disagreed about feeling uncomfortable in talking with other researchers about ethical behaviour, but after multiple discussions and the sharing of opinions during the course, this proportion increased to 84.6%, showing the importance of creating a working environment that fosters awareness on RI among researchers and helps them discuss with their peers.

However, we believe that with respect to the ultimate goal of this study, which was to assess whether introducing a training course on RI and RM within PhD courses could be useful in improving the work environment and the research itself (Selan & Metljak, 2023), the most significant results concerned, in addition to the participants' heightened awareness, their perceptions with respect to what could actually serve to improve the quality of their condition.

After attending the course, the totality of participants agreed with the need that all professional education programs should include information about standards of research ethics and that all academic and/or research institutions should establish RECSs to support researchers. In particular, this last finding is consistent with other studies on the value of implementing RECSs to support researchers at all stages of their research and to help them overcome doubts and critical issues that may arise, also with regard to rules and standards of conduct in research (McCormick et al., 2013; Porter et al., 2018).

A Consideration on Participants' Perceptions

Interestingly, participants' responses also revealed that they believed they had a greater understanding of the meaning and value of RI, as well as of the rules and procedures related to scientific misconduct, than researchers in general. In fact, as shown in Table 1, participants responded - both before and after the course - in significantly different ways to questions about the understanding of these aspects depending on the subjects the question referred to, attributing "high" and "very high" levels of understanding in lower percentages to researchers in general than to themselves.

This finding becomes even more interesting when analysed together with the percentages of "don't know" responses related to the same questions. In fact, with reference to their own understanding of the meaning and value of RI and the rules and procedures related to scientific misconduct, both before and after the course no participant answered "don't know" (0%), an indication that they perceived themselves to be very aware of their own understanding (or non-understanding) of these issues. In contrast, "don't know" answers concerning the researchers' understanding of the same aspects of RI and RM increased after the course, reaching 23.1% in both cases.

At first glance, this would suggest that the course somehow increased participants' uncertainty. However, this result can be interpreted - at least to some extent - also in a different way.

Certainly, considering the questionnaire as a whole, it can be observed that, with reference to the vast majority of the proposed questions, after the course the percentages of "don't know" answers decreased (out of 46 total questions, the percentage of "don't know" answers decreased for 32 items), and this can be interpreted as a sign of the participants' acquired awareness, that led them to give answers other than "don't know" to a greater

number of questions thanks to the information they learned (Mabou Tagne et al., 2020). Nevertheless - and although it may apparently sound paradoxical - the increased awareness gained through participation in the course could also be the reason for the sporadic increases in the percentages of “don’t know” answers. In fact, according to what has been described in the literature as the *Donning-Kruger effect* (i.e. the cognitive distortion that occurs when people with little skill or experience in a certain type of task or area of knowledge tend to overestimate their own skills or knowledge)(Kruger & Dunning, 1999), before attending the course participants may have overestimated their own knowledge and responded on the basis of what they believed they knew. In this sense, the course may have provided them with the tools necessary to understand the complexity of certain issues, making them less confident in their own assumptions.

Although a reflection on the possible cognitive biases that would have led participants to respond in a certain way to the questionnaire before and after the course is beyond the scope of this study, it is worth mentioning that most of the answers (4 out of 7) for which the percentages of “don’t know” increased were part of the first set of questions, relating to “Research and ethical climate in your work/study environment”. In fact, the “don’t know” percentages rose not only in relation to the already mentioned researchers’ understanding of RI meaning and values and RM issues, but also when it came to the “Severity of penalties for scientific misconduct” and to the “Chances of getting caught for scientific misconduct if it occurs”. In a very similar way, the percentage of “don’t know” also increased with reference to the possibility of “Insufficient censure for misconduct” (Table 5, on “Behavioural influences on research integrity and misconduct”). All these questions seem to have in common that they do not concern the participants’ individual perceptions or attitudes, but aspects that transcend their individuality, referring either to other individuals (the “researchers” in general) or to specific circumstances/consequences, of which they reasonably have had no experience. To these questions, some participants may therefore have overestimated their competence before the course, and realised only after the course that they did not have the direct knowledge or experience necessary to give an answer other than “don’t know”.

Comparison with a Previous Study

The study presented here is inspired by a study conducted in 2020 by Mabou Tagne et al.(2020) whose objective was to map the perceptions and attitudes about RM in a sample of young researchers attending a one-week intensive course on methodology, ethics and integrity in biomedical research.

The study by Mabou Tagne et al. represents one of the first studies designed to map the perceptions and attitudes about RM of a random sample of young researchers in Italy and although SMR-Q has been validated elsewhere (Broome et al., 2007), this is the first time it has been used for a follow-up study in order to assess the impact of a course on research integrity and methodology on the responsiveness of young researchers.

In addition to the difference in course length (the face-to-face online course in the present study was held on two contiguous days for a total of 8 h), an important difference lies in the number of participants (65 participants in the study by Mabou Tagne et al. compared to 16 participants in the study presented here).

Another difference can be found in the sample itself, in fact in our study all participants are early-career researchers at the University of Insubria, while in the paper by Mabou

Tagne et al. there is also the attendance of clinicians, lecturers, senior researchers and post-docs, some of whom declared to have attended a previous lecture, workshop or conference on ethics.

Both questionnaires used in the two studies are based on a questionnaire built upon the revised version of the well-established Scientific Misconduct Questionnaire (SMQ-R) (Broome et al., 2007) and partly adapted to the academic context in which the course was held.

The results of our study are in line with the results achieved by the study of Mabou Tagne et al., as well as other recent studies on the subject (Abdi et al., 2021; Selan & Metljak, 2023), especially regarding the importance that all professional education programs should include information about standards of research ethics and the findings about the pressing need for training programs on research ethics, research methodology and integrity. Although further in-depth empirical studies on this topic, with larger sample sizes, are therefore certainly needed, the obtained results allow us to argue that the possibility of benefiting from a course such as the one conducted in the present study in the first year of a doctoral program, targeting early-career researchers, can actually help to raise awareness about codes of good conduct in the academic environment, understand and identify risks that could lead to misconduct, know the tools and structures used to report misconduct and support research organizations in providing a clear and transparent RI policy.

Limitations

The course represents a training experience submitted to a PhD course characterised by a limited number of enrolled students. This limitation in the number of participants, although realistic, affects the actual statistical significance of the reported results.

This paper can, therefore, be regarded as a qualitative analysis of students' attitudes and knowledge on the subject. The numerical data serve as valuable supplementary insights rather than the primary basis for drawing conclusive statistical inferences. Despite this limitation, these numerical elements contribute to a more comprehensive understanding of the topic and complement the qualitative insights.

In addition, considering that the questionnaire was administered before and immediately after the course was held, it is not possible to know the medium- and long-term effects of the course's impact on participants nor the actual attendees' behaviours.

Conclusion

This course was very positively evaluated by participants, who actively contributed to discussions on various RI related issues, and encourages the implementation of this training tool by making it an integral part of the PhD programme.

Based on collected data, it seems possible to argue that institutions, especially the academia, should introduce specific RI training for researchers at a very early stage of their careers, also promoting the introduction and institutionalisation of RECSs to support all researchers. Senior scientists should also be responsible for promoting and integrating research ethics into their teaching and research practices, and for stimulating early-career

researchers to engage in peer-to-peer dialogue in order to develop good practices based on RI principles consistent with the ECoC.

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