Research Integrity

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Definition

Research integrity refers to the conduct of research in accordance with accepted research norms and practices as well as ethical values. It is helpful to examine the term's constituent parts in order to define this concept more precisely.

In general, *research* refers to a methodologically sound and critically minded scientific investigation: It is a process of exploring the new or unknown according to methodological standards usually derived from domain-specific contexts and under the premises of objectivity, reproducibility, and reliability. Students and research professionals must adhere to their discipline's standards, codes, and guidelines as well as those of their institutions (universities, businesses, or research organizations) and their respective governments' laws, rules, and regulations. The importance of disseminating findings to other researchers (*science to science*), practitioners who apply their findings in practice (*science to business*), or to the general public (*science to society*) is also growing. Given the societal, ecological, political, and economic significance of research findings, one of the most important requirements to all research actors, fields, and disciplines is "to ensure the highest levels of integrity in research" (OECD 2007, 1), to maintain society's trust in research, to protect the reputation of researchers and institutions, to ensure the reproducibility of research results, and to prevent fraud and misconduct (Science Europe 2017, 2-5).

The word *integrity* is composed by the Latin prefix *in-* (not) and the verb *tangere* (to touch). Its adjectival form, "integer", refers to the state of an entity that is "in no way touched, affected, altered [or] corrupted" (ten Have et al. 2021, 641). In this sense, research integrity consequently carries moral implications: There is widespread agreement that research should be conducted ethically and in conformity with the established norms in order to generate honest and reliable research results. In this context, the term "integrity" refers to the disposition of researchers to conduct research in accordance with appropriate ethical, legal, and professional frameworks, obligations, and standards. This relates to several levels of account-

ability, including those of individual researchers, their institutions, (potential) clients, the government, and the general public.

Between individuals, structures, and systems, research is conducted on a multilateral scale. Therefore, all parties involved in or influencing the research process are expected to generate scientific knowledge in an honest, valid, and trustworthy manner, ideally independent of ideological, economic, or political motives. Individual researchers, collaborative teams (institutional, inter-institutional, international, corporate), research performing organizations (such as universities and non-university research institutions), research funding organizations, scientific journals and publishers are parties involved in research. Moreover, public authorities, "university administrations, ethical review institutions, [and] legislation" (Helgesson and Bülow 2023, 118) are expected to establish the conditions necessary for the achievement of research integrity in its entirety.

Research integrity encompasses both external and internal research norms: external norms in the form of laws or regulations, guidelines, codes, or rules that guide the conduct of researchers, and internal norms in terms of internalized standards or desired behaviors. The research integrity framework addresses research *actors*' behavior and responsibility (a, c), as well as the conduct and impact of the *research itself* (b, c).

(a) Research integrity is the *attitude* of research actors to conduct research in an accountable, equitable, and reliable manner within the context of generally accepted scientific common sense and a scientific ethos (in the sense of a research habitus; Steneck 2006, 55). Different research integrity codes of conduct provide a normative framework for individual researchers, research collectives, institutions, and higher education. General codes cover content which is relevant across disciplines, such as the research environment, training, supervision and mentoring, research procedures and ethics structures, data practices and management, research collaboration, dissemination, publication, reviewing, and integrity breaches, and share (to varying degrees) fundamental principles to be applied in all research contexts, such as honesty, accountability, reliability, respect and others (WCRI 2010; WCRI 2013; ALLEA 2017), while discipline-specific, institution-specific, or region-specific codes focus on specialized aspects and needs of institutions.
(b) Research integrity also refers to both the research process (*conduct*) and the reporting or publishing (*dissemination*) of scientific information. As a result, it includes systematic procedural guidelines for responsible conduct of research to ensure the quality of the methodological process (Wilder et al. 2022, 206).
(c) Finally, research integrity is closely related to *research ethics*, which refers to the ethical responsibility of research and research actors (Steneck 2006, 56). Research ethics emphasizes behavior, attitude, values, and virtues. Therefore,

research integrity and research ethics should be understood holistically as complementary perspectives that relate to a situation, problem, or strategy to varying degrees.

Research integrity transcends disciplinary, thematic, cultural, and national boundaries by incorporating all of these factors and multiple viewpoints. Therefore, a transdisciplinary approach to research integrity education offers a promising means of effectively communicating pertinent aspects of research integrity across disciplines.

Background

Research integrity is not an enshrined construct, but has been a topic of ongoing activities of the research community for two decades. It spans national, institutional, and disciplinary boundaries in a "global effort to foster integrity" (Steneck et al. 2017, 3). Numerous guiding documents, conferences, studies, or educational resources have emerged in this context. Fifty-two nations are currently represented at the World Conferences on Research Integrity, held in Lisbon (2007), Singapore (2010), Montreal (2013), Rio de Janeiro (2015), Amsterdam (2017), Hong Kong (2019), and Cape Town (2022), as a result of initial work by the United States Office of Research Integrity and two members of the Organisation for Economic Co-operation and Development, Canada and Japan. The European Code of Conduct for Research Integrity (ESF and ALLEA 2011), which was intended to serve as an umbrella standard for Europe (revised and published in its final version in 2017), or the Montreal Statement on Research Integrity (3rd World Conference on Research Integrity) are some of the concrete reference documents for research standards that have emerged primarily in the last decade. The conclusions of the Council on research integrity (Council of the European Union 2015) was another significant document because it placed an emphasis on ethical principles in addition to integrity. This was followed by the Hong Kong principles (Moher et al. 2019), which emphasize researchers' behavior. On the global landscape, there are several other guidelines. To implement them on the institutional level, they are either imposed on institutions by government mandates or by making their establishment a requirement to receive funding. However, most higher education institutions implement the standards on the basis of their commitment (Steneck 2006, 67), with the demand for easy access and dissemination among their researchers, employees, and students emphasized.

These efforts paved the way for further initiatives promoting and safeguarding research integrity and ethics and creating an interplay of various types of expertise and methodologies. Among such initiatives are science-led infrastruc-

tures like the ombuds system as well as reproducibility networks, research integrity offices and research ethics committees, which serve as platforms for the dialogue between organizations and professionals and provide advisory services for the investigation of misconduct or ethical aspects. In addition, several guiding, mentoring, and training initiatives as well as studies thereof have emerged. The different instructional, methodological, and content-related programs for professionals, educators, students at different levels of qualification, institutions, policymakers, and ideally industry stakeholders show the different angles from which we can approach a comprehensive culture of research integrity and meet the current needs of specific communities.

The reason for many initiatives regarding research integrity are breaches in research. The research community places particular emphasis on serious misconduct like *fabrication* (creating data and reporting them as if they were real), *falsification* (the manipulation, modification, withholding, or elimination of data), and *plagiarism* (taking others' statements, data, ideas with inadequate or no citation of the source; Bouter 2020, 2364). Moreover, so-called *questionable research practices* exist in the gray area between scientifically desirable practices and those to be rejected (Fanelli 2009, 1). Among many others, such practices include *cooking* (giving ordinary observations extraordinary character), *mining* (highlighting a discovered statistically significant relationship as the true intention of the analysis), selective reporting or citing (only if it meets one's own expectations), etc. (Bouter 2020, 2364). Predatory and hijacked journals (Abalkina 2022) and AI-based paraphrasing tools or text generators pose new challenges to research integrity.

Debate and criticism

The need for trustworthy and high-quality research is the main driver in the establishment of research integrity, while persistence of misconduct and questionable research practices demonstrates that research integrity is not firmly established in the field. Especially the latter are considered to be remarkably detrimental due to their greater prevalence (Bouter et al. 2016, 2363). John et al. even assume "that some questionable practices may constitute the prevailing research norm" (2012, 524). Therefore, there is a great need for a multi-perspective approach of enabling, empowering, mentoring, and training across disciplines, actors, and institutional structures. These include the implementation of codes of conduct as guiding documents for institutions and the monitoring of their observance, the establishment of peer review systems, the introduction of ethics committees, the conduct of misconduct investigations, and strengthening the position of whistleblowers (e.g. ORI 1995). In addition, the concept of *open science* represents an opportunity to make research findings "more traceable and verifiable" (Haven et al. 2022, 2),

also for the benefit of citizens as recipients of research results (Priess-Buchheit et al. 2020, 30).

Kalichman points out that research integrity involves "socialization, incentives, and culture" (2016, 785). All actors are therefore called upon to work together in order to develop a structural, institutional, financial, and political environment that is conducive and stimulating for a responsible conduct of research (Sørensen et al. 2021, 2). The most problematic criticism, however, is that the research system creates incentives that work against research integrity such as funding and publication pressures (Bouter 2020, 2364) and that there are situations when the opportunities and obligations of each research actor are not entirely transparent or well-defined (Horbach and Halffmann 2017, 1464).

Consistent efforts to intensify training are therefore required from the educational sector. However, the effectiveness of interventions is the subject of ongoing research. The various requirements of research integrity in single disciplines (for example, data management or ethics codes in medical sciences versus humanities) raise the question whether a generic approach of the training or a more specialized, discipline-specific one should be chosen (Sørensen et al. 2021, 2), which didactic method is the most productive, and which content should be taught. Another aspect is the challenge to transmit or evoke values and an inner orientation in the sense of a scientific habitus, in addition to teaching concrete knowledge (such as rules or methods). This challenge can be addressed through a transdisciplinary approach, where learners can gain experience in other contexts, be confronted with insights from other disciplines or new theories, and thus enrich their inner attitude towards their research activity.

Since research results stemming from the private sector also affect society, it is necessary to investigate the extent to which research integrity is taught and practiced in the economic realm. Given that academic research integrity faces the behavioral, institutional, and infrastructural challenges outlined above, and that research, its funding, and its dissemination involve numerous, potentially very diverse interests, the assessment of responsible conduct of research in industry and the private sector is a crucial issue. This leads to the conclusion that research integrity education should be accessible not only to students, but also to researchers and educators at all career stages. A certain level of training should be available as well to non-researchers (such as funders, reviewers, journals, policy makers; Fanelli 2019, 5, 11) who are involved in the research process in different contexts. Considering that society's ability to understand research outcomes is a prerequisite for the trust in science, citizens should also be educated in research integrity (Priess-Buchheit et al. 2020, 30).

Current forms of implementation in higher education

The claim that "integrity in research should be developed in the context of an overall research education program" (Institute of Medicine and National Research Council 2002, 84) is highly pertinent and an ongoing effort of educational institutions. Key findings from the training program Path2Integrity (2019–2022) show that students at lower qualification levels are less motivated to engage in research integrity training lacking relevance for them (Valeva et al. 2022, 530). Whereas it is precisely during their university studies that learners are introduced to research activities and required to apply scientific methods such as literature review, responsible elaboration, and report of data, but also to be accountable and open for critical reflection (Steneck 2006, 56).

While universities offer various courses on individual research integrity topics (such as scientific writing, research methods, etc.), there are several educational programs, mostly developed in the academic context, which are applicable at an international level and which enrich the educational landscape both thematically and methodologically. These include, for example, the toolbox Standard Operating Procedures for Research Integrity, which assists institutions in developing a Research Integrity Promotion Plan (SOPs4RI) or the wiki-platform The Embassy of Good Science, which serves as a repository for comprehensive information on educational resources worldwide. By 2020, Pizzolato et al. have collected 237 mostly online and freely accessible domain and non-domain-specific educational resources consisting of videos, online (self-processing or collaborative) courses, textbooks or case study collections covering primarily misconduct-related content, followed by publication ethics, data management, and others such as research procedures or collaborative working. Examples of these are VIRT2UE, INTEGRITY, and Path2Integrity. While all of them make their training available worldwide, VIRT2UE addresses mainly educators from all disciplines and aims to strengthen the learners' attitudes towards research integrity. INTEGRITY is a modular training mainly for high school students, stimulating their critical awareness by mostly socially relevant (real or fictive) cases that are considered to be interesting for this target group (from activism to usage of mobile devices). Path2Integrity offers various modular and dialogue-based learning materials for citizens, undergraduates, graduates, and early career researchers that address the content fields of the European Code of Conduct for Research Integrity and are thus applicable across disciplines. Formal and informal learning pathways (learning materials, campaign, and role models) are used to address learner awareness. Additionally, it offers several evaluation instruments like a feedback sheet or a pre- and post-test survey in order to assess possible learning gains (Zollitsch et al. 2021).

Several recommendations and findings from training conducted can be gleaned from the available literature. Nonetheless, they do not constitute univer-

sal guidance and must be evaluated in light of the particular context and learning objective. Katsarov et al. (2022, 951) outline that voluntary courses have a more positive impact on learning outcomes. The much-needed learner attitude for research integrity, however, is partially hampered by learners with lower qualification levels who question the relevance of research integrity for them (Valeva et al. 2022, 530). The design and effectiveness of interventions, in addition to the question of an (effective) instructional approach, depend on the different statues of learners, such as prior knowledge, research experience, skills, and qualifications.

It is noteworthy that most of the trainings (especially the latter two) tend towards a learner-centered dialogical approach, allowing learners to experience research integrity through role-play, discussion, storytelling, or the presentation of concrete research-relevant scenarios (Hermeking and Priess-Buchheit 2022, 112). This, together with the cross-disciplinary topics and the aspect of formal and informal learning (Path2Integrity), is a useful example of how education in research integrity through a transdisciplinary teaching–learning setting is an effective way to teach and learn many aspects of research integrity.

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