PhD Thesis

Ethics of Contributor Role Ontologies and Taxonomies

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June 2021

Declaration

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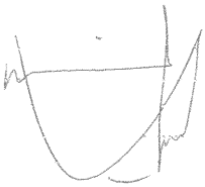
Signed:  (Candidate) ID No.:17212032 Date: 18/03/2021

Acknowledgements

I am grateful to have had Bert Gordijn as my first supervisor. In the past four years, he has been a composed and understanding role model who wholeheartedly supported me whenever I needed him. He made me feel that I can rely on him and that I am his top priority. I am also thankful to Jonathan Lewis for his feedback and help during this period. Without his guidance and advice, this thesis would have not been half as good.

I will take this opportunity to thank my parents (Ali and Fariba) and sisters (Fereshteh and Farzaneh) for their invaluable and loving support. Although they have been far from me, I always felt their presence, knowing that they pray for my success. I would like to show gratitude to all my friends who supported me with their honest care throughout this process, especially Mahdi, Kaveh, Ramin, Wolter, Peter, Aida, Patrick, Robbie, Aoife, Amir, Shiva, Alejandro, Noshad, Charlie and Margarette.

Lastly, I would like to thank the DCU academic, support and administrative staff who made this a pleasant journey by creating a caring and supportive environment.

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List of abbreviations

ALLEA: All European Academies

CASRAI: Consortia Advancing Standards in Research Administration Information

CD2H: National Centre for Data to Health

CNB: Core Needle Biopsy

COIs: Conflict of Interests

COPE: Committee of Publication Ethics

CRediT: Contributor Role Taxonomy

CRO: Contributor Role Ontology

CROTs: Contributor Role Ontology and Taxonomy

DARIAH: The Digital Research Infrastructure for the Arts and Humanities

DOI: Digital Object Identifier

ICMJE: International Committee of Medical Journal Editors

ORCID: Open Researcher and Contributor ID

QUAD: Quantitative Uniform Authorship Declaration

ROR: Research Organization Registry

TaDiRAH: Taxonomy of Digital Research Activities in the Humanities

URI: Uniform Resource Identifier

WAME: World Association of Medical Editors

WoS: Web of Science

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Abstract

Mohammad Hosseini, Ethics of contributor role ontologies and taxonomies

First introduced in 2015, Contributor Role Ontologies and Taxonomies (CROTs) are the most recent innovation developed to address ethical issues of scholarly authorship. By providing a standard list of roles to specify individual contributions to publications, CROTs enhance transparency and consistency about the reporting of conducted tasks, and accordingly, improve the attribution of credit and responsibilities. Although various parties such as academic journals and universities are increasingly adopting CROTs, thus far no study has evaluated them from an ethical perspective. To fill this gap, this study develops an assessment instrument and subsequently analyses three major CROTs including CRediT, CRO and TaDiRAH, and provides recommendations for improving them from an ethical perspective.

This study uses a bottom-up approach comprised of two literature reviews, combined with a review of non-conventional sources (i.e., forums, meeting notes, digital repositories) to collate concerns about authorship and use of CROTs, and generate candidate assessment criteria. Then with a top-down approach and using David Resnik's 12 principles of research ethics, developed candidate assessment criteria are further analysed, and an assessment instrument consisting of 25 justified criteria is compiled. This instrument is used to identify the ethical strengths and weaknesses of CRediT, CRO and TaDiRAH. Finally, using current best practices and available technology in publication processes, recommendations are provided for further development and improvement of CROTs.

Chapter 1. Introduction

Authorship is the traditional means of recognising contributions in academia. Sociologists of science have long been suggesting that, upon publication of research results, authorship status is employed as a commodity that is bartered (e.g., with the provision of scarce resources such as research samples) and used for academic evaluations and career trajectories (Latour & Woolgar 1986; Biagioli 2003). Furthermore, authorship status is used to hold contributors responsible for the accuracy and integrity of published claims (McNutt et al. 2018). Among other contributing factors, a steady increase in the average number of authors per publication across all disciplines (Fanelli & Larivière 2016) and symptoms of so-called hyperauthorship, e.g., authorship disputes (Cronin 2001), lead to a range of ethical issues that complicate the accurate attribution of credit and responsibilities (Marušić et al. 2011). Accordingly, various solutions are proposed to address ethical issues such as inaccurate/unfair attribution of credit and responsibilities. The most recent innovations that address some of these issues are called 'Contributor Role Ontologies and Taxonomies' (CROTs). The quick uptake of CROTs by major publishers such as Elsevier, Sage, Springer and Wiley (CASRAI 2020) suggests that they are likely to play a significant role in the future of scholarly publications. Nevertheless, these innovations have not yet been explored from an ethical perspective. Hence, this thesis aims to fill this gap.

1.1 Research objectives

This study has the following objectives:

1. Identify ethical issues of scholarly authorship
2. Develop an assessment instrument for the ethical evaluation of CROTs
3. Evaluate the three major CROTs from an ethical perspective
4. Provide recommendations for the improvement of these CROTs

1.2 Methodology

This dissertation uses different strategies to achieve each of its research objectives.

Identification of ethical issues of scholarly authorship

A literature review is the preferred method for achieving this objective. The rationale for this decision is twofold. Firstly, the latest review of the literature on ethical issues of scholarly authorship dates back to 2011 (Marušić et al. 2011). Secondly, as will be mentioned in section 2.2 of this thesis, the 2011 review and another one preceding it (Claxton 2005a; Claxton 2005b) have important limitations in relation to the ethical issues surrounding the attribution of author responsibilities. For the purpose of identifying ethical issues of scholarly authorship, this thesis employs a broad definition of ethical issues to capture both the traditional and tangential issues so as to be as comprehensive as possible. Furthermore, in order to include as many relevant items as possible, no restrictions on the publication-date and document-types are applied. A more detailed explanation of the methodology for this review will be provided in section 2.3.

Development of an assessment instrument for an ethical evaluation of CROTs

To develop an assessment instrument for evaluating CROTs from an ethical perspective, concerns that pertain to the use of CROTs are collated and analysed. As will be explained in more detail in section 3.2, this objective is achieved by employing a combination of a (1) bottom-up approach to identify concerns about CROTs and extract candidate assessment criteria, and (2) a top-down approach to justify the candidate assessment criteria from an ethical perspective.

1) The bottom-up approach involves the identification of concerns in three different sources. The first source is the list of issues resulting from the literature review on ethical issues of scholarly authorship. Using this list, issues that are relevant to the use of CROTs are analysed to develop the first set of candidate assessment criteria. The second source pertains to the publications that explicitly mention CROTs. As will be explained in 3.4, an additional focused

literature review retrieves publications, which discuss the ethical dimensions of CROTs, to extract additional candidate assessment criteria. The third source is the information provided by the developers of CROTs in their websites and public forums. These sources include promotional/discussion articles, notes from user meetings, and online forums to raise questions and concerns, all of which are used to develop candidate assessment criteria.

After compiling candidate assessment criteria from these three sources, the submission process and recent publications of two journals (i.e., *PLOS Medicine* and *PLOS Biology*[1]) that have adopted one of the CROTs are analysed to check how CROTs are used in practice and to determine whether the candidate assessment criteria are applicable to current publication processes. This test disqualifies candidate assessment criteria that are no longer relevant to current publication practices (see section 3.6 for further details).

2) The top-down approach entails choosing an ethical framework and using that framework to justify the candidate assessment criteria. As will be explained in section 4.1, ethical concerns related to CROTs are a subset of the ethical issues of scholarly authorship, which fall within the scope of research ethics and integrity. Hence, by using a research ethics framework, candidate assessment criteria are analysed to check whether there is ethical justification for their inclusion as assessment criteria in the assessment instrument. Candidate assessment criteria that cannot be justified are disqualified from the assessment instrument.

Evaluation of the three major CROTs from an ethical perspective

The assessment instrument is employed to evaluate and compare three major CROTs - CRediT, CRO and TaDiRAH. These CROTs are tested against each criterion, and their performance is

[1] *PLOS Medicine* and *PLOS Biology* are chosen in consultation with Ms. Alison McG-O'Connell (one of CRediT's chairs) because of the type of articles that are published in these two journals. These journals often publish papers with many co-authors entailing large datasets. Furthermore, these two journals are among the early adopters of new technologies and guidelines.

compared to highlight each of their strengths and weaknesses. For this purpose, details regarding the latest versions of these CROTs provided on the GitHub repository[2] are used.

Advancing recommendations for improving analysed CROTs

Finally, to achieve the fourth objective, current best practices will be employed to provide recommendations for the improvement of the three CROTs. As explained in section 6.1, the feasibility of provided recommendations is confirmed by field-experts. These recommendations offer directions for improving CROTs from an ethical perspective and are followed by possible solutions for their implementation.

1.3 Relevance

With the growing significance of collaborative research and a continuous increase in the average number of authors per publication (Fanelli & Larivière 2016), the preponderance and complexity of ethical issues of authorship also increase (Youtie & Bozeman 2014). The identification of ethical issues of authorship opens a window into the complexities involved in the attribution of credit and responsibilities, enables the scholarly community to discuss pertinent issues, and affords us an opportunity to propose solutions (Claxton 2005a). Changes to the submission, peer-review and publication processes (Stern & O'Shea 2019) as well as revisions to codes of conduct and authorship criteria (ICMJE archives 2020) exemplify what can be achieved by the identification of, and discussions about, the ethical issues of scholarly authorship.

As solutions to (some) ethical issues of scholarly authorship, CROTs standardise the descriptions of diverse research tasks and register individual contributions to the work leading to a publication. The developers of CROTs claim that by improving transparency in the specification of contributions to publications, CROTs improve systems of attribution, credit, and

[2] GitHub is an online repository to store and share software and source code and is used by the developers of all three analysed CROTs.

accountability (Brand et al. 2015). Uptake has not been limited to major publishers; CROTs are also being adopted by repositories and universities (CASRAI 2020, Ilik et al. 2018). Accordingly, CROTs are becoming a pivotal part of scholarly publications: they are useful not only for researchers but also for universities, libraries and funding organisations. Nevertheless, thus far, no study has thoroughly analysed CROTs from an ethical point of view.

The current dissertation fills this gap by developing an assessment instrument for the ethical evaluation of CROTs. This assessment instrument facilitates the comparison of different CROTs and allows parties that may be interested in adopting them to identify their strengths and weaknesses. Furthermore, it enables those that have adopted (or planning to adopt) one of the analysed CROTs to adjust their workflows and develop contingency plans for addressing known ethical issues that are not currently addressed. By comparing different CROTs, available best practices are identified, and areas that should be improved by each of the explored CROTs are clarified. These results inform specific suggestions for improvement and could support the developers of CROTs in enhancing future versions from an ethical perspective.

Since the reward system of academia (i.e., the elaborate system of allocating rewards to those who deserve it) relies on the attribution of credit and responsibilities in publications (Merton 1973), improving CROTs from an ethical perspective would also have a positive impact on how rewards are distributed in academic environments. These improvements will benefit almost all parties that use academic publications including researchers, members of hiring and promotion committees, research administrators, members of funding agencies and, ultimately, any public/private organisation that use academic outputs for various purposes.

1.4 Outline

Chapter two Identifies ethical issues of scholarly authorship through a literature review. Ethical issues are understood as issues about obligations, values or virtues. This review is not limited by date and contains a wide range of resource-types. After mapping the ethical issues and ranking

them based on preponderance in the sample, the results are critically examined, and issues that have not received enough attention are highlighted. This is the most up to date review of the literature that (to the best of the author's knowledge) benefits from the largest sample size among the existing reviews about scholarly authorship.

In chapter three, the criteria for evaluating CROTs is developed in four steps. The first step involves screening the ethical issues of scholarly authorship to identify those that could be employed as candidate criteria for the assessment of CROTs. In the second step, a focused literature review is conducted to identify ethical issues specific to CROTs and enrich the list of candidate assessment criteria. The third step involves collating issues and concerns raised by developers, adopters and users of CROTs from online sources that are provided by CROTs' developers in their websites and GitHub pages. The fourth step seeks to determine which candidate assessment criteria are applicable to the ethical analysis of CROTs with an applicability test. Accordingly, criteria that are not relevant to modern publication processes are disqualified from the assessment instrument.

In chapter four, the developed candidate assessment criteria are justified from an ethical perspective. Here, the choice of ethical framework is explained, and consequently, the chosen framework is employed to justify the candidate assessment criteria that have been identified and deemed to be applicable in the preceding chapter.

In chapter five, three prominent CROTs - CRediT, CRO and TaDiRAH - are assessed and compared with each other. Accordingly, the strengths and weaknesses of each in relation to the assessment criteria are highlighted.

Chapter six provides specific suggestions to improve the three analysed CROTs. These suggestions are based on available best practices and publication technologies, and their feasibility is confirmed by field-experts. Furthermore, suggestions are provided on how to implement these recommendations.

Finally, in the concluding chapter, a summary of the findings in relation to each of the four research objectives of this dissertation is presented. Additionally, possible limitations with this research, suggestions and possible directions for future research is explained.

References

Biagioli, M. (2003). Rights or rewards? In: Biagioli M. and Galison, P., (Eds.), *Scientific authorship: Credit and intellectual property in Science* (pp. 253-280). New York: Routledge.

Brand, A., Allen, L., Altman, M., Hlava, M., & Scott, J. (2015). Beyond authorship: Attribution, contribution, collaboration, and credit. *Learned Publishing*, *28*(2), 151–155. https://doi.org/10.1087/20150211

CASRAI. (2020). *CRediT - Contributor Roles Taxonomy*. CASRAI. https://casrai.org/credit/

Claxton, Larry D. (2005a). Scientific Authorship. Part 1. A Window into Scientific Fraud? *Mutation Research* 589 (1): 17–30. https://doi.org/10.1016/j.mrrev.2004.07.003.

Claxton, Larry D. (2005b). Scientific Authorship. Part 2. History, Recurring Issues, Practices, and Guidelines. *Mutation Research* 589 (1): 31–45. https://doi.org/10.1016/j.mrrev.2004.07.002.

Cronin, B. (2001). Hyperauthorship: A Postmodern Perversion or Evidence of a Structural Shift in Scholarly Communication Practices? *Journal Of The American Society For Information Science And Technology* 52 (7): 558–69. https://doi.org/10.1002/asi.1097.

Fanelli, D., & Larivière, V. (2016). Researchers' Individual Publication Rate Has Not Increased in a Century. *PLOS ONE*, *11*(3), e0149504. https://doi.org/10.1371/journal.pone.0149504

Ilik, V., Conlon, M., Triggs, G., White, M., Javed, M., Brush, M., … Holmes, K. L. (2018). OpenVIVO: Transparency in Scholarship. *Frontiers in Research Metrics and Analytics*, *2*. https://doi.org/10.3389/frma.2017.00012

International Committee of Medical Journal Editors. (2020). Archives. Accessed March 11, 2020. http://www.icmje.org/recommendations/archives/

Latour, B., & Woolgar, S. (1986). Laboratory life: The construction of scientific facts. Princeton University Press.

Marušić, A., Bošnjak, L., Jerončić, A. (2011). A Systematic Review of Research on the Meaning, Ethics and Practices of Authorship across Scholarly Disciplines. *PLOS ONE*, *6*(9), e23477. https://doi.org/10.1371/journal.pone.0023477

McNutt, M. K., Bradford, M., Drazen, J. M., Hanson, B., Howard, B., Jamieson, K. H., Kiermer, V., et al. (2018). Transparency in Authors' Contributions and Responsibilities to Promote Integrity in Scientific Publication. *Proceedings Of The National Academy Of Sciences Of The United States Of America* 115 (11): 2557–60. https://doi.org/10.1073/pnas.1715374115.

Merton, R. K. (1973). *The sociology of science: Theoretical and empirical investigations*. Chicago: University of Chicago Press.

Stern, B. M., & O'Shea, E. K. (2019). A proposal for the future of scientific publishing in the life sciences. *PLOS Biology*, *17*(2), e3000116. https://doi.org/10.1371/journal.pbio.3000116

Youtie, J., & Bozeman, B. (2014). Social dynamics of research collaboration: norms, practices, and ethical issues in determining co-authorship rights. *Scientometrics*, *101*(2), 953–962. https://doi.org/10.1007/s11192-014-1391-7

Chapter 2. Ethical issues of scholarly authorship

2.1 Introduction

To achieve the first research objective of this thesis, this chapter maps ethical issues of scholarly authorship as discussed in the scholarly literature.[3] By reviewing the literature to discover issues about obligations, values or virtues[4] having to do with reporting, authorship and the publication of research results (what is called *ethical issues of scholarly authorship* in this thesis), this chapter provides a broad understanding of ethical issues of authorship.[5] This chapter starts with a critical analysis of similar reviews that were conducted in the past and explains why a fresh review of the literature is needed. Next, the search methodology will be described, and results will be presented. Finally, in the discussion section, results will be critically examined.

2.2 Previous reviews

Conducting a literature review to map the ethical issues associated with scholarly authorship is not an entirely new endeavour. Similar studies have been conducted in the past. The two most cited literature reviews on this topic were undertaken in 2005 and 2011 (Claxton 2005a; Claxton 2005b; Marušić et al. 2011). In his 2005 review, Claxton distinguishes two kinds of problems in scholarly authorship:

1. Deceptive practices include different forms of fraud such as fabrication of data, falsification, plagiarism, and "unethical conflicts of interest" (Claxton 2005a, p. 35).

[3] An earlier version of this review is published in the journal of Accountability in Research (Hosseini & Gordijn 2020).

[4] By using v*alues* (i.e., "something that is worth desiring"), *virtues* (i.e., "desirable character traits"), and *obligations* (i.e., what can be interpreted as moral duties) this definition captures some of the most important aspects of normative ethics pertaining to "the standards of conduct" and "what people ought to follow" (Resnik 2015, Paragraph 22).

[5] This understanding is broader than a traditional interpretation of ethical issues of authorship, which mainly pertain to who deserves author status, authorship order, and abusive authorship practices. In broadening the scope, this review aims to include tangential issues that are connected to traditional concerns and provide directions for future research.

2. Issues resulting from the difficulties in the allocation of credit such as coercion authorship, mutual support/admiration authorships, gift authorship, ghost writing, duplicate production authorships, and assignment and ordering of authorship (Claxton 2005b).

In their 2011 review, Marušić and her colleagues provide a synthesis of research on authorship issues across all research fields. They identify four common problems of authorship:

1. "authorship perceptions, definitions and practices",
2. "defining order of authors on the byline",
3. "ethical and unethical authorship practices", and
4. "authorship issues related to student/non-research personnel-supervisor collaboration" (Marušić et al. 2011, p. 1).

Despite providing considerable clarity and insight into some ethical aspects, the two previous reviews have two shortcomings in common. The first one is that they both overlook difficulties in attribution of responsibilities about authored claims and rarely mention these explicitly.[6] This shortcoming seems to neglect the widely accepted notion that scholarly authorship is a two-sided coin, with credit on the one side and responsibility on the flipside (Rennie & Flanagin 1994; Biagioli et al. 1999). The second common shortcoming relates to misconceptions about instances of ethical issues, fraud and noncompliance. Whilst neither of the two reviews provides an explicit definition of what an ethical issue involves, they sometimes seem to take "ethical issues", "fraud", and "noncompliance" as synonymous expressions that may baffle scrupulous readers.[7] Although this confusion could be reflective of studies which they reviewed and

[6] For instance, while both studies mention guest/ghost authorship, they only mention the receipt of undeserved credit as a problematic issue about this practice and make no explicit mention of responsibilities.

[7] Two specific examples can help to clarify the problem. 1) Marušić et al.'s third category of common issues in authorship is titled ethical and unethical authorship practices. Various forms of authorship abuse such as guest/ghost/honorary authorship are mentioned in this category, suggesting that these authorship abuses are examples of ethical issues in authorship. Later, however, in making a reference to one of the reviewed studies they note that "it can be argued that omitting or adding authors on an article represents

differences in international policies, it is safe to argue that making a distinction between these issues could help in addressing ethical issues more effectively. In addition to addressing the two abovementioned shortcomings of the previous reviews, the current review also aims to incorporate more recent issues that were debated since the last review in 2011.

2.3 Methodology

For this review, the Web of Science (Clarivate Analytics 2020) core collection (hereafter referred to as WoS) was used to find relevant sources.[8] In order to retrieve the most useful items that pay specific attention to scholarly authorship, two groups of relevant search terms were developed and used (see table 1).

Rationale	**Search terms**
Referring to the context	1- scholar*(scholarly, scholarship) 2- scien* (scientific, science, scientist) 3- research* (research, researching)
Referring to authorship and dissemination	1- author* (authors, authoring, authorship) 2- report* (report, reporting) 3- communicat*(communicate, communication) 4- disseminat* (disseminate, dissemination) 5- writ* (write, writing) 6- publishing 7- publication

Table 1. used terms to find resources relevant to scholarly authorship.

falsification or fabrication" (Marušić et al. 2011, p. 14). Given that fabrication and falsification are strictly forbidden by all codes of conduct, comparing ghost/guest authorship with them would imply that they are instances of noncompliance with codes of conduct and not an ethical issue in the strictest sense. 2) Claxton's category of deceptive practices has two subcategories: Fraud, including fabrication of data and plagiarism, and, unethical conflict of interest. By making a distinction between unethical conflict of interests and other forms of conflict of interests, Claxton leaves the reader confused about the nature of conflicting interests. He notes that "the evaluation of scientific data and information is never 'completely independent of the scientists' convictions or theoretical apparatus' and is, therefore, influenced by previous knowledge, beliefs, and experiences" (Claxton 2005b, p. 35). Unethical conflict of interests, however, are those that provide "an incentive for fraud and misconduct" (Claxton 2005b, p. 35). In other words, according to Claxton, conflict of interests are inseparable from scientific endeavour but some unethical ones lead to fraud. In which case, the unethical conflicts of interests are merely fraudulent and an instance of noncompliance, but not an ethical issue in the strictest sense.

[8] An important advantage of using WoS is that the available tools within the platform allow consolidation of results from searches with different search terms while removing duplicate items. Additionally, WoS allows searching within the abstracts of the extracted items, which facilitates fine-tuning search results. These functions make the task of finding relevant articles straightforward and less prone to human mistakes.

The first group of search terms refers to the context (scholarship, science and research), and the second group to authorship and dissemination of results. Wildcards (enabled by using the asterisk symbol) that substitute for any other character range were used to increase the likelihood of finding more relevant resources.[9]

In conducting the search, the WoS *Advanced Search* tab was used to create search strings. The search was limited to items published in English. Results were also limited by *document type*, where journal articles, abstracts of published items, books, book chapters, editorial material, letters, and conference proceedings were selected. No filter was applied on the *timespan* to include all the available collections and citation indexes within WoS so that the search results would not be limited to a certain period or index. At the time of conducting the search (December 2018), the largest possible timespan to choose in WoS was 1945 to 2018. By using the aforementioned search terms and Boolean operators, 21 unique strings were created, which are shown in table 2 together with the number of items that these searches yielded in combination with the aforementioned limitations (i.e., language, document type):

	Search string	**Number of found items**
1	scholar* AND author*	182
2	scholar* AND report*	119
3	scholar* AND communicat*	569
4	scholar* AND disseminat*	40
5	scholar* AND writ*	288
6	scholar* AND publication	129
7	scholar* AND publishing	498
8	scien* AND author*	1024
9	scien* AND report*	2714
10	scien* AND communicat*	2681
11	scien* AND disseminat*	282
12	scien* AND writ*	1529
13	scien* AND publication	838
14	scien* AND publishing	807
15	research* AND author*	947
16	research* AND report*	6092
17	research* AND communicat*	4388

[9] For example, by using the term science, the algorithm would not search for scientific, but by using scien*, the algorithm will consider every word that starts with scien (e.g., science, scientific, scientifically, scientist, etc.).

18	research* AND disseminat*	657
19	research* AND writ*	1373
20	research* AND publication	1054
21	research* AND publishing	582
Total		**26,793**

Table 2. search strings and the number of items resulted from each query.

After searching with these 21 distinct strings, 26,793 items were found (including duplicates). Using the *Combine Sets* function in WoS that automatically removes duplicates, 24,799 items remained. In narrowing down the scope and refining results to only extract the items that are dealing with ethical issues of scholarly authorship, the following search terms were used:

- Three core terms that formed the basis of the definition of ethical issues (i.e., issues about obligations, values or virtues having to do with reporting, authorship and the publication of research results)
    - value* (value, valued, values)
    - virtu* (virtue, virtues, virtuous)
    - obligatio* (obligation, obligational, obligations)
- Three generic terms that are used in describing ethical issues[10]
    - ethic* (ethics, ethical, ethically)
    - moral* (morally, morality, morals)
    - norm* (norms, normative, normal)
- Responsibility (as a specific issue that was neglected in previous reviews)
    - responsib* (responsible, responsibly, responsibility)

Accordingly, the following search string was created and used to search within abstracts and keywords:

value* OR virtu* OR obligatio* OR ethic* OR moral* OR norm* OR responsib*

[10] *Ethics* and *morals* are used to describe "standards of conduct (or behaviour) that distinguish between right/wrong, good/bad", and *normative* pertains to the strand of ethics that aims to "prescribe and evaluate conduct" (Resnik 2015, paragraph 5).

This led to a list of 2485 titles. The abstracts of these items were screened one by one to check if the selected documents in any significant way addressed issues of obligations, values and/or virtues in relation to scholarly authorship. Given that editorials, commentaries and letters to the editors do not have abstracts, all of these were included for full-text reading. After going through all 2485 documents in the manner described, 403 items were deemed eligible for full-text reading. After reading the selected full-text articles, 79 additional items were excluded. 61 items did not focus on the ethical issues of authorship in any significant manner after all. These documents primarily dealt with: Editorial processes and issues (21 items), Impact and citation analysis (8), Readership and open access (7), Science journalism (5), Research with humans and animals (5), Science policy (4), Training material and courses (3), Research ethics committees (3), Style/Language proficiency (2), Predatory publishing (2), and Methodology (1). Other reasons for exclusion were: Irretrievable documents[11] (10), Duplicate editorials with different DOIs published in other journals (7), and Report of an investigation of misconduct without a significant ethical argumentation (1).

As a result, 324 items were deemed eligible for the analysis. Figure. 1 depicts a summary of the selection process.

[11] Despite elaborate and multiple attempts to mobilise our network we were not able to retrieve these items.

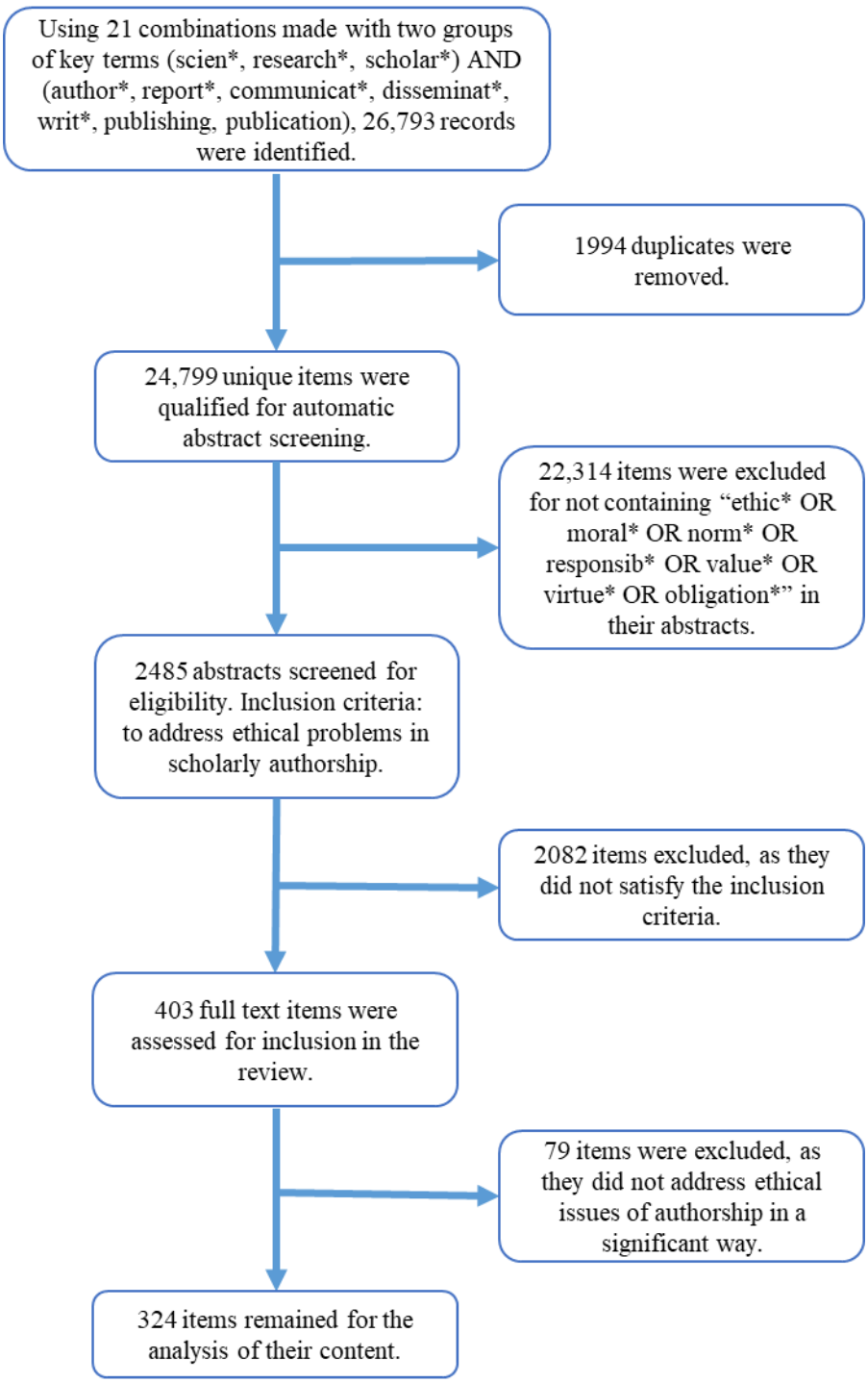


Figure 1. The selection process deemed 324 documents eligible for the analysis of their content.

To start the analysis of the selected sample and the identification of the ethical issues, 50 randomly selected documents were examined. Using an inductive approach, sections that described an ethical issue were highlighted and a label was created for that part (e.g., ghost authorship, citation amnesia). These labels were then subsumed under themes (e.g., attribution, citations and referencing) and accordingly, one or more themes were used to tag each

document. Subsequently, a first set of ethical issues was compiled and after reducing overlaps (e.g., financial and non-financial conflict of interests were listed under the theme of bias), ten unique themes were compiled. With the help of this first list of issues, the 50 randomly selected documents were reviewed once more, tagging each document in accordance with the theme(s). As a result of this, the list of ethical issues and corresponding themes was reviewed once again and further refinements were made. Accordingly, the list of ethical issues was finalised and all the other papers were reviewed and tagged (Figure 2). While tagging the entire sample, all the identified issues (including some that were not mentioned in the first 50) could be subsumed under the ten themes. So, no new issues were identified at this stage that necessitated the creation of completely a new theme. Before drafting the first version of the results section, the entire sample was checked with the new list once more and tags were improved.

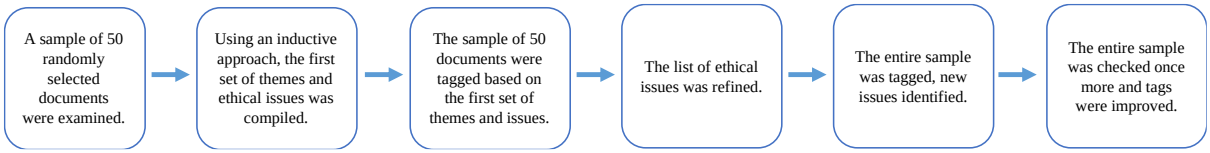


Figure 2. The examination and tagging process.

2.4 Results

2.4.1 Characteristics of the sample

Document types

The document types of the 324 items eligible for the final analysis is shown in Figure 3.

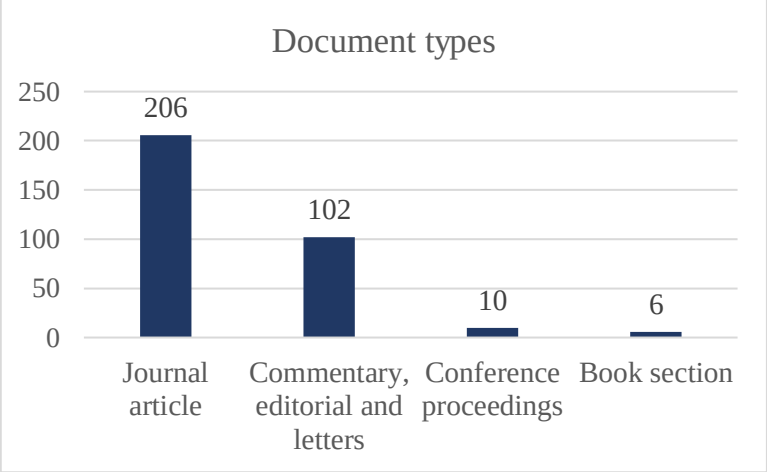


Figure 3. makeup of the 324 documents considered for analysis.

Number of publications over time

Furthermore, the review shows a rapid increase in the number of items published in the last 20 years (Figure 4).

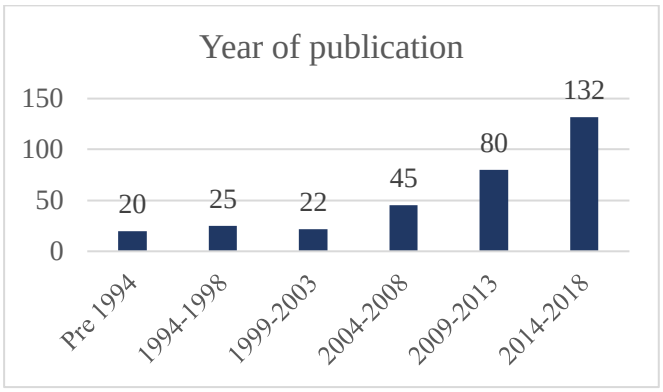


Figure 4. Years of publication of the documents considered for analysis.

Most common keywords

Within the selected sample, 124 items had keywords. Figure 5 shows the top 10 most common keywords among these items.

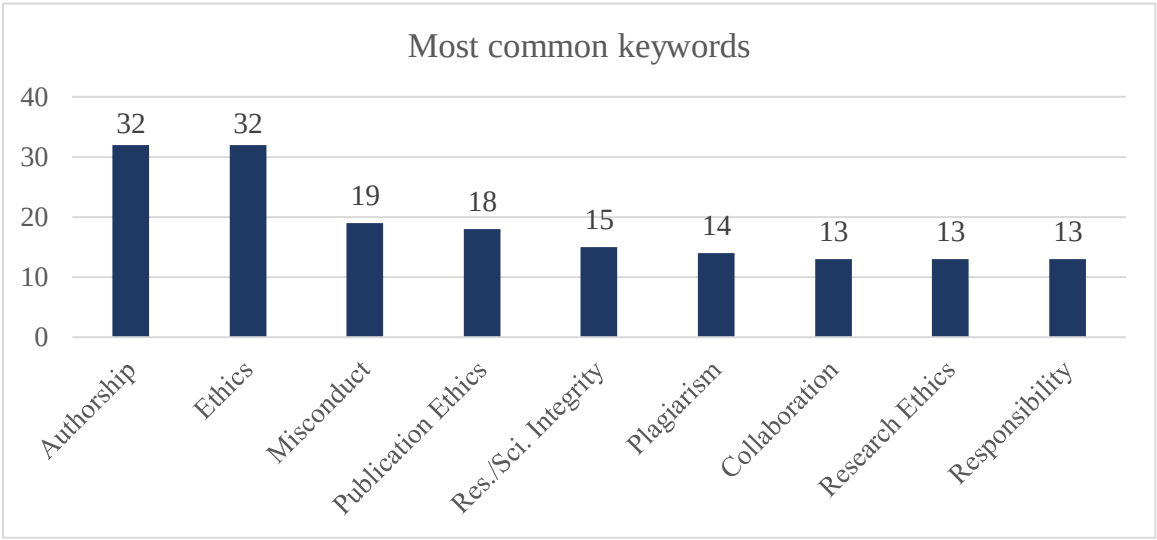


Figure 5. Most common keywords within the sample.

2.4.2 Most common ethical issues

A close reading of the selected sample resulted in the identification of 10 core ethical issues that each contain several sub-issues and questions. Figure 6 shows the ranking of these items based on the number of items that mention these issues.[12] It should be noted that some documents mention more than one issue.

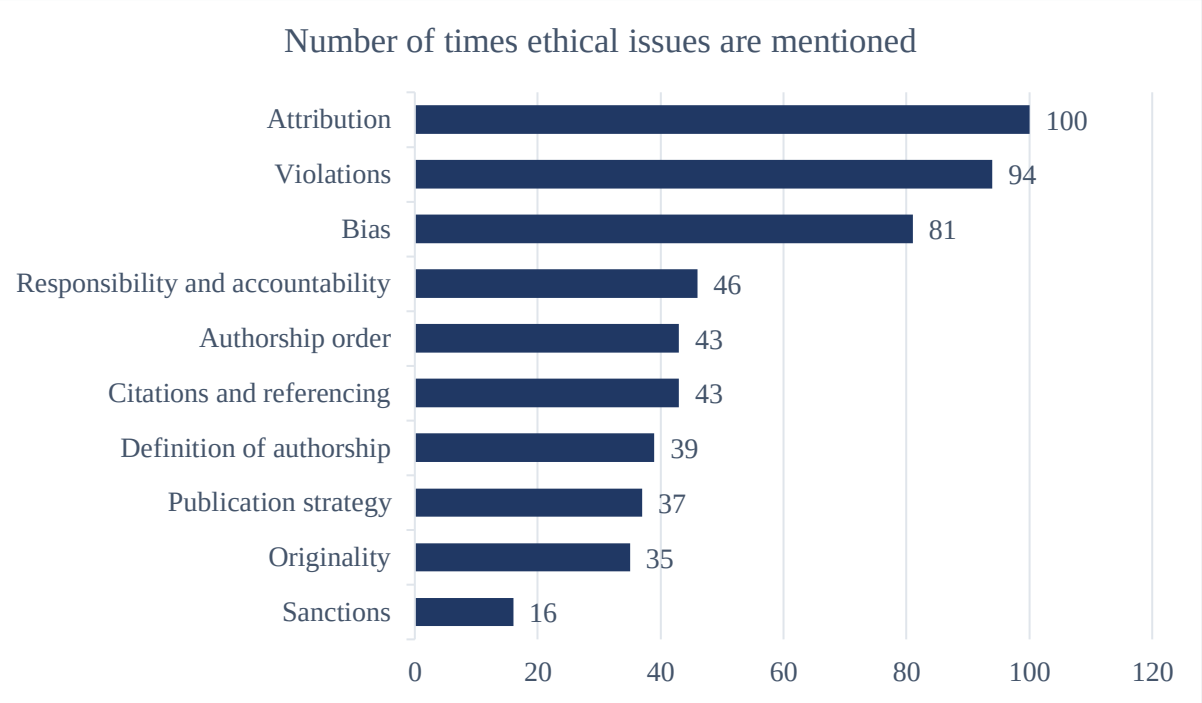
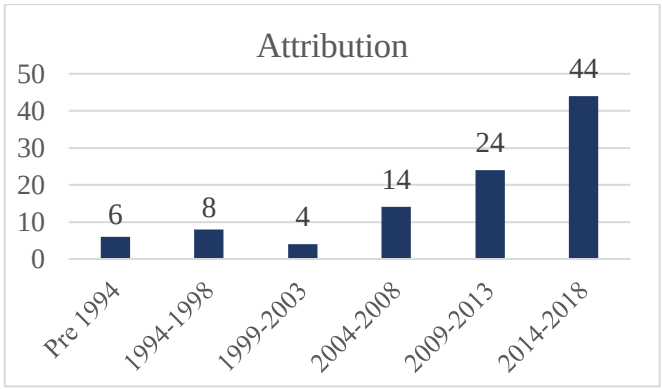


Figure 6. Ethical issues ranked on the basis of their occurrence in the literature.

1- Attribution (100 documents)



[12] Although specific discussions within each theme might have changed over time, it has not been the focus of this review to explore these changes from a quantitative perspective.

Figure 7. Frequency of occurrence in the sample- Attribution.

Ethical issues related to attribution (Figure 7) pertain to factors that should be considered in recognising contributors' efforts in publications. Recognising one's contribution implies that their work was regarded as necessary/useful for the publication, which entitles them to some form of credit. The awarded credit can take various forms, such as authorship status and being mentioned in the acknowledgment section of a publication. An improper distribution of credit either leads to giving credit to those who do not deserve it or withholding credit from those who actually deserve it (Chen 2011; Anderson 2013; Youtie & Bozeman 2014; Adeney 2015; Bozeman & Youtie 2016).

The discussion about attribution of credit involves two more specific debates. The first is about the type of recognition that different kinds of contributions deserve. Some authors suggest that inherent ambiguities about collaboration to modern scholarly projects complicate the recognition of contributors' work and the making of a clear distinction between various tasks (Wagner et al. 1994; Eisenberg et al. 2014; Rajasekaran et al. 2014; Syed et al. 2015). The notion of intellectual contribution and its differences with non-intellectual contributions is among the most contentious issues that might complicate the recognition of some tasks (Colledge et al. 2013; Helgesson 2015; Hammer & Miaskowski 2017). For example, tasks such as writing assistance provided by professional writers are deemed as substantial for improving clarity and structure, but they can be seen as non-intellectual, and are sometimes not rewarded with any kind of recognition beyond monetary compensation (Morley 2013; Shashok 2013; Wager et al. 2014). The so-called non-author contributions (e.g., routine tasks such as enrolling patients for clinical trials) are another group of tasks that seem often overlooked and not sufficiently credited in publications (Mentzelopoulos & Zakynthinos 2017).[13] Furthermore, the form of credit that is awarded to contributions seem to vary significantly across disciplines (Mendez & Angeles

[13] Attitudes toward some non-author contributions are changing. For more on this topic and an example, see the last subheading in the discussion section titled "Future research, from author to contributor".

Alcaraz 2015; Jabbehdari & Walsh 2017; Logan et al. 2017), which is seen as a factor that complicates the attribution of credit in multidisciplinary projects (Hays 2010; Cutas & Shaw 2015; Galdas 2016).

The second debate is not about the kind of contribution but the extent to which one must contribute to a certain task, in order to be eligible to receive various forms of credit. In other words, after having clarified the kind of credit that should be awarded to each contribution-type, the extent of contribution that is required to deserve that particular type of credit needs to be clarified (Bebeau & Monson 2011). Various factors are considered in these discussions. For instance, the notion of a significant or substantial contribution as a requirement for authorship has triggered extensive discussions (Lynch 1994; Jeffery 2014). Some maintain that researchers have developed "rules of thumb" regarding what constitutes a significant contribution, but these rules might bend depending on the value of resources possessed by different parties (Louis et al. 2008, p. 105).

Furthermore, a bias toward overestimating one's own inputs (Lissoni et al. 2013), and inaccurate perceptions about the extent and importance of others' contributions are believed to complicate the evaluation of the extent of the contributions of different collaborators (Ivanis et al. 2011; Jian & Xiaoli 2013).

2- Violations (94 documents)

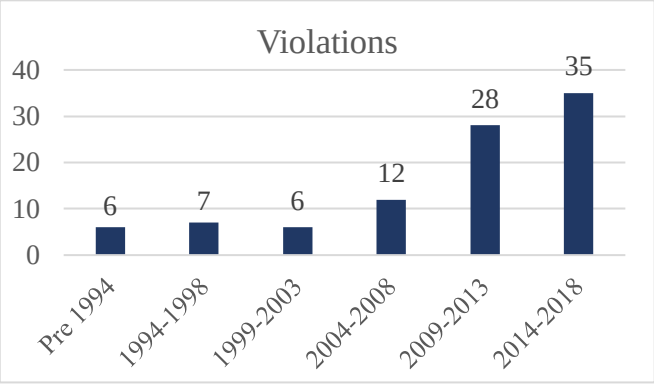


Figure 8. Frequency of occurrence in the sample – Violations.

Discussions subsumed under the theme of violations mainly centre around the precise nature of violations of norms of authorship and the best solutions for tackling them (Figure 8). Regarding the nature of violations, one question is the difference between serious violations and questionable practices as well as the difficulties in drawing a line between the two (Fenton & Jones 2002; Marcovitch et al. 2010; Matthes et al. 2015; Pickett & Roche 2018). While serious violations are linked with fabrication, falsification and plagiarism, the so-called questionable practices are believed to be much harder to identify, and difficult to frame as a violation (Steinbok 1995; Price et al. 2001; Das & Biradar 2016). For example, exploiting/overburdening research subordinates to publish more, adding honorary authors, or excessive self-citations are among questionable practices that have no immediate effect on the veracity or quality of scientific claims but are problematic all the same. These problematic practices are called misdemeanours (Badaway 1996) or questionable practices (Rubenstein et al. 1989). Similarly, a failure to raise ethical concerns or report misbehaviour of others is not always easy to identify and frame as a violation (Wenger et al. 1999; Satalkar & Shaw 2018).

When it comes to the proposed solutions to tackle violations, disagreements are noticeable. Some believe that by improving current authorship guidelines and promoting them (Horner & Minifie 2011; Chattopadhyay 2014; Jawaid 2015), or by making them more specific, the rate of violations will go down (Wager & Kleinert 2013). However, others believe that without having stricter control mechanisms in place to make sure that policies are implemented and enforced, guidelines are not likely to be effective (Berardo 1993; Rizk 2007; Lissoni & Montobbio 2015). One problem with using guidelines as a solution for tackling violations (especially in international projects) is the discrepancy between different guidelines in terms of their definition of misconduct (Rockwell 2002; Redman 2013). For example, while the national policy on research integrity in Brazil lists self-plagiarism in parallel with fabrication, falsification and plagiarism as an instant of misconduct, “some of the most well-known definitions of research misconduct [in

other countries, e.g., Australia, Canada, Germany, Sweden, United States] do not include any form of self-plagiarism as a type of misconduct" (Vasconcelos & Roig 2015, p. 4).

Another difference of opinion among experts concerns proposals that suggest the initiation of early conversations among contributors to specify authors and order of names. Some take early conversations to be a reasonable measure to mitigate unfairness and bias (that may be due to disciplinary preferences) towards certain contribution types (Smith & Master 2017), and also helpful in avoiding disputes (Hess et al. 2015). Others claim that authorship "cannot be determined until a publication is developed" (Wager et al. 2014, p. 7), and that the presence of unequal relationships challenges the effectiveness of early agreements (Bozeman & Youtie 2016).

The successful application of technology in detecting plagiarism has encouraged suggestions to use software programs to detect authorship anomalies (Shinyaeva & Tarasevich 2018), improve the planning and supervision of projects, and minimise mistakes/mishaps that contribute to violations (DeTora et al. 2015; Das & Biradar 2016, 2018). While supporting whistle-blowers is seen as an effective solution in extreme cases (Beisiegel 2010; Bonito et al. 2012), the suggested long-term solution is moving away from detection and retraction toward prevention of violations (Marušić 2005). In fact, training programmes and researcher education are often mentioned as effective solutions for preventing violations (Benos et al. 2005; Arda 2012; Fang et al. 2012; Cabral et al. 2015).

3- Bias (81 documents)

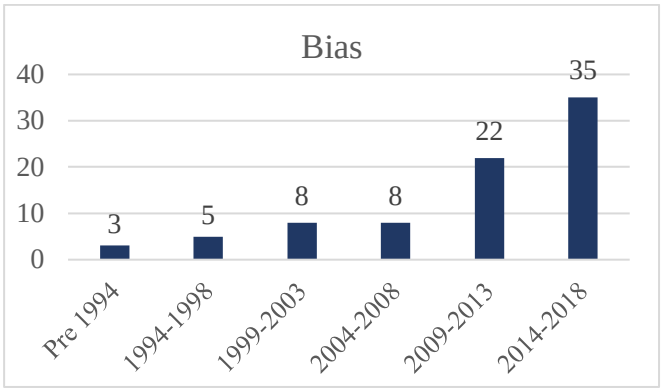


Figure 9. Frequency of occurrence in the sample – Bias.

Issues related to bias in authorship (Figure 9) are framed as a financial or non-financial conflict of interests (COIs). Financial COIs are often explored in parallel with discussions about collaborations between academia and industry, and sponsors' influence on authors' independence (Edwards & Bhopal 1999; McComas 2008; Adams 2009; Moeller 2009; Miller et al. 2017). Lack of clear definitions of COIs (Patel et al. 2011), inadequate guidance on declaring COIs (Rohwer et al. 2017), and discrepancies between institutional and national guidelines or between various universities and professional societies are seen as factors that complicate compliance with guidelines about COIs (Hillman et al. 1991; Lanken et al. 1995; Woteki 2006).

While some COIs might be inevitable (e.g., in case of scientists who move between academia, industry, and government), disclosure of conflicting interests and provision of additional information about these interests is believed to enable readers to place credence in presented data (Marcovitch et al. 2010). That said, it is also argued that disclosing sources of funding might not reveal much about funders' actual pressure on researchers (Kukla 2012; Morley 2013), or their economic interests (Pardo-Hernandez et al. 2018). Furthermore, in some cases the disclosure of financial sources might actually worsen reporting bias, as it may increase authors' inclination to exaggerate results "in anticipation of reader discounting brought about by financial disclosure" (Johnson 2013, p. 2244).

Discussions about non-financial COIs involve a broad range of issues, five of which are mentioned here. The first is bias in hypothesis-based studies, which formulate hypotheses and

test them through experimentation. It is argued that since hypothesis-based studies rarely reject their initial hypothesis (Stern & Simes 1997; Hall et al. 2007; Rost & Ehrmann 2017), and many studies do not even mention their hypothesis in publications, identifying bias in hypothesis-based studies is challenging (Kilkenny et al. 2009). Not publishing negative results and zero-relations (so-called file-drawer problem) is an issue which a range of non-author parties bear responsibility for, such as the editorial staff and the readers of journal articles who might not accept, or read/cite these articles (Jennings & VanHorn 2012; Kepes et al. 2014; Meerpohl et al. 2015; Mueller 2018). While determining the research methodology in advance (Marco & Larkin 2000) and preregistration of studies are suggested as possible solutions for preventing biased hypotheses (Schmucker et al. 2014), even preregistered studies with negative results might be published in ways that convey a positive outcome (Dawson & Dawson 2018). Another form of biased hypothesis is called "HARKing" (Hypothesising After the Results are Known), which leads to false-positive and improbable interpretations (Kerr et al. 2015, p. 225).

Discussions about the second issue, the biased use of language, analyse the text from a reader's perspective, highlighting linguistic features that could mislead the reader. Examples of language bias include the use of confusing, inaccurate, equivocal, metaphoric, euphemistic and exaggerated statements (Schreiber 2005; Walcott et al. 2012; Kueffer & Larson 2014; Abrams et al. 2015; Vinkers et al. 2015). The requirement to use formal language and portray the research process as ultimately planned and predicted is believed to result in a constructed text that misleads readers about what actually happened (Webster 2003). While using the passive voice is sometimes believed to mislead readers about individual contributions and responsibilities (e.g., *1 kg of topsoil was taken* instead of "The technician took 1 kg of topsoil") (Webster 2003, p. 218 [part in italics added]), using the active voice would not always guaranty ethical behaviour and an accurate reflection of research process (Gray 2017).

The third issue relates to biased interpretations of results and their difference with outright falsification (Finney 1995). For example, unethical use of statistical methods that leads to

favouring/cherry-picking specific aspects of results is seen as a biased interpretation of results (Irvin 2009; Kilkenny et al. 2009; Wicherts et al. 2011; Wang et al. 2018). Furthermore, while changing a key variable to improve results is seen as an instance of falsification, omitting necessary information to make the interpretation appear relevant and sound is seen as an ethical issue pertaining to biased interpretation of results (Payne & Ireland 2015).

The fourth issue involves scientific visuals. Correcting, improving, or manipulating images to exaggerate findings, or present a prejudiced view of results are frowned upon (Zietman 2017). Questions about the acceptability of various degrees of correction, and what distinguishes acceptable improvements of an image from unacceptable ones (image manipulation) are mentioned in some studies (Carraway 2009; Jernstedt 2014). Selective illustration of results or summarising preferred parts of the results in figures are among other problematic uses of visuals (Reiss 2014).

Discussions about gender bias, the last issue mentioned here, focus on disparities between male and female authors in relation to the attribution of credit and rewards. For example, authors' positions in the byline (Walshbowers 1995; Arauja & Fontainha 2017; Lerchenmueller et al. 2018) and chances for receiving grants are sometimes believed to be influenced by gender (Pereira & Diaz 2016). Another type of gender bias occurs when the gender composition of a group of authors is said to influence the way in which certain topics are addressed in research (e.g., "male scholars being more oriented towards diseases concerning the male body and women vice versa") (Andersen et al. 2016, p. 853).

4- Responsibility and accountability (46 documents)

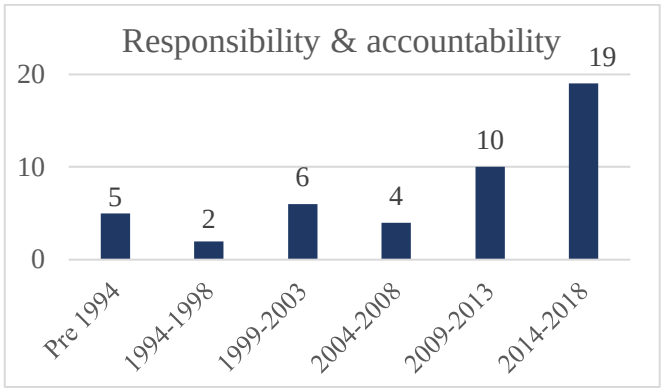


Figure 10. Frequency of occurrence in the sample – Responsibility and accountability.

Responsibility and accountability (Figure 10) are mainly discussed in the context of collaboration and co-authorship. Not being able to hold contributors accountable when problems arise is believed to have an adverse effect on the quality of findings (Wray 2006) and society's trust in the communicated science (Cronin 2001). Thus, clear responsibilities in relation to content, which can later be used to hold individual contributors accountable for certain elements of what is published is seen as an essential aspect of authorship (Tobin 2000; Kukla 2012; Jeffery 2014; Adeney 2016; McNutt et al. 2018).

In research projects that include a variety of tasks or very large tasks with numerous contributors, responsibilities might be difficult to delineate and hence, holding individuals accountable could be challenging (Saxon 2001; Carraway 2009; Mongeon et al. 2017). Given the broad spectrum of specialties involved in large research projects, expecting contributors to know the exact details and quality of work done by others[14] (and vouching for it) is impractical, if not impossible (Schechter et al. 1989; Jones 2003; Clement 2014; Smith & Master 2017).

[14] This concern is mainly raised in response to the fourth authorship criteria put forward by the International Committee of Medical Journal Editors that obligates authors to know the exact details of contributions made by every other author: "Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. In addition to being accountable for the parts of the work he or she has done, an author should be able to identify which co-authors are responsible for specific other parts of the work. In addition, authors should have confidence in the integrity of the contributions of their co-authors" (ICMJE 2019, p. 2).

Consequently, the rationale behind the idea of holding all contributors accountable for the entire work is questioned (Relman 1990; Smith et al. 2014).

Responsibility is sometimes interpreted in terms of the obligations and duties of senior authors in mentoring and protecting young scholars (Hays 2010). This interpretation of responsibility obligates senior researchers to guide/usher young scholars in the process of authorship and help them beyond what policies and guidelines offer (Netting & Nichols-Casebolt 1997; Syed et al. 2015; Bozeman & Youtie 2016). Furthermore, senior figures have a responsibility to ensure that all contributions (including those of young scholars) are acknowledged (Welfare & Sackett 2011; Andes & Mabrouk 2018).

Junior researchers are believed to lack a thorough awareness of guidelines and their application, and consequently, their responsibilities are believed to be different from senior researchers (Street et al. 2010; Chen 2011). In addition, due to uncertain career prospects and the absence of permanent contracts, early-stage researchers might be reluctant to raise questions or concerns about abusive/unethical/questionable behaviour that involves figures of authority (Newman & Jones 2006; Karani et al. 2013).

5- Authorship order (43 documents)

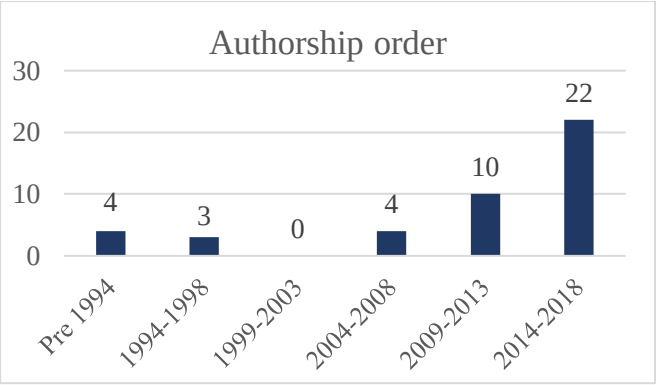


Figure 11. Frequency of occurrence in the sample - Authorship order.

Three questions dominate the discussion about the authorship order (Figure 11). The first is about the criteria that should be used to decide in which order to list authors' names, for

example, alphabetical or relative to the contribution (Smith et al. 2014). Disciplinary differences in terms of meaning and/or implications of the sequence in which authors are listed are seen as factors that complicate a universal understanding of authorship order (Garfield 1978; Maciejovsky et al. 2009; Cutas & Shaw2015; Kassis 2017; Stvilia et al. 2017). While some authors propose user-friendly systems for listing authors' names that would be useful/acceptable to all disciplines (Baerlocher et al. 2007; Jawad 2013; Warrender 2016), others believe there is no simple solution for authorship order quandaries (Jeffery 2014).

The second question concerns power dynamics and how unequal relations affect authorship order (Washburn 2008; Street et al. 2010; Bozeman & Youtie 2016; Hammer & Miaskowski 2017). Given that some positions are more coveted than others (e.g., first or last position), competition for occupying these places contributes to tensions that require solid negotiation skills to address (Lissoni et al. 2013), and may result in unfair treatment of less powerful authors (Jian & Xiaoli 2013; Lerchenmueller et al. 2018).

The third question concerns the relationship between authorship order and the anticipated responsibility from one's place in the sequence. It is argued that in the absence of contributorship statements, the responsibility of authors is not always clear from their authorship order (Endersby 1996; Mongeon et al. 2017). Since authorship order might also be used to indicate seniority (e.g., securing the last position for the most senior member), occupying a particular position could obscure responsibilities (e.g., if the most senior author is expected to take overall responsibility for the integrity of the work but the last position is not occupied by the most senior person) in relation to published claims (Lissoni & Montobbio 2015). Suggestions to list middle authors randomly (Kremenak 2010) or listing all/some of the co-authors alphabetically across all disciplines are also believed to obscure responsibilities (Youtie & Bozeman 2014).

6- Citations and referencing (43 documents)

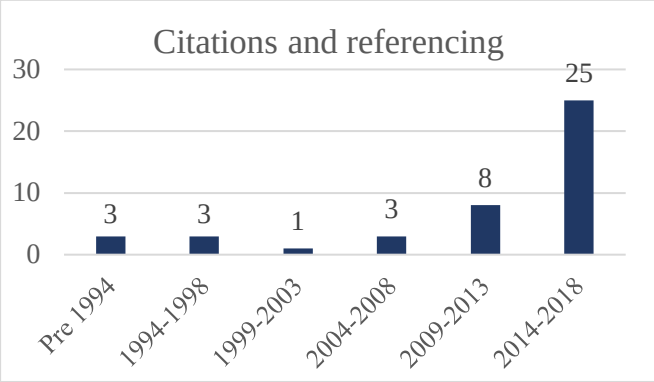


Figure 12. Frequency of occurrence in the sample – Citations and referencing.

The debate about citations and referencing (Figure 12) focuses on four major issues. The first concerns the employment of various methods to increase citations. An example is excessive self-citations and how such a practice differs from appropriately citing one's own work in subsequent research (Bilic-Zulle 2010; Fong & Wilhite 2017). While some self-citations are necessary, the publication of several short papers to facilitate more self-citations is considered excessive (Flatt et al. 2017).

Teaming up with some co-authors/colleagues and only citing articles of a certain group, the so-called citation cartels (Zietman 2017), and selective citations that involve a careful selection of available evidence to corroborate desired claims[15] are other examples of unethical use of previously published work (Cope & Allison 2010; Neusar 2015). Another problematic method to increase citations is called coercive citation that is imposed by peer-reviewers or journal editors to improve reviewers'/editors' citations or the journal's ranking (Statzner & Resh 2010; Lee & Jun 2014; Gasparyan et al. 2015).

The second issue is concerned with how researchers interact with the referenced material and sources (Rudolph 2015). For instance, inaccurate citations, copy-pasting references, using a publication or dataset without acknowledging it (citation amnesia), and referencing sources

[15] If available resources are selectively used to make one point of view look more supported/justified, or make desired conclusions, this issue can also be seen as a form of bias.

without (a full) reading/comprehending them are among reproached behaviours (Garfield 1982; Dayton 1992; Stoker 1996; Mooney 2011; Liang et al. 2014).

The third issue is superfluous referencing. At a certain point adding more references might not improve the validity of claims (also called padding). Accordingly, this is considered as an attempt to increase the chances for publication (e.g., by citing many popular sources) or to give an impression of thoroughness (e.g., when some of the cited sources might not have directly inspired authors or are common knowledge) (Statzner & Resh 2010; Chattopadhyay 2014; Neusar 2015).

The last issue pertains to plagiarism. While verbatim plagiarism is a clear-cut violation of codes of conduct and considered a fraudulent practice, other forms of appropriation can be problematic as well (Saha 2017; Vassallo 2018). Examples are patch-writing that involves combining borrowed and original text, using extended paraphrases, copying the structure of other texts (Cameron et al. 2012; Dougherty 2017), and rewording old ideas to make them sound new (Sly 1997). These practices would not always be identified, let alone be treated as plagiarism (Swaan 2010). Other forms of plagiarism include self-plagiarism, which is generally understood as researchers reusing their own previously published text without acknowledgment (Daroff 2007; Dixon 2014; Vasconcelos & Roig 2015), and translational plagiarism that involves copying text from sources in another language (Qu and Wiwanitkit 2015; Baydik & Gasparyan 2016). Some authors stress the importance of personal intentions in considerations about plagiarism and make distinctions between flat-out wrongs (e.g., exact copying of text while knowing that plagiarism is inappropriate) and regrettable but understandable mistakes (e.g., unintentionally forgetting to cite used work) (Gotterbarn et al. 2006; Noyori & Richmond 2013).

7- Definition of authorship (38 documents)

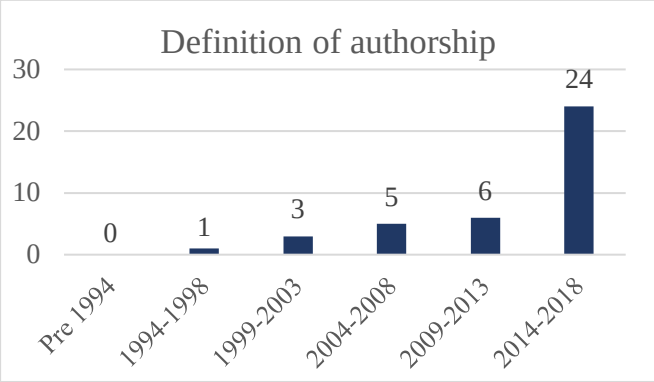


Figure 13. Frequency of occurrence in the sample - Definition of authorship.

Debates about the definition of authorship (Figure 13) are concerned with different criteria for accrediting authorship status and the challenges of reaching a consensus about how to apply and uphold them (Teixeira da Silva 2015; Tang 2018). One of the questions discussed is how to interpret the differences between the standard requirements for authorship, and the way authorship is awarded in practice (Jones 2003; Louis et al. 2008; Bebeau & Monson 2011; Moffatt 2011; Shashok 2013). While some studies consider researchers' awareness of authorship criteria (e.g., ICMJE criteria and their implications in a research context) as an indicator of ethical authorship (Alshogran & Al-Delaimy 2018), others believe that mere awareness is not helpful because these criteria are often unworkable in practice anyway (Sheikh 2000). In particular, due to the steady increase in the average number of co-authors per publication (Cronin 2001; Ludvigsson et al. 2018), strict application of definitions of authorship (e.g., in case of the ICMJE criteria, a strict application would require every named author to meet all four authorship criteria) to modern research contexts is becoming impractical (Garcia et al. 2010). Since a strict application of authorship criteria may lead to exclusion of some contributors, in practice, some researchers may find it reasonable to make their own interpretations of authorship criteria to avoid tension (Gollogly & Momen 2006; Uijtdehaage et al. 2018).

It is also common to criticise authorship criteria and compare different definitions of authorship with each other to find out which would be the most appropriate to cope with the ethical challenges of attributing authorship in different disciplines (Colledge et al. 2013; Teixeira da Silva

& Judit 2016). For instance, the definition provided by the International Committee of Medical Journal Editors (ICMJE) is compared with definitions provided by other influential organizations such as those by the World Association of Medical Editors (WAME) to explore their adequacy in coping with ethical issues of various disciplines (Logan et al. 2017; Moffatt 2018). Sometimes a specific research methodology (e.g., sociological participatory research with non-academic collaborators) is chosen to expose the shortcomings of authorship definitions in crediting all the contributors (Sarna-Wojcicki et al. 2017).

8- Publication strategy (37 documents)

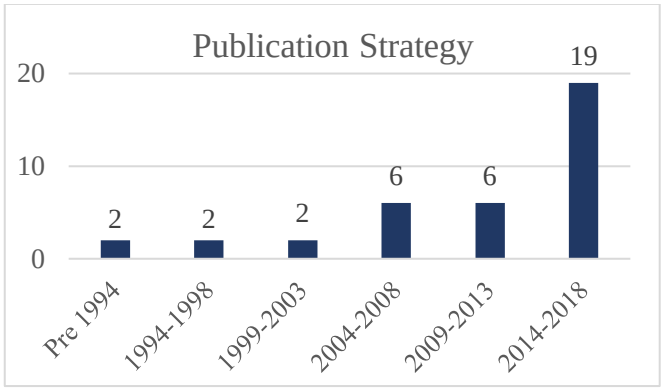


Figure 14. Frequency of occurrence in the sample - Publication Strategy.

In planning to increase their publications' visibility or success, researchers might get involved in strategic behaviour (Hayer et al. 2013) that sometimes makes them look more like entrepreneurs (who are continuously worried about money/funding and have to act in a calculating manner) rather than serious scholars (Zwart 2005). Several kinds of strategic behaviour (Figure 14) are discussed in the literature. Discussions about the necessity for a full disclosure of all the available results are often debated in the context of collaborations between academia and the industry. For example, there are worries about hiding and censoring information, or partial publication of results (Song et al. 2009; Matheson 2016; Miller et al. 2017). When it comes to the disclosure of methodologies, concerns are raised about leaving vital parts out to cover flaws (Mack 2018), and not sharing unique methods or the underpinning software that were integral to the findings (Cech et al. 2003; Gavaghan 2018). A reluctance to

publish all the available data, methods, or results is linked with the fear to have errors and biases exposed (Wicherts et al. 2011), or to help the competition to catch up (Bunnett 1983; Munro 1993).[16]

Choosing the time of publication merely to improve impact, is also seen as a strategic decision that might be problematic, because results should be published as soon as they are known (Rost & Ehrmann 2017). Other examples pertaining to questionable practices regarding the time of publication include the publication of intermediate but unverified results (Keohane et al. 2014), the reporting of results only after having registered a patent (Lissoni & Montobbio 2015), or the delayed communication of novel methods to keep the competitors behind (Boyer 2014).

Sometimes journals are chosen strategically for the submission of manuscripts. Choosing journals that have less rigorous editorial and peer-review procedures, or journals where authors have close relations with the editors (to speed up the publication process) are among the examples mentioned (Chen 2011). Another example is publishing controversial or sensitive issues in irrelevant journals with less visibility to minimise the likelihood of being noticed by media, public or lawyers (Rier 2004). While publishing in journals that promote a political agenda attracts both support and critique (Glick et al. 2015), publishing manuscripts in journals merely due to impact factor without considering their target audience is frowned upon (Rowlands et al. 2004).

Another example of questionable behaviour is being possessive and territorial about research topics and projects in order to improve the likelihood of success. Using personal authority to stop others from entering a scientific field (Sheikh 2000), and cherry-picking authors/collaborators merely due to their reputation or gender (and thereby controlling who will enter a certain field or gets involved in interesting projects) to reach desired outcomes are

[16] It should be noted that some of these issues could also be subsumed under the theme of bias. The reason why they are mentioned here is because these studies frame these behaviours as strategic.

among mentioned examples (Charlton 2008; Arauja & Fontainha 2017; Johal et al. 2017; Stvilia et al. 2017).

9- Originality (35 documents)

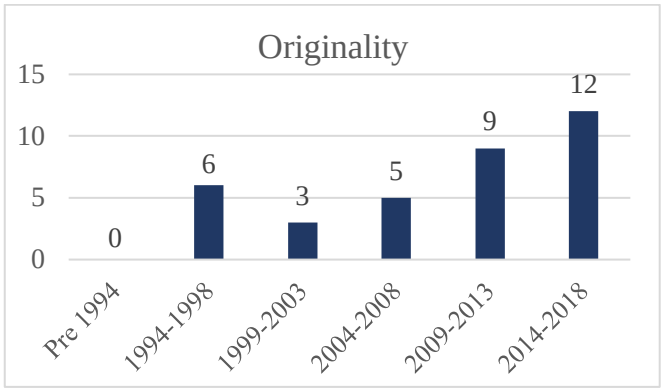


Figure 15. Frequency of occurrence in the sample – Originality.

Discussions about originality (Figure 15) are concerned with the noteworthiness and importance of new findings (Interrante & Reichmanis 2005; Mueller & Soares 2017). Having made noticeable progress compared to previous publications and extending available knowledge are considered as necessary requirements of originality, and a prerequisite for publication of new material (Steinbok 1996; Jerrells 2001; Lariviere & Gingras 2010). In contrast, attempts to publish manuscripts that have substantial similarities with previous publications (Amos 2014), massaging data used in previous publications to publish a new article (Chanson 2009; Rohwer et al. 2017), or publishing a series of short articles that include very thin slices of information are seen as unethical (Svensson & Andersson 2013; Meyer et al. 2016; Flatt et al. 2017). Furthermore, hiding similarities with other studies or not disclosing them when there are substantial overlaps (to make the study look original) are regarded as clandestine efforts that increase the noise-to-signal ratio (the ratio of nearly identical/irrelevant publications to original/useful publications) in the academic record (Barker 1994; Riis 1994).

10- Sanctions (16 documents)

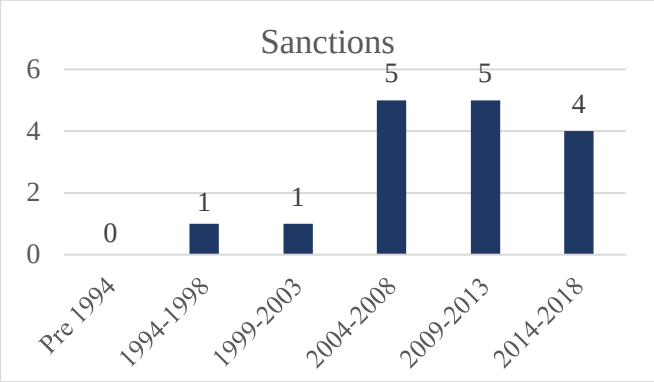


Figure 16. Frequency of occurrence in the sample – Sanctions.

What should happen to the culprits of scientific misconduct? What are proportionate sanctions? (Figure 16). Increasing the social and personal costs of trespassing norms of scientific integrity is sometimes seen as an appropriate punishment (for culprits) that also deters malpractice (Cotter & Shattil 2006; Horner & Minifie 2011). For instance, some authors propose using strict or permanent punitive measures (Gotterbarn et al. 2006; Wong & Hui 2015), enforcing zero-tolerance standards (Goldberg 2006), or even criminalising scientific misconduct (Pickett & Roche 2018). However, others believe that shaming culprits has not been effective and is not likely to improve research behaviour (Hatcher 2011; Saurin 2016). While some studies highlight the complexities of making sanctions proportional to the severity of violations (Price et al. 2001), others simply go ahead and rank different forms of misbehaviour and suggest sanctions (Marcovitch et al. 2010; Levin 2011; Foo & Wilson 2012).

2.5 Discussion

The role of codes of conduct and guidelines

In discussions about ethical issues of scholarly authorship, disagreements are noticeable when it comes to reliance on institutional/international codes of conduct. Some authors (Gandy 2007; Freedman 2008; Cohen et al. 2012; Shewan & Coats 2012; Dhammi & Ul Haq 2017) focus on various forms of misconduct (e.g., guest/ghost authorship) and fraud (e.g., data fabrication), which are clearly banned in codes of conduct. Accordingly, ethical authorship is understood as

steadfastly following the prescriptions of codes of conduct. This interpretation is often followed by references to various codes and guidelines, to remind researchers of the fact that when it comes to authorship of scholarly results, certain norms should be taken into account and as long as these are being upheld, ethical problems will be prevented. The proponents of this view seem to assume that prescriptions are sufficiently relevant to practice and clear enough to serve their purpose. Under this assumption, scholarly authors have the necessary instructions to make ethical decisions regarding the authorship of research results, and the transgressors are guilty of not having followed the available prescriptions (Hodge et al. 2012).

In contrast to the above understanding, the ethical issues related to authorship are sometimes interpreted as complicated matters in grey areas that cannot be fully captured by codes of conduct (Bulger 2004; Svensson & Andersson 2013). Hence, researchers cannot make correct judgments about ethical issues by simply relying only on codes or guidelines (Tabbara & Al-Kawi 2006). In this interpretation, researchers would have to rely on resources other than codes of conduct (e.g., intuition, experienced colleagues, role models, etc.) to find out what is the right thing to do. Issues such as authorship order or what counts as a significant (intellectual) contribution to a paper cannot be readily clarified in codes of conduct because reaching a consensus about these issues is not straightforward.

The proponents of the first approach (who support a steadfast adherence to the prescriptions of codes of conduct) seem to expect codes of conduct to provide "the decision support mechanism necessary to address ambiguous and complex ethical dilemmas" and enable ethical decision making (Hatcher 2011, p. 145). Accordingly, certain features are required for codes of conduct to facilitate the making of (ethical) decisions. These features include ease of adherence to their prescriptions (Alshogran & Al-Delaimy 2018), ease of understanding the provided prescriptions (Nambiar et al. 2014), sensitivity to structural issues (Jabbehdari & Walsh 2017), objectiveness (Pellizzon et al. 2007), and explicitness (Lissoni & Montobbio 2015). This approach can be regarded as based on a deontological conception of ethics where norms should be obeyed, and

noncompliance amounts to immorality. In this understanding, what makes a choice right/wrong is its conformity/nonconformity with prescribed moral norms (e.g., those mentioned in codes of conducts), and all agents (e.g., researchers) should obey norms regardless of the consequences.

The proponents of the second approach (who believe that ethical issues cannot be fully captured by codes of conduct) seem to favour the view that codes of conduct cannot always provide specific guidance on how we should act in every single situation because there are myriads of unique situations that cannot be covered by codes (Welfare & Sackett 2011). In other words, there are no universal action-guiding principles that are applicable to all different scenarios and disciplines. Proponents of this approach claim that codes of conduct should identify values and beliefs, discuss concepts (Matheson 2016), and promote moral and social values (Stichler 2014). This view of the role of codes of conduct seems more in line with a virtue-cantered approach to ethics and considers codes of conduct as aspirational documents. A virtue-cantered approach holds that norms are not always codifiable, and it is unrealistic to apply norms to practice without experience or moral exemplars.

What can be achieved with codes of conduct and guidelines?

The aforementioned difference in the envisaged role of codes of conduct is also mirrored in discussions regarding what can be achieved with them. Those who consider codes of conduct and guidelines as the ultimate solution to unethical authorship regard the lack of adherence to guidelines as a major contributing factor to ethical problems in relation to authorship. This point of view implies that whether through current guidelines or improved ones, having a set of principles and heavily promoting them to achieve 100% compliance seem necessary (and sometimes sufficient) for preventing these ethical problems (Wester 2011; Hernandez-Ruiz 2016; Kassis 2017; Ludvigsson et al. 2018; McCuen 2018). The idea of using guidelines as the ultimate solution for tackling ethical issues and violations also suggests that for the proponents of this approach, creating the perfect guideline does not seem to be an unreasonable idea.

In contrast, those who are sceptical of what can be achieved with codes of conduct and guidelines argue that relying on these codes and guidelines has thus far not been successful, and therefore, alternatives such as putting more stress on self-regulation (Hatcher 2011; Barrios et al. 2017), and the promotion of virtues and role models should be taken more seriously (Pitak-Arnnop et al. 2011). While not denying the importance of codes of conduct, these authors propose using other methods that would help to internalise good practice (Tobin 2000; Levin 2011; Penders 2017). Examples are fostering discussions and negotiations (Galdas 2016; Sarna-Wojcicki et al. 2017), creating awareness via training and modern educational techniques (Buckwalter et al. 2015; Payne & Ireland 2015; Rosenkrantz & Ginocchio 2016; Rost & Ehrmann 2017), as well as using role models to motivate reflection and adjustment (Agoramoorthy 2014; Rohwer et al. 2017; Eisenberg et al. 2018).

Codes of conduct and guidelines in international collaborations

Things become more complicated in the context of co-authorship within international collaborations where authors may use/know dissimilar codes of conduct. For instance, some studies highlight the absence of a global understanding of issues such as authorship criteria (Cronin 2001; Moffatt 2018), the order of authors (Jian & Xiaoli 2013), or conflicting interests in the context of international multidisciplinary projects (Rohwer et al. 2017). However, since most of these studies also confirm the presence of different norms and practices across disciplines or local protocols, it is not clear whether creating a global code of conduct would be possible or at all helpful. Even if creating a global code of conduct that equally applies to all partners in international collaborations were possible, adherence to such a code would be a much more complicated matter, because these codes might not always conform with local/institutional codes. In other words, global codes of conduct could only be successfully adhered to if all the national or institutional guidelines (that may be different from the global code of conduct) are abolished/rescinded. Where international standards currently do exist, they are not uniformly

endorsed[17] or equally enforced by all partners in international collaborations. For example, in cases where discrepancies between journal guidelines and national society ethics codes (Elliott et al. 2017; Logan et al. 2017), or, institutional guidelines and international standards do exist (Colledge et al. 2013) selecting one guideline over another may become a matter of personal preference.

Different understandings of culture and its role in shaping individual conduct

Although culture is often seen as an important factor in shaping individuals' behaviour, within the reviewed documents in this chapter, the term "culture" is sometimes under-defined and used without appreciating its complexities. This can lead to ambiguities about 1) the extent to which researchers can alter their behaviour, 2) the extent of researchers' autonomy, and 3) the responsibilities of individual researchers when it comes to upholding ethical norms. Since within debates on ethical issues related to scholarly authorship it is possible to interpret "culture" in different ways, this chapter suggests a more attentive use of this term to prevent ambiguities or lack of respect.

(1) In relation to whether researchers' behaviour is changeable, culture is sometimes used to highlight differences in the norms and values of researchers from different countries. Accordingly, culture brings with it a set of norms and values that are automatically instilled into individuals brought up in that culture. Thus, individuals' understanding of norms of authorship is formed by, for instance, "Confucian influenced cultures" (Cameron et al. 2012, p. 52), "local culture" (Cronin 2001, p. 567), or "national culture" (Tucker et al. 2011, p. 2). An important implication of this understanding of culture is that the moral reasoning and behaviour of researchers within a certain culture are controlled and regulated – to a certain extent – by the moral fabric of that culture. These interpretations of culture seem to suggest that the behaviour

[17] As mentioned in this chapter, different national guidelines may have a different interpretation of what constitutes misconduct. On that basis, what is prescribed in a global guideline might not always be endorsed by national authorities.

of researchers from certain cultures might be difficult to change simply because of their cultural imprint.

(2) In addition to geographic descriptions of culture, there are notions of culture that are primarily associated with certain institutions or academic disciplines. In this understanding, culture seems to be something that individuals acquire during their professional lives and eventually internalise. Examples of this notion of culture are “general scientific culture” (Holm and Hofmann 2018, p. 1), “institutional culture” (Rohwer et al. 2017, p. 1), and “disciplinary culture” (Smith and Master 2017, p. 4). In this understanding of culture, researchers largely agree with the prevalent norms and values of their working environment (whatever they may be). This interpretation of culture considers researchers as a conformist group with limited autonomy (to raise ethical concerns), because by default they simply tend to comply with available disciplinary and institutional norms. In other words, if researchers eventually comply with all the available norms and internalise the culture of their environment, they would be very unlikely to raise any concern, even in cases where that culture has unethical or questionable aspects.

(3) Finally, culture is sometimes used in ways that suggest researchers have no other option than to condone malpractice. For instance, in discussions about the attribution of authorship credit, culture refers to unwritten rules of authorship attribution. These unwritten rules are seen as side-effects of modern science, which thwart ethical behaviour but nevertheless, researchers play along with them (Barrios et al. 2017). For example, according to Noyori and Richmond the “winner-take-all culture of science”, which refers to judging researchers purely on the basis of the “production of successful results”, may create an incentive to cheat (Noyori & Richmond 2013, p. 5). A “culture in which the first author feels the need to pay back, or flatter” hints at the prevalence of undeserved authorship and promotion of contributors from the acknowledgment section to the authors list merely due to their positions (Zietman 2017, p. 276). A “culture of misattribution” highlights the tolerating/condoning of credit misattribution, especially when it

happens in collaborations between academia and industry (e.g., ghost-authorship practices) (Matheson 2016, p. 32). According to this understandings of culture, even the most ethical researcher might eventually feel inclined to subscribe to lower standards in order to progress in academia. The view that researchers turn a blind eye on malpractices (whether individually or collectively) seems to imply that accumulation of authorship credit to build or maintain a successful career takes precedence over responsibilities as a good researcher in academia.

Unethical behaviour: external contributing factors and personal motivations

Among the explored studies, unethical behaviour is sometimes connected with situational factors imposed by external circumstances[18], and motivations[19] are seen as individual factors that serve academics' personal interests. While some studies attempt to present these two as distinct contributing factors to unethical behaviour, personal motivations and external factors seem to be entangled to such an extent that they cannot always be explored independently. For example, while personal motivations such as eagerness to succeed, thirst for more publications and power can be seen as signs of egotism, they can also be seen as efforts to survive in a competitive environment and resulted from the pressure to publish, both of which can be regarded as external factors. While the pressure to publish and significance of authorship order for evaluations are seen as external factors, they can also be seen as policies and strategies

[18] Some the most discussed external factors to unethical behaviour pertain to the disconnect between codes and practice (Logan et al. 2017; McNutt et al. 2018), competition in academia, and the pressure to publish (Tijdink et al. 2014; Tijdink et al. 2016; Vinkers et al. 2015; Flatt et al. 2017). Also, the importance of authorship order for evaluation and promotion, and the focus on impact rather than quality (Shapiro et al. 1994; Avanzas et al. 2011; Noyori & Richmond 2013; Miller et al. 2017), and difficulties of dealing with smaller contributions and longer bylines are regarded as factors contributing to various kinds of unethical behaviour (Hammer & Miaskowski 2017; Mongeon et al. 2017).

[19] In contrast, motivations are mainly described as personal or career-related aspirations. Examples are the desire for visibility and professional development (Jeffery 2014; Stichler 2014), eagerness to gain power (Charlton 2008; Levin 2011), and strategic plans for improving impact and citation (Chattopadhyay 2014; Flatt et al. 2017). Furthermore, temptations to take shortcuts (Buckwalter et al. 2015; Reid & Cress 2016), and aspirations to increase the chances of publications, are regarded as motivations for meddling with research results and authorship lists (Mack 2018). Although these are presented as personal motivations, as mentioned above they cannot be completely detached from external circumstances (e.g., pressure to perform and publish).

adopted by research administrators to recruit the best talents and attract more funding to satisfy personal motivations (e.g., to improve their own reputation).

Future research, from author to contributor

Within the body of analysed studies, there is a strong focus on exploring the difficulties of using definitions of authorship as the sole indicator of contributions. Issues pertinent to the definition of authorship, such as notions of substantial contribution, intellectual contribution and authorship order are discussed at great length. Given the importance of authorship credit for tenure and promotion (Lariviere & Gingras 2010; Shapiro et al. 1994) this focus seems reasonable. However, reports about lack of adequate attribution of credit in one context, does not imply that it happens in all publications all the time.[20] Attitudes toward authorship change regularly and some of these are reflected in modern solutions that are believed to improve the attribution of credit and responsibilities.[21] The development of contributor role taxonomies and ontologies (e.g., CRediT, OpenVIVO's Contributor Role Ontology and TaDiRAH) provides evidence for the regular change of attitude toward authorship. In fact, within the reviewed items four studies mention the CRediT taxonomy and highlight advantages of its application for the attribution of credit and responsibilities (Smith & Master 2017; Kumar 2018; McNutt et al. 2018; Uijtdehaage et al. 2018).

It is safe to assume that using these new solutions for describing contributions could contribute to ethical problems of a different kind than those that arise from using definitions of authorship. As one of the studies that mention the CRediT taxonomy notes, these new models attribute credit and responsibilities based on the notion of contribution and accordingly, are prone to different ethical issues, especially regarding the listed contribution-types and those not listed in

[20] We thank the anonymous reviewer for their suggestion to add more nuance here and providing some references that show a change of attitude toward crediting citizen scientists (see Resnik et al. 2015 and Ward-Fear et al. 2020).
[21] For instance, between 1979 and 2019, the ICMJE authorship guidelines are updated 20 times (ICMJE archives 2020).

each taxonomy (Smith & Master 2017). It is pivotal, that these new solutions receive more consideration and are explored more critically in the discussions about ethical issues related to scholarly authorship. For instance, highlighting their strengths and weaknesses in terms of capturing complexities of collaboration in different disciplines would help journal editors and research administrators to choose the most suitable model for their respective contexts.

References

Abrams, K. M., Thais Z., & Chad C. (2015). Communicating Sensitive Scientific Issues: The Interplay Between Values, Attitudes, and Euphemisms in Communicating Livestock Slaughter. *Science Communication* 37 (4): 485–505. https://doi.org/10.1177/1075547015588599

Adams, A. J. (2009). Public Involvement in the Ethics of Research Publications? *Optometry And Vision Science* 86 (10): 1135–36. https://doi.org/10.1097/OPX.0b013e3181be4aad

Adeney, E. (2015). Medical and Scientific Authorship: A Conflict between Discipline Rules and the Law. *Journal Of Law And Medicine* 23 (2): 413–26.

Adeney, E. (2016). Research Collaborations and 'Authorship': Differentiating Legal from Management Norms. *Australian Business Law Review* 44 (2): 132–43.

Agoramoorthy, G. (2014). "Truthfulness: The Ultimate Ethics in Scientific Writing." *Current Science* 107 (11): 1777–78.

Alshogran, O. Y., & Al-Delaimy, W.K. (2018). Understanding of International Committee of Medical Journal Editors Authorship Criteria Among Faculty Members of Pharmacy and Other Health Sciences in Jordan. *Journal Of Empirical Research On Human Research Ethics* 13 (3): 276–84. https://doi.org/10.1177/1556264618764575

Amos, K. A. (2014). The Ethics of Scholarly Publishing: Exploring Differences in Plagiarism and Duplicate Publication across Nations." *Journal Of The Medical Library Association* 102 (2): 87–91. https://doi.org/10.3163/1536-5050.102.2.005

Analytics, C. (2020). Web of Science. Philadelphia, United States. Accessed 2 August 2019. https://apps.webofknowledge.com/

Andersen, J.P., Schneider, J. W. & Nielsen M. W. (2016). Mapping the Author Gender-Distribution of Disease-Specific Medical Research. In *21st International Conference On Science And Technology Indicators (STI 2016)*, edited by Rafols, I. and Molas Gallart, J. and CastroMartinez, E. and Woolley, R., 852–62. CAMINO VERA S-N, Valencia, Spain: University Politecnica Valencia.

Anderson, M. S. (2013). Commentary on `Honorary Authorship Epidemic in Scholarly Publications? How the Current Use of Citation-Based Evaluative Metrics Make (Pseudo)Honorary Authors from Honest Contributors of Every Multiauthor Article.'. *Journal Of Medical Ethics* 39 (8): 513. https://doi.org/10.1136/medethics-2012-100940

Andes, A., & Mabrouk, P. A. (2018). Authorship in Undergraduate Research Partnerships: A Really Bad Tango Between Undergraduate Proteges and Graduate Student Mentors While Waiting for Professor Godot. In: *Credit Where Credit Is Due: Respecting Authorship And Intellectual Property*, edited by Mabrouk, P.A. and Currano, J.N., 1291:133–58. ACS Symposium Series. Washington DC, USA: American Chemical Society.

Arauja, T., & Fontainha, E. (2017). The Specific Shapes of Gender Imbalance in Scientific Authorships: A Network Approach. *Journal Of Informetrics* 11 (1): 88–102. https://doi.org/10.1016/j.joi.2016.11.002

Arda, B. (2012). Publication Ethics from the Perspective of PhD Students of Health Sciences: A Limited Experience. *Science And Engineering Ethics* 18 (2): 213–22. https://doi.org/10.1007/s11948-011-9256-4

Avanzas, P., Bayes-Genis, A., de Isla, L. P., Sanchis, J., & Heras, M. (2011). Ethical Considerations in the Publication of Scientific Articles. *Revista Espanola De Cardiologia* 64 (5): 427–29. https://doi.org/10.1016/j.rec.2011.02.005

Badaway, A. B. (1996). Ethics in Alcohol Research and Publishing. *Alcohol And Alcoholism* 31 (1): 7–9.

Baerlocher, M. O., Newton, M., Gautam, T., Tomlinson, G., & Detsky, A. S. (2007). The Meaning of Author Order in Medical Research. *Journal of Investigative Medicine*, *55*(4), 174–180. https://doi.org/10.2310/6650.2007.06044

Barker, K. L. (1994). Editorial: Implementing Ethical Guidelines for Publication of Research in Endocrine Society Journals. *Endocrine Reviews*, *15*(1), 3–4. https://doi.org/10.1210/edrv-15-1-3

Barrios, L. M., Tapia, J. A. J., Mercado, D. M. M., & Mora, L. S. (2017). Regulation and self-regulation of ethical practices in scientific publication. *Salud Mental*, *40*(5), 227–234. https://doi.org/10.17711/SM.0185-3325.2017.029

Baydik, O. D., & Gasparyan, A. Y. (2016). How to Act When Research Misconduct Is Not Detected by Software but Revealed by the Author of the Plagiarized Article. *Journal of Korean Medical Science*, *31*(10), 1508–1510. https://doi.org/10.3346/jkms.2016.31.10.1508

Bebeau, M. J., & Monson, V. (2011). Authorship and Publication Practices in the Social Sciences: Historical Reflections on Current Practices. *Science and Engineering Ethics*, *17*(2), 365–388. https://doi.org/10.1007/s11948-011-9280-4

Beisiegel, U. (2010). Research Integrity and Publication Ethics. *Atherosclerosis* 212 (2): 383–85. https://doi.org/10.1016/j.atherosclerosis.2010.01.050

Benos, D. J., Fabres, J., Farmer, J., Gutierrez, J.P. Hennessy, K., Kosek, D., Lee, J. H., Olteanu, D., Russell, T., Shaikh, F., & Wang, K. (2005). Ethics and Scientific Publication. *Advances In Physiology Education* 29 (2): 59–74. https://doi.org/10.1152/advan.00056.2004

Berardo, F. M. (1993). Scientific Norms and Research Publication: *Marriage & Family Review*, *18*(1–2), 119–141. https://doi.org/10.1300/J002v18n01_14

Biagioli, M., Judith, C., Pamela, D., Gruber, M., Drummond, R., & Horton, R. (1999). Council of Science Editor's Task Force on Authorship. Accessed October 30, 2019 Retrieved from: https://www.councilscienceeditors.org/resource-library/editorial-policies/cse-policies/retreat-and-task-force-papers/authorship-task-force/cse-task-force-on-authorship/

Bilic-Zulle, L. (2010). Responsible writing in science. *Biochemia Medica*, *20*(3), 279–281. https://doi.org/10.11613/BM.2010.034

Bonito, A. J., Sandra L. T., Greene, A. M., Amoozegar, J., Eicheldinger, C., & Wright, D. E. (2012). Preparing Whistleblowers for Reporting Research Misconduct. *Accountability In Research-Policies And Quality Assurance* 19 (5): 308–28. https://doi.org/10.1080/08989621.2012.718683

Boyer, T. (2014). Is a bird in the hand worth two in the bush? Or, whether scientists should publish intermediate results. *Synthese*, *191*(1), 17–35. https://doi.org/10.1007/s11229-012-0242-4

Bozeman, B., & Youtie, J. (2016). Trouble in Paradise: Problems in Academic Research Co-authoring. *Science and Engineering Ethics*, *22*(6), 1717–1743. https://doi.org/10.1007/s11948-015-9722-5

Buckwalter, J. A., Tolo, V. T., & O'Keefe, R. J. (2015). How do you know it is true? Integrity in research and publications: AOA critical issues. *The Journal of Bone and Joint Surgery. American Volume*, *97*(1), e2. https://doi.org/10.2106/JBJS.N.00245

Bulger, R. E. (2004). The Responsible Conduct of Research, Including Responsible Authorship and Publication Practices. In *Ethics for Life Scientists*, edited by Korthals, M. and Bogers, R., 5:55–62. Wageningen UR Frontis Series. New York, United States: Springer.

Bunnett, J. F. (1983). A Scientists Ethical Obligation To Publish. *Accounts Of Chemical Research* 16 (11): 393. https://doi.org/10.1021/ar00095a600

Cabral, I. E., Egry, E. Y. & Barbosa, D. A. (2015). Integrity and Ethics in Research and Scientific Communication: Issues for Nursing Considerations. *Revista Da Escola De Enfermagem Da Usp* 49 (5): 712–13. https://doi.org/10.1590/S0080-623420150000500001

Cameron, C., Zhao, H., & McHugh, M. K. (2012). Perspective: Publication Ethics and the Emerging Scientific Workforce: Understanding "Plagiarism" in a Global Context. *Academic Medicine*, *87*(1), 51. https://doi.org/10.1097/ACM.0b013e31823aadc7

Carraway, L. N. (2009). Ethics For and Responsibilities of Authors, Reviewers and Editors in Science. *The American Midland Naturalist*, *161*(1), 146–164. https://doi.org/10.1674/0003-0031-161.1.146

Cech, TR, Eddy, SR, Hersey, K, Eisenberg, D, Holtzman, SH, Poste, GH, Raikhel, NV, Scheller, RH, Singer, DB, & Waltham, MC. (2003). Sharing Publication-Related Data and Materials: Responsibilities of Authorship in the Life Sciences. *Plant Physiology*, *132*(1), 19–24. https://doi.org/10.1104/pp.900068

Chanson, H. (2009). Digital Publishing, Indexing, and Ethics: Implications in Civil and Hydraulic Engineering and Research. *Journal of Professional Issues in Engineering Education and Practice*, *135*(4). https://ascelibrary.org/doi/10.1061/%28ASCE%291052-3928%282009%29135%3A4%28117%29

Charlton, B. G. (2008). Figureheads, ghost-writers and pseudonymous quant bloggers: The recent evolution of authorship in science publishing. *Medical Hypotheses*, *71*(4), 475–480. https://doi.org/10.1016/j.mehy.2008.06.023

Chattopadhyay, A. (2014). Ethics of scientific publication: (Mal)-practices and Consequentialism. *2014 IEEE International Symposium on Ethics in Science, Technology and Engineering*, 1–5. https://doi.org/10.1109/ETHICS.2014.6893451

Chen, X.-P. (2011). Author Ethical Dilemmas in the Research Publication Process. *Management and Organization Review*, *7*(3), 423–432. https://doi.org/10.1111/j.1740-8784.2011.00229.x

Claxton, L. D. (2005a). Scientific authorship. Part 1. A window into scientific fraud? *Mutation Research*, *589*(1), 17–30. https://doi.org/10.1016/j.mrrev.2004.07.003

Claxton, L. D. (2005b). Scientific authorship. Part 2. History, recurring issues, practices, and guidelines. *Mutation Research*, *589*(1), 31–45. https://doi.org/10.1016/j.mrrev.2004.07.002

Clement, T. P. (2014). Authorship Matrix: A Rational Approach to Quantify Individual Contributions and Responsibilities in Multi-Author Scientific Articles. *Science and Engineering Ethics*, *20*(2), 345–361. https://doi.org/10.1007/s11948-013-9454-3

Cohen, J., Grudzinskas, G., & Johnson, M. (2012). Challenges for modern scientific writing and editorship: Have we lost our moral compass? *Reproductive BioMedicine Online*, *24*(3), 255–256. https://doi.org/10.1016/j.rbmo.2012.01.011

Colledge, F. M. A., Elger, B. S., & Shaw, D. M. (2013). "Conferring Authorship": Biobank Stakeholders' Experiences with Publication Credit in Collaborative Research. *PLOS ONE*, *8*(9), e76686. https://doi.org/10.1371/journal.pone.0076686

Cope, M. B., & Allison, D. B. (2010). White Hat Bias: A Threat to the Integrity of Scientific Reporting. *Acta Paediatrica* 99 (11): 1615–17. https://doi.org/10.1111/j.1651-2227.2010.02006.x

Cronin, B. (2001). Hyperauthorship: A postmodern perversion or evidence of a structural shift in scholarly communication practices? *Journal of the American Society for Information Science and Technology*, *52*(7), 558–569. https://doi.org/10.1002/asi.1097

Cutas, D., & Shaw, D. (2015). Writers Blocked: On the Wrongs of Research Co-authorship and Some Possible Strategies for Improvement. *Science and Engineering Ethics*, *21*(5), 1315–1329. https://doi.org/10.1007/s11948-014-9606-0

Daroff, R. B. (2007). Report from the Scientific Integrity Advisor | Neurology. *Neurology*, *68*(21), 1841–1842. https://doi.org/10.1212/01.wnl.0000262044.46077.ae

Das, K. K., & Biradar, M. S. (2016). Ethical Publications in Medical Research. In P. A. Clark (Ed.), *Bioethics—Medical, Ethical and Legal Perspectives*. InTech. https://doi.org/10.5772/64947

Dawson, P., & Dawson, S. L. (2018). Sharing Successes and Hiding Failures: 'reporting Bias' in Learning and Teaching Research. *Studies In Higher Education* 43 (8): 1405–16. https://doi.org/10.1080/03075079.2016.1258052

Dayton, P. K. (1992). Scientific Communication - The Burden Of Responsibility. *Trends In Ecology & Evolution* 7 (11): 392. https://doi.org/10.1016/0169-5347(92)90011-Y

DeTora, L., C., Foster, C. S., Yarker, Y. E., & Crawley, F. P. (2015). Publication Planning: Promoting an Ethics of Transparency and Integrity in Biomedical Research. *International Journal Of Clinical Practice* 69 (9): 915–21. https://doi.org/10.1111/ijcp.12708

Dhammi, I. K., and Ul Haq, R. (2017). Ethics of Medical Research and Publication. *Indian Journal Of Orthopaedics* 51 (1): 1–3. https://doi.org/10.4103/0019-5413.197513

Dixon, S. D. (2014). Ethics in Scientific Publishing: A 21st Century Primer. *Journal Of Developmental And Behavioral Pediatrics* 35 (5): 347–48. https://doi.org/10.1097/DBP.0000000000000068

Dougherty, M. V. (2017). Correcting the Scholarly Record in the Aftermath of Plagiarism: A Snapshot of Current-Day Publishing Practices in Philosophy. *Metaphilosophy*, *48*(3), 258–283. https://doi.org/10.1111/meta.12241

Edwards, R., & Bhopal, R. (1999). The covert influence of the tobacco industry on research and publication: A call to arms. *Journal of Epidemiology & Community Health*, *53*(5), 261–262. https://doi.org/10.1136/jech.53.5.261

Eisenberg, R. L., Ngo, L. H, & Bankier, A. A. (2014). Honorary Authorship in Radiologic Research Articles: Do Geographic Factors Influence the Frequency? *Radiology* 271 (2): 472–78. https://doi.org/10.1148/radiol.13131710

Eisenberg, R. L., Ngo, L. H., Heidinger, B. H., & Bankier, A. A. (2018). Honorary Authorship in Radiologic Research Articles: Assessment of Pattern and Longitudinal Evolution. *Academic Radiology* 25 (11): 1451–56. https://doi.org/10.1016/j.acra.2018.02.023

Elliott, K. C., Settles, I. H., Montgomery, G. M., Brassel, S. T., Cheruvelil, K. S., & Soranno, P. A. (2017). Honorary Authorship Practices in Environmental Science Teams: Structural and Cultural Factors and Solutions. *Accountability in Research*, *24*(2), 80–98. https://doi.org/10.1080/08989621.2016.1251320

Endersby, J. W. (1996). Collaborative Research in the Social Sciences: Multiple Authorship and Publication Credit. *Social Science Quarterly*, *77*(2), 375–392. JSTOR.

Fang, F. C., Grant Steen, R. & Casadevall, A. (2012). Misconduct Accounts for the Majority of Retracted Scientific Publications. *Proceedings Of The National Academy Of Sciences Of The United States Of America* 109 (42): 17028–33. https://doi.org/10.1073/pnas.1212247109

Fenton, J. E., & Jones, A. S. (2002). Integrity in medical research and publication. *Clinical Otolaryngology & Allied Sciences*, *27*(6), 436–439. https://doi.org/10.1046/j.1365-2273.2002.00623.x

Finney, D. J. (1995). Statistical Science And Effective Scientific Communication. *Journal Of Applied Statistics* 22 (2): 293-308. https://doi.org/10.1080/757584623

Flatt, J. W., Blasimme, A., & Vayena, E. (2017). Improving the Measurement of Scientific Success by Reporting a Self-Citation Index. *Publications*, *5*(3), 20. https://doi.org/10.3390/publications5030020

Fong, E. A., & Wilhite, A. W. (2017). Authorship and citation manipulation in academic research. *PLOS ONE*, *12*(12), e0187394. https://doi.org/10.1371/journal.pone.0187394

Foo, J. Y. A., & Wilson, S. J. (2012). An Analysis on the Research Ethics Cases Managed by the Committee on Publication Ethics (COPE) Between 1997 and 2010. *Science And Engineering Ethics* 18 (4): 621–31. https://doi.org/10.1007/s11948-011-9273-3

Freedman, J. E. (2008). Promoting Ethical Conduct in the Publication of Research. *Cardiovascular Therapeutics* 26 (2): 89–90. https://doi.org/10.1111/j.1527-3466.2008.00045.x

Galdas, P. (2016). Who Is Writing What? A Proposed Taxonomy of Roles and Responsibilities When Collaboratively Writing a Research Proposal. *International Journal Of Qualitative Methods* 15 (1). https://doi.org/10.1177/1609406916684290

Gandy, J. (2007). Editorial: Ethics in Research and Publishing. *Journal Of Human Nutrition And Dietetics* 20 (2): 73–74. https://doi.org/10.1111/j.1365-277X.2007.00759.x

Garcia, C. C., Martrucelli, C. R. N., Rossilho, M. de M. F., & Denardin, O. V. P. (2010). Authorship for scientific papers: The new challenges. *Brazilian Journal of Cardiovascular Surgery*, *25*(4), 559–567. https://doi.org/10.1590/S0102-76382010000400021

Garfield, E. (1978). The ethics of scientific publication. *Essays of an Information Scientist*, *3*(40), 5–12.

Garfield, E. (1982). More On The Ethics Of Scientific Publication - Abuses Of Authorship Attribution And Citation Amnesia Undermine The Reward System Of Science. *Current Contents: Social And Behavioral Sciences,* 30(10): 5-10.

Gasparyan, A. Y., Yessirkepov, M., Voronov, A. A., Gerasimov, A. N., Kostyukova, E. I., & Kitas, G. D. (2015). Preserving the Integrity of Citations and References by All Stakeholders of Science Communication. *Journal of Korean Medical Science*, *30*(11), 1545–1552. https://doi.org/10.3346/jkms.2015.30.11.1545

Gavaghan, D. (2018). Problems with the Current Approach to the Dissemination of Computational Science Research and Its Implications for Research Integrity. *Bulletin Of Mathematical Biology* 80 (12): 3088–94. https://doi.org/10.1007/s11538-018-0499-y

Glick, S. A., Clarfield, M., Strous, R. D., & Horton, R. (2015). Academic Debate: Publications Which Promote Political Agendas Have No Place in Scientific and Medical Journals, and Academics Should Refrain from Publishing in Such Journals. *Rambam Maimonides Medical Journal* 6 (1). https://doi.org/10.5041/RMMJ.10178

Goldberg, D. M. (2006). Is Scientific Publishing a Criminal Activity? *Clinical Biochemistry* 39 (5): 473–81. https://doi.org/10.1016/j.clinbiochem.2006.04.017

Gollogly, L., & Momen, H. (2006). Ethical Dilemmas in Scientific Publication: Pitfalls and Solutions for Editors. *Revista de Saúde Pública* 40 (SI): 24–29. https://doi.org/10.1590/S0034-89102006000400004

Gotterbarn, D., Miller, K., & Impagliazzo, J. (2006). Plagiarism and Scholarly Publications: An Ethical Analysis. Proceedings. Frontiers in Education. 36th Annual Conference, 22–27. https://doi.org/10.1109/FIE.2006.322365

Gray, G. C. (2017). Academic Voice in Scholarly Writing. *Qualitative Report* 22 (1): 179–96.

Hall, R., de Antueno, C., & Webber, A. (2007). Publication bias in the medical literature: A review by a Canadian research ethics board. *Canadian Journal of Anesthesia*, *54*(5), 380–388. https://doi.org/10.1007/BF03022661

Hammer, M. J., & Miaskowski, C. (2017). Authorship Ethics in the Era of Team Science. *Oncology Nursing Forum*, *44*(6), 655–657. https://doi.org/10.1188/17.ONF.655-657

Hatcher, T. (2011). Becoming an Ethical Scholarly Writer. *Journal of Scholarly Publishing*, *42*(2), 142–159. https://doi.org/10.3138/jsp.42.2.142

Hayer, C. A., Kaemingk, M., Breeggemann, J. J., Dembkowski, D., Deslauriers, D., & Rapp, T. (2013). Pressures to Publish: Catalysts for the Loss of Scientific Writing Integrity? *Fisheries* 38 (8): 352–55. https://doi.org/10.1080/03632415.2013.813845

Hays, J. C. (2010). A Primer on the Responsibilities and Abuses of Scientific Authorship. *Public Health Nursing*, *27*(6), 471–473. https://doi.org/10.1111/j.1525-1446.2010.00903.x

Helgesson, G. (2015). Scientific authorship and intellectual involvement in the research: Should they coincide? *Medicine, Health Care and Philosophy*, *18*(2), 171–175. https://doi.org/10.1007/s11019-014-9585-6

Hernandez-Ruiz, A. (2016). Antifraud Editorial Policy in Spanish and Latin American Scientific Publication: JCR Social Sciences Edition. *Comunicar* 24 (48): 19–27. https://doi.org/10.3916/C48-2016-02

Hess, C. W., Brueckner, C., Kaiser, T., Mauron, A., Wahli, W., Justus, U. Salathe, M., Sci Integrity Comm, and Swiss Acad Arts Sci. (2015). Authorship in Scientific Publications: Analysis and Recommendations. *Swiss Medical Weekly* 145 (February). https://doi.org/10.4414/smw.2015.14108

Hillman, A. L., Eisenberg, J. M., Pauly, M. V., Bloom, B. S., Click, H., Kinosian, B., & Schwartz, J. S. (1991). Avoiding Bias in the Conduct and Reporting of Cost-Effectiveness Research Sponsored by Pharmaceutical Companies. *New England Journal of Medicine*, *324*(19), 1362–1365. https://doi.org/10.1056/NEJM199105093241911

Hodge, A., Haapala, I., Yngve, A., McNeill, G., & Tseng, M. (2012). A Refresher in Research Publication Ethics. *Public Health Nutrition* 15 (3): 377–78. https://doi.org/10.1017/S136898001200002X

Holm, S., & Hofmann, B. (2018). Associations between attitudes towards scientific misconduct and self-reported behavior. *Accountability in Research*, *25*(5), 290–300. https://doi.org/10.1080/08989621.2018.1485493

Horner Jennifer & Minifie Fred D. (2011). Research Ethics III: Publication Practices and Authorship, Conflicts of Interest, and Research Misconduct. *Journal of Speech, Language, and Hearing Research*, *54*(1), S346–S362. https://doi.org/10.1044/1092-4388(2010/09-0263)

International Committee of Medical Journal Editors. (2020). Archives. Accessed March 11, 2020. http://www.icmje.org/recommendations/archives/

Interrante, L. V., & Reichmanis, E. (2005). Ethics of Scientific Publication. *Chemical & Engineering News* 83 (26): 4–5.

Irvin, R. S. (2009). The Role of Conflict of Interest in Reporting of Scientific Information. *Chest* 136 (1): 253–59. https://doi.org/10.1378/chest.09-0890

Ivanis, A., Hren, D., Marusic, M., & Marusic, A. (2011). Less Work, Less Respect: Authors' Perceived Importance of Research Contributions and Their Declared Contributions to Research Articles. *PLOS ONE* 6 (6). https://doi.org/10.1371/journal.pone.0020206

Jabbehdari, S., & Walsh, J. P. (2017). Authorship Norms and Project Structures in Science. *Science, Technology, & Human Values*, *42*(5), 872–900. https://doi.org/10.1177/0162243917697192

Jawad, F. (2013). Research Ethics: Authorship and Publication. *Journal Of Pakistan Medical Association*, *63*(12). https://jpma.org.pk/article-details/5527?article_id=5527

Jawaid, S. A. (2015). Publication Ethics. *Proceedings of Second International Conference on Publication Ethics (COPE) Organized by Shiraz University of Medical Sciences*, *31*, 251–262. https://doi.org/10.12669/pjms.312.7313

Jeffery, R. (2014). Authorship in multi-disciplinary, multi-national North-South research projects: Issues of equity, capacity and accountability. *Compare: A Journal of Comparative and International Education*, *44*(2), 208–229. https://doi.org/10.1080/03057925.2013.829300

Jennings, R. G., & Van Horn, J. D. (2012). Publication Bias in Neuroimaging Research: Implications for Meta-Analyses. *Neuroinformatics* 10 (1): 67–80. https://doi.org/10.1007/s12021-011-9125-y

Jernstedt, J. (2014). Trust and scientific publication: AJB policy for digital images. *American Journal of Botany*, *101*(12), 2019–2021. https://doi.org/10.3732/ajb.1400499

Jerrells, T. R. (2001). Duplicative publication of data and other ethical issues in publishing of scientific findings. *Journal of Substance Abuse Treatment*, *20*(2), 111–113. https://doi.org/10.1016/S0740-5472(01)00168-4

Jian, D., & Xiaoli, T. (2013). Perceptions of author order versus contribution among researchers with different professional ranks and the potential of harmonic counts for encouraging ethical co-authorship practices. *Scientometrics*, *96*(1), 277–295. https://doi.org/10.1007/s11192-012-0905-4

Johal, J., Loukas, M., Oskouian, R. J., & Tubbs, R. S. (2017). 'Political Co-Authorships' in Medical Science Journals. *Clinical Anatomy* 30 (6): 831–34. https://doi.org/10.1002/ca.22932

Johnson, D. H. (2013). Financial Disclosure, Industry Sponsorship, and Integrity in Cancer Research Reporting. *Journal Of Clinical Oncology* 31 (18): 2243–45. https://doi.org/10.1200/JCO.2013.48.8817

Jones, A. H. (2003). Can authorship policies help prevent scientific misconduct? What role for scientific societies? *Science and Engineering Ethics*, *9*(2), 243–256. https://doi.org/10.1007/s11948-003-0011-3

Karani, R., Ognibene, F., Fallar, R., & Gliatto, P. (2013). Medical Students' Experiences With Authorship in Biomedical Research. *Academic Medicine*, *88*(3), 364–368. https://doi.org/10.1097/ACM.0b013e31827fc6ae

Kassis, T. (2017). How do research faculty in the biosciences evaluate paper authorship criteria? *PLOS ONE*, *12*(8), e0183632. https://doi.org/10.1371/journal.pone.0183632

Keohane, R. O., Lane, M., & Oppenheimer, M. (2014). The Ethics of Scientific Communication under Uncertainty. *Politics Philosophy & Economics* 13 (4): 343–68. https://doi.org/10.1177/1470594X14538570

Kepes, S., Banks, G. C. & Oh, I. S. (2014). Avoiding Bias in Publication Bias Research: The Value of 'Null' Findings. *Journal Of Business And Psychology* 29 (2, SI): 183–203. https://doi.org/10.1007/s10869-012-9279-0

Kerr, A., Prescott, R., & Theologis, T. (2015). Bad science and how to avoid it, a movement analysis perspective: Study design, statistics and publication ethics. *Gait & Posture*, *42*(3), 224–226. https://doi.org/10.1016/j.gaitpost.2015.08.004

Kilkenny, C., Parsons, N., Kadyszewski, E., Festing, M. F. W., Cuthill, I. C., Fry, D., Hutton, J., & Altman, D. G. (2009). Survey of the Quality of Experimental Design, Statistical Analysis and Reporting of Research Using Animals. *PLOS ONE*, *4*(11), e7824. https://doi.org/10.1371/journal.pone.0007824

Kremenak, N. (2010). Authorship of the Research Report: Perils and Responsibilities. *Journal Of Prosthodontics-Implant Esthetic And Reconstructive Dentistry* 19 (5): 420–21. https://doi.org/10.1111/j.1532-849X.2010.00618.x.

Kueffer, C., & Larson, B. M. H. (2014). Responsible Use of Language in Scientific Writing and Science Communication. *BioScience*, *64*(8), 719–724. https://doi.org/10.1093/biosci/biu084

Kukla, R. (2012). "Author TBD": Radical Collaboration in Contemporary Biomedical Research. *Philosophy of Science*, *79*(5), 845–858. https://doi.org/10.1086/668042

Kumar, S. (2018). Ethical Concerns in the Rise of Co-Authorship and Its Role as a Proxy of Research Collaborations. *Publications* 6 (3). https://doi.org/10.3390/publications6030037

Lanken, P. N., Osborne, M. L., & Terry, P. B. (1995). Introduction: The ethics of publishing research sponsored by the tobacco industry in ATS/ALA journals. *American Journal of Respiratory and Critical Care Medicine*, *151*(2), 269–270. https://doi.org/10.1164/ajrccm.151.2.7842174

Larivière, V., & Gingras, Y. (2010). On the prevalence and scientific impact of duplicate publications in different scientific fields (1980-2007). *Journal of Documentation*, *66*(2), 179–190. https://doi.org/10.1108/00220411011023607

Lerchenmüller C., Lerchenmueller M. J., & Sorenson O. (2018). Long-Term Analysis of Sex Differences in Prestigious Authorships in Cardiovascular Research Supported by the National Institutes of Health. *Circulation*, *137*(8), 880–882. https://doi.org/10.1161/CIRCULATIONAHA.117.032325

Lee, J. H. W., & Jun, K. S. (2014). Editor's Note for 32nd Issue: The Ethics of Scientific Publishing. *Journal Of Hydro-Environment Research* 8 (4): 329. https://doi.org/10.1016/j.jher.2014.11.001

Levin, J. R. (2011). Ethical Issues in Professional Research, Writing, and Publishing. In A. T. Panter & S. K. Sterba (Eds.), *Handbook of Ethics in Quantitative Methodology* (1st ed., pp. 463–492). Routledge. https://doi.org/10.4324/9780203840023-30

Liang, L., Zhong, Z., & Rousseau, R. (2014). Scientists' referencing (mis)behavior revealed by the dissemination network of referencing errors. *Scientometrics*, *101*(3), 1973–1986. https://doi.org/10.1007/s11192-014-1275-x

Lissoni, F., & Montobbio, F. (2015). Guest Authors or Ghost Inventors? Inventorship and Authorship Attribution in Academic Science. *Evaluation Review*, *39*(1), 19–45. https://doi.org/10.1177/0193841X13517234

Lissoni, F., Montobbio, F., & Zirulia, L. (2013). Inventorship and Authorship as Attribution Rights: An Enquiry into the Economics of Scientific Credit. *Journal Of Economic Behavior & Organization* 95 (November): 49–69. https://doi.org/10.1016/j.jebo.2013.08.016

Logan, J. M., Bean, S. B., & Myers, A. E. (2017). Author contributions to ecological publications: What does it mean to be an author in modern ecological research? *PLOS ONE*, *12*(6), e0179956. https://doi.org/10.1371/journal.pone.0179956

Louis, K. S., Holdsworth, J. M., Anderson, M. S., & Campbell, E. G. (2008). Everyday Ethics in Research: Translating Authorship Guidelines into Practice in the Bench Sciences. *The Journal of Higher Education*, *79*(1), 88–112. https://doi.org/10.1353/jhe.2008.0002

Ludvigsson, J., Lefebvre, P., & Nerup, J. (2018). It is time to restore Rules for Authorship of scientific publications. *Pediatric Diabetes*, *19*(3), 586–586. https://doi.org/10.1111/pedi.12572

Lynch, A. (1994). Publication Of Research - The Ethical Dimension. *Journal Of Dental Research* 73 (11): 1778–82. https://doi.org/10.1177/00220345940730111601

Maciejovsky, B., Budescu, D. V., & Ariely, D. (2008). Research Note—The Researcher as a Consumer of Scientific Publications: How Do Name-Ordering Conventions Affect Inferences About Contribution Credits? *Marketing Science*, *28*(3), 589–598. https://doi.org/10.1287/mksc.1080.0406

Mack, C. A. (2018). The Ethics of Scientific Publication. *Journal of Micro/Nanolithography, MEMS, and MOEMS*, *17*(1), 010101. https://doi.org/10.1117/1.JMM.17.1.010101

Marco, C. A., & Larkin, G. L. (2000). Research Ethics: Ethical Issues of Data Reporting and the Quest for Authenticity. *Academic Emergency Medicine*, *7*(6), 691–694. https://doi.org/10.1111/j.1553-2712.2000.tb02049.x

Marcovitch, H., Barbour, V., Borrell, C., Bosch, F., Fernández, E., Macdonald, H., Marušić, A., & Nylenna, M. (2010). Conflict of Interest in Science Communication: More than a Financial Issue. *Croatian Medical Journal*, *51*(1), 7–15. https://doi.org/10.3325/cmj.2010.51.7

Marušić, A. (2005). Author misconduct: Editors as educators of research integrity. *Medical Education*, *39*(1), 7–8. https://doi.org/10.1111/j.1365-2929.2004.02050.x

Marušić, A., Bošnjak, L., & Jerončić, A. (2011). A Systematic Review of Research on the Meaning, Ethics and Practices of Authorship across Scholarly Disciplines. *PLOS ONE*, *6*(9), e23477. https://doi.org/10.1371/journal.pone.0023477

Matheson, A. (2016). The Disposable Author: How Pharmaceutical Marketing Is Embraced within Medicine's Scholarly Literature. *Hastings Center Report* 46 (4): 31–37. https://doi.org/10.1002/hast.576

Matthes, J., Marquart, F., Naderer, B. Arendt, F., Schmuck, D., & Adam, K. (2015). Questionable Research Practices in Experimental Communication Research: A Systematic Analysis From 1980 to 2013. *Communication Methods And Measures* 9 (4, SI): 193–207. https://doi.org/10.1080/19312458.2015.1096334

McComas, K. A. (2008). The Role of Trust in Health Communication and the Effect of Conflicts of Interest among Scientists. *Proceedings Of The Nutrition Society* 67 (4): 428–36. https://doi.org/10.1017/S0029665108008689

McCuen, R. H. (2018). Advancing Scientific Knowledge: Ethical Issues in the Journal Publication Process. *Publications* 6 (1). https://doi.org/10.3390/publications6010001

McNutt, M. K., Bradford, M., Drazen, J. M., Hanson, B., Howard, B., Jamieson, K. H., Kiermer, V., Marcus, E., Pope, B. K., Schekman, R., Swaminathan, S., Stang, P. J., & Verma, I. M. (2018). Transparency in authors' contributions and responsibilities to promote integrity in scientific publication. *Proceedings of the National Academy of Sciences*, *115*(11), 2557–2560. https://doi.org/10.1073/pnas.1715374115

Meerpohl, J. J., Schell, L. K., Bassler, D., Gallus, S., Kleijnen, J., Kulig, M., La Vecchia, C., Marusic, A., Ravaud, P., Reis, A., Schmucker, C., Strech, D., Urrutia, G., Wager, E., Antes, G., & Consortium, O. P. (2015). Evidence-informed recommendations to reduce dissemination bias in clinical research: Conclusions from the OPEN (Overcome failure to Publish nEgative fiNdings) project based on an international consensus meeting. *BMJ OPEN*, *5*(5). https://doi.org/10.1136/bmjopen-2014-006666

Mendez, D. I., & Angeles Alcaraz. M. (2015). Exploring Acknowledgement Practices in English-Medium Astrophysics Research Papers: Implications on Authorship. *Lfe-Revista De Lenguas Para Fines Especificos* 21 (1, SI): 132–59. https://doi.org/10.20420/rlfe.2015.0007

Mentzelopoulos, S. D., & Zakynthinos, S. G. (2017). Research Integrity, Academic Promotion, and Attribution of Authorship and Nonauthor Contributions. *JAMA-Journal Of The American Medical Association* 318 (13): 1221–22. https://doi.org/10.1001/jama.2017.11790

Meyer, H., Varpio, L., Gruppen, L., & Sandhu, G. (2016). The Ethics and Etiquette of Research Dissemination. *Academic Medicine* 91 (12): E14. https://doi.org/10.1097/ACM.0000000000001440

Miller, P., Martino, F., Gross, S., Curtis, A., Mayshak, R., Droste, N., & Kypri, K. (2017). Funder interference in addiction research: An international survey of authors. *Addictive Behaviors*, *72*, 100–105. https://doi.org/10.1016/j.addbeh.2017.03.026

Moeller, H. J. (2009). Declaration of Conflicts of Interest in Scientific Publications. *World Journal Of Biological Psychiatry* 10 (1): 2–5. https://doi.org/10.1080/15622970802685032

Moffatt, B. (2011). Responsible Authorship: Why Researchers Must Forgo Honorary Authorship. *Accountability in Research*, *18*(2), 76–90. https://doi.org/10.1080/08989621.2011.557297

Moffatt, B. (2018). Scientific authorship, pluralism, and practice. *Accountability in Research*, *25*(4), 199–211. https://doi.org/10.1080/08989621.2018.1437347

Mongeon, P., Smith, E., Joyal, B., & Larivière, V. (2017). The rise of the middle author: Investigating collaboration and division of labor in biomedical research using partial alphabetical authorship. *PLOS ONE*, *12*(9), e0184601. https://doi.org/10.1371/journal.pone.0184601

Mooney, H. (2011). Citing Data Sources in the Social Sciences: Do Authors Do It? *Learned Publishing* 24 (2): 99–108. https://doi.org/10.1087/20110204

Morley, G. (2013). The Writer's Approach to Facilitating Research Communication: A Very Different Way of Engaging with Authors." In *Supporting Research Writing: Roles And Challenges In Multilingual Settings*, edited by Matarese, V, 191–204. Chandos Information Professional Series. Cambridge, England: Chandos Publications.

Mueller, G. P. (2018). When the Search for Truth Fails: A Computer Simulation of the Impact of the Publication Bias on the Meta-Analysis of Scientific Literature. *Scientometrics* 117 (3): 2061–76. https://doi.org/10.1007/s11192-018-2942-0

Mueller, M. J., & Soares, M. J. (2017). The Ethics of Research Publication. *European Journal Of Clinical Nutrition* 71 (5): 569. https://doi.org/10.1038/ejcn.2017.20

Munro, A. J. (1993). Publishing The Findings Of Clinical Research. *British Medical Journal* 307 (6915): 1340–41. https://doi.org/10.1136/bmj.307.6915.1340

Nambiar, R., Tilak, P., & Cerejo, C. (2014). Quality of Author Guidelines of Journals in the Biomedical and Physical Sciences. *Learned Publishing* 27 (3): 201–6. https://doi.org/10.1087/20140306

Netting, F. E., & Nichols-Casebolt, A. (1997). Authorship and Collaboration: Preparing the Next Generation of Social Work Scholars. *Journal of Social Work Education*, *33*(3), 555–564. https://doi.org/10.1080/10437797.1997.10778893

Neusar, A. (2015). From Burgers to Tenure: Preserving Quality Amid the Choices and Dilemmas Facing Authors of Scientific Articles. *Human Affairs*, *25*(3), 327–341. https://doi.org/10.1515/humaff-2015-0027

Newman, A., & Jones, R. (2006). Authorship of Research Papers: Ethical and Professional Issues for Short-Term Researchers. *Journal Of Medical Ethics* 32 (7): 420–23. https://doi.org/10.1136/jme.2005.012757

Noyori, R., & Richmond, J. P. (2013). Ethical Conduct in Chemical Research and Publishing. *Advanced Synthesis & Catalysis*, *355*(1), 3–9. https://doi.org/10.1002/adsc.201201128

Pardo-Hernandez, H., Urrutia, G., Meerpohl, J. J., Marusic, A., Wager, E., Bonfill, X., & Consortium, O. P. (2018). Opinions and potential solutions regarding dissemination bias from funding agencies of biomedical research in Europe. *Journal of Evaluation in Clinical Practice*, *24*(1, SI), 72–79. https://doi.org/10.1111/jep.12692

Patel, A. A., Whang, P. G., White, A. P., Fehlings, M. G., & Vaccaro, A. R. (2011). Pitfalls in the publication of scientific literature: A road map to manage conflict of interest and other ethical challenges: Clinical article. Journal of Neurosurgery, 114(1), 21–26. https://doi.org/10.3171/2010.8.JNS091834

Payne, G. T., & Ireland, R. D. (2015). It Takes a Village: Ethical Publishing of Family Business Research. *Family Business Review* 28 (2): 96–103. https://doi.org/10.1177/0894486515574193

Pellizzon, R. de F., de Souza Monter, E. F., Poblacion, D. A., Monteiro, R., & Figueiredo Castro, R. C. (2007). Brazilian scientific journals in surgery. III: analysis of the Instructions for authors based on Vancouver uniform requirements. *ACTA CIRURGICA BRASILEIRA*, *22*(6), 503–510. https://doi.org/10.1590/S0102-86502007000600016

Penders, B. (2017). All for One or One for All? Authorship and the Cross-Sectoral Valuation of Credit in Nutrition Science. *Accountability In Research-Policies And Quality Assurance* 24 (8): 433–50. https://doi.org/10.1080/08989621.2017.1386565

Pereira, D., & Diaz, C. (2016). Are Women Properly Represented in Scientific Publication and Research? Interim Results from a Spanish Case Study in Earth Sciences. *EPISODES* 39 (1): 52–58. https://doi.org/10.18814/epiiugs/2016/v39i1/89237

Pickett, J. T., & Roche, S. P. (2018). Questionable, Objectionable or Criminal? Public Opinion on Data Fraud and Selective Reporting in Science. *Science and Engineering Ethics*, *24*(1), 151–171. https://doi.org/10.1007/s11948-017-9886-2

Pitak-Arnnop, P., Dhanuthai, K., Hemprich, A., & Pausch, N. C. (2011). Research and publication ethics: What have we learned thus far? *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, *111*(1), 10–12. https://doi.org/10.1016/j.tripleo.2010.10.001

Price, J. H., Dake, J. A., & Islam, R. (2001). Selected Ethical Issues in Research and Publication: Perceptions of Health Education Faculty. *Health Education & Behavior*, *28*(1), 51–64. https://doi.org/10.1177/109019810102800106

Qu, S., & Wiwanitkit, V. (2015). Response to 'The Ethics of Scholarly Publishing: Exploring Differences in Plagiarism and Duplicate Publication across Nations'. *Journal Of The Medical Library Association* 103 (1): 57. https://doi.org/10.3163/1536-5050.103.1.012

Rajasekaran, S., Li Pi Shan, R., & Finnoff, J. T. (2014). Honorary Authorship: Frequency and Associated Factors in Physical Medicine and Rehabilitation Research Articles. *Archives of Physical Medicine and Rehabilitation*, *95*(3), 418–428. https://doi.org/10.1016/j.apmr.2013.09.024

Redman, B. K. (2013). Are Current Publication Standards Protecting the Integrity of the Scientific Record? In *Research Misconduct Policy In Biomedicine: Beyond The Bad-Apple Approach*, 59–78. Basic Bioethics. Cambridge, MA, USA: MIT Press.

Reid, C., & Cress, P. (2016). Update on Scholarly Publication Ethics: Navigating the Confusing Landscape. *Aesthetic Surgery Journal* 36 (10): 1195–97. https://doi.org/10.1093/asj/sjw116

Reiss, C. S. (2014). Integrity of Scientific Content and Authorship Disputes Continue to Plague Scientific Journals. *DNA And Cell Biology* 33 (3): 121. https://doi.org/10.1089/dna.2014.1502

Relman, A. S. (1990). Publishing Biomedical-Research - Roles And Responsibilities. *Hastings Center Report* 20 (3): 23–27. https://doi.org/10.2307/3563157

Rennie, D., & Flanagin, A. (1994). Authorship! Authorship! Guests, ghosts, grafters, and the two-sided coin. *JAMA*, 271(6), 469–471. https://doi.org/10.1001/jama.271.6.469

Resnik, D. B. (2015). Glossary of Commonly Used Terms in Research Ethics. [Website] Retrieved 27 March 2020: https://www.niehs.nih.gov/research/resources/bioethics/glossary/index.cfm

Resnik, D. B., Elliott, K. C., & Miller, A. K. (2015). A Framework for Addressing Ethical Issues in Citizen Science. Environmental Science & Policy 54 (December): 475–481. https://doi.org/10.1016/j.envsci.2015.05.008

Rier, D. A. (2004). Publication Visibility of Sensitive Public Health Data: When Scientists Bury Their Results. *Science and Engineering Ethics* 10 (4): 597–613. https://doi.org/10.1007/s11948-004-0041-5

Riis, P. (1994). Publication Ethics - One Of Many Areas Of Scientific Fraud. *Acta Obstetricia Et Gynecologica Scandinavica* 73 (7): 526–28. https://doi.org/10.3109/00016349409006267

Rizk, D. E. E. (2007). Publication Ethics: Science at Its Best and Always Informative. *International Urogynecology Journal* 18 (7): 715–17. https://doi.org/10.1007/s00192-007-0363-3

Rockwell, S. (2002). Some Thoughts on the Ethics of Research and Publication. *Radiation Research* 157 (1): 1–2. https://doi.org/10.1667/0033-7587(2002)157[0001:STOTEO]2.0.CO;2

Rohwer, A., Young, T., Wager, E., & Garner, P. (2017). Authorship, plagiarism and conflict of interest: Views and practices from low/middle-income country health researchers. *BMJ Open*, *7*(11), e018467. https://doi.org/10.1136/bmjopen-2017-018467

Rosenkrantz, A. B., & Ginocchio, L. A. (2016). Instructional Vignettes in Publication and Journalism Ethics in Radiology Research: Assessment via a Survey of Radiology Trainees. *Academic Radiology* 23 (7): 823–29. https://doi.org/10.1016/j.acra.2016.02.016

Rost, K., & Ehrmann, T. (2017). Reporting Biases in Empirical Management Research: The Example of Win-Win Corporate Social Responsibility. *Business & Society*, *56*(6), 840–888. https://doi.org/10.1177/0007650315572858

Rowlands, I., Nicholas, D., & Huntington, P. (2004). Scholarly Communication in the Digital Environment: What Do Authors Want? *Learned Publishing* 17 (4): 261–73. https://doi.org/10.1087/0953151042321680

Rubenstein, A. H., Anlyan, W. G., Angell, M. E., Barber, B., Daddario, Emilio. Q., Davie, J. M., Djerassi, C., Friedman, P. J., Hallum, J., Jerome, F., Lorimer, L. K., May, W. F., Meinert, C. L., & Moertel, C. G. (1989). *The Responsible Conduct of Research in the Health Sciences*. National Academies Press. https://doi.org/10.17226/1388

Rudolph, J. L. (2015). Scholarly Norms For Writing History. *American Journal of Physics* 83 (11): 911. https://doi.org/10.1119/1.4930894

Saha, R. (2017). Plagiarism, Research Publications and Law. *Current Science* 112 (12): 2375–78. https://doi.org/10.18520/cs/v112/i12/2375-2378

Sarna-Wojcicki, D., Perret, M., Eitzel, M. V., & Fortmann, L. (2017). Where Are the Missing Coauthors? Authorship Practices in Participatory Research. *Rural Sociology*, *82*(4), 713–746. https://doi.org/10.1111/ruso.12156

Satalkar, P., & Shaw, D. (2018). Is Failure to Raise Concerns about Misconduct a Breach of Integrity? Researchers' Reflections on Reporting Misconduct. *Accountability In Research-Policies And Quality Assurance* 25 (6): 311–39. https://doi.org/10.1080/08989621.2018.1493577

Saurin, T. A. (2016). Ethics in Publishing: Complexity Science and Human Factors Offer Insights to Develop a Just Culture. *Science And Engineering Ethics* 22 (6): 1849–54. https://doi.org/10.1007/s11948-015-9735-0

Saxon, A. (2001). Research, Ethics, and Publishing. *Clinical Immunology* 98 (2): 155–56. https://doi.org/10.1006/clim.2000.4935

Schechter, A. N., Wyngaarden, J. B., Edsall, J. T., Maddox, J., Relman, A. S., Angell, M., & Stewart, W. W. (1989). Colloquium on scientific authorship: Rights and responsibilities. *The FASEB Journal*, *3*(2), 209–217. https://doi.org/10.1096/fasebj.3.2.2914630

Schmucker, C., Schell, L. K., Portalupi, S., Oeller, P., Cabrera, L., Bassler, D., Schwarzer, G., Scherer, R. W., Antes, G., von Elm, E., Meerpohl, J. J., & Consortium, O. (2014). Extent of Non-Publication in Cohorts of Studies Approved by Research Ethics Committees or Included in Trial Registries. *PLOS ONE*, *9*(12). https://doi.org/10.1371/journal.pone.0114023

Schreiber, L. (2005). The Importance of Precision in Language: Communication Research and (so-Called) Alternative Medicine. *Health Communication* 17 (2): 173–90. https://doi.org/10.1207/s15327027hc1702_4

Shapiro, D. W., Wenger, N. S., & Shapiro, M. F. (1994). The contributions of authors to multiauthored biomedical research papers. *JAMA*, *271*(6), 438–442.

Shashok, K. (2013). Ethical Contributions to Research Articles by Medical Writers. *Anesthesia & Analgesia*, *116*(2), 500–503. https://doi.org/10.1213/ANE.0b013e318274e29a

Sheikh, A. (2000). Publication ethics and the research assessment exercise: Reflections on the troubled question of authorship. *Journal of Medical Ethics*, *26*(6), 422–426. https://doi.org/10.1136/jme.26.6.422

Shewan, L. G., & Coats, A. J. S. (2012). Adherence to Ethical Standards in Publishing Scientific Articles: A Statement from the International Journal of Cardiology. *International Journal Of Cardiology* 161 (3): 124–25. https://doi.org/10.1016/j.ijcard.2012.10.021

Shinyaeva, T. S., & Tarasevich, Y. T. (2018). Science and Ethics Meet: A Mathematical View on One Kind of Violation of Publication Ethics. In *Computer Simulations In Physics And Beyond (CSP2017)*. Vol. 955. Journal of Physics Conference Series. Bristol, England: IOP Publishing Ltd. https://doi.org/10.1088/1742-6596/955/1/012034

Sly, R. M. (1997). Ethical Scientific Writing and Responsible Medical Practice. *Annals of Allergy, Asthma & Immunology*, *79*(6), 489–494. https://doi.org/10.1016/S1081-1206(10)63054-2

Smith, E., Hunt, M., & Master, Z. (2014). Authorship ethics in global health research partnerships between researchers from low or middle income countries and high income countries. *BMC Medical Ethics*, *15*(1), 42. https://doi.org/10.1186/1472-6939-15-42

Smith, E., & Master, Z. (2017). Best Practice to Order Authors in Multi/Interdisciplinary Health Sciences Research Publications. *Accountability in Research*, *24*(4), 243–267. https://doi.org/10.1080/08989621.2017.1287567

Song, F., Parekh-Bhurke, S., Hooper, L., Loke, Y. K., Ryder, J. J., Sutton, A. J., Hing, C. B., & Harvey, I. (2009). Extent of publication bias in different categories of research cohorts: A meta-analysis of empirical studies. *BMC Medical Research Methodology*, *9*, 79. https://doi.org/10.1186/1471-2288-9-79

Statzner, B., & Resh, V. H. (2010). Negative changes in the scientific publication process in ecology: Potential causes and consequences. *Freshwater Biology*, *55*(12), 2639–2653. https://doi.org/10.1111/j.1365-2427.2010.02484.x

Steinbok, P. (1995). Ethical considerations relating to writing a medical scientific paper for publication. *Child's Nervous System*, *11*(6), 323–328. https://doi.org/10.1007/BF00301663

Steinbok, P. (1996). Ethical Considerations Regarding Scientific Publications. *Pediatric Neurosurgery*, *25*(3), 164–164. https://doi.org/10.1159/000121118

Stern, J. M., & Simes, R. J. (1997). Publication bias: Evidence of delayed publication in a cohort study of clinical research projects. *BMJ*, *315*(7109), 640–645. https://doi.org/10.1136/bmj.315.7109.640

Stichler, J. F. (2014). The Ethics of Research, Writing, and Publication. *HERD-HEALTH ENVIRONMENTS RESEARCH & DESIGN JOURNAL*, *8*(1), 15–19. https://doi.org/10.1177/193758671400800103

Stoker, D. (1996). Ethics in scientific publication—Fraud, redundancy and errors. *Skeletal Radiology*, *25*(3), 205–206.

Street, J. M., Rogers, W. A., Israel, M., & Braunack-Mayer, A. J. (2010). Credit where credit is due? Regulation, research integrity and the attribution of authorship in the health sciences. *Social Science & Medicine*, *70*(9), 1458–1465. https://doi.org/10.1016/j.socscimed.2010.01.013

Stvilia, B., Hinnant, C. C., Wu, S., Worrall, A., Lee, D. J., Burnett, K., Burnett, G., Kazmer, M. M., & Marty, P. F. (2017). Toward collaborator selection and determination of data ownership and publication authorship in research collaborations. *Library & Information Science Research*, *39*(2), 85–97. https://doi.org/10.1016/j.lisr.2017.03.004

Svensson, P., & Andersson, L. (2013). Cutting the cake! Publication ethics in science. *Journal of Oral Rehabilitation*, *40*(7), 483–483. https://doi.org/10.1111/joor.12051

Swaan, P. W. (2010). Publication Ethics—A Guide for Submitting Manuscripts to Pharmaceutical Research. *Pharmaceutical Research*, *27*(9), 1757–1758. https://doi.org/10.1007/s11095-010-0188-5

Syed, S., Tran, D. Q., Kemper, A. R., Geme, J. W. S., & Lantos, J. D. (2015). Authorship Concerns and Who Truly Owns a Research Idea? *Pediatrics*, *136*(5), 969–973. https://doi.org/10.1542/peds.2015-1421

Tabbara, K., & Al-Kawi, M. Z. (2006). Ethics in Medical Research and Publication. *Annals Of Saudi Medicine* 26 (4): 257–60. https://doi.org/10.5144/0256-4947.2006.257

Tang, B. L. (2018). Letter to the Editor: On Plurality and Authorship in Science. *Accountability In Research-Policies And Quality Assurance* 25 (4): 254–58. https://doi.org/10.1080/08989621.2018.1457959

Teixeira da Silva, J. A. (2015). Issues in Science Publishing: What's Hot and What's Not? *KOME-An International Journal Of Pure Communication Inquiry* 3 (1): 81–87. https://doi.org/10.17646/KOME.2015.16

Teixeira da Silva, J. A., & Dobránszki, J. (2016). Multiple Authorship in Scientific Manuscripts: Ethical Challenges, Ghost and Guest/Gift Authorship, and the Cultural/Disciplinary Perspective. *Science and Engineering Ethics* 22 (5): 1457–72. https://doi.org/10.1007/s11948-015-9716-3

Tijdink, J. K., Schipper, K., Bouter, L. M., Pont, P. M., de Jonge, J., & Smulders, Y. M. (2016). How do scientists perceive the current publication culture? A qualitative focus group interview study among Dutch biomedical researchers. *BMJ OPEN*, *6*(2). https://doi.org/10.1136/bmjopen-2015-008681

Tijdink, Joeri K., Verbeke, R., & Smulders, Y. M. (2014). Publication Pressure and Scientific Misconduct in Medical Scientists. *JOURNAL OF EMPIRICAL RESEARCH ON HUMAN RESEARCH ETHICS*, *9*(5), 64–71. https://doi.org/10.1177/1556264614552421

Tobin, M. J. (2000). Reporting Research, Retraction of Results, and Responsibility. *American Journal of Respiratory and Critical Care Medicine* 162 (3): 773–74. https://doi.org/10.1164/ajrccm.162.3.ed08-00

Tucker, J. D., Chang, H., Brandt, A., Gao, X., Lin, M., Luo, J., Song, P., Sun, K., & Zhang, X. (2011). An Empirical Analysis of Overlap Publication in Chinese Language and English Research Manuscripts. *PLOS ONE*, *6*(7). https://doi.org/10.1371/journal.pone.0022149

Uijtdehaage, S., Mavis, B., & Durning, S. J. (2018). Whose Paper Is It Anyway? Authorship Criteria According to Established Scholars in Health Professions Education. *Academic Medicine*, *93*(8), 1171–1175. https://doi.org/10.1097/ACM.0000000000002144

Vasconcelos, S. M. R, & Roig, M. (2015). Prior Publication and Redundancy in Contemporary Science: Are Authors and Editors at the Crossroads? *Science And Engineering Ethics* 21 (5): 1367–78. https://doi.org/10.1007/s11948-014-9599-8

Vassallo, J. (2018). WASP (Write a Scientific Paper): Plagiarism and the Ethics of Dealing with Colleagues. *Early Human Development* 124: 65–67. https://doi.org/10.1016/j.earlhumdev.2018.04.028

Vinkers, C. H., Tijdink, J. K., & Otte, W. M. (2015). Use of positive and negative words in scientific PubMed abstracts between 1974 and 2014: Retrospective analysis. *BMJ*, *351*, h6467. https://doi.org/10.1136/bmj.h6467

Wager, E., & Kleinert, S. (2013). Why do we need international standards on responsible research publication for authors and editors? *Journal of Global Health*, *3*(2). https://doi.org/10.7189/jogh.03.020301

Wager, E., Woolley, K., Adshead, V., Cairns, A., Fullam, J., Gonzalez, J., Grant, T., & Tortell, S. (2014). Awareness and Enforcement of Guidelines for Publishing Industry-Sponsored Medical Research among Publication Professionals: The Global Publication Survey. *BMJ OPEN* 4 (4). https://doi.org/10.1136/bmjopen-2013-004780

Wagner, M. K., Dodds, A., & Bundy, M. B. (1994). Psychology Of The Scientist .67. Assignment Of Authorship Credit In Psychological-Research. *Psychological Reports* 74 (1): 179–87. https://doi.org/10.2466/pr0.1994.74.1.179

Walcott, B. P., Sheth, S. A., Nahed, B. V. & Coumans, J. V. (2012). Conflict of Interest in Spine Research Reporting. *PLOS ONE* 7 (8). https://doi.org/10.1371/journal.pone.0044327

Walshbowers, R. (1995). The Reporting And Ethics Of The Research Relationship In Areas Of Interpersonal Psychology, 1939-89. *Theory & Psychology* 5 (2): 233–50. https://doi.org/10.1177/0959354395052004

Wang, M. Q., Yan, A. F., & Katz, R. V. (2018). Researcher Requests for Inappropriate Analysis and Reporting: A US Survey of Consulting Biostatisticians. *Annals Of Internal Medicine* 169 (8): 554-558. https://doi.org/10.7326/M18-1230

Ward-Fear, G., Pauly, G. B., Vendetti, J. E., & Shine, R. (2020). Authorship Protocols Must Change to Credit Citizen Scientists. Trends in Ecology & Evolution 35 (3): 187–190. https://doi.org/10.1016/j.tree.2019.10.007

Warrender, J. M. (2016). A Simple Framework for Evaluating Authorial Contributions for Scientific Publications. *Science And Engineering Ethics* 22 (5): 1419–30. https://doi.org/10.1007/s11948-015-9719-0

Washburn, J. J. (2008). Encouraging Research Collaboration Through Ethical and Fair Authorship: A Model Policy. *Ethics & Behavior* 18 (1): 44–58. https://doi.org/10.1080/10508420701712917

Webster, R. (2003). Let's Re-Write the Scientific Paper. *European Journal Of Soil Science* 54 (2): 215–18. https://doi.org/10.1046/j.1365-2389.2003.00515.x

Welfare, L. E., & Sackett, C. R. (2011). The Authorship Determination Process in Student-Faculty Collaborative Research. *Journal Of Counseling And Development* 89 (4): 479–87. https://doi.org/10.1002/j.1556-6676.2011.tb02845.x

Wenger, N. S., Korenman, S. G., Berk, R., & Liu, H. H. (1999). Reporting Unethical Research Behavior. *Evaluation Review* 23 (5): 553–70. https://doi.org/10.1177/0193841X9902300504

Wester, K. L. (2011). Publishing Ethical Research: A Step-by-Step Overview. *Journal Of Counseling And Development* 89 (3): 301–7. https://doi.org/10.1002/j.1556-6678.2011.tb00093.x

Wicherts, J. M., Bakker, M. & Molenaar, D. (2011). Willingness to Share Research Data Is Related to the Strength of the Evidence and the Quality of Reporting of Statistical Results. *PLOS ONE* 6 (11). https://doi.org/10.1371/journal.pone.0026828

Wong, K. K. L., & Hui, S. C. N. (2015). Ethical Principles and Standards for the Conduct of Biomedical Research and Publication. *Australasian physical & engineering sciences in medicine* 38 (3): 377–80. https://doi.org/10.1007/s13246-015-0364-3

Woteki, C. E. (2006). Ethics Opinion: Conflicts of Interest in Presentations and Publications and Dietetics Research. *Journal of the American Dietetic Association* 106 (1): 27–31. https://doi.org/10.1016/j.jada.2005.11.011

Wray, K. B. (2006). Scientific Authorship in the Age of Collaborative Research. *Studies in History and Philosophy of Science Part A* 37 (3): 505–14. https://doi.org/10.1016/j.shpsa.2005.07.011

Youtie, J., & Bozeman, B. (2014). Social Dynamics of Research Collaboration: Norms, Practices, and Ethical Issues in Determining Co-Authorship Rights. *Scientometrics* 101 (2): 953–62. https://doi.org/10.1007/s11192-014-1391-7

Zietman, A. L. (2017). The Ethics of Scientific Publishing: Black, White, and 'Fifty Shades of Gray.' *International Journal of Radiation Oncology*Biology*Physics* 99 (2): 275–79. https://doi.org/10.1016/j.ijrobp.2017.06.009

Zwart, H. (2005). Professional Ethics and Scholarly Communication. In *Ethics for Life Scientists*, edited by Michiel Korthals and Robert J. Bogers, 5:67–80. Dordrecht: Springer Netherlands. https://doi.org/10.1007/1-4020-3180-7_8

Chapter 3: Criteria for assessing Contributor Role Ontologies and Taxonomies

3.1 Introduction

The second research objective of this thesis is to develop an assessment instrument for the evaluation of Contributor Role Ontologies and Taxonomies (CROTs). Various CROTs have been developed to specify contributions to publications. CROTs are believed to improve "systems of attribution, credit, and accountability" in publications and address (some) ethical issues of scholarly authorship (Brand et al. 2015, p. 153). Given the importance of credit and accountability in academia[22], any changes to how these are attributed impacts authorship practices and accordingly, various parties such as researchers and scientific institutions. Therefore, with an increase in using CROTs for specifying contributions in publications, it is vital to explore them from an ethical perspective. This exploration may help developers of CROTs to improve future revisions and also support adopters (e.g., journal editors and institutions) to select the CROTs that address their most pressing issues. Furthermore, this analysis can be a useful resource from a theoretical perspective, because it moves forward the debate about ethical issues of using CROTs and accordingly, facilitates the identification of the ethical strengths and weaknesses of current and future CROTs from an ethical perspective.

This chapter starts with a brief introduction of three CROTs, and describes the process of developing criteria for the assessment instrument. After following the suggested process to extract issues and concerns about CROTs, candidate assessment criteria are compiled for the next chapter to be justified from an ethical perspective.

[22] Awarded credit from publications is the single most significant factor in career advancement in academia (Alfonso & Editors' Network, 2019), and accountabilities are used to hold contributors liable about what is reported and published (Cronin 2001).

3.1.1 CRediT (Contributor Role Taxonomy)

First introduced in 2015, CRediT classifies diverse scholarly contributions to research outputs in a high-level standardised vocabulary (figure 17). These contributions include tasks such as conceptualisation, methodology, software, validation, formal analysis, investigation, resources, data curation, writing (original draft preparation), writing (review and editing), visualisation, supervision, project administration, and funding acquisition (Brand et al. 2015). CRediT has been incorporated into several academic workflows, including journal submission and review systems (e.g., Editorial Manager, PubSweet, Scholar One, ReView) and other tools such as Rescognito and OpenConf (Vasilevsky et al. 2020). CRediT is particularly popular among academic journals and publishing outlets and has been adopted by major publishers like Elsevier, Sage, Springer and Wiley (CASRAI 2020). CRediT can also be incorporated into Universities' output repositories and library management systems. So far, the University of Glasgow has been the only institution to adopt and use CRediT for this purpose.

#	Role	Definition
1	**Conceptualization**	Ideas; formulation or evolution of overarching research goals and aims.
2	**Data curation**	Management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later re-use.
3	**Formal analysis**	Application of statistical, mathematical, computational, or other formal techniques to analyse or synthesize study data.
4	**Funding acquisition**	Acquisition of the financial support for the project leading to this publication.
5	**Investigation**	Conducting a research and investigation process, specifically performing the experiments, or data/evidence collection.
6	**Methodology**	Development or design of methodology; creation of models.
7	**Project administration**	Management and coordination responsibility for the research activity planning and execution.
8	**Resources**	Provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation, computing resources, or other analysis tools.
9	**Software**	Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components.
10	**Supervision**	Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team.
11	**Validation**	Verification, whether as a part of the activity or separate, of the overall replication/reproducibility of results/experiments and other research outputs.
12	**Visualization**	Preparation, creation and/or presentation of the published work, specifically visualization/data presentation.
13	**Writing – original draft**	Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation).
14	**Writing – review & editing**	Preparation, creation and/or presentation of the published work by those from the original research group, specifically critical review, commentary or revision – including pre- or post-publication stages.

Figure 17. CRediT roles and their definitions (retrieved on October 8, 2019, from https://casrai.org/credit/).

3.1.2 Contributor Role Ontology (CRO)

Introduced in 2016, Contributor Role Ontology (CRO) is one part of the OpenVIVO ecosystem[23], which indicates individual contributions to publications or projects. CRO is built on and expands CRediT (figure 18) to cover a larger group of tasks from various fields (Illic et al. 2018). As an open-source, community-developed ontology containing over 50 terms, CRO provides a structured representation of contributions in research and scholarship (Vasilevsky et al. 2020). Although CRO is currently being used by Research Management Repositories such as CERN's InvenioRDM, it has not been used for the purpose of specifying contributions to published items such as journal articles yet.[24]

[23] OpenVIVO is a semantic-based platform that gathers and facilitates the sharing and representation of information about scholarly works and their participants.
[24] The only exception is the FORCE conference in 2016 where CRO was used to classify contributions to presented items (Ilik et al. 2018).

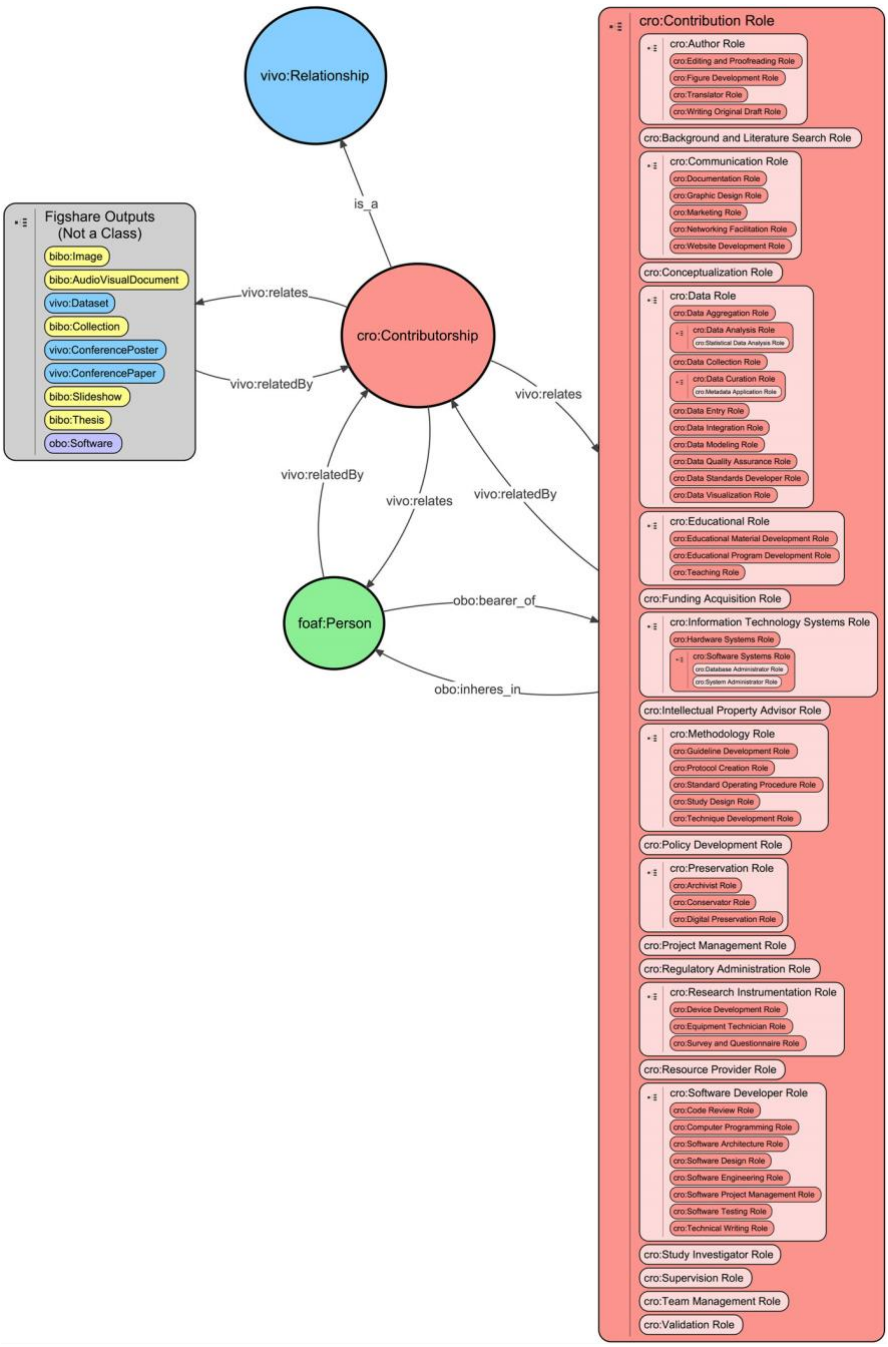


Figure 18. A visualisation of CRO contributions (retrieved on October 8, 2019, from: https://www.frontiersin.org/articles/10.3389/frma.2017.00012/full).

3.1.3 TaDiRAH (Taxonomy of Digital Research Activities in the Humanities)

TaDiRAH is a taxonomy to classify and categorise contributions within the field of humanities that was introduced in 2016 (figure 19). It consists of several categories for research activities, research goals and research methods. It also entails a list of specific research techniques, and research objects to which methods and goals can be applied (Borek et al. 2016a). Although TaDiRAH is currently adopted by some humanities bibliographies and online directories for

indexing purposes (e.g., DARIAH-DE bibliography), it has not been used for the purpose of specifying contributions to published items such as journal articles yet.[25]

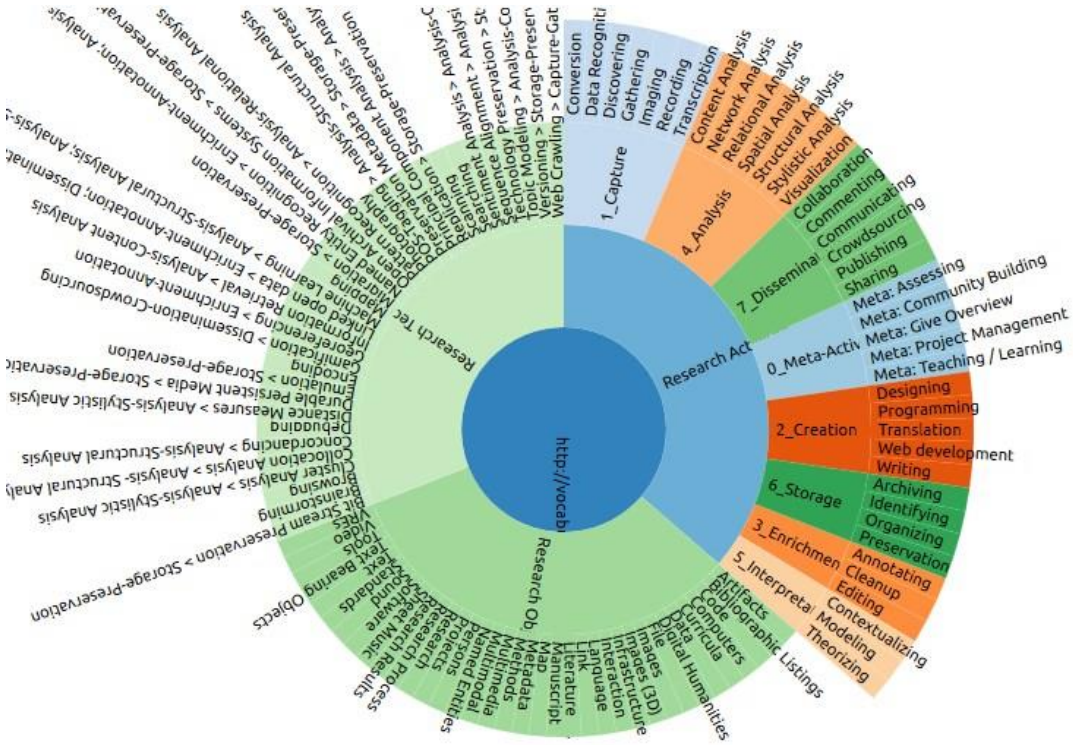


Figure 19. A visualisation of TaDiRAH roles (retrieved on October 8, 2019, from: https://de.dariah.eu/en/weiterfuhrende-informationen).

3.2 Methodology for developing an assessment instrument

To facilitate an ethical analysis of CROTs, this chapter compiles an assessment instrument. Towards that end, a five-step process will be followed to develop candidate assessment criteria from various sources and then justify them from an ethical perspective (Figure 20). While the first four steps use a bottom-up approach to collect issues and relevant concerns raised, the fifth step employs a top-down approach to justify raised concerns and issues (about CROTs) from an ethical perspective.

[25] The only exception is the DHd conference in 2016, where TaDiRAH was used to classify contributions to presented items (Borek et al. 2016b).

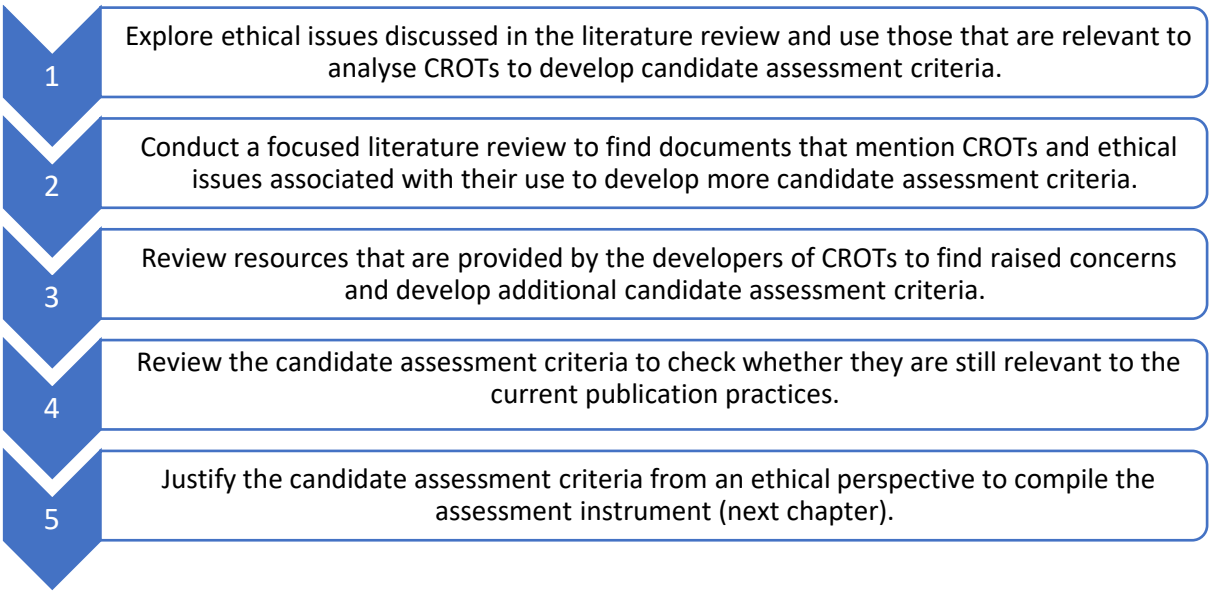


Figure 20. The five-step process to develop an assessment instrument for an ethical analysis of CROTs.

Firstly, the ten ethical issues of scholarly authorship that resulted from the literature review (presented in Chapter 2) will be explored. These issues will be checked to see which ones (or which aspects of them) are relevant to how CROTs are applied in specifying contributions to publications, and on that basis, candidate assessment criteria will be developed.

Secondly, to prevent neglecting issues that are specific to CROTs but may not have been mentioned among the items in the review of the literature on ethical issues of scholarly authorship[26], a (new) focused literature review with narrow and more specific search terms will be conducted. Retrieved resources and issues/concerns mentioned will be used to develop additional candidate assessment criteria.

Thirdly, in order to explore issues that may not have been published in traditional scholarly outlets, resources provided by developers of various CROTs will be explored to generate further candidate assessment criteria. These resources may present useful insights into issues that CROTs aimed to address and tensions that may follow upon their integration into academic

[26] Among the 324 documents deemed eligible for the literature review on ethical aspects of scholarly authorship, only four documents mention CRediT taxonomy (Smith & Master 2017; Kumar 2018; McNutt et al. 2018; Uijtdehaage et al. 2018). While these four articles note some benefits of using CROTs such as minimising tensions in collaborations, none of them provides a critical and thorough analysis of any of the CROTs. Only smith and Master (2017) provide a brief analysis of CRediT.

workflows. Furthermore, developers of CROTs hold regular users' meetings to discuss current issues and publish attendants' feedback on how CROTs are used in practice. Attending these meeting where possible or asking for meeting notes further enrich the candidate assessment criteria. Due to the novelty of CROTs and the rarity of information about them, this approach can be seen as a pragmatic way of gathering input for the assessment instrument.

Fourthly, extracted candidate assessment criteria will be tested for their applicability to the publication practice and submission workflows of journals that have adopted one of the CROTs. This is to prevent qualifying criteria that pertain to issues and concerns already addressed by now, and hence, are no longer applicable.

Finally, candidate assessment criteria that resulted from the previous four steps will be justified from an ethical perspective (in the next chapter). One advantage of postponing the justification of candidate assessment criteria is that this way, a complete list of raised issues/concerns relevant to CROTs is compiled. Especially, since the list of justified criteria would change depending on the chosen *ethical* approach/framework, postponing the justification would allow for future research to access a complete list of concerns about CROTs.

3.2.1 Methodology for content analysis and developing candidate assessment criteria

In terms of analysing relevant items to develop candidate assessment criteria, due to the variety of resources that need to be explored (results of a literature review, journal articles, blogs, conference presentations, meeting notes, slides, etc.) an inductive analysis is the preferred strategy. For this purpose, the methodology suggested by Thomas will be used (Thomas 2006). This method involves highlighting sections of the document that contain concerns possibly relevant to the application of CROTs for specifying contributions to publications. Each highlighted section is then labelled with a title that represents the issue raised. Such issues/points/concerns are then used as examples to infer a general rule that should be met by

CROTs. These general rules comprise the candidate assessment criteria and are generated in a Yes/No format to enable a straightforward evaluation of CROTs. Although inductive methods always involve a degree of interpretation (Elo et al. 2014), since the developed candidate assessment criteria will be tested for their applicability to current practices, and also (in the following chapter) will be justified from an ethical perspective, the possibility/risk of adding irrelevant criteria to the final assessment instrument is minimised.

3.3 Candidate assessment criteria to assess CROTs based on ethical issues of scholarly authorship

The review of the literature about scholarly authorship (presented in Chapter 2) highlighted ten ethical issues. In what follows, these issues will be explored to identify aspects that are relevant to the application of CROTs in specifying contributions to publications.

3.3.1 Attribution

In the context of scholarly authorship, attribution refers to factors that should be considered in recognising contributors' work, which allow for the reception of (some form of) credit. Two major questions regarding attribution of credit include:

I. What contributions to which tasks deserve receiving credit?
II. What is the necessary extent of contribution to receive various forms of credit?

Ad. I) Since CROTs use a standard list of tasks, (in theory) they resolve ambiguities about tasks that deserve credit. However, in offering standard and pre-defined tasks, issues may arise due to having some relevant tasks omitted. In such cases, accurate attribution of credit to those who contribute to omitted tasks will not be possible.[27] The literature review notes non-author

[27] Since developing a complete list of all the possible contribution-types in all research areas (to check which tasks are mentioned in CROTs and which ones are omitted) would be an insurmountable task and out of the scope of this thesis, here only tasks that were specifically mentioned are used.

contributions (i.e., tasks that are traditionally deemed insignificant or non-intellectual and do not merit authorship status, hence, are often mentioned in the acknowledgement section of publications), and the more specific example of enrolling patients for clinical trials[28] among tasks that are often inadequately recognised. Accordingly, two aspects to check include whether CROTs allow for the attribution of credit to tasks that do not traditionally meet authorship status (whatever they are according to relevant guidelines and research contexts), and the task of enrolling patients for clinical trials:

Candidate assessment criterion 1. Is it possible to recognise tasks that would traditionally not merit authorship status (e.g., those mentioned in the acknowledgement section)?
Candidate assessment criterion 2. Is it possible to recognise the task of enrolling patients for clinical trials?

Ad. II) Regarding the extent of contribution necessary to receive various forms of credit, unlike the authorship model that allows the attribution of two unequal forms of credit (i.e., authorship credit and being mentioned in the acknowledgements), CROTs attribute only one form of credit (i.e., being mentioned as a contributor). Therefore, all relevant tasks are recognised to the same degree, meaning that the issue of the extent of contributions does not play the same role in CROTs. Nevertheless, the extent of contributions could become a matter of dispute, if more than one contributor is involved in conducting the same task.[29] Accordingly, providing the means for clarifying the extent of contributions would be necessary to prevent misattribution of credit:

Candidate assessment criterion 3. Within tasks that involve more than one contributor, is it possible to clarify the extent of their individual contributions?

[28] Although enrolling patients can also be seen as an example of a non-author contribution, since no major guideline includes this task among common non-author contributions, it will be explored separately here.
[29] For example, if contributor A is the only one involved in data analysis, it does not matter how big or small their contribution is. However, when two or more persons are involved in a similar role, it is likely for them to make unequal contributions. In these cases, failing to register different degrees of contribution leads to misattribution of credit.

3.3.2 Violations

Ethical issues about violations of norms of authorship are mainly centred around:

I. Defining what counts as a violation

II. The best solution for preventing violations

Ad. I) Defining violations of research norms and specifying good conduct mainly occur in codes of conduct (Davis 1999). However, given the distinctiveness of various authorship criteria used for the attribution of credit, developers of these criteria often provide more specific guidelines that describe acceptable/unacceptable behaviour while using these criteria.[30] Good examples of these kinds of guidelines include *Authorship Policy* provided by the World Association of Medical Editors (WAME), and the *Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals* published by the International Committee of Medical Journal Editors (ICMJE).[31] Accordingly, CROTs are also expected to describe what are considered violations in their terms:

Candidate assessment criterion 4. In their instructions for researchers, do CROTs describe what is regarded as a violation while using them?

Ad. II) In terms of solutions too, developers of authorship criteria provide suggestions and best practices to prevent violations that may negatively affect authors.[32] Accordingly, it is reasonable

[30] While fraudulent authorship practices (e.g., plagiarism) are defined in codes of conduct (Davis 1999), these codes cannot possibly entail all forms of unacceptable practices that might happen while using different authorship criteria. This is perhaps due to the disparity between various authorship criteria in terms of how they define authorship and the associated responsibilities (Hosseini & Lewis 2020).

[31] For instance, after specifying who is an author with four criteria, the ICMJE recommendations provide suggestions on workflow and policies for journals and institutions to deal with violations while using their definition of authorship: "Authors should avoid entering in to agreements with study sponsors, both for-profit and nonprofit, that interfere with authors' access to all of the study's data or that interfere with their ability to analyze and interpret the data and to prepare and publish manuscripts independently when and where they choose. Policies that dictate where authors may publish their work violate this principle of academic freedom. Authors may be required to provide the journal with the agreements in confidence. Purposeful failure report those relationships or activities specified on the journal's disclosure form is a form of misconduct, as is discussed in Section III.B." (ICMJE 2019, pp. 3-4).

[32] For instance, ICMJE provides suggestions on how publications in predatory journals should be discouraged and prevented: "Guidance from various organizations is available to help identify the characteristics of reputable peer-reviewed journals (www.wame.org/identifyingpredatory-or-pseudo-

to expect CROTs to provide useful and relevant suggestions to minimise the likelihood of violations:

Candidate assessment criterion 5. In their instructions for researchers, do CROTs attempt to suggest possible solutions and best practices to minimise the likelihood of (common) violations?

3.3.3 Bias

Bias in authorship involves two forms of conflict of interests (COIs):

I. Financial COIs

II. Non-financial COIs

Ad. 1) Publications that follow from academia-industry partnerships are prone to financial COIs because instructions on how results should be published are not always clear and sometimes the sources of funding remain undisclosed. Although defining the norms for academia-industry collaborations are out of the scope/reach of CROTs[33], since the provision of funds is a form of contribution to scientific projects, disclosure of the sources of funding is an aspect that could be covered by CROTs.[34] Therefore, in relation to financial COIs, checking whether CROTs allow the registration of funders' contributions is necessary:

Candidate assessment criterion 6. Are there mechanisms to disclose funders' contribution?

Ad. 2) Non-financial COIs include biased hypotheses, biased use of language, biased interpretation of results, biased correction of images and gender bias. These are often difficult to define, and sometimes challenging to identify within publications. CROTs are not designed to capture flaws in the content or take over the role of national or institutional codes of conduct in

journals). Authors have a responsibility to evaluate the integrity, history, practices and reputation of the journals to which they submit manuscripts" (ICMJE 2019, p.4).

[33] Norms of collaboration depend on legal agreements between academia and industry, legal systems that each subscribes to, and the public support that they receive (Ankraha & AL-Tabbaa 2015). Additionally, the descriptions and definitions of financial COIs is often provided via codes of conduct (Resnik 2015a).

[34] Failing to (openly) acknowledge the sources of funding not only misleads readers, but it also misattributes credit and accountabilities (Morley 2013).

defining various forms of bias or in exposing them. Therefore, no candidate assessment criterion can be developed to address concerns about non-financial COIs.

3.3.4 Responsibility and accountability

Issues raised about this matter include:

I. Ambiguities in relation to individual and overlapping responsibilities

II. Supervisors' responsibilities in guiding junior researchers

Ad. 1) Given the stratification of tasks and clarity of individual contributions, (in theory) there will be no ambiguity in relation to individual responsibilities when using CROTs. Nevertheless, in cases where several contributors are involved in carrying out a large task, identifying who is responsible for what part of the task may not be straightforward (see red arrows in figure 21). Consequently, one way of minimising ambiguities about responsibilities (especially in cases similar to the one highlighted in figure 21) is to check whether CROTs provide mechanisms to indicate individual and overlapping responsibilities:

Candidate assessment criterion 7. Are there mechanisms to indicate individual and overlapping responsibilities concerning tasks conducted by two or more contributors?

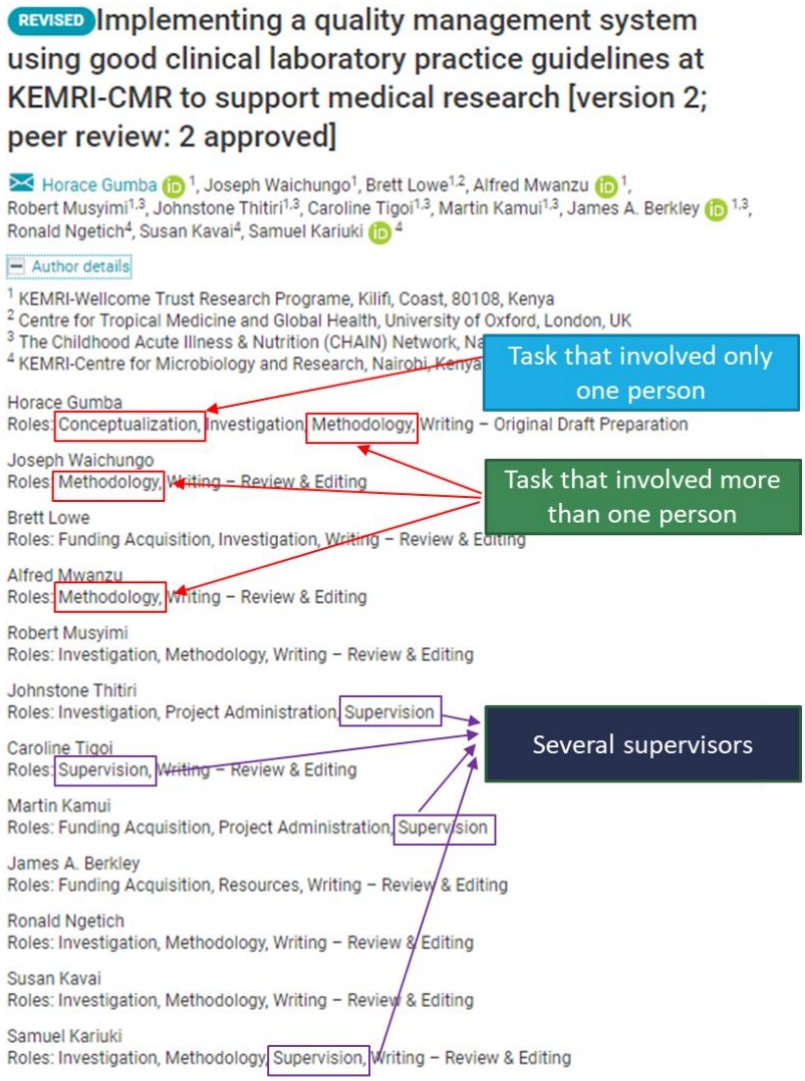


Figure 21. An example of how overlapping responsibilities might contribute to ambiguities about individual responsibilities.

Ad. 2) The lack of a thorough awareness of guidelines and their application among junior researchers is the underlying reason for senior researchers' duty to guide/usher them through the research process and publication. This implies that if a junior researcher makes a mistake, the supervisor may also be held responsible (e.g., if it becomes evident that the junior researcher did not receive adequate training or mentorship). This connected responsibility of junior and senior researchers demands clarity as to the relation/connection between mentors and mentees. Especially in cases where several supervisors are involved in a project (see purple arrows in figure 21), it is essential to specify mentor-mentee relations to avoid ambiguities about supervisory responsibilities:

Candidate assessment criterion 8. Are there mechanisms to indicate mentor-mentee relations and the subsequent responsibilities for mentors?

3.3.5 Order of names

Among the three raised issues regarding the order of names[35], none are relevant to an ethical analysis of CROTs. This is because currently CROTs are used in parallel with the authorship model and list contributions based on their authorship order[36] (see figure 22 for an example of how CRediT is used in a publication). On that basis, in their current application, CROTs do not need a separate rationale for listing names, and therefore, no criterion can be developed based on this issue.

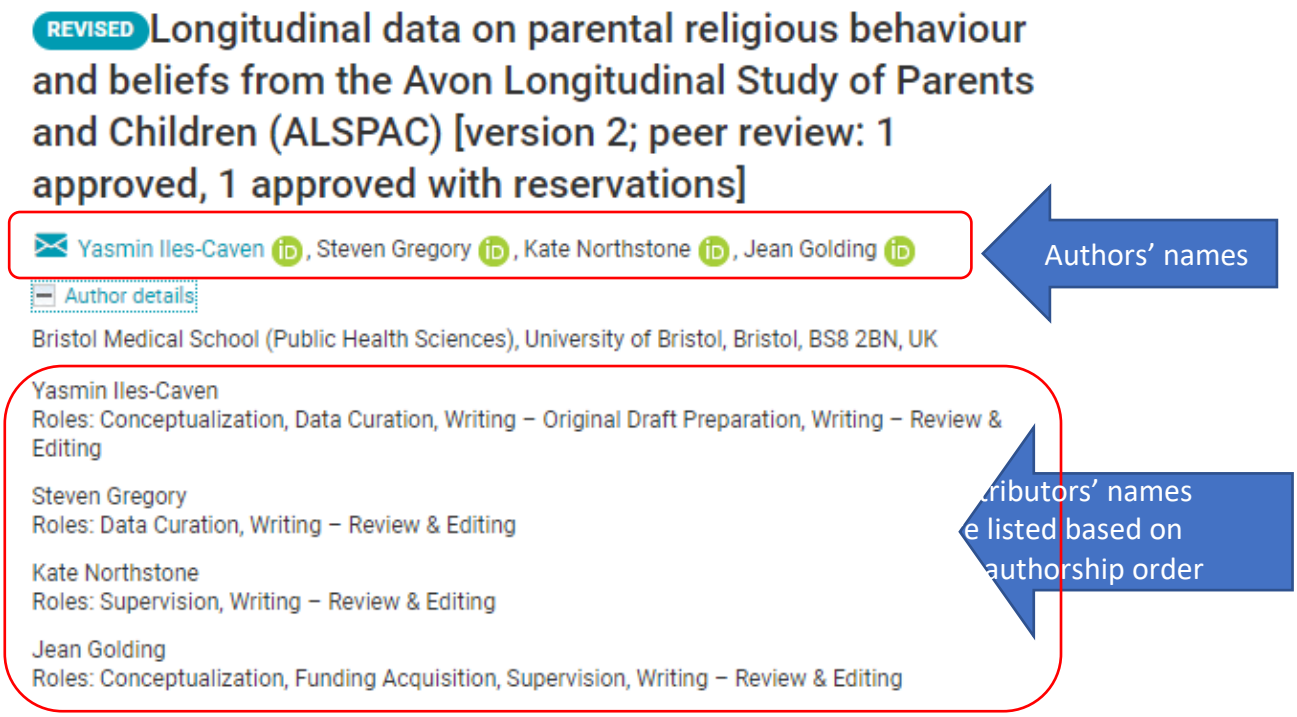


Figure 22. The way contributions are described while using CROTs makes the issue of the order of names irrelevant.

[35] The criteria that should be used to put names in order, the fairness of the criteria used to order names, and the relationship between authorship order and the inferred responsibility from one's place in the sequence.

[36] Even in a (future) scenario where CROTs are used without the authorship model, differences between the authorship model and CROTs make fairness of the order, and the relationship between authorship order and the inferred responsibility as criteria irrelevant to the analysis of CROTs. While within the authorship model, the first, second, or last positions imply a certain meaning (i.e., who contributed how much or who was the supervisor, etc.), and the awarded credit correlates with that position (Steneck 2007), within CROTs, these implicit connotations are made explicit through connecting contributors to tasks, and the amount of awarded credit does not change based on the order of names.

3.3.6 Definition of authorship

Given that in using CROTs (in theory) all contributions are equally recognised (whether made by authors or non-authors[37]), the definition of authorship and difficulties in the attribution of the authorship status seem irrelevant to an ethical analysis of CROTs.[38]

3.3.7 Citations and referencing

Discussion about citations and referencing focus on how previously published materials are used/referred to within publications. Since interaction with previously published material has nothing to do with giving credit to those who collaborated in a given publication, this issue is not related to an ethical analysis of CROTs.

3.3.8 Publication strategy

Issues subsumed under the heading of publication strategy are about questionable practices to improve the visibility and success of published items after they are published. Hence, they are unrelated to an ethical analysis of CROTs.

3.3.9 Originality

Concerns about originality raise questions about how noteworthy the results should be (in light of the extant literature and also as a standalone research item) to get published as a new article, or how many publications can/should be extracted from a study or dataset. These issues are irrelevant to an ethical analysis of CROTs.

[37] It should be noted that some authorship guidelines may attempt to link their definition of authorship to tasks that are recognised by CROTs, in which case roles that would qualify one for the authorship status should be specified by the developers of authorship guidelines and not CROTs.
[38] One may argue that the definition of contributor could be analogous to that of authorship. However, since CROTs aim to capture all contributions (even those that are tangential to traditionally accepted contribution types such as data collection and analysis) the definition of contributor would not be comparable to that of authorship.

3.3.10 Sanctions

Questions about how to deal with those who violated norms and the type of sanctions that should be applied to various violations are among the issues discussed. Since investigating violations and sanctioning wrongdoers differ per jurisdiction and institution (ALLEA 2011), the issue of sanctions is not relevant to an ethical analysis of CROTs.

3.4 Issues and concerns specific to CROTs (Focused literature review)

3.4.1 Methodology for a focused literature review about CROTs

In order to retrieve documents that discuss ethical issues related to CROTs, three generic terms occurring in describing ethical issues[39], and four nouns often employed in combination with the first set of terms were used[40] (table 3).

Rationale	**Search terms**
Three generic terms often used in describing ethical issues	(1) Moral (2) Ethical (3) Normative
Four nouns often used in combination with the first set of terms about ethics	(1) Issue OR Issues[41] (2) Concern OR Concerns (3) Problem OR Problems (4) Question OR Questions

Table 3. Relevant search terms to find resources relevant to ethical issues.

After combining search terms mentioned in table 3 with the names of three CROTs ("CRediT taxonomy"[42], "Contributor Role Ontology" and "TaDiRAH") as well as two other relevant terms

[39] *Ethics* and *morals* are used to describe "standards of conduct (or behaviour) that distinguish between right/wrong, good/bad", and *normative* pertains to the strand of ethics that aims to "prescribe and evaluate conduct" (Resnik 2015b, paragraph 5).
[40] After conducting a scoping practice together with CROTs' names, these nouns yielded more hits than nouns such as affair, matter, trouble, complication, dispute and obstacle.
[41] The wildcard option (*) does not always work accurately in Google Scholar. For instance, in using the first string, while using *"ethical issue" OR "ethical issues"* yielded 11 hits, using *"ethical issu*"* yielded only 3 hits. Therefore, after a scoping exercise, it was decided not to use wildcards.
[42] Since search engines are not case-sensitive, using CRediT without "taxonomy" results in tens of thousands of irrelevant hits.

used in discussions about CRO and CRediT ("OpenVIVO"[43] and "Contributor Role Taxonomy"[44]), 60 distinct strings were created. Web of Science (Clarivate Analytics 2020a) and Google Scholar (Alphabet Inc. 2020) were used for this purpose. Whereas Web of Science did not yield any results, Google Scholar found 54 documents.[45] Table 4 shows search strings that retrieved at least one item in March 2020 (including the duplicates). The complete table is available in Appendix A.

Search string	**Number of found items**
"ethical issue" OR "ethical issues" AND "CRediT Taxonomy"	11
"ethical concern" OR "ethical concerns" AND "CRediT Taxonomy"	10
"ethical problem" OR "ethical problems" AND "CRediT Taxonomy"	1
"ethical question" OR "ethical questions" AND "CRediT Taxonomy"	2
"ethical issue" OR "ethical issues" AND "OpenVIVO"	4
"ethical concern" OR "ethical concerns" AND "OpenVIVO"	1
"ethical problem" OR "ethical problems" AND "OpenVIVO"	1
"ethical issue" OR "ethical issues" AND "TaDiRAH"	3
"ethical concern" OR "ethical concerns" AND "TaDiRAH"	3
"ethical question" OR "ethical questions" AND "TaDiRAH"	3
"ethical issue" OR "ethical issues" AND "Contributor Role Ontology"	4
"ethical concern" OR "ethical concerns" AND "Contributor Role Ontology"	1
"ethical problem" OR "ethical problems" AND "Contributor Role Ontology"	1
"ethical issue" OR "ethical issues" AND "contributor role taxonomy"	4
"ethical concern" OR "ethical concerns" AND "contributor role taxonomy"	4
"ethical question" OR "ethical questions" AND "contributor role taxonomy"	1
Total	54

Table 4. Search strings and the number of items resulted from each query. Strings that did not yield any results are not mentioned here.

Once duplicate items had been removed, 28 unique titles remained. After checking the abstract and initial analysis, eight documents were excluded because they did not discuss concerns about the application of CROTs concerning contributions to publications. Six of these documents only

[43] Since the Contributor Role Ontology (CRO) was initially developed as a component within the OpenVIVO ecosystem, in some academic discussions the two terms are still used interchangeably.
[44] CRediT is an acronym for Contributor Role Taxonomy.
[45] Various combination of search strings (with or without wild cards) were tried without any success. This could be because relevant sources are published in outlets that are not captured/indexed in Web of Science (the debate has not moved to traditional literature yet and mainly takes place in other spaces such as the blog-sphere). Furthermore, Web of science only allows searching in titles and abstracts and not in full texts, which decreases the chances of finding relevant items. In Google Scholar, however, one can adjust the search settings to search through the full texts, which in this case increased the likelihood of finding relevant items.

named one of the CROTs as a new solution/development without adding any further insights. One research proposal and one collaboration charter noted that they would use one of the CROTS (i.e., CRediT taxonomy) to acknowledge contributions to their future publications. Accordingly, 20 items that discuss CROTs in a meaningful way were deemed eligible for full-text reading (figure 23).

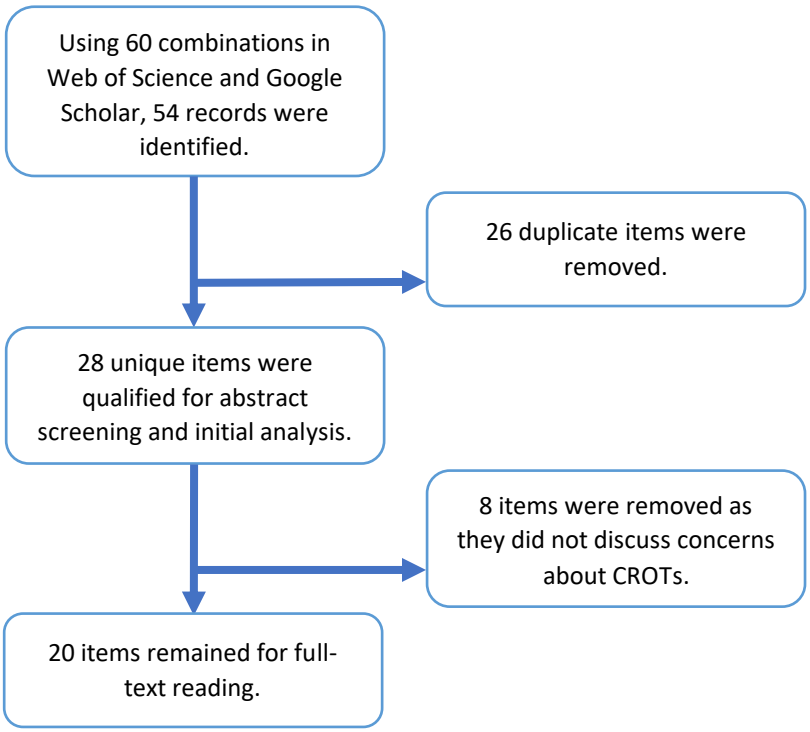


Figure 23. The selection process deemed 20 documents eligible for the analysis of their content.

3.4.2 Developed candidate assessment criteria based on the focused literature review

The selected sample is analysed through the inductive approach introduced in 2.2.1. A brief analysis of relevant sections and labels used to tag these are listed below. Documents that contain no concerns about the application of CROTs in specifying contributions to publications and a brief analysis of their content are listed in Appendix B.

The order in which extracted items are listed here is based on their sequence in the results shown in Google Scholar (the *Sort by relevance* function was applied), using search strings mentioned in table 4.

1. (Hosseini 2020)

Label: Attribution – Equal contribution

This article discusses the growing trend of sharing one of the positions in the byline between two or more authors (so-called equal co-authorship). CRediT is introduced as a solution because it allows acknowledging equal contributions to publications. The availability of this option in CRedit is believed to prevent ambiguities about the recognition of equal contributions. This note relates to the issue of attribution and highlights the importance of specifying the extent of contributions when two or more contributors make equal contributions to a large task:

Candidate assessment criterion 9. In clarifying the extent of contributions to tasks, is it possible to specify two or more contributors as equal?

2. (Vasilevsky et al. 2020)

Label: Usability – User guidelines

This article discusses barriers to the further uptake of CROTs and highlights the creation and provision of practical guidance for using CROTs as an effective strategy that can promote their use. In this context, practical guidance is provided via clear instructions as to how CROTs should be used. In addition to promoting their use, such instructions can decrease the likelihood of misattribution of credit and responsibilities. Therefore, it is necessary to check whether CROTs provide researchers with adequate and straightforward instructions about how they should be used:

Candidate assessment criterion 10. Are there adequate and straightforward instructions to guide researchers on how CROTs should be used?

Label: Usability – Incorporation of resolvable URIs[46]

With the suggestion to incorporate resolvable URIs in CROTs, this article implies that it should be possible to click on tasks and land on a webpage or document that mentions more information about that task. This could be the definition of that specific task at the time it was used.[47] Alternatively, when a task requires the participation of several contributors, incorporation of resolvable URIs provides an additional space to clarify individual contributions (and accordingly, the delineation of responsibilities) in relation to each tasks.[48] Since vagueness about the definition of tasks or individual contributions could result in ambiguities about why each contributor deserves credit, and who is responsible for each task, it is necessary to check whether CROTs allow linking tasks to resolvable URIs:

Candidate assessment criterion 11. Are tasks linked to resolvable URIs?

3. (Holcombe 2019a)

Label: Usability – Instructions for adopters

This article focuses on inadequate use of CRediT taxonomy by *PLoS* portfolio of journals. It is argued that by not using CROTs to describe the contributions of those who are listed in the acknowledgement section of publications, *PLoS* journals prevent the delineation of the contributions of acknowledged researchers. One way of addressing this issue is to check

[46] A Uniform Resource Identifier (URI) is a sequence of characters used to identify a particular resource (e.g., http://) in the digital landscape (Churchville 2016). For an URI to be resolvable, it should be dereferenceable meaning that, "when a user clicks on a URI in their browser, we want them to be redirected to a suitable document" (EMBL-EBI 2020).

[47] Since CROTs could be updated, this feature would allow clarifying the exact definition of a task at the time when it was used.

[48] For example, the provided definition for Formal Analysis in CRediT is: "Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data" (CASRAI 2020, Paragraph 1). In cases where the task of formal analysis is so large that it needs several contributors (e.g., one for mathematical analysis and one for statistical analysis), a Resolvable URI would allow adding more details about individual contributions to tasks and clarifying who contributed to which task.

whether clear instructions are provided for adopters as to how CROTs should be implemented, and within these instructions, describing acknowledged contributions is encouraged:

Candidate assessment criterion 12. Are there reasonably comprehensive instructions for adopters (e.g., journals, universities) that explain how CROTs should be implemented and used?

Candidate assessment criterion 13. In their instructions for adopters, is the use of CROTs for describing acknowledged contributions encouraged?

4. (Alaoui M'Darhri et al. 2019)

Label: Usability – Capturing outdated methods and practices

This article notes that using TaDiRAH's current list of activities, it is not always possible to capture tasks that pertain to outdated research methods and practices. This shortcoming could be a problematic issue in indexing publications that involved tasks that are no longer used in research. For instance, if libraries and repositories aim to use CROTs to retrospectively index publications[49], the inability to (accurately) register outdated methods and practices may result in inconsistent recognition of old and new contributions. These inconsistencies may lead to unfair treatment of those who contributed to older publications. One way of addressing this issue is to check whether developers of CROTs suggest any solutions on how to represent outdated methods and practices in their instructions for adopters:

Candidate assessment criterion 14. In their instructions for adopters, do CROTs provide suggestions on how to represent outdated tasks and practices?

[49] This would only be possible when contributorship statements are available. In these cases, updating the corpus of past publications to clarify individual contributions could improve the consistency of available records.

3.5 Concerns identified in sources provided by the developers of CROTs

Each of the three CROTs explored in this dissertation has a dedicated website and provide various resources for public use.[50] In analysing these resources, issues and concerns that are raised by users as well as adopters, plus issues discussed in meetings about CROTs are analysed to check whether they can provide input for additional candidate assessment criteria. These resources are analysed through the inductive approach described in section 3.2.1. Documents that contain no concerns about the application of CROTs in specifying contributions to publications, or those that raise concerns that have already been addressed at this stage[51], are listed in the Appendix B.

3.5.1 Sources provided by developers of CRediT

In extending candidate assessment criteria to assess CROTs using sources provide by CRediT's developers, the CASRAI website and notes from CASRAI annual meetings are used. Under the heading *Links of Interest* on CASRAI website (per March 2020), experiences of adopters (*Resources*) and other publications about CRediT (*Articles & Publications*) are shared (CASRAI 2020). Moreover, due to my participation in *Annual CASRAI meetings* held in 2018 (Glasgow) and 2019 (Belfast), issues discussed during these meetings are explored to find concerns that are relevant to the application of CROTs. Finally, issues raised on the CRediT forum until May 2020 were screened to identify any relevant items. The sequence of presented items here is based on

[50] While developers of authorship criteria (e.g., ICMJE) hold meetings behind closed doors and only share final guidelines; plans, ideas, notes and discussions related to CROTs are freely available and shared for public use on the internet. This way of developing and promoting CROTs allows providing feedback and communicating ideas about them and stems — in part — from a new research paradigm called *open science.* (Most of the developers involved in these CROTs have a background in Library and Information Studies, IT, and Software, all of which are disciplines with lots of proponents of the open science movement).

[51] If more than one document raised the same concern in the same subsection, the one that appears higher in the list of items provided in CROTs' websites is mentioned here, and others are mentioned in Appendix B. If more than one document raised the same concern in different subsections, the resource that was provided by the CROTs analysed earlier in this thesis (3.5.1 CRediT, 3.5.2 CRO, 3.5.3 TaDiRAH) is mentioned here, and others are mentioned in Appendix B.

how they were listed on CRediT website, and then notes from the two user meetings are listed in the end.

1. (Atkins 2016)

Label: Usability – Corresponding contributor

This blog post notes that after implementing CRediT in the submission workflow of *PLOS* journals, corresponding contributors were asked to assign CRediT roles per individual contributor, and make sure that all contributions are recognised. This task involves communication with all contributors as well as the editorial team of the target journal and is meant to ensure that one person is in charge of recording and submitting individual contributions. Given the importance of this task, it is reasonable to expect CROTs to mention it in their instructions for researchers:

Candidate assessment criterion 15. In their instructions for researchers, do CROTs require one person to be aware of individual contributions and in charge of correspondence with other contributors and the editorial team?

Label: Attribution – Communication and correspondence

As this task is essential for the accurate attribution of credit and responsibilities, it deserves credit and should be recognised among tasks relevant to the publication of research:

Candidate assessment criterion 16. Is it possible to recognise the task of communication and correspondence with other contributors and editorial teams?

2. (Allen, O'Connell & Kiermer 2019)

Label: Attribution – Provision of access to resources

This article stresses the importance of recognition of the full range of activities carried out by various contributors. Examples of contributions that may be ignored (and not recognised in

research output) include the provision of funds and providing access to resources.[52] In analysing the review of literature on ethical issues of scholarly authorship, the disclosure of funding information was mentioned (section 3.3.3), and subsequently, an assessment candidate criterion was developed.[53] However, providing access to resources is a task that has not been mentioned earlier. This note relates to the issue of attribution, and capturing tasks relevant to the publication of research by CROTs:

Candidate assessment criterion 17. Is it possible to recognise the task of providing access to resources?

3. (Craig, Hosseini & O'Connell 2019)

Label: Attribution – Legal support and translation

This blog post notes that CRediT does not capture the tasks of translation and legal support (e.g., provided by legal advisors or patent-experts). This note relates to the issue of attribution and covers two tasks relevant to the publication of research:

Candidate assessment criterion 18. Is it possible to recognise the task of legal support? *Candidate assessment criterion 19. Is it possible to recognise the task of translation?*

4. (Ridley 2019)

Label: Attribution – Recognising the contribution of groups and teams

This article highlights the team-based nature of some tasks and notes that major research assessment frameworks are encouraging the submission of team-based outputs where the

[52] Exploring other relevant roles (that are currently not recognised adequately) within all areas of science is out of the scope of this thesis. Future research might be necessary to analyse different areas to find roles that are currently not mentioned in CROTs.
[53] The developed criterion: Is it possible to disclose funders' contribution?

team's name is specifically recognised. This note relates to the issue of attribution and the possibility to recognise the contributions of teams and groups:

Candidate assessment criterion 20. Is it possible to recognise the contributions of teams and groups?

5. (Pierce et al. 2019)

Label: Usability – Linking datasets with their generators

This article notes that CRediT does not allow linking datasets with their generators and highlights this issue as a shortcoming. If a dataset forming the basis of the research is generated by researchers who are members of groups other than the group using the dataset (e.g., datasets available in the public domain), groups often cite articles that used the dataset for the first time. However, this procedure does not always attribute credit and responsibilities correctly, especially if data generators were not among the authors of the first paper that used the dataset. The absence of links between datasets and their generators leads to misattribution of credit and responsibilities. Therefore, it is necessary to check whether CROTs provide the possibility to link the two:

Candidate assessment criterion 21. Is it possible to link datasets with data generators to recognise their contributions?

6. (Allen et al. 2012)

Label: Bias – Sources of funds and linking contributors to different sources

This report notes the necessity to clarify the link between contributors and their funding sources. This issue is partly addressed under the subheading of bias in section 3.3.3, and resulted in the development of a candidate assessment criterion.[54] However, this report also mentions

[54] The developed criterion: Are there mechanisms to disclose funders' contribution?

two other issues concerning the clarification of sources of funds in cases where different contributors are funded through dissimilar sources, and cases where individuals receive funds from more than one funder. These notes relate to the issue of bias and whether CROTs provide the possibility to specify funders' contributions to research:

Candidate assessment criterion 22. Is it possible to specify the contributions of several funders?

Candidate assessment criterion 23. Is it possible to link various contributors to different sources of funding?

Label: Extensibility

This report also suggests that CROTs should be "extensible" (Allen et al. 2012, p. 17). If the scientific inquiry and methods employed evolve in such a way that adding new tasks would be necessary, it should be possible to revise tasks and/or add new ones. Two important issues to consider in this context include informing CROTs developers of the need to extend their list of tasks, and having (in-house) experts to evaluate the received feedback with authority to add new tasks or revise existing tasks.[55] Since the absence of these two prerequisites (i.e., collection and evaluation of feedback) would affect CROTs' extensibility, it is reasonable to check whether CROTs collect feedback and evaluate these for future revisions:

Candidate assessment criterion 24. Do CROTs developers collect and evaluate user feedback for future revisions?

Label: Attribution – Use of percentages to show the extent of contributions

This report notes that using a percentage to specify a contributor's share of the total credit is an unfair practice that should be avoided:

Candidate assessment criterion 25. Do CROTs refrain from using percentages to specify contributors' share of the total credit?

[55] From a technical point of view, extensibility is not a complicated matter because extending CROTs only requires improving/revising the existing code.

7. (Canadian Academy of Health Sciences 2017)

Label: Attribution – Community engagement

This report notes that CRediT and CRO do not cover all the relevant tasks carried out in clinical research and health services and mentions the specific example of community engagement. Since clinical research and health services entail numerous tasks, and the report does not provide other examples currently not covered[56], only the task of community engagement is considered:

Candidate assessment criterion 26. Is it possible to recognise the task of community engagement?

Label: Usability – Assessment and evaluation of contributions

This report also highlights that within CRediT and CRO, the complexities of interpreting contributions by assessors are not fully evaluated. This may lead to inconsistent assessment of similar contributions (e.g., due to different interpretations about tasks) and discrimination against some contributors. One way of checking whether CROTs attend to complexities of interpreting contributions by assessors is to check whether they provide any recommendations for adopting institutions on how registered contributions are to be assessed and interpreted:

Candidate assessment criterion 27. In their instructions to adopters, do CROTs provide reasonably comprehensive recommendations on how registered contributions should be used for assessment and evaluations?

8. (The Academy of medical sciences 2016)

Label: Usability – Confirming others' contributions

[56] Exploring relevant tasks within specific areas such as Clinical research and Health services is out of the scope of this thesis. Future research might be necessary to analyse these areas and find tasks that are currently not covered by CROTs.

This report notes that guidelines should explain how the contributions are to be allocated transparently and agreed consensually. False claims to contribution may lead to over-/under-crediting, and hence, lead to unfair treatment of some contributors. This note relates to the usability of CROTs and whether they encourage adopters to seek the confirmation of all contributors about listed contributions[57]:

Candidate assessment criterion 28. In their instructions for adopters, do CROTs encourage seeking the confirmation of all contributors about listed contributions?

Label: Usability – Linking contributions to digital identifiers

This report also highlights the importance of linking contributions to digital identifiers (e.g., ORCID). Failing to do this might result in misattributions (e.g., in cases of similar first/last names). This note relates to the usability of CROTs, and the possibility to link individual contributions to digital identifiers:

Candidate assessment criterion 29. Do CROTs allow linking contributions to digital identifiers?

3.5.2 Sources provided by developers of CRO

In extending candidate assessment criteria to assess CROTs using sources provided by CRO's developers, items listed on the *Contributor Role Ontology* page in the GitHub repository[58] are analysed. On this page, under *Relevant publications and scholarly products* (per March 2020) several published items are listed. Moreover, 11 issues collected with GitHub's Issue Tracker are screened to find relevant items. All these resources are analysed (with an inductive approach) to find concerns about the application of CROTs to the specification of contributions in publications. The sequence of presented items here is based on their order on the GitHub page.

[57] Although the report does not mention any guidance as to how the confirmation of all contributors could/should be collected, it is reasonable to argue that this requirement would be problematic in large multidisciplinary/multi-site projects.
[58] Accessed here: https://github.com/data2health/contributor-role-ontology

1. (Holmes et al. 2018)

Label: Availability – Publication of contributions under Open Access licence

This conference presentation introduces the availability of data about contributions as a factor encouraging transparency. Since unavailable information about contributions may negatively affect contributors in assessments[59], it is advised to publish the description of contributions under Open Access licence. This implies that similar to articles' abstracts and keywords (always published under Open Access licence, so as to be accessible for everyone regardless of their access level or institutions' subscription to journals), individual contributions too should be accessible for all users and never go behind a paywall:

Candidate assessment criterion 30. Is the description of contributions to tasks published under Open Access licence?

2. (Holmes 2018)

Label: Attribution – Underrepresented tasks

This video recording of a conference presentation concerns the attribution of credit in modern research projects. It mentions five tasks that could be essential for the conduct of research but are often under-credited. This note relates to the issue of attribution and capturing tasks relevant to the publication of research by CROTs:

Is it possible to recognise the task of: *Candidate assessment criterion 31. Creative efforts* *Candidate assessment criterion 32. Education and training* *Candidate assessment criterion 33. Research Coordination* *Candidate assessment criterion 34. Data warehousing*

[59] For example, if an article is behind a paywall and evaluators do not have institutional access to see individual contributions, contributors could be treated unfairly.

Candidate assessment criterion 35. Software programming

3. (Haendel 2016)

Label: Attribution - Underrepresented tasks

This conference presentation mentions difficulties of recognising all the relevant contributions with authorship credit. Nearly 20% of contributions to published research are not credited. Curation and annotation of datasets are among these underrepresented tasks. This note relates to the issue of attribution and covering tasks relevant to the publication of research by CROTs:

Is it possible to recognise the task of:

Candidate assessment criterion 36. Data curation

Candidate assessment criterion 37. Data annotation

4. (Haendel et al. 2015)

Label: Responsibility and accountability

In this conference presentation, contributions such as peer-reviewing by anonymous contributors are mentioned as challenging to recognise. Reviewers have responsibilities towards readers[60], and on that basis, they deserve credit as well. One can argue that since peer-reviewers in double blind peer reviews (those where reviewers and authors do not know each other's identity) agree to provide their service on a voluntary basis and under the condition of anonymity, in virtue of accepting to review, they indicate having no expectation to receive explicit recognition for their contribution.[61] However, in cases of open peer-reviews, their

[60] These include: "1- Ensuring that the methods are adequately detailed to allow the reader to judge the scientific merit of the study design and be able to replicate the study, if desired. 2- Ensuring that the article cites all relevant work by other scientists" (Council of Science Editors 2020, Paragraph 4). Furthermore, in case of an "ethics disaster" for example, they may be liable for "a failure to exercise due care in giving advice" (Hendrick 2001, p. 52).

[61] It should be noted that lack of explicit recognition would not affect their responsibilities, because their identities are known to the editors.

contribution could be considered for recognition[62] via CROTs. This note relates to the issue of responsibility and accountability and the clarification of individual responsibilities:

Candidate assessment criterion 38. Is it possible to recognise the contribution of those who played a review role (in open peer-reviews) and confirmed the quality of methods and claims?

5. (Haendel 2014)

Label: Attribution – Provision of samples

In this conference presentation, a short scenario is introduced to highlight the lack of attributing credit to those who support the development of datasets by providing research samples. This note relates to the issue of attribution and capturing of tasks relevant to the publication of research by CROTs:

Candidate assessment criterion 39. Is it possible to recognise the task of providing research samples?

3.5.3 Sources provided by developers of TaDiRAH

To extend candidate assessment criteria to assess CROTs using these sources, items listed on the *TaDiRAH* page in the GitHub repository[63] are analysed. This page lists several published items under *Presentations and publications on TaDiRAH* (per March 2020). Moreover, 21 issues collected with GitHub's Issue Tracker are screened to find relevant items. All these resources are analysed through an inductive approach to find concerns about the application of CROTs to the specification of contributions in publications.

1. (Borek et al. 2016b)

[62] Elsewhere, it is argued that insufficient recognition of peer reviewing is affecting the quality of peer reviews (Ross-Hellauer et al. 2017).
[63] Accessed here: https://github.com/dhtaxonomy/TaDiRAH

Label: Availability – Translated version of tasks and their definitions

This poster announces the translation of TaDiRAH's tasks and their definitions in Spanish and plans for translation into Serbian and German. Misunderstanding tasks and their definitions in English may lead to misattribution of credit and responsibilities in using CROTs and discriminate against not very fluent speakers of the English language. Consequently, the availability of roles and their definitions in other languages seems necessary. This note relates to the availability of CROTs in languages other than English[64]:

Candidate assessment criterion 40. Do CROTs' developers provide translated versions of research tasks and their definitions in languages other than English?

3.6 Test of applicability

After the first three steps and reviewing the sources indicated, 40 candidate assessment criteria were developed. It should be noted that issues and concerns resulting in the development of these criteria are collected from a wide range of sources published at different times. Given quick advances and regular changes of publication practice in terms of how articles are submitted, processed and published, a test of applicability will ensure that every candidate assessment criterion is still relevant and applicable to current practices.

3.6.1 Methodology for applicability test

This applicability test (for all criteria except one[65]) starts with choosing two different journals that have incorporated CROTs[66] in their submission workflow to check their submission process

[64] Although non-English translations may include numerous languages, translating CROTs into major languages is what is implied here. For instance, the United Nations translates all online resources into five languages other than English, including Arabic, Chinese, French, Russian and Spanish.
[65] Criterion about the provision of instructions for assessment and evaluations requires exploring hiring and assessment processes in universities. For this purpose, some details about the assessment process at the University of Glasgow is used.
[66] As mentioned in section 3.1.2 and 3.1.3, CRO and TaDiRAH have only been used in a conference and at the time of writing this thesis, they were not adopted by any journals. On that basis, the test of applicability cannot check whether candidate assessment criteria appeal to the application of these two CROTs.

and recent publications. For this purpose, the journals of *PLOS Medicine* and *PLOS Biology* have been chosen[67] (both have incorporated CRediT). In an attempt to submit an article with the provided workflow (i.e., Editorial Manager), the most recent processes are observed and available guidelines (per May 2020) analysed to ensure that the developed candidate assessment criteria are still relevant. Furthermore, recent articles published by these two journals are analysed to find out how registered contributions are presented (per May 2020).

Both journals provide a list of "Author contributions" in their submission guidelines and note tasks conducted by each contributor in a separate tab within publications titled *About the Authors* (Figure 24). In order to prevent repeating all the candidate assessment criteria here, this section only notes those that are *not* relevant anymore and hence, are disqualified.

Figure 24. Presentation of contributions in the journal of PLOS Biology (Smith et al. 2020).

[67] *PLOS Medicine* and *PLOS Biology* are chosen in consultation with Ms. Alison McG-O'Connell (one of CRediT's chairs) because of the type of articles that are published in these two journals. These journals publish papers with many co-authors and large datasets. Furthermore, both journals are believed to be among the early adopters of the most recent technologies and guidelines.

3.6.2 Inapplicable candidate assessment criteria[68]

Are there mechanisms to disclose funders' contribution?

Financial support of projects is indeed a valid form of contribution that should be recognised in publications. Information about sources of funds was traditionally collected under *Acknowledgements*. In modern publication practices, however, and especially after Web of Science's index of funders (that links articles to funders), information about sources of funds can be registered (in a structured and centralised manner) via the *Financial disclosure section* and published under the *Funding table* (figure 25) (Clarivate 2020b; Liu, Tang & Hu 2020). Both *PLOS Medicine* and *PLOS Biology* inform authors about this specific issue with the following statement:

> "Do not include funding sources in the Acknowledgments or anywhere else in the manuscript file. Funding information should only be entered in the financial disclosure section of the submission system" (PLOS Biology 2020a; PLOS Medicine 2020a).

Hence, although researchers are expected to disclose their sources of funds, in modern publication processes funding information is not registered via CROTs. On that basis, this criterion is deemed inapplicable.

Funding: The research was funded by grants from the National Key Research and Development Program of China (2018YFA0800200, and 2016YFA0100500, FL; 2018YFA0801000, DM), the Strategic Priority Research Program of the Chinese Academy of Sciences, China (XDA16010207, FL), the National Natural Science Foundation of China (31830061, 81530004, and 31425016, FL), and Youth Innovation Promotion Association, CAS (2016083, DM). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

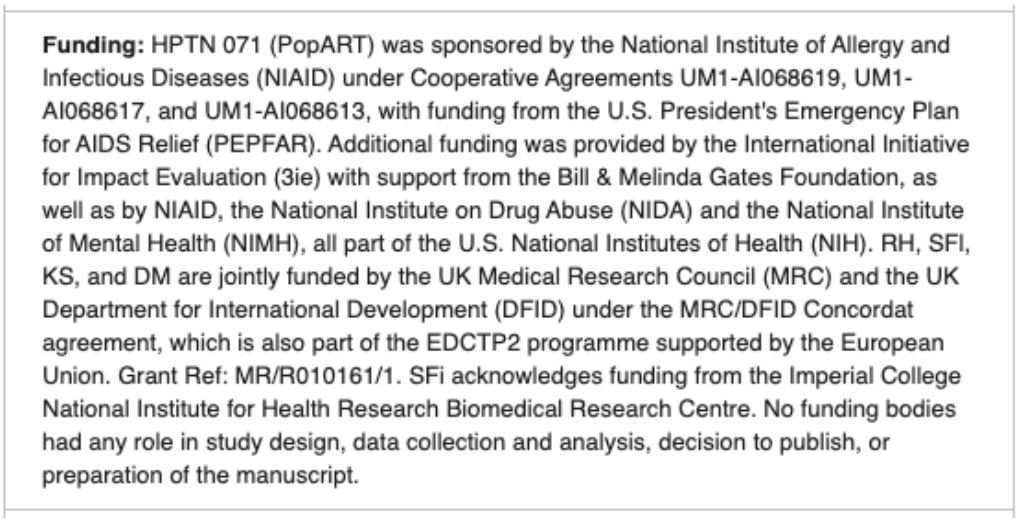
Figure 25. In recent publications, funders' are listed in Funding tables (This funding table is related to Heng et al. 2020).

Is it possible to specify the contribution of several funders?

[68] Since CRO and TaDiRAH have not been adopted by any journals yet, this section cannot check candidate assessment criteria against the application of these two CROTs. Furthermore, although each journal might use a different submission system and present contributions differently, since journals of *PLOS Medicine* and *PLOS Biology* are considered as early adopters of technology and guidelines, only these two are considered in this section.

Is it possible to link various contributors to different sources of funding?

As figure 26 shows, using *Financial disclosure sections* and *Funding tables,* it is also possible to register and mention different sources of funds and link different contributors to different sources. Hence, although researchers are expected to disclose detailed information about their sources of funds, in modern publication practices funding information is not registered via CROTs, and these two criteria are deemed inapplicable.



Funding: HPTN 071 (PopART) was sponsored by the National Institute of Allergy and Infectious Diseases (NIAID) under Cooperative Agreements UM1-AI068619, UM1-AI068617, and UM1-AI068613, with funding from the U.S. President's Emergency Plan for AIDS Relief (PEPFAR). Additional funding was provided by the International Initiative for Impact Evaluation (3ie) with support from the Bill & Melinda Gates Foundation, as well as by NIAID, the National Institute on Drug Abuse (NIDA) and the National Institute of Mental Health (NIMH), all part of the U.S. National Institutes of Health (NIH). RH, SFI, KS, and DM are jointly funded by the UK Medical Research Council (MRC) and the UK Department for International Development (DFID) under the MRC/DFID Concordat agreement, which is also part of the EDCTP2 programme supported by the European Union. Grant Ref: MR/R010161/1. SFi acknowledges funding from the Imperial College National Institute for Health Research Biomedical Research Centre. No funding bodies had any role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Figure 26. Using the funding table it is possible to specify different sources of funds or link different contributors to dissimilar funders (This funding table is related to Floyd et al. 2020).

Is it possible to link (used) datasets with data generators to recognise their contributions?

Data (and datasets) are considered as legitimate research outputs, and those who generated data should be credited. However, in modern publishing practices, the availability of data and information about its generators are mentioned under the separate section of *Data Availability Statement* (figure 27). In cases where a project uses a dataset generated by another group, information about these datasets and their generators are published as supplementary material and not in the main manuscript (figure 28). It should be noted that both journals have identical guidelines on data availability and provide best practices for authors (PLOS Biology 2020a; PLOS Medicine 2020a).

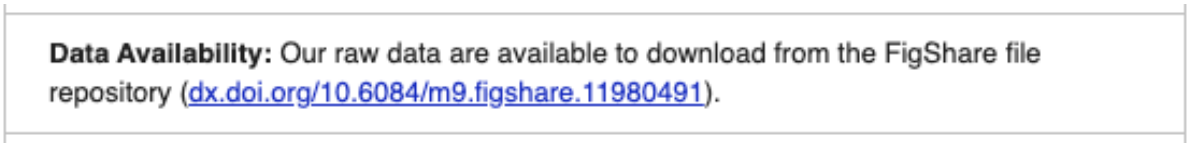
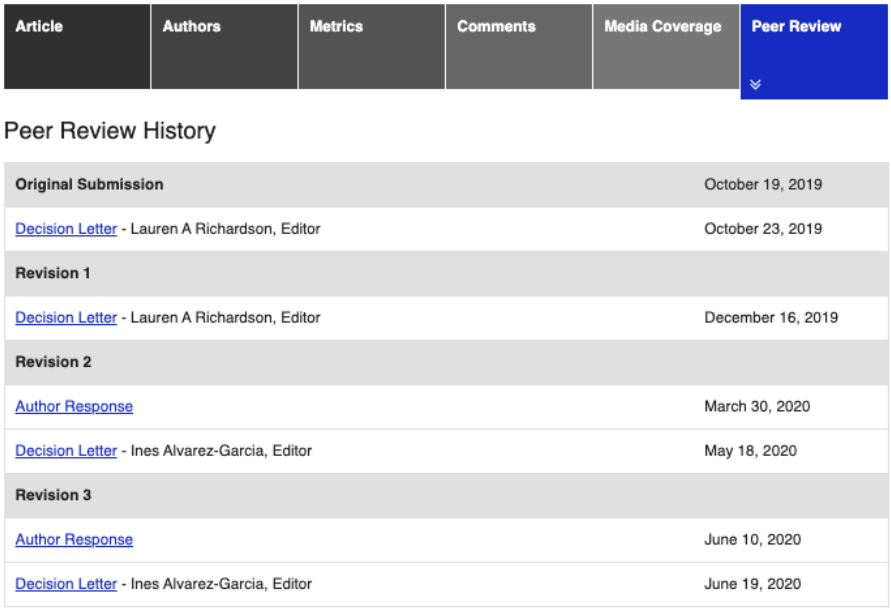


Figure 27. Data availability statement of Smith et al. 2020.

Figure 28. Smith et al. 2020's linked dataset stored in an online repository, with data generators highlighted via the red box.

Are there mechanisms to specify those who played a review role (in open peer-review journals) and confirmed the quality of methods and claims?

Careful peer-review contributes to the production of accurate publications, and therefore, reviewers' contribution to publications should be recognised. However, these efforts are traditionally not published in the authorship byline but only mentioned in the acknowledgement section. In cases where a journal has adopted Open Peer-Review policy, reviewers' comments and authors' responses are made available under a specific tab titled "Peer Review". For instance, both *PLOS Medicine* and *PLOS Biology* openly publish their peer review history (figure 29). Hence, there is no need to mention these in CROTs, and this criterion is deemed inapplicable.



Article	Authors	Metrics	Comments	Media Coverage	Peer Review

Peer Review History

Original Submission	October 19, 2019
Decision Letter - Lauren A Richardson, Editor	October 23, 2019
Revision 1	
Decision Letter - Lauren A Richardson, Editor	December 16, 2019
Revision 2	
Author Response	March 30, 2020
Decision Letter - Ines Alvarez-Garcia, Editor	May 18, 2020
Revision 3	
Author Response	June 10, 2020
Decision Letter - Ines Alvarez-Garcia, Editor	June 19, 2020

Figure 29. Antonets et al. 2020's peer review history and reports published in the journal of PLOS Biology.

In their instructions to adopters, do CROTs provide reasonably comprehensive recommendations on how registered contributions should be used for assessment and evaluations?

To test the applicability of this criterion, recent practices of adopters that might use registered contributions for assessment and evaluation should be explored. Therefore, looking at how CROTs are used for evaluation at an institutional level would be the test of applicability here.

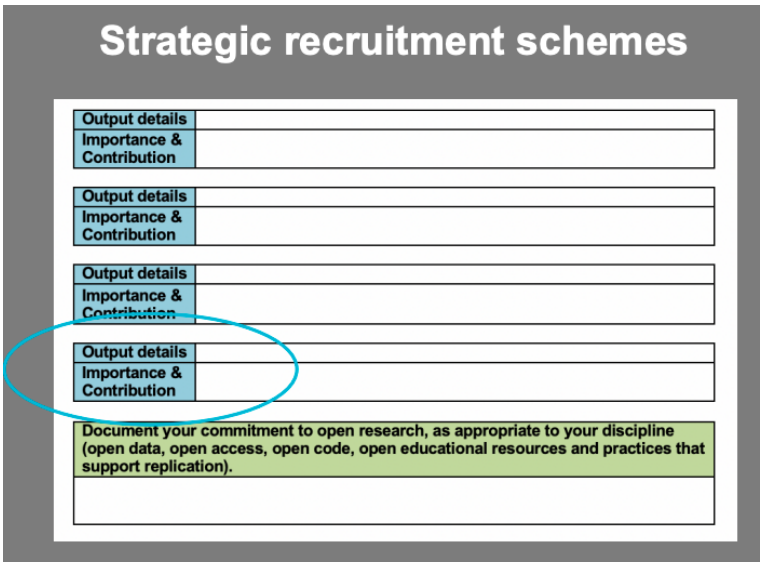


Figure 30. The strategic recruitment scheme at the University of Glasgow (Casci & McCutcheon 2019)

Currently, the University of Glasgow is the only institution that has fully integrated one of the

CROTs (i.e., CRediT) into its assessment and evaluation process.[69] Exploring these processes at the University of Glasgow shows that CRediT is connected to various other institutional processes. The University of Glasgow, incorporates CRediT into recruitment schemes (part of their Human Resources workflow, see figure 30), but concomitantly into the library and output repository (figure 31)[70] (Casci & McCutcheon 2019). Providing instructions for interpretation of contributions in this complex workflow raises a range of complexities.

On the one hand, since assessment and evaluation processes, library systems and output repositories are specific to each individual institution and country, it seems unreasonable to expect CROTs to provide instructions for institutions as to how tasks should be interpreted. If their digital infrastructure is not designed to accommodate storing and transferring contributions from one system to another, contributions might simply not be available across the board. On the other hand, interpreting CROTs' tasks could highly depend on the context, discipline and personal affinity with, or views about tasks. The way decisions about contributions are made differs per faculty/school of each adopting university (let alone in different universities[71]),

[69] While attending the FORCE11 conference in Edinburgh, I attended Ms. Valerie McCutcheon's (Research information manager at University of Glasgow) presentation on how the University of Glasgow uses CRediT for hiring and promotion.

[70] The University of Glasgow's library and output repository is called Enlighten platform: https://www.gla.ac.uk/research/enlighten/

[71] An excellent example that shows these decisions are made at a local level pertains to the use of authorship status. For instance, to use the number of authored publications in a nuanced way, "some universities require candidates for professorships and other posts to limit their bibliographies submitted in support of their applications to the best 10" (Badaway 1996, p. 7). Other universities, however, may opt to interpret authorship status in a different manner and give more weight to the quantity of authored publications (Mojon-Azzi 2004). Besides showing local differences in hiring and evaluation policies (Sanz-Menéndez & Cruz-Castro 2017), this also demonstrates a different interpretation of the notion of authorship.

and therefore it is not feasible to provide (universal) instructions on how tasks should be interpreted. On that basis, this criterion is deemed inapplicable.

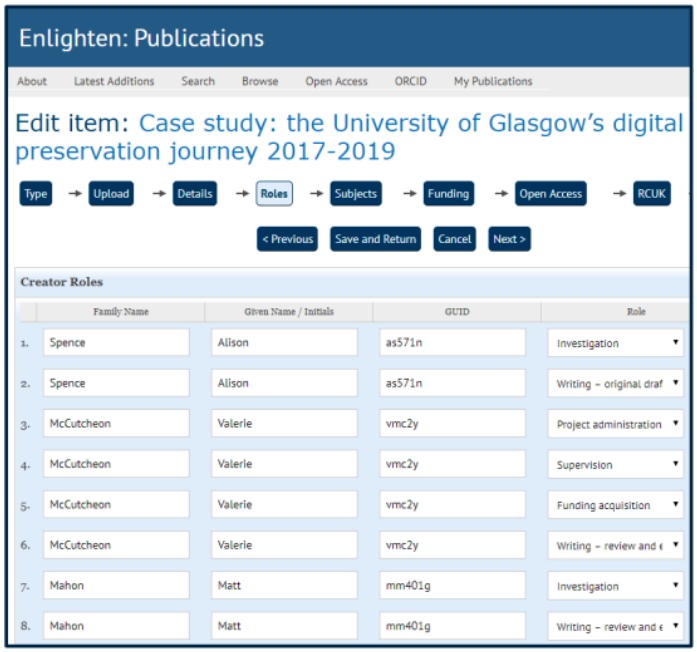


Figure 31. Integration of CRediT roles into Enlighten Output Repository (Casci & McCutcheon 2019)

3.7 Results

Thus far, using a four-step process to locate and analyse sources, candidate assessment criteria have been developed and also tested for their applicability. These candidate assessment criteria are formulated in the format of YES/NO questions in such a way that the YES answer would be the acceptable/desirable response. Based on labels that were used to tag raised issues, candidate assessment criteria can be subsumed under six categories, including attribution, availability, extensibility, responsibility and accountability, usability and violations.

More than half of the candidate assessment criteria (19 out of 34) pertain to the issue of attribution and recognition of tasks, and eight are concerned with the usability of CROTs and mechanisms that should be regarded in their design. Table 5 contains a list of these criteria and provides input for chapter four, where these criteria will be justified from an ethical perspective. Justified criteria will be used to evaluate and compare CROTs in chapter five.

Issue	Criteria to assess CROTs
Availability	1. Is the description of contributions to tasks published under Open Access licence?
	2. Do CROTs' developers provide translated versions of research tasks and their definitions in languages other than English?
Extensibility	3. Do CROTs developers collect and evaluate user feedback for future revisions?
Responsibility and accountability	4. Are there mechanisms to indicate individual and overlapping responsibilities concerning tasks conducted by two or more contributors?
	5. Are there mechanisms to indicate mentor-mentee relations and the subsequent responsibilities for mentors?
Usability	6. Are there adequate and straightforward instructions to guide researchers on how CROTs should be used?
	7. In their instructions for researchers, do CROTs require one person to be aware of individual contributions and in charge of correspondence with other contributors and the editorial team?
	8. Are there reasonably comprehensive instructions for adopters (e.g., journals, universities) that explain how CROTs should be implemented and used?
	9. In their instructions for adopters, is the use of CROTs for describing acknowledged contributions encouraged?
	10. In their instructions for adopters, do CROTs provide suggestions on how to represent outdated tasks and practices?
	11. In their instructions for adopters, do CROTs encourage seeking the confirmation of all contributors about listed contributions?
	12. Do CROTs allow linking contributions to digital identifiers?
	13. Are tasks linked to resolvable URIs?
Violations	14. In their instructions for researchers, do CROTs describe what is regarded as a violation while using them?
	15. In their instructions for researchers, do CROTs attempt to suggest possible solutions and best practices to minimise the likelihood of (common) violations?
Attribution	16. Within tasks that involve more than one contributor, is it possible to clarify the extent of their individual contributions?
	17. In clarifying the extent of contributions to tasks, is it possible to specify two or more contributors as equal?
	18. Is it possible to recognise the contributions of teams and groups?
	19. Do CROTs refrain from using percentages to specify contributors' share of the total credit?
	Is it possible to recognise the following tasks:
	20. Tasks that would traditionally not merit authorship status (e.g., those mentioned in the acknowledgement section)?
	21. Communication and correspondence with other contributors and editorial teams
	22. Community engagement
	23. Creative efforts
	24. Data annotation
	25. Data curation
	26. Data warehousing
	27. Education and training
	28. Enrolling patients for clinical trials
	29. Translation
	30. Legal support
	31. Providing access to resources
	32. Providing research samples

	33. Research Coordination
	34. Software programming

Table 5. Full list of candidate assessment criteria to assess CROTs (not yet justified from an ethical perspective).

3.8 Discussion

3.8.1 The significance of attribution and advocating for tasks

The number of developed criteria about the issue of attribution highlights its importance in discussions about CROTs. Among the 19 candidate assessment criteria concerned with the issue of attribution, 14 are about the recognition of tasks often underrepresented in publications. Those who highlighted these tasks and stressed their importance seem to argue that they are essential for the conduct/success of modern scientific projects and therefore, they should be explicitly recognised in CROTs.

These tasks are sometimes mentioned by researchers and experts who criticise CROTs and make suggestions to improve the current list of tasks and definitions. For instance, in the workshop on CRediT organised by Craig, Hosseini and O'Connell during the FORCE11 conference in 2018 in Montreal, legal support and translation were mentioned among tasks that are not covered by CRediT. On other occasions, the importance of tasks is advocated by developers of CROTs. For example, developers of CRO have regularly highlighted tasks that are currently *not* recognised by traditional authorship criteria or other CROTs, but indeed captured by CRO. Tasks such as creative efforts, education and training, research coordination, data curation, data annotation, data warehousing and software programming were mentioned during several conference presentations by members of the consortia that develop CRO.

That being said, none of the explored sources suggested that CROTs currently recognise tasks that should *not* be explicitly recognised. On that basis, this chapter developed no criterion that required a task to be absent from the current list of tasks recognised in CROTs.

3.8.2 Usability of CROTs for users and adopters

Out of eight candidate assessment criteria that pertain to the usability of CROTs, five are extracted from documents that were found in the focused literature review. With one exception (incorporation of resolvable URIs), all of these candidate assessment criteria are concerned with the provision of formal instructions for adopters and users. This shows that among those who voice their concerns about CROTs (and CRediT in particular), the provision of formal instructions is one of the major worries.

3.8.3 Inapplicable criteria

Among the six candidate assessment criteria that were eliminated in the applicability test, three pertained to the registration of funding information, one was about linking datasets to their generators, one about peer-reviewers' responsibilities and another concerned the provision of instructions for assessment and evaluations.

In relation to the registration of funding information, advances in the scholarly landscape have enabled journals to collect information about funders in a structured and centralised manner. Especially, after the establishment of Crossref's open funder registry and the integration of funders' unique identifiers into journal submission software programs (Crossref 2020), journals can collect funders' information much more efficiently. In addition to enhanced transparency and facilitating/improving the detection of conflicting interests by providing accurate funding information that can be linked with article metadata, this new way of collecting information about funders enables a better understanding of the research funding landscape.[72] Therefore, since in modern publication practices the acknowledgement section of articles is no longer the

[72] These benefits include:

- "Readers and researchers can read and assess literature in the context of knowing who funded it;
- Research institutions can monitor the published outputs of their researchers;
- Publishers can track who is funding their authors, and check if they're meeting funding mandates;
- Service providers can offer integrated time-saving features to their users; and
- Funders can easily track the reach and return of the work they have supported" (Crossref 2020).

right place to mention information about funders, the three criteria that were about the registration of funding information were eliminated.

The same is true about linking datasets to their generators. In modern publication practices, *Data availability statements* are considered the right place to mention used datasets and give due credit to their generators. Collecting this information in a structured manner is believed to improve the attribution of responsibilities in terms of the quality of generated data but also legal/ethical aspects (e.g., in cases where datasets contain confidential or sensitive information) about the methods used in generating datasets (Wallis & Borgman 2011). Therefore, the acknowledgement section of articles is no longer used to highlight datasets and their generators, which resulted in the elimination of this criterion.

Peer-reviewers' contribution is an essential element in promoting quality and excellence in publications but in modern publishing practices, the task of peer-reviewing, expectations of peer-reviewers and also the way reports are presented in publications are changing (Brazeau 2008). For instance, with the increased popularity of open peer reviews, many review reports are published online, some of which entail reviewers' names too.[73] This trend has helped in seeing reviewers as an independent factor that contribute to maintaining "the integrity of science's published record" (Horbach & Halffman 2018). On that basis, in modern publishing practices reviewers' contributions have also received their own dedicated space (i.e., peer-review reports) within the online version of publications and are not reflected in acknowledgement sections or CROTs.

In relation to the provision of instructions for use and interpretation of tasks in assessment and evaluations, as the integration of one of the CROTs into the University of Glasgow workflow showed (section 3.6.2), these efforts are tightly linked with universities' human resources systems, library systems and output repositories. In other universities, assessment and

[73] While in 2001 only 38 journals had adopted open peer review model, by the end of 2019, 617 journals had switched their peer reviews to the open model (Wolfram 2020).

evaluations may be linked with other types of software systems or even other workflows (e.g., school/faculty database). Furthermore, in terms of interpretation of tasks, different schools/departments/universities may have different interpretations of tasks based on their priorities or context. Consequently, it would be almost impossible for developers of CROTs to provide instructions that guide specific assessment and evaluation processes of every single university, and also meets the needs of various contexts in terms of how tasks should be interpreted.

3.8.4 The significance of each assessment candidate criterion is not explored

Within the analysed sample, some concerns that led to the development of candidate assessment criteria were mentioned several times (see table 6).

Concerns	**Number of documents that mention this concern**
Instructions for users	4
Instructions for adopters	3
Documents that describe what is considered as a violation	3
Clarifying the sources of funds	3
Clarifying the extent of contributions	2
The role of communicating/submitting contributor	2
Extensibility	2

Table 6. Issues that were mentioned more than once in the analysed sample.

Although it is tempting to interpret preponderance as an indication of overall significance, this should be discouraged because candidate assessment criteria are not developed with this objective (i.e., to be ranked) in mind. It should be noted that issues and concerns that led to the development of candidate assessment criteria are collected from a wide range of sources, *without* other considerations such as their overall significance for the publication process, the expertise/priorities of person(s) that raised them or the scope of the outlet that published them. As mentioned in section 3.8.1, some concerns may have been raised to promote a specific approach or point of view and on that basis, they may weight differently for different

stakeholders. Hence, this study makes no attempt to provide an overall hierarchy among developed criteria to prevent over-representation of a specific perspective.

References

Academy of Medical Sciences. (2016). Improving recognition of team science contributions in biomedical research careers. London. Retrieved 27 March 2020, https://acmedsci.ac.uk/file-download/38721-56defebabba91.pdf

Adie, E. (2017, November 10). Giving credit where credit is due. *Altmetric*. [Blog Post] Retrieved 27 March 2020, https://www.altmetric.com/blog/giving-credit-where-credit-is-due/

Alaoui M'Darhri, A., Baillet, V., Bourineau, B., Calantropio, A., Carpentiero, G., Chayani, M., De Luca, L., Dudek, I., Dutailly, B., GAUTIER, H., Grilli, E., Grimaud, V., Hoffmann, C., Joffres, A., Jončić, N., Jordan, M., Kimball, J. J. L., Manuel, A., McInerney, P., … Zuanni, C. (2019). Share—Publish—Store—Preserve. Methodologies, Tools and Challenges for 3D Use in Social Sciences and Humanities. *PARTHENOS*. https://hal.archives-ouvertes.fr/hal-02155055

Alfonso, F., & Editors' Network. (2019). Authorship: From credit to accountability. *Netherlands Heart Journal*, *27*(6), 289–296. https://doi.org/10.1007/s12471-019-1273-y

All European Academies (ALLEA), and European Science Foundation (ESF). (2011). The European Code of Conduct for Research Integrity. Retrieved 27 March 2020, https://www.allea.org/wp-content/uploads/2015/07/Code_Conduct_ResearchIntegrity.pdf

Allen, L., Altman, M., Brand, A., Crosas, M., Scott-Lichter, D., & Taylor, M. (2012). *Report on the International Workshop on Contributorship and Scholarly Attribution*. Harvard University and the Wellcome Trust. [Workshop report] Retrieved 27 March 2020, https://projects.iq.harvard.edu/files/attribution_workshop/files/iwcsa_report_final_18sept12.pdf

Allen, L., O'Connell, A., & Kiermer, V. (2019). How can we ensure visibility and diversity in research contributions? How the Contributor Role Taxonomy (CRediT) is helping the shift from authorship to contributorship. *Learned Publishing*, *32*(1), 71–74. https://doi.org/10.1002/leap.1210

Allen, L., Scott, J., Brand, A., Hlava, M., & Altman, M. (2014). Publishing: Credit where credit is due. *Nature News*, *508*(7496), 312. https://doi.org/10.1038/508312a

Alphabet Inc. (2020). Google Scholar [Website]. https ://scholar.google.com/.

Ankrah, S., & AL-Tabbaa, O. (2015). Universities–industry collaboration: A systematic review. *Scandinavian Journal of Management*, *31*(3), 387–408. https://doi.org/10.1016/j.scaman.2015.02.003

Antonets, K. S., Belousov, M. V., Sulatskaya, A. I., Belousova, M. E., Kosolapova, A. O., Sulatsky, M. I., Andreeva, E. A., Zykin, P. A., Malovichko, Y. V., Shtark, O. Y., Lykholay, A. N., Volkov, K. V., Kuznetsova, I. M., Turoverov, K. K., Kochetkova, E. Y., Bobylev, A. G., Usachev, K. S., Demidov, O. N., Tikhonovich, I. A., & Nizhnikov, A. A. (2020). Accumulation of storage proteins in plant seeds is mediated by amyloid formation. *PLOS Biology*, *18*(7), e3000564. https://doi.org/10.1371/journal.pbio.3000564

Aries Systems. (2017). Editorial Manager CRediT Integration. [FAQ Document] Retrieved 27 March 2020: https://www.ariessys.com/wp-content/uploads/CRediT-FAQ_8.5x11.pdf

Aries Systems. (2018). *CRediT Integration*. [Video] Retrieved 27 March 2020: https://www.ariessys.com/views-and-press/resources/video-library/credit-integration/

Atkins, H. (2016, July 8). *Author Credit: PLOS and CRediT Update*. [Blog Post] Retrieved 27 March 2020, https://blogs.plos.org/plos/2016/07/author-credit-plos-and-credit-update/

Bacalexi, D., & Skarsouli, P. (2017). Digital literacies and the study of Antiquity: Case studies on databases. *HAL*, 22. https://halshs.archives-ouvertes.fr/halshs-01660858

Badaway, A. a.-B. (1996). ETHICS IN ALCOHOL RESEARCH AND PUBLISHING. *Alcohol and Alcoholism*, *31*(1), 7–9. https://doi.org/10.1093/oxfordjournals.alcalc.a008119

Barnes, K. I., Canario, J. A., Vernekar, S. S., Goudar, S. S., Espinal, R., Merson, L., & Cheah, P. Y. (2019). Equitable data sharing: Challenges and suggestions for ways forward. *Wellcome Open Research*, *4*, 172. https://doi.org/10.12688/wellcomeopenres.15425.1

Borek, L., Dombrowski, Q., Perkins, J., & Schöch, C. (2014, July 14). *Scholarly Primitives Revisited: Towards a Practical Taxonomy of Digital Humanities Research Activities and Objects*. Digital Humanities Conference 2014, Lausanne, Switzerland. https://doi.org/10.5281/zenodo.10866

Borek, L., Dombrowski, Q., Perkins, J., & Schöch, C. (2016a). TaDiRAH: A Case Study in Pragmatic Classification. *Digital Humanities Quarterly*, *010*(1). http://digitalhumanities.org/dhq/vol/10/1/000235/000235.html

Borek, L., Schöch, C., & Thoden, K. (2016b). *Digitale Forschungsaktivitäten multilingual: TaDiRAH für die deutschsprachige DH-Community*. [Poster Presentation] Retrieved 27 March 2020: http://dhd2016.de/abstracts/posters-007.html

Brand, A., Allen, L., Altman, M., Hlava, M., & Scott, J. (2015). Beyond authorship: Attribution, contribution, collaboration, and credit. *Learned Publishing*, *28*(2), 151–155. https://doi.org/10.1087/20150211

Brazeau, G. A., DiPiro, J. T., Fincham, J. E., Boucher, B. A., & Tracy, T. S. (2008). Your Role and Responsibilities in the Manuscript Peer Review Process. *American Journal of Pharmaceutical Education*, *72*(3). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2508722/

Canadian Academy of Health Sciences. (2017). Academic Recognition of Team Science: How to Optimize the Canadian Academic System. Ottawa (ON): The Expert Panel on Academic Recognition of Team Science in Canada, CAHS. Retrieved 27 March 2020: https://cpp.178.myftpupload.com/wp-content/uploads/2017/07/2017-06-22-Team-Science-Report-Eng-FINAL-Web.pdf

Casci, T., & McCutcheon, V. (2019, October 18). *CRediT: Recognising author contributions to publications*. https://doi.org/10.5281/zenodo.3508624
CASRAI. (2018). CASRAI Reconnect 18. [Meeting notes] University of Glasgow, Glasgow, Scotland.

CASRAI. (2019). CASRAI Reconnect 19. [Meeting notes] Ulster university, Belfast, Northern Ireland.

CASRAI. (2020). *CRediT - Contributor Roles Taxonomy*. CASRAI. https://casrai.org/credit/

Churchville, F. (2016). What is URI (Uniform Resource Identifier)? - Definition from WhatIs.com. In *WhatIs.com*. https://whatis.techtarget.com/definition/URI-Uniform-Resource-Identifier

Clarivate Analytics. (2020a). Web of science [Website]. Philadelphia, United States. https://apps.webofknowledge.com/

Clarivate analytics. (2020b). *LibGuides: Web of Science Core Collection: Funding Information*. //clarivate.libguides.com/woscc/funding

Coko Foundation. (2019, April 15). Increase transparency by adding CRediT to workflow with PubSweet. [Blog post] Retrieved 27 March 2020: https://coko.foundation/increase-transparency-by-adding-credit-to-workflow-with-pubsweet/

Council of Science Editors. (2020). *White paper on publication ethics - 2.3 Reviewer Roles and Responsibilities*. Retrieved 27 March 2020: https://www.councilscienceeditors.org/resource-library/editorial-policies/white-paper-on-publication-ethics/2-3-reviewer-roles-and-responsibilities/

Craig, C. (2018). Contributorship and Authorship Hierarchy as a Form of Credit. In *Credit Where Credit Is Due: Respecting Authorship and Intellectual Property* (Vol. 1291, pp. 37–49). American Chemical Society. https://doi.org/10.1021/bk-2018-1291.ch003

Craig, C., Hosseini, M., & O'Connell, A. (2019, April 15). Making research contributions more transparent: Report of a FORCE workshop. *F1000 Blogs*. [Blog post] Retrieved 27 March 2020: https://blog.f1000.com/2019/04/15/making-research-contributions-more-transparent-report-of-a-force-workshop/

Cronin, B. (2001). Hyperauthorship: A postmodern perversion or evidence of a structural shift in scholarly communication practices? *Journal of The American Society for Information Science and Technology*, *52*(7), 558–569. https://doi.org/10.1002/asi.1097

Davis, M. (1999). *Ethics and the University*. New York: Routledge.

DIGHUMLAB. (2016). [Advisory board meeting notes] Retrieved 27 March 2020: http://dighumlab.org/wp-content/uploads/2016/11/Sagsfremstillinger-med-bilag_Styregruppem%C3%B8de_11032016.pdf

Dombrowski, Q. (2014, May 21). TaDiRAH: Building Capacity for Integrated Access. *Dh+lib*. [Blog post] Retrieved 27 March 2020: https://acrl.ala.org/dh/2014/05/21/tadirah-building-capacity-integrated-access/

Driver, S. (2014). [Master's degree Thesis] *As You Like IT: An investigation into how Digital Humanities and Culture can foster innovative pedagogy for Leaving Certificate English Paper 2* [Trinity College]. Retrieved 27 March 2020: https://www.academia.edu/11926532/As_You_Like_IT_An_investigation_into_how_Digital_Humanities_and_Culture_can_foster_innovative_pedagogy_for_Leaving_Certificate_English_Paper_2

Elo, S., Kääriäinen, M., Kanste, O., Pölkki, T., Utriainen, K., & Kyngäs, H. (2014). Qualitative Content Analysis: A Focus on Trustworthiness. *SAGE Open*, *4*(1), 2158244014522633. https://doi.org/10.1177/2158244014522633

EMBL-EBI. (n.d.). *Good practice for URIs*. [Website] Retrieved May 30, 2020, from https://www.ebi.ac.uk/rdf/documentation/good_practice_uri/

Eriksson, S., Godskesen, T., Andersson, L., & Helgesson, G. (2018). How to counter undeserving authorship. *Insights: The UKSG Journal*, *31*(1), 1–6. http://www.diva-portal.org/smash/get/diva2:1185272/FULLTEXT01.pdf

Floyd, S., Shanaube, K., Yang, B., Schaap, A., Griffith, S., Phiri, M., Macleod, D., Sloot, R., Sabapathy, K., Bond, V., Bock, P., Ayles, H., Fidler, S., Hayes, R., & Team, the H. 071 (PopART) study. (2020). HIV testing and treatment coverage achieved after 4 years across 14 urban and peri-urban communities in Zambia and South Africa: An analysis of findings from the HPTN 071 (PopART) trial. *PLOS Medicine*, *17*(4), e1003067. https://doi.org/10.1371/journal.pmed.1003067
Guglielmi, G. (2018). Who gets credit? Survey digs into the thorny question of authorship. *Nature*. https://doi.org/10.1038/d41586-018-05280-0

Gureev, V. N., Lakizo, I. G., & Mazov, N. A. (2019). Unethical Authorship in Scientific Publications (A Review of the Problem). *Scientific and Technical Information Processing*, *46*(4), 219–232. https://doi.org/10.3103/S0147688219040026

Gutzman, K., Konkiel, S., White, M., Brush, M., Ilik, V., Conlon, M., Haendel, M., & Holmes, K. (2016, April 13). *Attribution of Work in the Scholarly Ecosystem*. [Poster presentation] Retrieved 27 March 2020: https://doi.org/10.6084/m9.figshare.3175198.v1

Haendel, M. (2014). *Project Credit: Melissa Haendel-On the Nature of Credit*. [Presentation slides] Retrieved 27 March 2020: https://www.slideshare.net/CASRAI/contribution-roles-42704805

Haendel, M., Konkiel, S., Gutzman, K., & Kristi Holmes. (2015). *Measuring success through improved attribution* [Presentation slides] Retrieved 27 March 2020: https://www.slideshare.net/kristiholmes/measuring-success-through-improved-attribution

Haendel, M. (2016). *Credit where credit is due: Acknowledging all types of contributions*. COASP16. [Presentation slides] Retrieved 27 March 2020: https://oaspa.org/wp-content/uploads/2016/10/haendel_COASP_2016_final.pdf

Hendrick, J. (2001). Legal aspects of clinical ethics committees. *Journal of Medical Ethics*, *27* (Suppl. 1), i50–i53. https://doi.org/10.1136/jme.27.suppl_1.i50

Heng, J., Lv, P., Zhang, Y., Cheng, X., Wang, L., Ma, D., & Liu, F. (2020). Rab5c-mediated endocytic trafficking regulates hematopoietic stem and progenitor cell development via Notch and AKT signaling. *PLOS Biology*, *18*(4), e3000696. https://doi.org/10.1371/journal.pbio.3000696
Holcombe, A. O. (2019a). Contributorship, Not Authorship: Use CRediT to Indicate Who Did What. *Publications*, *7*(3), 48. https://doi.org/10.3390/publications7030048

Holcombe, A. O. (2019b). Farewell authors, hello contributors. *Nature*, *571*, 147. https://doi.org/10.1038/d41586-019-02084-8

Homles. K. (2018, November 18). *Giving credit where it is due—Kristi Holmes*. Force11 Conference McGill University, Montreal, Canada. [Video] Retrieved 27 March 2020: https://www.youtube.com/watch?v=HImkSbC81Ng

Holmes, K., Gutzman, K., Smith, P., Eichmann, D., & Haendel, M. (2018, July 16). *Making it count: A computational approach to attribution*. IEEE eScience Conference, Amsterdam, The Netherlands. https://doi.org/10.5281/zenodo.1312652

Holmes, K., Gutzman, K. E., Wescott, A. B., Smith, P., & Gonzales, S. (2019, January 18). *People+Technology+Data+Credit: Developing a sustainable community-driven approach to attribution*. [Poster presentation] Retrieved 27 March 2020: https://digitalhub.northwestern.edu/files/09baabdb-e5ad-477b-abfc-f6cf70f19df0

Horbach, S. P. J. M. (. S., & Halffman, W. (. W. (2018). The changing forms and expectations of peer review. *Research Integrity and Peer Review*, *3*(1), 8. https://doi.org/10.1186/s41073-018-0051-5

Hosseini, M. (2020). Equal Co-authorship Practices: Review and Recommendations. *Science and Engineering Ethics*. https://doi.org/10.1007/s11948-020-00183-8

Hosseini, M., & Gordijn, B. (2020). A review of the literature on ethical issues related to scientific authorship. *Accountability in Research*, 1–41. https://doi.org/10.1080/08989621.2020.1750957

Hosseini, M., & Lewis, J. (2020). The norms of authorship credit: Challenging the definition of authorship in The European Code of Conduct for Research Integrity. *Accountability in Research*, *27*(2), 80–98. https://doi.org/10.1080/08989621.2020.1721288

Hostler, T. (2020). *Towards a Rigorous ASMR Research Program: Five Practices for Researchers*. PsyArXive Preprints. Retrieved 27 March 2020: https://doi.org/10.31234/osf.io/v6jbr

International Committee of Medical Journal Editors. (2019). Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals. Accessed March 11, 2020. http://www.icmje.org/icmje-recommendations.pdf.

Ilik, V., Conlon, M., Triggs, G., White, M., Javed, M., Brush, M., … Holmes, K. L. (2018). OpenVIVO: Transparency in Scholarship. *Frontiers in Research Metrics and Analytics*, *2*. https://doi.org/10.3389/frma.2017.00012

Kerridge, S. (2018). CRediT where credit is due – DORA. [Blog post] Retrieved 27 March 2020: https://sfdora.org/2018/11/27/credit-where-credit-is-due/

Kingsley, D. A. (2017, December 12). Open and Shut?: Open Access: What should the priorities be today? Retrieved July 23, 2019, from Open and Shut? [Blog post] Retrieved 27 March 2020: https://poynder.blogspot.com/2017/12/open-access-what-should-priorities-be.html

Koller, J. (2018). Using CRediT to Capture Author Contributions in Editorial Manager. [Blog post] Retrieved 27 March 2020: https://wkauthorservices.editage.com/resources/author-resource-review/2018/may-2018.html

Kumar, S. (2018). Ethical Concerns in the Rise of Co-Authorship and Its Role as a Proxy of Research Collaborations. *Publications*, *6*(3). https://doi.org/10.3390/publications6030037

Liu, W., Tang, L., & Hu, G. (2020). Funding information in Web of Science: An updated overview. *Scientometrics*, *122*(3), 1509–1524. https://doi.org/10.1007/s11192-020-03362-3

McNutt, M. K., Bradford, M., Drazen, J. M., Hanson, B., Howard, B., Jamieson, K. H., Kiermer, V., Marcus, E., Pope, B. K., Schekman, R., Swaminathan, S., Stang, P. J., & Verma, I. M. (2018). Transparency in authors' contributions and responsibilities to promote integrity in scientific publication. *Proceedings of The National Academy of Sciences of The United States of America*, *115*(11), 2557–2560. https://doi.org/10.1073/pnas.1715374115

Mojon-Azzi, S. M., Jiang, X., Wagner, U., & Mojon, D. S. (2004). Redundant publications in scientific ophthalmologic journals: The tip of the iceberg? *Ophthalmology*, *111*(5), 863–866. https://doi.org/10.1016/j.ophtha.2003.09.029

Morley, G. (2013). The writer's approach to facilitating research communication: a very different way of engaging with authors. In Matarese, V (Ed.), *Supporting Research Writing: Roles and Challenges in Multilingual Settings* (pp. 191–204). Cambridge, England: Chandos Publ.

Murphy, F. (2018). Open access, open data, FAIR Data and their implications for life sciences researchers. *Emerging Topics in Life Sciences*, *2*(6), 759–762. https://doi.org/10.1042/ETLS20180163

Northern Illinois University. (2005). *RCR resources-Data management module*. Responsible Conduct in Data Management. [Online educational material] Retrieved 27 March 2020: https://ori.hhs.gov/education/products/n_illinois_u/datamanagement/datopic.html

O'Connell, A., & Harp, G. (2017). Implementing CRediT: An Interview with Cell Press's Gabriel Harp. [Blog post] Retrieved 27 March 2020:

https://www.csescienceeditor.org/article/implementing-credit-interview-cell-presss-gabriel-harp/

Perkins, J., Dombrowski, Q., Borek, L., & Schöch, C. (2014). Building Bridges to the Future of a Distributed Network: From DiRT Categories to TaDiRAH, a Methods Taxonomy for Digital Humanities. *International Conference on Dublin Core and Metadata Applications*, 181–183. https://dcpapers.dublincore.org/pubs/article/view/3720

Pierce, H. H., Dev, A., Statham, E., & Bierer, B. E. (2019). Credit data generators for data reuse. *Nature*, *570*(7759), 30. https://doi.org/10.1038/d41586-019-01715-4

PLOS Biology. (2020a). *Submission guidelines*. PLOS BIOLOGY. https://journals.plos.org/plosbiology/s/submission-guidelines#loc-title-page

PLOS Biology. (2020b). *Data availability*. PLOS BIOLOGY. https://journals.plos.org/plosbiology/s/data-availability

PLOS Medicine. (2020a). *Submission guidelines*. PLOS MEDICINE. https://journals.plos.org/plosmedicine/s/submission-guidelines

PLOS Medicine. (2020b). *Data availability*. PLOS MEDICINE. https://journals.plos.org/plosmedicine/s/data-availability

Radford, M. L., Kitzie, V., Mikitish, S., Floegel, D., Radford, G. P., & Connaway, L. S. (2018). Investigating practices for building an ethical and sustainable scholarly identity with online platforms and social networking sites. *Proceedings of the Association for Information Science and Technology*, *55*(1), 404–413. https://doi.org/10.1002/pra2.2018.14505501044

Resnik, D. B. (2015a). What is Ethics in Research & Why is it Important? [Website] Retrieved 27 March 2020: https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

Resnik, D. B. (2015b). Glossary of Commonly Used Terms in Research Ethics. [Website] Retrieved 27 March 2020: https://www.niehs.nih.gov/research/resources/bioethics/glossary/index.cfm

Ridley, A. (2019, April 5). Now is the time for a team-based approach to team science. *F1000 Blogs*. [Blog post] Retrieved 27 March 2020:https://blog.f1000.com/2019/04/05/now-is-the-time-for-a-team-based-approach-to-team-science/

Ross-Hellauer, T., Deppe, A., & Schmidt, B. (2017). Survey on open peer review: Attitudes and experience amongst editors, authors and reviewers. *PLoS ONE*, *12*(12). https://doi.org/10.1371/journal.pone.0189311

Sanz-Menéndez, L., & Cruz-Castro, L. (2019). University academics' preferences for hiring and promotion systems. *European Journal of Higher Education*, *9*(2), 153–171. https://doi.org/10.1080/21568235.2018.1515029

Setchell, J. M. (2019). *Studying Primates: How to Design, Conduct and Report Primatological Research*. Cambridge University Press.

Smiraglia, R. P. (2017). Ethos, Geopolitical Realities, and the Digital Realm—An Editorial. *Knowledge Organization*, *44*(4), 251–264. https://doi.org/10.5771/0943-7444-2017-4-251

Smith, E., & Master, Z. (2017). Best Practice to Order Authors in Multi/Interdisciplinary Health Sciences Research Publications. *Accountability in Research*, *24*(4), 243–267. https://doi.org/10.1080/08989621.2017.1287567

Smith, W. P. J., Vettiger, A., Winter, J., Ryser, T., Comstock, L. E., Basler, M., & Foster, K. R. (2020). The evolution of the type VI secretion system as a disintegration weapon. *PLOS Biology*, *18*(5), e3000720. https://doi.org/10.1371/journal.pbio.3000720

Starck, J. M. (2017). The Journal Peer Review. In J. M. Starck (Ed.), *Scientific Peer Review: Guidelines for Informative Peer Review* (pp. 15–28). https://doi.org/10.1007/978-3-658-19915-9_5

Steneck, N. H. (2007). *ORI Introduction to the Responsible Conduct of Research*. Government Printing Office. Available online: https://ori.hhs.gov/sites/default/files/2018-04/rcrintro.pdf

Thomas, D. R. (2006). A General Inductive Approach for Analyzing Qualitative Evaluation Data. *American Journal of Evaluation*, *27*(2), 237–246. https://doi.org/10.1177/1098214005283748

Uijtdehaage, S., Mavis, B., & Durning, S. J. (2018). Whose Paper Is It Anyway? Authorship Criteria According to Established Scholars in Health Professions Education. *Academic Medicine*, *93*(8), 1171–1175. https://doi.org/10.1097/ACM.0000000000002144

Vasilevsky, N. A., Hosseini, M., Teplitzky, S., Ilik, V., Mohammadi, E., Schneider, J., Kern, B., Colomb, J., Edmunds, S. C., Gutzman, K., Himmelstein, D. S., White, M., Smith, B., O'Keefe, L., Haendel, M., & Holmes, K. L. (2020). Is authorship sufficient for today's collaborative research? A call for contributor roles. *Accountability in Research*. https://doi.org/10.1080/08989621.2020.1779591

Weiss, P. S. (2012). Who Are Corresponding Authors? *ACS Nano*, *6*(4), 2861–2861. https://doi.org/10.1021/nn301566x

Wodtke, L. (2018). Online Resources for Scholarly Journal Publishing. *Scholarly and Research Communication*, *9*(1). https://doi.org/10.22230/src.2018v9n1a283

Wolfram, D., Wang, P., Hembree, A., & Park, H. (2020). Open peer review: Promoting transparency in open science. *Scientometrics*. https://doi.org/10.1007/s11192-020-03488-4

Yang, C., Ambayo, H., Baets, B. D., Kolsteren, P., Thanintorn, N., Hawwash, D., Bouwman, J., Bronselaer, A., Pattyn, F., & Lachat, C. (2019). *An Ontology to Standardize Nutritional Epidemiologic Research Output: From Paper-Based Standards to Linked Content*. https://www.preprints.org/manuscript/201905.0178/v1

Chapter 4. Ethical justification of candidate assessment criteria

4.1 Introduction

In the first three steps of the process of developing the assessment instrument, a bottom-up approach was employed to collect issues and concerns about CROTs and generate candidate assessment criteria. In the fourth step, the applicability of developed criteria to modern publishing practices was tested. In the fifth step, which is presented in this chapter, a top-down approach is employed to justify candidate assessment criteria from an ethical perspective. By exploring the ethical appropriateness of each criterion, this chapter will clarify why assessment criteria have to be met by current and future CROTs. Towards that end, choosing an ethical framework is required.

4.1.1 Ethical framework to justify candidate criteria

As shown in section 2.5 of this thesis, ethical aspects of using CROTs fall within the scope of ethical issues of scholarly authorship. Since ethical issues of authorship are among core discussions in research ethics and integrity (Horner & Minifie 2010; Moffatt 2011), a framework for research ethics and integrity can be used to justify candidate assessment criteria.

To find a suitable framework to justify the assessment instrument, a scoping search was conducted on 28 September 2020 using Google Scholar (Alphabet inc. 2020). In ensuring that identified frameworks adequately deal with specific questions in relation to authorship practices, the three terms that referred to the context (i.e., scholar*, research* and scien*, also used in the review of the literature about ethical issues of scholarly authorship) were combined with “framework”, and “authorship”, generating the following six search strings:

- “scholar* integrity” AND “framework” AND “authorship”
- “scholar* ethics” AND “framework” AND “authorship”

- "research* integrity" AND "framework" AND "authorship"
- "research* ethics" and "framework" AND "authorship"
- "scien* ethics" and "framework" AND "authorship"
- "scien* integrity" and "framework" AND "authorship"

After screening titles and abstracts, and also considering the number of times that the first 100 retrieved sources (ordered in terms of relevance) from each search string were cited, it was found that David Resnik's 1998 book, *Ethics of science,* is the most suitable item for this purpose. First published in 1998, this book has been cited 523 times up to September 2020 (more than any other retrieved source).[74]

There are other advantages for employing this framework to assess the ethical dimensions of research in general, and those pertaining to authorship practices in particular:

- This framework employs twelve principles to facilitate the understanding of questions, problems, values and concerns in relation to practical decisions that need to be considered when conducting research. These principles include honesty, carefulness, openness, freedom, credit, education, social responsibility, legality, opportunity, mutual respect, efficiency and respect for subjects. The twelve principles are inspired by, and extend, Robert Merton's norms of science (communism, universalism, disinterestedness, organised scepticism), which are widely endorsed by researchers in terms of required norms to conduct research responsibly.[75]
- This framework is not based on a specific ethical theory (e.g., utilitarianism or virtue ethics). Accordingly, it facilitates guidance in relation to ethical dilemmas without defending an entire ethical theory. Hence, it is more likely to yield non-controversial

[74] In this thesis, the digital version of the book published in 2005 is used.
[75] Mertonian norms are crucial for the production of reliable knowledge (Cottey 2016). While first introduced decades ago, they are still highly popular among scientists. In fact, scientists in different disciplines and levels of seniority feel to a great extent that these norms "should represent the behaviour of scientists" (Anderson et al. 2010, p. 385)

ethical norms (e.g., if one were to employ utilitarianism to ground actions in relation to research practices, then seemingly controversial practices, such as pressurising junior researchers to publish their research in ways that undermine or violate the typical standards of research integrity could be argued to be justifiable).[76]

- From a theoretical perspective, available frameworks in the literature use different approaches to research ethics and integrity. While some ethicists such as Bruce MacFarlane remain loyal to virtue-based theories to both extract and describe the norms of research ethics, David Resnik combines general ethical principles and values relevant to the conduct of research and uses specific examples to extract mid-level principles.[77] Consequently, he describes his action-guiding norms with twelve principles, while also considering the aims of conducting research. This approach results in the development of practical and non-controversial norms understandable for most if not all researchers.
- Without claiming to provide an exhaustive list of principles that would seek to capture all possible scenarios and circumstances related to research practices, the twelve principles capture valued standards of science and core aspects of research ethics.

In what follows, each of the principles are briefly described:

1. **Honesty**: "Scientists should not fabricate, falsify, or misrepresent data or results. They should be objective, unbiased, and truthful in all aspects of the research process" (Resnik 2005, p. 48).

[76] Some of the ethical issues that were mentioned in chapter two could also be considered as examples that are justifiable with a utilitarian approach. For instance, issues mentioned under the subheading of *publication strategy*, that pertain to demonstrating a calculating and self-serving attitude merely to improve the chance of success (e.g., by choosing the time/outlet of publications strategically or choosing co-authors purely based on their gender) could be justified from a utilitarian perspective.

[77] Mid-level principles are used in justification of rules and moral assessments, but they are neither deduced from abstract, top-down moral theories such as utilitarianism, or purely induced from bottom-up cases (Bayles 1986). Instead, they are extracted via reflecting on moral theories and particular cases (Ibid.). In this sense, Resnik's principles can broadly be described as the ethical reflection on issues in science and research.

Honesty is science's most important rule that promotes cooperation and trust. Dishonesty and error may have similar consequences, but dishonesty is motivated by the intention to deceive an audience that is expecting to be told the truth. Dishonest reporting of data contributes to misrepresentation (e.g., data trimming/fudging/cooking) or in severe cases, to the fabrication and falsification of results.

2. **Carefulness**: "Scientists should avoid errors in research, especially in presenting results. They should minimize experimental, methodological, and human errors and avoid self-deception, bias, and conflicts of interest" (Resnik 2005, p. 51).

   Carefulness prevents errors that waste resources, harm subjects/people and erode trust in science. Errors can be due to experimental issues (related to the use of scientific instruments in data collection), methodological issues (related to the use of theoretical assumptions and analyses/inferences), human-related issues (in performing calculations) or a combination of all three (e.g., self-deception and not being sceptical).

3. **Openness**: "Scientists should share data, results, methods, ideas, techniques, and tools. They should allow other scientists to review their work and be open to criticism and new ideas" (Resnik 2005, p. 52).

   Without openness, science becomes dogmatic, uncritical and biased. Via improving access to previous research, openness also promotes the building of an atmosphere of cooperation and trust. Nevertheless, limited secrecy may be justified in specific cases (e.g., incomplete projects) to protect ongoing research, subjects' reputation/identity and researchers' share of credit.

4. **Freedom**: "Scientists should be free to conduct research on any problem or hypothesis. They should be allowed to pursue new ideas and criticize old ones" (Resnik 2005, p. 54).

   Freedom facilitates expansion of knowledge, nurturing scientific creativity, and challenging old ideas/assumptions. Sometimes minor restrictions are justified to prevent harm and violation of rights, or to prioritise the allocation of funds to projects with more direct benefit for the society.

5. **Credit**: “Credit should be given where credit is due but not where it is not due” (Resnik 2005, p. 55).

   Giving credit where it is due motivates scientists to conduct research, promotes cooperation and trust and ensures fair competition for science’s rewards such as recognition, respect and prestige. It also allows punishing scientists in cases of erroneous and fraudulent conduct. Hence, a scientist should be given just rewards for their contributions as long as they take responsibility for it. Plagiarism and honorary authorship are two examples of unethical attribution of credit.

6. **Education**: “Scientists should educate prospective scientists and insure that they learn how to conduct good science. Scientists should educate and inform the public about science”(Resnik 2005, p. 56).

   Education may happen at schools, labs, university lectures, in various forms of public media or via personal mentoring. All of these educational activities are important and necessary forms of promoting the scientific profession, without which this profession will grind to a halt.

7. **Social responsibility**: “Scientists should avoid causing harms to society and they should attempt to produce social benefits. Scientists should be responsible for the consequences of their research and they should inform the public about those consequences” (Resnik 2005, p. 57).

   Social responsibility requires researchers to do their best to anticipate consequences of research, and uphold their moral/professional duties of beneficence, nonmaleficence, and utility towards people. It also demands researchers to avoid the pursuit of knowledge for its own sake, and to assume that others should worry about the impact and consequences of their research.

8. **Legality**: “In the process of research, scientists should obey the laws pertaining to their work” (Resnik 2005, p. 58).

Legality pertains to aspects with legal ramifications such as the use of hazardous/forbidden substances, the use of human/animal subjects, waste disposal, hiring practices, funding appropriation, copyrights and patents. Although sometimes legal restrictions may impair the advancement of knowledge and disobedience of researchers might be justified, the burden of proof lies with the trespassers.

9. **Opportunity**: "Scientists should not be unfairly denied the opportunity to use scientific resources or advance in the scientific profession" (Resnik 2005, p. 59).
   Opportunities open the scientific community to new people and ideas, hypotheses, approaches and methods. Accordingly, via overcoming the consensus of like-minds and biases, knowledge is more likely to be objective. The principle of opportunity also demands the distribution of funding and employment opportunities in a manner to include minorities/under-privileged groups, and necessitates the prohibition of discrimination.
10. **Mutual respect**: "Scientists should treat colleagues with respect" (Resnik 2005, p. 60).
    Researchers should not inflict physical or psychological harm on their colleagues, disrespect privacy, or tamper with their colleagues' experiments/results.
11. **Efficiency**: "Scientists should use resources efficiently" (Resnik 2005, Ibid. p. 60).
    Using limited economic/human/technological resources efficiently prevents waste and should be promoted. Dividing up a paper to get more publications out of ideas/results is an example of an inefficient attitude because it wastes scientific community's resources including peer-reviewers' time.
12. **Respect for subjects**: "Scientists should not violate rights or dignity when using human subjects in experiments. Scientists should treat non-human, animal subjects with appropriate respect and care when using them in experiments" (Resnik 2005, p. 61).
    Respecting animal/human subjects is necessary due to their inherent moral dignity and basic rights. Researchers have legal and ethical obligations to treat research subjects carefully.

4.2 Ethical justification

The previous chapter resulted in the development of 34 candidate assessment criteria subsumed under six categories including availability, extensibility, responsibility and accountability, usability, violations and attribution of credit. In this section, these candidate assessment criteria are analysed to check whether they can be justified using Resnik's principles. A candidate assessment criteria is justified if it is supported by (at least) one of Resnik's principles. In justifying candidate assessment criteria, additional sources are used to clarify and contextualise the importance of raised issues in research projects.

4.2.1 Availability

Candidate assessment criterion 1. Is the description of contributions to tasks published under Open Access licence?

This criterion is required by Resnik's principles of *Openness, Opportunity* and *Carefulness*. Depending on their subscription model, journals might only publish some of their publications' content under Open Access licence (e.g., authors' names, keywords, abstracts), and keep the rest (e.g., full-text articles, references) under a paywall.[78] According to Resnik's principle of *Openness*, information about research should be as open as possible as long as this openness would not negatively affect the completion of the project, research subjects' reputation/identity or researchers' share of credit/recognition. Accordingly, since the publication of contributions to tasks under Open Access licence improves the recognition of researchers' contributions through increasing their visibility, this criterion is necessary based on the principle of *Openness*.

According to Resnik's principle of *Opportunity*, scientists should not be unfairly denied the opportunity to advance in scientific professions. Lack of publishing researchers' contributions

[78] It should be noted that since this decision is made at a publisher/journal level, if CROTs' publish their tasks and definitions under Open Access licence, then there would be no external barrier to the publication of contributions other than what is decided at a publisher/journal level.

under Open Access licence, however, negatively affects (some) contributors in annual assessments and academic evaluations (Marques et al. 2019). Especially when researchers are being assessed by evaluators who are affiliated with institutions without a subscription to *all* journals, the recognition and comparison of individual contributions would be impossible because evaluators would not be able to access these contributions. Hence, the principle of *Opportunity* would also necessitate this criterion to facilitate the equal treatment of all researchers in academic evaluations.

Not publishing contributions under Open Access licence might result in errors and biases about individual contributions to research. Hence, this criterion is also required by Resnik's principle of *Carefulness*, which requires avoiding errors in presenting results and contributions.

Candidate assessment criterion 2. Do CROTs' developers provide translated versions of research tasks and their definitions in languages other than English?

This criterion is required by Resnik's principles of *Credit*, *Mutual Respect*, *Openness, Efficiency,* and *Carefulness.* Journals and universities that adopt CROTs might not always be dealing with fluent speakers of the English language. If non-English speaking contributors do not understand what the definition of tasks are, their consent to tasks used to describe their contributions would be invalid. Since these situations might result in the misattribution of credit, this criterion is required by Resnik's principle of *Credit*. Both misattribution of credit, and, using the English language to communicate research tasks with contributors who do not understand it are disrespectful and hence, this criterion is also required by principle of *Mutual Respect*.

Resnik's principle of *Openness* demands sharing as much information about research as possible, which would also include data about contributions. Journals that publish their content in a language other than English (or universities' library and depository systems that work in a non-English language), have (arguably) chosen to do so to reach out to a wider audience, some of whom may not understand English. If CROTs' developers do not provide translated versions of

research tasks and their definitions, adopters such as journals and universities would either have to publish researchers' contributions in English or each make their own translation of research tasks. If the former, published contributions could perhaps be meaningless for the users who do not understand English, which (partially)[79] undermines the *Openness* of research and contributes to errors. If the latter, then it is very likely to end up with dissimilar translations of research tasks across the board, which would defeat the purpose of developing CROTs in the first place[80], and would undermine the principle of *Efficiency*. When every adopting party develops their own translation, resources are not used in an efficient manner.

Since CROTs are likely to be used by non-fluent/-native users of the English language, having research tasks and their definitions translated into other languages prevents misunderstanding and confusion about the meaning of tasks.[81] Since these translations minimise the likelihood of errors and biases about individual contributions, this criterion is required by the principle of *Carefulness*.

4.2.2 Extensibility

Candidate assessment criterion 3. Do CROTs developers collect and evaluate user feedback for future revisions?

This criterion is required by Resnik's principle of *Carefulness*. Collecting feedback and evaluating them for the purpose of revising CROTs is an important activity that results in keeping CROTs up to date with evolving user needs such as functionality and the addition of new tasks (Vasilevsky et al. 2020). By putting in place mechanisms to collect user feedback, and appointing expert

[79] These tasks would still be meaningful for those who understand English.
[80] As explained in section 3.1, among other reasons, CROTs were developed to standardise tasks and enable a uniform application of terms that describe contributions to research
[81] This is perhaps why current resources about the attribution of credit with other means (e.g., authorship criteria) are often available in several languages. For example, ICMJE's definition of authorship and descriptions for using it in specific contexts (e.g., how to apply the definition of authorship to a large multi-author group) are translated into ten different languages other than English (ICMJE translated sources 2020).

groups to monitor and evaluate the received feedback, usability of CROTs and their clarity about new research tasks/methods in science is improved, and the likelihood of error in the presentation of contributions is minimised. Hence this criterion is required by the principle of *Carefulness*.[82]

4.2.3 Responsibility and accountability

Candidate assessment criterion 4. Are there mechanisms to indicate individual and overlapping responsibilities concerning tasks conducted by two or more contributors?

This criterion is required by Resnik's principles of *Credit*, *Mutual respect*, *Carefulness, Honesty, Social Responsibility* and *Openness*.[83] In explaining the principle of *Credit*, Resnik highlights how inseparable credit and responsibilities are by describing them as "two sides of the same coin" (Resnik 2005, p. 55). He notes that it should be possible to know who is responsible for flawed research "so that the errors can be corrected or the person(s) can be punished" (Ibid.). Accordingly, if two contributors are involved in conducting the same task, it should be possible to clarify who did what, so as to enable the identification of responsibilities for flawed research. Inability to clarify individual and overlapping responsibilities complicates investigations about allegations of misconduct and results in unfounded accusations and disrespect for contributors. Hence, this criterion is necessary based on the principle of *Mutual Respect*.

While CROTs improve the attribution of responsibilities via providing standard research tasks and definitions, there might be cases where additional mechanisms would be required to prevent erroneous attribution of responsibilities. For instance, in cases where a task is conducted by more than one contributor, without mechanisms to indicate what part of that task was conducted by which contributor, accurate identification of responsibilities would not be

[82] One can also argue that if the absence of a mechanism to collect and evaluate feedback results in the misattribution of credit, the principle of *Credit* is undermined as well.
[83] One can also consider the principle of *Legality*, but that would only apply to situations where non-clarification of responsibilities results in illegal conduct.

readily possible (e.g., if data analysis is conducted by Contributor. X and Y, ideally it should be possible to know what part of data analysis was done by each, otherwise, in case of erroneous analysis, CROTs cannot help in finding out where the responsibilities lie). Therefore, because inaccurate identification of responsibilities results in errors, this criterion is required by Resnik's principle of *Carefulness*.

Since not clarifying individual responsibilities in relation to tasks might imply that everyone is equally responsible, in cases where contributors are not equally responsible, lack of mechanisms that indicate individual and overlapping responsibilities would contribute to untruthful reporting of responsibilities. Hence, this criterion is required by the principle of *Honesty*.

Lack of a clear distinction between individual and overlapping responsibilities obscures researchers' role in informing the public about the consequences of particular research aspects (e.g., waste disposal). Hence, this criterion is necessary based on the principle of *Social Responsibility*, because it supports scientists in taking responsibility for the consequences of their research.

Furthermore, by clarifying individual and overlapping responsibilities, more information is disclosed about contributions. Since this disclosure improves transparency about research, this criterion is also necessary based on Resnik's principle of *Openness*.

Candidate assessment criterion 5. Are there mechanisms to indicate mentor-mentee relations and the subsequent responsibilities for mentors?

This criterion is required by Resnik's principles of *Education*, *Credit*, *Mutual respect*, *Carefulness, Honesty, Social Responsibility* and *Openness*. Mentors show "students how to do good research, how to teach, how to write research papers, how to obtain funding, and how to survive in academia" (Resnik 2005, p. 39). In fact, based on the principle of *Education*, mentors have a duty to educate junior researchers and have certain responsibilities in relation to them. If it is proven that errors/mistakes committed by junior researchers were due to inadequate mentoring,

mentors are held partially responsible for mentees' mistakes.[84] Since the principle of *Credit* demands clarification of responsibilities, it would also necessitate describing the relationship between mentors and mentees so as to enable the delineation of mentors' responsibilities. Inability to clarify mentors' responsibilities might complicate investigations about allegations of misconduct and result in unfounded accusations and disrespect. Hence, this criterion is also necessary based on the principle of *Mutual Respect*.

Unclear mentor-mentee relations in cases where junior researchers "may not receive adequate mentoring" (Resnik 2005, p. 108), would complicate the attribution of responsibilities in investigations of misconduct and contribute to errors. Especially if numerous mentors supervise different junior researchers, clarification of supervisory roles would be necessary to prevent errors in the attribution of supervisory responsibilities, and necessary based on Resnik's principle of *Carefulness*.

Since not clarifying mentors' responsibilities in relation to junior researchers might imply that all mentors are equally responsible for every junior researcher, in cases where mentors are not equally responsible, lack of mechanisms to indicate mentors responsibilities would contribute to untruthful reporting of responsibilities. Hence, this criterion is required by the principle of *Honesty*.

This criterion is also necessary based on the principle of *Social Responsibility*. Clarifying supervisory responsibilities encourages mentors to inform the public about consequences of the work delivered by their mentees/teams.

Furthermore, by reporting mentor-mentee relations, more information is disclosed about contributions. Since this disclosure improves transparency about research, this criterion is necessary based on Resnik's principle of *Openness*.

[84] Resnik clarifies this in his description of Summerlin's case of misconduct. In that case, although Summerlin had fabricated the data, a lab director too was "held partly responsible" for the misconduct only because she "supervised Summerlin's research" (Resnik 2005, p. 67).

4.2.4 Usability

Candidate assessment criterion 6. Are there adequate and straightforward instructions to guide researchers on how CROTs should be used?

This criterion is required by Resnik's principles of *Carefulness*, *Efficiency*, *Education* and *Openness*.[85] Instructions about how CROTs should be used minimise the likelihood of personal interpretations, misunderstanding or confusion, which could amount to erroneous and biased use of CROTs. Hence, providing adequate and straightforward[86] user instructions makes CROTs less prone to become a contributing factor to questionable/inconsistent use[87], and required by Resnik's principles of *Carefulness*.

In the absence of adequate instructions on how CROTs should be used and in an effort to prevent erroneous use, (some) parties that adopt CROTs might end up developing instructions of their own. In addition to the likelihood of spreading inconsistent practice, this is an inefficient use of human resources that should be prevented based on Resnik's principle of *Efficiency*.

Instructions inform and educate researchers about how contributions should be reflected. Without these educational resources, researchers would not have a solid reference to learn about CROTs, and therefore, providing these instructions would also be required based on Resnik's principle of *Education*.

[85] Depending on the type of error that might occur as a result of not having adequate and straightforward instructions, other principles might become relevant as well. For instance, if the lack of instructions results in the misattribution of credit, then principles of *Honesty, Credit, Mutual respect and Opportunity* would also necessitate this criterion. If the lack of instructions results in illegal conduct of research or the misattribution of responsibilities, then the principles of *Legality and Social Responsibility* would respectively necessitate this criterion.

[86] In relation to being straightforward, Resnik notes that standards of conduct "need to be made public in the appropriate communication forum" and attempts should be made "to express them as clearly as possible" (Resnik 2005, p. 155).

[87] For instance, while both *PLOS Medicine* and *PLOS Biology* are owned by the same publisher (i.e., PLOS), in their submission guidelines they provide a dissimilar explanation on how CRediT should be used in combination with authorship guidelines. This disparity is explained in detail in Appendix C.

In relation to the principle of *Openness*, since instructions on how CROTs should be used, would naturally improve research methods and practices, sharing them with the scientific community would be necessary. This openness would also enable members of the scientific community (e.g., researchers working on ethical issues of authorship and CROTs) to review, criticise and provide suggestions to improve these instructions.

Candidate assessment criterion 7. In their instructions for researchers, do CROTs require one person to be aware of individual contributions and in charge of correspondence with other contributors and the editorial team?

This criterion is required by principles of *Carefulness* and *Efficiency*.[88] By highlighting that one person should be in charge of noting contributions and correspondence with contributors and the editorial team, CROTs should clarify specific responsibilities that are associated with this task.[89] Specific instructions minimise the likelihood of misunderstandings and errors about this important task and are required by Resnik's principle of *Carefulness*.[90]

The principle of *Efficiency* demands making efficient use of human resources. Without one person in charge of correspondence and communication, every single contributor would have to be in contact with the journal and other contributors separately. This is time-consuming for contributors and the editorial team, and indeed an inefficient use of human resources.

[88] Depending on what can go wrong as a consequence of not noting this issue in instructions for researchers, it is also possible to justify this criterion with other principles. For instance, if the lack of having one person in communication results in the misattribution of credit, then principles of *Honesty, Credit, Mutual Respect* and *Opportunity* would also necessitate this criterion. If the lack of having one person in charge of communication results in the misattribution of responsibilities, then the principle of *Social Responsibility* also necessitates this criterion.

[89] It should be noted that instructions provided by authorship guidelines, (e.g., the ICMJE) assign these tasks to the corresponding author. Among their specific responsibilities, a corresponding author "ensures that all the journal's administrative requirements, such as providing details of authorship, ethics committee approval, clinical trial registration documentation, and disclosures of relationships and activities, are properly completed and reported (ICMJE 2020, p. 3).

[90] Furthermore, Resnik mentions the significance of submitting accurate papers with relevant information about "names and institutional affiliations of authors" and "acknowledgments" in preventing biased publications (Resnik 2005, p. 85). Since these information are submitted by corresponding contributors, mentioning this task and highlighting the associated responsibilities in instructions to researchers minimise the likelihood of biased publications.

Therefore, the principle of *Efficiency* would require CROTs to highlight in their instructions that one person should be in charge of the task of correspondence.

Candidate assessment criterion 8. Are there reasonably comprehensive instructions for adopters (e.g., journals, universities) that explain how CROTs should be implemented and used?

This criterion is required by Resnik's principles of *Carefulness*, *Efficiency*, *Education* and *Openness*.[91] Providing instructions to adopters on how CROTs should be implemented and used minimises the likelihood of arbitrary and incorrect application, which might result in errors. Hence, this criterion is required by the principle of *Carefulness*.[92] Especially since the software code behind CROTs is often Open Source[93] (allowing adopters to freely change the code according to their needs), lack of specific instructions could result in incorrect implementation, and consequently, inaccurate representation of contributions.

In relation to the principle of *Efficiency*, if instructions are not provided by developers of CROTs, then each adopter would have to figure out how to implement and use CROTs, which would be an inefficient use of resources. It should be noted that in some cases, adopters might have to figure out some technicalities depending on their specific needs, which CROTs could not always be helpful with. For instance, since different publishers use dissimilar submission workflows, it might be necessary to follow a specific technical path to incorporate CROTs into their workflow. That said, general requirements that would be relevant to all applications (e.g., how to link contributions to articles' metadata) should be provided to adopters.

[91] Depending on what can go wrong as a consequence of not having instructions for adopters, it is also possible to justify this criterion with other principles. For instance, if the lack of instructions for adopters results in the misattribution of credit, then principles of Honesty, Credit, Mutual respect and Opportunity would also necessitate this criterion. If the lack of having instructions for adopters results in the misattribution of responsibilities, then the principle of Social Responsibility would also necessitate this criterion.

[92] This is perhaps why the developers of other attribution methods (e.g., authorship criteria) provide specific guidelines to journals to support their implementation and help them in avoiding common problems. For instance, both the World Association of Medical Journal Editors (WAME 2016) and the International Committee of Medical Journal Editors (ICMJE 2020) provide instructions to journals about dealing with common authorship/peer-review/editorial issues.

[93] All three CROTs analysed in this study have Open Source codes.

Instructions for adopters could be considered as an educational resource as well. Providing these instructions ensures that adopters receive adequate educational support to apply CROTs correctly and hence, this criterion is required by Resnik's principle of *Education*.

Since instructions for adopters would naturally entail methods that facilitate the presentation of individual contributions, sharing them would be necessary based on the principle of *Openness*. Sharing these instructions would enable members of the scientific community (e.g., researchers working on publication software and technologies) to review, criticise and provide suggestions to improve them.

Candidate assessment criterion 9. In their instructions for adopters, is the use of CROTs for describing acknowledged contributions encouraged?

This criterion is required by Resnik's principles of *Credit, Mutual Respect* and *Opportunity*. At the moment, CROTs are used to describe authors' contributions and omit recognising tasks conducted by non-authors. This means that the contributions of acknowledged names (i.e., those who do not meet authorship criteria and are only listed in the acknowledgement section of articles) are not described with CROTs (Matarese & Shashok 2019).

In cases where a published item includes both authors and acknowledged contributors, failing to use CROTs for describing acknowledged contributions might result in inconsistent attribution of credit between the two groups of contributors. Therefore, since this criterion ensures a consistent and just recognition of contributions, it is supported by the principle of *Credit*. Since inconsistent attribution of contributions is disrespectful, this criterion is also necessary based on the principle of *Mutual Respect*.

An inconsistent attribution of credit may negatively affect future opportunities of those whose contributions are mentioned in the acknowledgement section. Since researchers should not be unfairly denied the opportunity to advance in academic professions, this criterion is required by the principle of *Opportunity*.

Candidate assessment criterion 10. In their instructions for adopters, do CROTs provide suggestions on how to represent outdated tasks and practices?

This criterion is required by Resnik's principles of *Credit*, *Mutual Respect*, *Opportunity, Carefulness* and *Efficiency*. Through extracting individual contributions from contributorship statements, CROTs could be employed to highlight contributions to items that were published before the introduction of CROTs (e.g., to improve the consistency of records within indices and repositories). However, since methods and involved tasks in research evolve over time, CROTs and their list of research tasks might not always capture contributions to outdated tasks (e.g., coding with punch cards).

The principle of *Credit* requires giving due credit to all researchers who can take responsibility for their contributions. If all researchers should receive credit for their contributions, this principle should also apply to those who contributed to projects that (at the time of publication) did not have their contributions registered via CROTs.[94] Furthermore, although contributors to outdated tasks might have already received some form of credit for their contribution (e.g., authorship status), in cases where contributorship statements are available, responsibilities will be attributed much more accurately via specifying contributions with CROTs. Accordingly, this criterion is required by the principle of *Credit*.

Treating researchers with respect requires an accurate reflection of their contributions. Via providing suggestions on how to capture outdated tasks with CROTs, a more accurate presentation of contributions and a respectful treatment of researchers is facilitated. Hence, this criterion is required by the principle of *Mutual Respect*.

Inaccurate capturing of outdated tasks would amount to inconsistent indexing of contributions and might limit opportunities for researchers who contributed to publications that are not

[94] For instance, in cases where at the time of publication, the publishing journal had not incorporated CROTs, or cases where an item is published before the introduction of CROTs (i.e., before 2015).

specified with CROTs. Since Resnik's principle of *Opportunity* requires providing equal opportunities to all researchers (which also includes those who contributed to outdated tasks or items published before the introduction of CROTs), it also necessitates this criterion.

In the absence of suggestions provided by developers of CROTs, different adopters might develop their own solution to capture outdated tasks, which is likely to increase inconsistency and errors. Since providing suggestion on how to represent (outdated) tasks minimises the likelihood of error and biases in reflecting contributions, this criterion is required by Resnik's principle of *Carefulness*.

Lack of providing these suggestions by CROTs' developers might encourage each adopter to develop their own solution, which is inefficient. Hence this criterion is required by Resnik's principle of *Efficiency*.

Candidate assessment criterion 11. In their instructions for adopters, do CROTs encourage seeking the confirmation of all contributors about listed contributions?

This criterion is required by Resnik's principles of *Carefulness*, *Credit, Mutual Respect* and *Opportunity*. Modern manuscript submission systems require adding an email address for each listed co-author upon submission of a manuscript. These email addresses are used by the editor to send an automatic email (to all co-authors) to confirm the receipt of the manuscript. After the manuscript is reviewed, follow-on emails are sent to the corresponding contributor (with all co-authors in the cc) about the required revisions and ultimately acceptance or rejection of the manuscript (Sarna-Wojcicki 2017). This process is meant to keep all co-authors informed about the publication process, and also give them a chance to object to the reported list of contributions (if they wanted to).[95] However, since this email is only sent to listed authors,

[95] For instance, the journal of *Science and Engineering Ethics*, sends the following email to all co-authors upon receiving a manuscript: "We have received the submission entitled: XYZ [title removed] for possible publication in Science and Engineering Ethics, and you are listed as one of the co-authors. The manuscript has been submitted to the journal by Dr. X [Author's name anonymised] who will be able to track the status of the paper through his/her login. *If you have any objections, please contact the editorial office as*

contributors who are acknowledged would not be kept in the communication loop and accordingly, do not get a chance to file a complaint or object before an item is published. This could become a thorny issue in projects that involve both authors and non-authors.

Asking each contributor (both authors and non-authors) to confirm the listed contributions before an item is published minimises the likelihood of errors and biases about reported contributions. Hence, this criterion is required based on Resnik's principle of *Carefulness.*

Seeking contributors' confirmation about listed contributions ensures that due credit is given to all involved researchers, and hence, required based on the principle of *Credit*.

This confirmation also enables treating researchers with respect via respecting their opinion about contributions and required by the principle of *Mutual Respect*.

Failing to ensure that all contributions are recognised might limit opportunities for researchers whose contributions are not adequately recognised. Since Resnik's principle of *Opportunity* requires providing equal opportunities to all researchers, it also necessitates this criterion.

Candidate assessment criterion 12. Do CROTs allow linking contributions to digital identifiers?

This criterion is required by Resnik's principles of *Carefulness, Credit, Mutual Respect* and *Opportunity.* Using unique digital identifiers is a characteristic of modern publications. Among available digital identifiers, "ORCID ('ORCID' n.d.) for authors and Research Organization Registry ('ROR' n.d.) for institutions, are the most promising ones" (Vasilevsky et al. 2020, p. 27). Since, linking contributions to digital identifiers prevents name/affiliation ambiguity and minimises the likelihood of errors and mistakes in publications, this criterion is required by the principle of *Carefulness*.

soon as possible. If we do not hear back from you, we will assume you agree with your co-authorship [Emphasis added] (Editorial communication Science and Engineering Ethics, 2020).

In cases of researchers who have common first and last names (e.g., ORCID registry contains more than 26,000 members with the name Mohammad Hosseini as their full name or at least part of their first/middle/last names), failing to link contributions to the correct person prevents the attribution of just rewards and responsibilities. Therefore, linking contributions to digital identifiers ensures that credit and responsibilities are attributed to the right person and required by the principle of *Credit*.

Furthermore, all contributors to research should be treated with respect, including those who have common names (e.g., Murphy in Ireland, de Jong in the Netherlands and Wang in China) or those who work in institutions with similar names (e.g., Miami University in Ohio, and the University of Miami in Florida). Since name/affiliation ambiguity prevents giving due credit to the right person, it is disrespectful and should be prevented based on the principle of *Mutual Respect*.

Once the contributions of all researchers are equally accessible, then they are less likely to be treated unfairly in academic evaluations. Via ensuring continued access to publications (e.g., in case of DOIs), linking contributions to digital identifiers improves the findability of researchers' academic portfolio. Since accessible and findable academic portfolios are necessary for evaluation and hiring purposes, this criterion is required by the principle of *Opportunity*.

Candidate assessment criterion 13. Are tasks linked to resolvable URIs?

This criterion is required by Resnik's principles of *Carefulness, Credit, Mutual Respect* and *Openness*. Resolvable URIs allow readers of scholarly publications to click on a task and land on a webpage or document that provides more specific information about that task (e.g., if X and Y are introduced as contributors involved in Data Analysis of a project, by clicking on *Data Analysis*, extra information will be shown about the used definition of Data Analysis at the time of publication, and specific contributions of Contributor X and Y in relation to Data analysis). Resolvable URIs are considered as an essential "pre-condition for proper data management and

reuse", which allows digital items to be consistently available and referenced through time (Inspire 2017, p. 11).

Since the incorporation of resolvable URIs and provision of more information about contributions minimise the likelihood of errors and mistakes (e.g., about the definition of tasks and individual contributions/responsibilities), this criterion is required by the principle of *Carefulness*.

Resolvable URIs also improve clarity about what each contributor did and facilitate the specification of individual/overlapping responsibilities about conducted tasks. Since Resnik's principle of *Credit* demands giving credit where it is due and stresses on clarifying responsibilities as much as possible, it necessitates this criterion.

Since using resolvable URIs facilitates the attribution of just rewards and respecting contributions of those involved, this criterion is required by the principle of *Mutual Respect.*

This criterion is required by the principle of *Openness* because resolvable URIs facilitate the sharing of more information about research and involved contributions.

4.2.5 Violations

Candidate assessment criterion 14. In their instructions for researchers, do CROTs describe what is regarded as a violation while using them?

This criterion is required by Resnik's principles of *Carefulness, Efficiency, Education* and *Openness*.[96,97] Similar to other means used for the attribution of credit and responsibilities (e.g.,

[96] Depending on what violations might happen as a consequence of not having these descriptions, it is also possible to justify this criterion with other principles. For instance, if the lack of description of violations results in the misattribution of credit, then principles of Honesty, Credit, Mutual respect and Opportunity would also necessitate this criterion. If the lack of these descriptions results in the misattribution of responsibilities, then the principle of Social Responsibility would necessitate this criterion too.

[97] Although Resnik is in favour of formal instructions for communication of norms and promotion of good conduct (Resnik 2005), he believes that sometimes specific definitions of violations "oversimplify complex problems" (Ibid., p. 71), and on that basis he has advanced some reservations about the usefulness of

definitions of authorship), CROTs too can be used in improper and erroneous ways. An example of improper use of CROTs pertains to the clarification of supervisors' responsibilities. In CROTs such as CRediT and CRO where there is a specific task titled Supervision, lack of descriptions about violations might result in the attribution of this task in a manner that obscures supervisory responsibilities. For instance, published by *PLOS Medicine,* Tanaka et al. (2020) has 23 contributors affiliated with 19 different institutions in Japan. Out of the 23 contributors, 22 are reported to have been involved in the task of supervision. It is reasonable to claim that designations like these not only obscure supervisory responsibilities, they also make the task of supervision meaningless[98], and are in violation of proper use of CROTs. As explained in section 3.1, CROTs were developed to improve the attribution of credit and responsibilities, but cases like this shows that if used carelessly, they can actually contribute to further ambiguity in the attribution of credit and responsibilities. One can reasonably argue that while using CROTs, the Japanese scientists could not know whether they are in violation of proper use of CROTs because at the moment there is no description that explains what these violations are.

Providing descriptions that explain what is considered as a violation while using CROTs, minimises the likelihood of ambiguities about prohibited practices, and required by Resnik's principle of *Carefulness*.

In the absence of descriptions provided by CROT's developers, each adopter would have to develop their own list of prohibited practices. This would be an inefficient use of human resources, which makes this criterion required by Resnik's principle of *Efficiency*.

descriptions of violations. He notes that (sometimes) the ambiguity of these descriptions defeats their purpose, and additionally, it is impossible to come up with instructions that address all[97] violations (Resnik 2005, pp. 64-65). Hence, descriptions of violations should be developed in a clear manner, and include a disclaimer about their non-exhaustive nature.

[98] The provided definition for the task of Supervision in both CRO and CRediT includes "oversight and leadership responsibility for the research activity planning and execution" (CASRAI 2020. Paragraph 1). The oversight and leadership responsibilities for what is conducted by one researcher would arguably not require 22 supervisors.

Since descriptions about violations increase researchers' awareness about prohibited research processes, this criterion is required by the principle of *Education*.

Providing descriptions that explain what is considered as a violation while using CROTs allows the research community to provide feedback and make suggestions for improving these description, which is necessary based on the principle of *Openness*.

Candidate assessment criterion 15. In their instructions for researchers, do CROTs attempt to suggest possible solutions and best practices to minimise the likelihood of (common) violations?

This criterion is required by Resnik's principles of *Carefulness, Efficiency, Education* and *Openness.* Various tools are developed to prevent the likelihood of misattribution of credit when using CROTs. Endorsement or making a reference to these tools could minimise the likelihood of improper use of CROTs. For instance, *Tenzing* is a new information sheet template that can be used by project groups to highlight individual tasks as they proceed with the project (Tenzing 2020). Using this template could ensure that all contributors know how their tasks will be reflected in the manuscript, which will minimise the likelihood of misunderstandings and violations. Another useful source is *Rescognito* that allows researchers to complete their Contributor CRediT Checklist, and ensure that these are linked to their ORCID ID and the DOI (Digital Object Identifier) of the publication (Resognito 2020).

Promotion of solutions and best practices minimise the likelihood of errors/mistakes in using CROTs. Therefore, with its stress on avoiding errors and biases in research, Resnik's principle of *Carefulness* justifies this criterion.

In the absence of solutions and best practices provided by CROT's developers, each adopter would have to come up with their own set of solutions and best practices. Since this would be an inefficient use of resources, this criterion is required by Resnik's principle of *Efficiency*.

Furthermore, by suggesting possible solutions and best practices that might minimise the likelihood of errors and common violations, research community's awareness about these solutions is increased. Hence, this criterion is required by the principle of *Education*.

The promotion of these solutions and best practices allows research community to provide feedback and suggestions for improving them, which is necessary based on the principle of *Openness*.

4.2.6 Attribution of credit

Candidate assessment criterion 16. Within tasks that involve more than one contributor, is it possible to clarify the extent of their individual contributions?

This criterion is required by Resnik's principles of *Honesty, Carefulness, Credit*, *Mutual Respect, Openness* and *Opportunity*. Authors' contributions to specific tasks within a project may vary significantly, but this is not always accurately reflected by the authorship order of published items (Larivière et al. 2016). Furthermore, since not clarifying the extent of contributions to tasks often implies having made equal contributions (Mongeon et al. 2017), providing the possibility to differentiate the extent of contributions would prevent misattribution of credit. That said, attempts to clarify the *exact* extent of contributions could also contribute to ambiguities because neither all contributions (e.g., contribution to ideas), nor credit and responsibilities are weighable with exact measures (Moustafa 2016; Silva 2011). On that basis, using broad categories (e.g., major/minor contribution) appears to be a reasonable compromise[99] that prevents the misattribution of credit without contributing to further ambiguities (these ambiguities are explained in more detail in analysing candidate assessment criterion 19).

[99] It should be noted that in using broad categories too, further details about the roles and responsibilities of major/minor contributors may be required to prevent responsibilities from being obscured, but nevertheless, in comparison with exact numbers, broad categories provide less controversial means to differentiate degrees of contributions.

If one researcher contributed more than others to a specific task, it would be untruthful not to reflect the difference and therefore, this criterion is required by the principle of *Honesty*.

Clarifying the extent of contributions prevents errors and biases about contributions, making this criterion necessary based on the principle of *Carefulness*. Furthermore, it facilitates an accurate recognition of contributions and giving credit where it is due, hence, also required by the principle of *Credit*.

Clarifying and mentioning degrees of contributions (where there is a difference between contributors' input) is necessary based on the principle of *Mutual Respect*, because failing to do so would diminish the input of those who contributed more, which is disrespectful.

This criterion is required by the principle of *Openness* because by indicating the extent of individual contributions to tasks, researchers disclose more information about contributions and accordingly, improve transparency.

Not clarifying the extent of contributions may negatively affect future opportunities of those who contributed more than others. Hence, this criterion is also required by the principle of *Opportunity*.

Candidate assessment criterion 17. In clarifying the extent of contributions to tasks, is it possible to specify two or more contributors as equal?

This criterion is required by Resnik's principles of *Honesty, Carefulness, Credit*, *Mutual Respect, Openness* and *Opportunity*. Making exactly equal contributions to a specific task (e.g., in a review practice two contributors may review an equal number of documents or within lab-based disciplines, two contributors may analyse an equal number of samples) is becoming more prevalent (Hosseini & Bruton 2020).[100] Despite being popular in areas such as natural and life

[100] It should be noted that in recognising equal contributions, the term equal does not always mean *exactly* equal contribution (e.g., 50.00% in case of two equal contributors). Equal is sometimes used to

sciences (Akhabue & Lautenbach 2010; Conte et al. 2013), equal contributions are not always adequately recognised and highlighted in authorship bylines (Hosseini 2020).

When two or more researchers contribute equally to a task, it would be untruthful not to clarify it. Therefore, this criterion is required by the principle of *Honesty*.

The principle of *Carefulness* also necessitates this criterion because it prevents biases and errors in presenting individual contributions.

Providing the possibility to register equal contributions also facilitates giving credit where it is due and hence, required by the principle of *Credit*.

Specifying equal contributions is required by the principle of *Mutual Respect* because it prevents misrecognising the contributions of equal contributors, which is disrespectful.

Furthermore, specifying equal contributions reveals more information about research and therefore, required by the principle of *Openness*.

Not clarifying equal contributions may negatively affect the career prospects of those who made equal contributions. Therefore, this criterion is required by the principle of *Opportunity*.

Candidate assessment criterion 18. Is it possible to recognise the contributions of teams and groups?

This criterion is required by Resnik's principles of *Honesty, Carefulness, Credit*, *Mutual Respect, Openness* and *Opportunity*.

Research shows that the number of scholarly articles with a collective name has significantly increased in the past few years. These articles involve "multicenter study investigators, members of working groups, and official or self-appointed expert boards, panels, or committees, who wish

refer to comparable or complementary contributions. The claim to have made equal contributions is valid in both cases (Hosseini & Bruton 2020).

to display a group name to indicate authorship" (Fontanarosa 2017, p. 2434). A recent analysis of PubMed database has shown that while between 2000 and 2004 only 29,635 articles had a group or corporate author in their byline, between 2015 and 2019 this number increased to 78,590 articles (US National Library of Medicine 2020). Due to this increase in activities that are collectively conducted by a team of researchers, research funders are being asked by researchers to encourage and promote the recognition of group authorships (Elliott 2017). For an example of a team contribution that is not explicitly recognised by CROTs (see figure 32). In this example, while the *BILHIV study team* is listed as a co-author, their contribution is not specifically mentioned among authors' contributions.

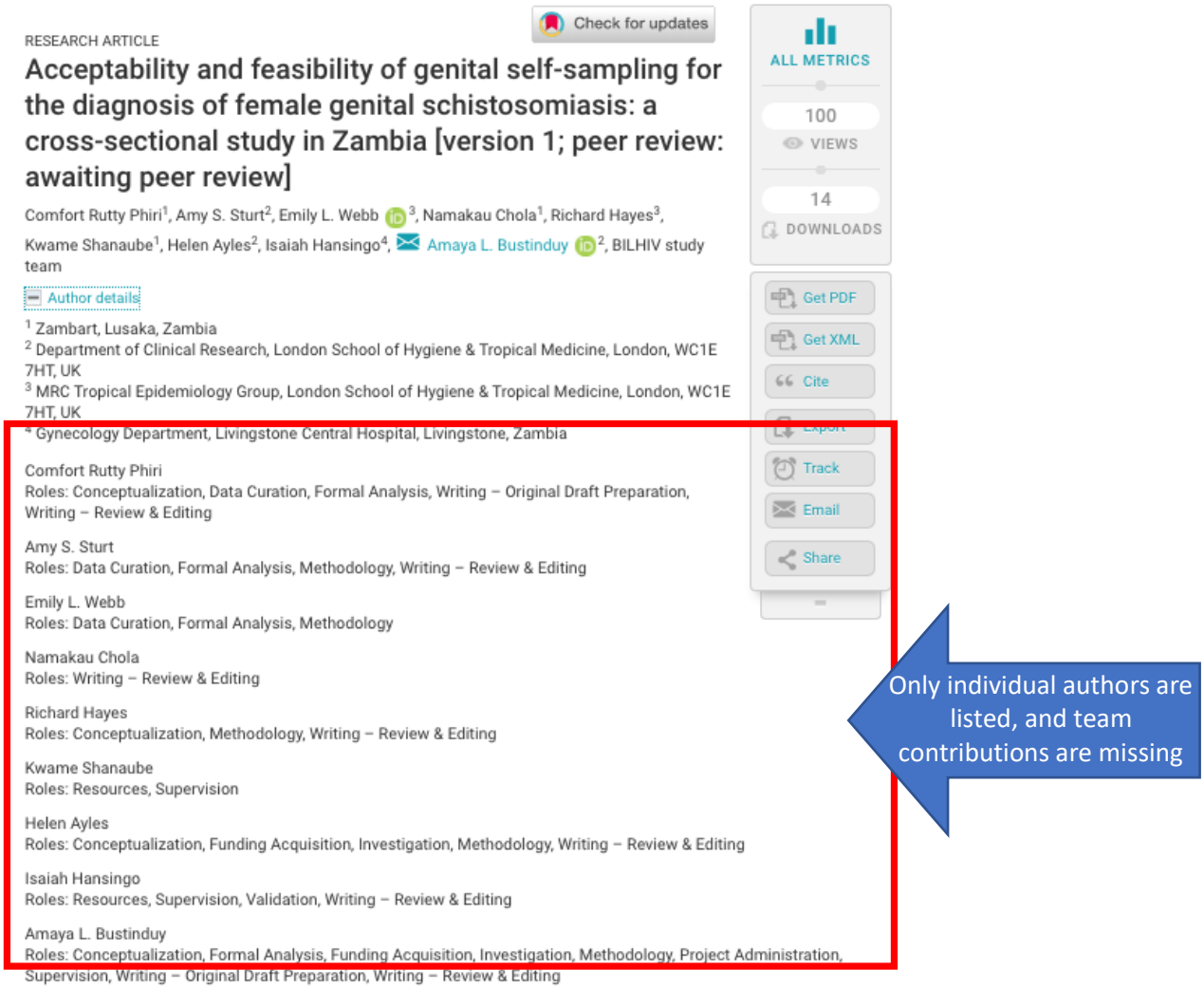


Figure 32. Inadequate recognition of team contributions (BILHIV study team) in a recent publication.

If there are contribution-types that are provided by a team or group, it would be untruthful not to mention these and therefore, this criterion is required by the principle of *Honesty*.

Recognising teams'/groups' contributions prevents errors in presenting research contributions and is required by the principle of *Carefulness*.

If teams/groups can take responsibility for their contributions, recognising their contributions would be required by the principle of *Credit*.

In terms of the principle of *Mutual Respect*, just as individual contributors deserve to be treated respectfully, members of a team who work under a collective name should also be respected and have their contributions recognised.

Disclosing information about team contributions increases the transparency about research and is required by the principle of *Openness*.

Not recognising collective contributions may negatively affect members of teams and groups in academic assessments. Therefore, this criterion is also required by the principle of *Opportunity*, because members of research groups should not be unfairly denied the opportunity to advance in academic professions.

Candidate assessment criterion 19. Do CROTs refrain from using percentages to specify contributors' share of the total credit?

This criterion is required by Resnik's principles of *Carefulness*, *Credit* and *Mutual Respect.* In using percentages, a score is assigned to each contribution proportionate to the required time and effort to complete assigned tasks. The most well-known among these models is the Quantitative Uniform Authorship Declaration (QUAD) that was introduced by Verhagen et al. (2003).[101] Difficulties in quantifying contributions and the deserved credit with exact numbers are among the main concerns in using percentages (Annunziata & Giordano 2014; Joob &

[101] The QUAD is based on "four categories of contribution: conception and design; data collection; data analysis and conclusions; and manuscript preparation" (Verhagen 2003, p. 1). In addition to providing a threshold point, the model places a restriction on the maximum number of authors. According to the QUAD, "the least that one could contribute to a paper would be 10% within a single category, placing a theoretical limit of 40 on the total number of authors" (Verhagen 2003, p. 1).

Wiwanitkit 2016). It is argued that one "cannot measure the 'weight' of an idea, a qualitative result, or an argument made by an author" and compare it with those made by another author because ideas/results/arguments are simply not quantifiable (Moustafa, 2017, p. 389). Accordingly, using percentages to highlight degrees of contributions is almost always inaccurate[102], and should be prevented based on Resnik's principle of *Carefulness*.

Moreover, credit and responsibilities cannot always be quantified/divided using percentages (Silva, 2011). Besides complexities in dividing the total amount of work into quantifiable parts (e.g., in large and multidisciplinary projects), it would be extremely complex to identify the exact share of each contributor from the total amount of credit (e.g., in the presence of hundreds of contributors). In delineation of responsibilities too, claims such as 'X is 10% and Y is 11% responsible for the task of data collection' would not help in specifying responsibilities for the integrity of the task of data collection, or the work as a whole. Furthermore, research tasks are intertwined and sometimes inseparable (e.g., an error in developing research methodology would have a knock-on effect on several tasks). Hence, this criterion is required by the principle of *Credit* because it prevents the misattribution of responsibilities. Since misattribution of responsibilities is disrespectful, this principle is also required by the principle of *Mutual Respect*.[103]

Candidate assessment criteria 20-34. Recognition of tasks

[102] It may be possible to use percentages in specifying degrees of contributions to some manual and repetitive tasks (e.g., in a project that requires analysing 1000 samples, a contributor who analysed 370 samples has contributed 37%), but since almost all research tasks also involve writing (e.g., writing a report about the sampling process) these percentages can hardly be totally accurate. In cases where research tasks do not involve any writing, extrapolating the percentage of contribution to the whole work from that of one/more task(s) would again become inaccurate.

[103] It should be noted that one could appeal to the principle of openness to argue *for* the disclosure of percentages. Since percentages are very unlikely to be accurate, upholding the principle of *Openness* would undermine the principles of *Honesty* and *Carefulness*. As mentioned in the previous footnote, even in cases where percentages are accurate about individual tasks, they can never be accurate about the percentage of contributions/responsibilities in relation to the whole work.

This group of criteria pertain to a range of research tasks that - depending on the ethical assessment below - may require explicit recognition in CROTs.[104] Resnik's principle of *Credit* necessitates the attribution of just rewards and the recognition of any task as long as credit is due to them *and* those who conduct these tasks take responsibility for their contributions. In addition to the principle of *Credit*, some other principles (e.g., *Mutual Respect*) could also be considered relevant in this assessment. However, since other principles would only become relevant if credit is due to a task, the principle of *Credit* is considered as the decisive principle, which is both necessary and sufficient for justifying the explicit recognition of tasks in CROTs. Being the decisive principle also implies that if a task is not justified by the principle of *Credit*, no other principle (or group of principles) could outweigh this verdict.

If conducting a task deserves credit, then the principle of *Mutual Respect* would also demand acknowledging that task because it is disrespectful not to give credit to those who deserve it. Additionally, explicit recognition of tasks that are due credit would prevent errors in the presentation of contributions, as required by the principle of *Carefulness*. Explicit recognition of tasks that are due credit would also improve the transparency of conducted research, as required by the principle of *Openness*. Since not recognising credit-worthy tasks hinders future opportunities (e.g., promotion and funding) of those who contributed to these tasks, this criterion is also required by the principle of *Opportunity*. Hence, if credit is due to a task, Resnik's principles of *Mutual Respect, Carefulness, Openness* and *Opportunity* would also corroborate the claim that the task should be explicitly recognised in CROTs.

However, explicit recognition of *all* potentially credit-worthy tasks in CROTs would undermine some of Resnik's principles such as *Mutual Respect*, *Opportunity, Efficiency* and *Carefulness*. In particular, explicit recognition of insignificant tasks (e.g., catering/cleaning services, resource

[104] As mentioned in 3.8.1, since none of the explored sources in chapter three suggested that CROTs currently recognise tasks that should *not* be explicitly recognised, this chapter does not investigate CROTs' current list of tasks.

deliveries) depletes the value of core research tasks such as data collection and analysis.[105] This depletion of the value of core tasks is disrespectful to their contributors, undermining the principle of *Mutual Respect*. Once the value of a core task is depleted, it may be interpreted as less important in the context of the whole work, which might negatively affect the future opportunities of their contributors in academic evaluations, hence undermining the principle of *Opportunity*. Furthermore, explicitly recognising every task that is somehow directly or indirectly related to the conduct of a project will negatively impact upon the CROTs' efficiency in reflecting involved tasks in a research project (e.g., because CROTs' users would have to spend more time reporting individual contributions and readers of academic publications would have to spend more time reading and interpreting reported contributions). This may contribute to errors and biases in assessing the real value of each task relative to the entire work. Accordingly, explicit recognition of all tasks would also undermine the principles of *Efficiency* and *Carefulness*.

The aforementioned friction between principles within Resnik's framework is, for the most part, due to a lack of clarity regarding, and specification of, the decisive principle, i.e., *Credit*. On the one hand, given the range of necessary tasks for the conduct of research in various disciplines, this principle should indeed be general enough to allow the inclusion of all relevant tasks. On the other hand, in its original form and without further specification, this generality contributes to ambiguities that undermine the value of core tasks and accordingly contributes to the aforementioned tension among the principles.

In order to specify Resnik's principle of credit, one solution is to check other widely used suggestions for distinguishing between core and mundane research tasks. For instance, Resnik relies on the notion of authorship to further specify the principle of *Credit* and suggests a rule of thumb for authorship, noting that "an author of a scientific work is a person who makes a *significant* contribution to the work and can take responsibility for its content" [emphasis added]

[105] Since the total amount of extractable credit from a publication does not necessarily correlate with the number of contributors, by dividing the credit pie into more and more slices, core contributors are likely to end up with a smaller slice of the total amount of credit.

(Resnik 2005, p. 93).[106] However, since this thesis analyses CROTs independently of the debates regarding authorship definitions and tasks deserving of authorship status, and due to the ambiguities in the concept of *significant contribution* (Vasilevsky et al. 2020)[107], different ways of specifying Resnik's principle of *Credit* are required.

Another possible solution is to make a distinction between tasks that require intellectual contributions and those that require non-intellectual contributions with the aim of granting explicit recognition only to tasks deemed to be intellectual. This dichotomy is developed to specify the definition of authorship and is meant to distinguish core from non-core tasks in scholarly projects. Some characteristics that distinguish intellectual from non-intellectual tasks pertain to whether conducting a task requires creativity, originality or personal judgement (Hosseini & Lewis 2020). However, since these characteristics are dependent on the context of, and methodology employed in, a specific research project or output[108], and are not always applicable to CROTs[109], they cannot be employed to distinguish tasks that should be explicitly recognised.

Thus, this thesis suggests a new approach to identify tasks that should be explicitly recognised in CROTs in a way that draws on, yet specifies, Resnik's principle of *Credit*. This approach is independent of the notion of authorship and also has the potential to apply to tasks within a wide range of scholarly fields and contexts. The proposed approach is called the *significance*

[106] Furthermore, Resnik seems to implicitly rely on ICMJE's notion of authorship and its requirement for all authors to be responsible for all aspects of the work. He notes that those who cannot take responsibility for all parts of the work are "recognized in an acknowledgments section" (Resnik 2005, p. 93).
[107] "What constitutes a 'significant contribution' is ambiguous and difficult to formally define" (Vasilevsky et al. 2020, p. 3).
[108] For instance, while data analysis in a project that employs ground-breaking techniques might involve creativity and originality, in projects where data analysis merely replicates an existing methodology to new data, creativity and originality cannot be used as solid criteria to distinguish significant from insignificant tasks.
[109] Exercising personal judgement requires professional autonomy. Therefore, using personal judgement as a criterion would eventually create a hierarchy between tasks based on who conducts the task and whether they have professional autonomy, which is irrelevant to the analysis of tasks for the current purpose. For instance, in cases where a task is conducted by junior researchers who might rely on their seniors to make important decisions, a task might be deemed insignificant, but if the same task is conducted by a senior researcher who has had full autonomy, the task would be deemed significant.

threshold test, which proposes conditions to demarcate significant from insignificant tasks, and on that basis, clarifies which tasks should be explicitly mentioned and recognised in CROTs.[110] This test stipulates two conditions that should be met for a task to be regarded as significant:

I. *Indispensability* for the conduct of research and achieving its objectives. Indispensable tasks are so important that research objectives cannot be achieved without them.

   It should be noted that sometimes a task would only become indispensable if researchers contribute to them to a certain degree (e.g., although translating one line of text might be influential, translating two pages that are directly used in data analysis could be indispensable). However, in the current analysis, questions about the extent of contributions are left out of our consideration to allow for the comparison of tasks independent of any other variable. Therefore, it is assumed that, in all analysed tasks, the degree to which one contributes to a specific task is sufficient to warrant its indispensability or dispensability.

II. *Specificity* of tasks. Specific tasks are directly associated with the questions and content of research, and constructively affect the reliability, validity and the justification of the reported data, claims, results and conclusions.

Using these two conditions, tasks related to assessment criteria 20-34 will be analysed to assess their significance for inclusion in CROTS. The methodology for assessing these tasks includes searching for the title of each task in the literature to explore their indispensability and specificity in research projects. For this purpose, Google Scholar was used on two separate occasions. Firstly, between June and August 2020, an analysis was conducted to identify the ways in which tasks are described in the literature. Secondly, between January and February 2021, a scoping search was conducted to determine whether specific tasks should be included in

[110] It should be noted that even tasks that do not pass the test should arguably be acknowledged in a different manner. That said, due to the scope of the current analysis, recognition of insignificant tasks is not explored in this thesis.

or excluded from the assessment instrument. Search strings were developed using the title of each task and the three keywords that describe the context (i.e., scholar*, research* and scien*).[111] For example, the search string developed for the task of supervision was:

- scholar* or research* or scien* AND "supervision"

Since this chapter analyses 18 tasks[112], 18 unique strings were developed for the scoping search. After screening titles and abstracts of the first 20 retrieved sources (ordered in terms of relevance) for each search string, items that provided a description of these tasks and/or explained how these tasks are employed in research contexts were deemed to be relevant for testing via the significance threshold test (see appendix D for a full list of reviewed items and the verdict).[113] The content of these sources were analysed via an inductive approach (for more details see section 3.2.1), resulting in one of the following three verdicts:

1. Tasks that pass both the indispensability and the specificity conditions according to *all* 20 of the investigated sources in the scoping search are deemed to be *significant*, and their explicit recognition by CROTs is required.
2. Tasks that do *not* satisfy both indispensability and specificity conditions according to *any* of the 20 investigated sources in the scoping search are deemed *insignificant*, and their explicit recognition and inclusion in CROTs cannot be justified.

[111] These keywords were used in the review of the literature about ethical issues of scholarly authorship and also the focused review that aimed to discover ethical issues of CROTs. Using the same keywords here improves the consistency of approach.

[112] While 15 candidate assessment criteria pertain to research tasks, since criterion 20 entails four tasks, the total number of analysed tasks is 18.

[113] It should be noted that the first official CROT (i.e., CRediT) was originally developed based on how often different tasks were mentioned in contributorship statements: "We drafted a preliminary taxonomy by analyzing acknowledgments and free-text contribution statements, and conducted a survey study in partnership with several publishers to gauge the feasibility of asking corresponding authors to assign the roles" (Brand et al. 2015, p. 154). CRediT's list of 14 roles and all the tasks that are mentioned in the definition of each of these roles were chosen on the basis of how often they are mentioned in published articles in a certain period (nearly 100,000 articles were analysed). Since conducting such a huge empirical study is out of the scope of this thesis, relying on available examples that show up in Google scholar appears to be the most feasible method to complement what developers did. While they conducted a huge empirical analysis to find tasks that are commonly mentioned in the acknowledgement section of publications to develop CROTs, this thesis conducted a bottom-up approach to find tasks that are currently *not* mentioned in CROTs. By using the suggested search methodology in this chapter, this thesis explores how these tasks are described in the literature, to provide an account of their significance.

3. Tasks whose indispensability and/or specificity cannot be sufficiently clarified are of *inconclusive significance*, and their recognition can neither be indisputably justified nor conclusively denied. These are tasks that some of the retrieved items in the sample of 20 sources point towards their indispensability and specificity, and others towards their dispensability and/or generality.

Although the first two verdicts seem rather black and white, there might always be rare instances where a task that is deemed to be indispensable and specific on the basis of the 20 analysed sources might be dispensable and generic in a special context or project (similarly, a task that is deemed dispensable and generic on the basis of the 20 analysed sources might be indispensable and specific in another context). Given the range of variables involved in different research contexts, this thesis does not intend to draw universal conclusions concerning the significance of each task. The rationale is that if exceptional instances do not currently appear among the 20 retrieved sources in the scoping search, then they are so rare that they would not make a significant difference to the results of the current analysis. Once a task passes the threshold of significance, its explicit recognition by CROTs is not only required by Resnik's principle of *Credit*, but also by other principles.[114]

Inconclusively significant tasks are those that, based on the first 20 sources retrieved from the scoping search, are considered to be indispensable and specific (i.e., significant) according to some sources and dispensable and/or generic (i.e., insignificant) according to others. While these tasks are not necessarily mundane so as to qualify for outright exclusion from the assessment instrument, they are not always considered to be significant and thereby deserving

[114] If a task is deemed significant, then the principle of *Mutual Respect* would also demand acknowledging that task because it is disrespectful to avoid explicit recognition of those who directly affect the status of research and its conclusions. Furthermore, recognition of specific tasks would increase the transparency about research and would be required by the principle of *Openness*. This would also prevent confusion about contributions and required by the principle of *Carefulness*. Not recognising specific tasks, may negatively affect the career prospects of those who contributed to these tasks. Therefore, this criterion is also required by the principle of *Opportunity*, because contributors should not be unfairly denied the opportunity to advance in academic professions.

of inclusion. In deliberations about whether to include inconclusive tasks in the assessment framework or exclude them altogether, the following considerations are relevant:

- In cases where inconclusive tasks have not made indispensable and/or specific contributions to a project, their inclusion in CROTs would disrespect those who contributed to significant research tasks and undermine the principle of *Mutual respect*. This would also negatively impact the future opportunities of those who contributed to significant tasks and undermine the principle of *Opportunity*. The inclusion of inconclusive tasks in CROTs might confuse readers about the used methodology and exaggerate their significance in relation to the project as a whole, which affects the truthful presentation of contributions and undermines the principle of *Honesty*. Furthermore, the inclusion of these tasks in CROTs results in a lengthier list of tasks, which negatively affects efficiency and increases the likelihood of errors when using CROTs. Accordingly, the inclusion of inconclusive tasks would also undermine the principles of *Carefulness* and *Efficiency*.
- In projects where inconclusive tasks do make indispensable and specific contributions, their exclusion from CROTs would result in an untruthful presentation of contributions and disrespect those who contributed to these tasks. Exclusion of these tasks from CROTs might confuse readers about the used methodology, and downplay their significance in relation to the project as a whole. This would also impact upon the openness of research, hamper the future opportunities of researchers who contributed to these tasks and increase the likelihood of errors and biases. On that basis, their exclusion undermines the principles of *Mutual respect, Honesty, Openness, Opportunity* and *Carefulness*. However, the principles of *Mutual respect, Honesty, Opportunity* and *Carefulness* are arguably undermined to a lesser degree when compared with having inconclusive tasks included in CROTs. While in the case of exclusion, only those who contributed to a significant task are disrespected, their tasks misrepresented and their

opportunities hampered; in cases of inclusion, all others who contributed to every significant task are disrespected, have their tasks misrepresented and their opportunities hampered. More importantly, the exclusion of inconclusive tasks would have less of a negative impact on the principles of *Efficiency* and *Carefulness*. This is because CROTs with a shorter list of tasks are arguably less prone to conflicting and inconsistent applications and are more efficient to use.

- A third option is to include inconclusive tasks under a new category or with a special amendment (e.g., using asterisks for further descriptions, noting that since these tasks are not significant in all research contexts, it is up to researchers or the corresponding contributor to specify whether these tasks were significant in the context of their research). Although this option seems like a compromise between inclusion and exclusion of inconclusive tasks, it is arguably prone to different problems. As mentioned in section 3.1, CROTs have been developed to improve systems of attribution and streamline the process of specifying contributions to academic publications. However, by including a separate category of tasks with a special status (i.e., tasks whose significance is dependent on the responses of users), the process of specifying contributions is further complicated. In particular, due to the complexity of the significance threshold test and definitions of indispensability and specificity, the inclusion of inconclusive tasks under specific circumstances requires a sophisticated analysis of tasks. Since some researchers might not have the required skills to apply the significance threshold test, or might misunderstand it, including inconclusive tasks under a special category could confuse users about these tasks, hence, increasing the likelihood of errors. Furthermore, the inclusion of these tasks in CROTs results in a lengthier list of tasks, and also more complicated descriptions about how CROTs should be used, both of which negatively affect efficiency and increase the likelihood of errors in the application of CROTs. Accordingly, the inclusion of inconclusive tasks under a special status undermines the principles of *Carefulness* and *Efficiency*.

Given the aforementioned considerations, in balance, it seems prudent to exclude inconclusive tasks from the assessment instrument. This decision is made based on the overall ethical impact of excluding versus including these tasks.

Candidate assessment criterion 20. Is it possible to recognise tasks that would traditionally not merit authorship status (e.g., those mentioned in the acknowledgement section)?

Although these tasks may differ per discipline or may be defined differently in various guidelines, they often include various technical, administrative and managerial tasks (Hosseini & Lewis 2020). While Resnik's principles of *Credit, Mutual Respect, Carefulness, Openness* and *Opportunity* justify the recognition of these tasks in CROTs, he also specifically mentions the importance of recognising these tasks for accurate attribution of credit and responsibilities. He notes that the impossibility to appropriately credit so-called *non-author tasks* encourages project groups to give undue authorship credit to their contributors in order to ensure that they receive a form of recognition that can be used in assessment and evaluations.[115]

To apply the test of significance threshold on this criterion, a guideline is used as a reference to extract a list of non-author tasks. Among available guidelines, those developed by the International Committee of Medical Journal Editors (ICMJE) are a good fit for this purpose because in addition to being widely used across almost all disciplines, they also introduce a list of non-author tasks[116] including funding acquisition, supervision, administrative support, writing assistance, technical editing, language editing, and proofreading (ICMJE 2019). By applying the significance threshold test on these tasks, it will be clarified whether this group of tasks should be explicitly recognised in CROTs.

- Funding acquisition

[115] He further adds that over-crediting non-author contributors may result in the publication of papers with many (undeserved) co-authors, which will "completely obscure responsibilities" (Resnik 2005, p. 94).
[116] These tasks are not explicitly described in all guidelines. For instance, the European Code of Conduct for Research Integrity does not specifically mention non-author contributions. (Hosseini & Lewis 2020).

This task involves the development and submission of proposals to funding agencies and if successful, it secures required funds to translate research ideas into reality (Pérez & María 2017). Conducting this task requires years of experience combined with the drive, and credibility to put together a team of experts to develop a proposal that presents the idea and the chosen approach in a rigorous and precise manner (Opipari et al. 2019; Pogue 2018). Since without funding, researchers cannot pursue the development of their ideas or new technology (Hoser 2013), funding acquisition is an indispensable task.

Depending on the allocated funds to projects, researchers have different amounts of financial resources in their disposal. Accordingly, research agenda of different disciplines (Overland & Sovacool 2019; Titley et al. 2017) and research priorities of various countries are impacted by the (amount) of funds allocated to different projects (Han & Appelbaum 2018; Hoekman 2013; Maes et al. 2019). Different amounts of financial resources impact methodology, comprehensiveness, sample size and consequently, research results and conclusions of empirical studies (Nadal 2016). Moreover, "with funding scientists can free up their time from other institutional duties, hire assistants, obtain supplies and travel for project completion and gather large, valid, reliable and informative samples of data that can be used to construct answers to important questions within one's discipline" (Mustaine & Tewksbury 2009, p. 43). In funded projects, securing smaller budgets results in preferring short-term goals, quality decline, a lower likelihood of innovation (Conraths & Smidt 2005) and also openness of data/results (Assante et al. 2019). Therefore, this task is directly associated with the questions and content of research and constructively affects the status of data, claims and results. Accordingly, the task of funding acquisition is both indispensable and specific and deemed *significant* (table 7).

Funding acquisition	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible

Verdict (out of 20)	12	12	12	0	8

Table 7. The results of the scoping search for the task of funding acquisition.

- Supervision

In addition to their pedagogical tasks (Vehviläinen & Löfström 2016), supervisors make indispensable contributions to projects by managing interpersonal relations and professional development of researchers and teams (Kumaran et al. 2018). Supervisors ensure that members of research projects work effectively and efficiently as part of a cohort, and also as an individual. As such, personal development, teamwork and research progress would fail without supervisors' contribution (Lee 2019). Furthermore, supervisors support supervisees with applying the norms of research ethics and integrity in practice (Muthanna & Alduais 2020) and sometimes protect them from (psychological) harm, which prevents researchers from getting burnouts that may bring projects to a halt (Ellis 2010). Since supervisors assign tasks and implement research plans, they are sometimes described using the metaphor of "chief surgeon" in an operation room who is "unequivocally in charge" (Austin & Baldwin 1991, p. 38). Hence, supervision is an indispensable task.

In terms of its specificity, supervision is necessary for steering research activities, and requires awareness of research questions/content to enable the identification and establishment of collaborative research goals (Goodyear et al. 2016). Supervision is related to "the nature of the research project" (Coutinho 2020, p. 207), so much so that excellent supervision is believed to improve interpretation of research results and outcome regardless of the research context or location where research is being conducted (Milne 2010). Inadequate supervision could contribute to research

misconduct[117], nullify results (in case of breaches of norms of research ethics and integrity), inflict psychological harm on researchers (Ellis 2010), or in case of doctoral candidates, impede the successful completion of work (Chiang 2003; Gisemba Bagaka's et al. 2015). Hence, since supervision directly and constructively impact research and its content it is considered specific. Being both indispensable and specific, this task is deemed *significant* (table 8).

Supervision	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	13	13	13	0	7

Table 8. The results of the scoping search for the task of

- Administrative support

Contributors to this task are believed to make two major contributions to research (especially in large and complex projects). Firstly, they relieve academics from administrative burden around proposals and projects. Secondly, they are seen as "agents of change" who play a strategic and necessary part in the research process through networking with internal and external partners and promoting collaboration (Cox & Verbaan 2016, p. 5). Particularly, in interdisciplinary research projects where administrative burden is likely to be heavier, administrative support improves productivity (Mitcham 2010, p. 395) and enables research by helping overcome personal and professional challenges (Pfirman & Martin 2017) and accordingly, is an indispensable task.

However, neither in relieving academics from administrative burden nor in promoting collaboration the task of administrative support is associated with research questions or

[117] Resnik's description of Summerlin case is an excellent example that shows the importance of inadequate supervision in discussions about scientific misconduct (Resnik 2005, p. 67).

content.[118] Administrative support helps researchers to improve communication (Stokols et al. 2008) and supports the overall research process (Jones & Milne 2017) via making contacts and coordinating meetings (Jacobson et al. 2004) but it cannot directly affect conclusions or results. For example, in science parks numerous administrative staff "fulfil a team role in helping to identify" market opportunities to commercialise research for a range of projects (Phan et al. 2005, p. 172) but they do not interact with research questions. Furthermore, as a generic task[119], administrative support could be so routine that some describe it as a repetitive task that will be eradicated with the advancement of technology and further automation of research processes (Oliver 2019). On that basis, although administrative support is an indispensable task since it is not realistic for this task to be associated with research questions and content or directly affect the status of research results, it is deemed *insignificant* (table 9).

Administrative support	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	11	0	0	16	4

Table 9. The results of the scoping search for the task of administrative support.

- Writing assistance, technical editing, language editing, and proofreading

All of these tasks can be subsumed under the heading of writing/editorial support for research reports and manuscripts provided by writing experts as opposed to content experts (Aitchison et al. 2012). These tasks may involve different types or levels of editing, from correcting "grammar, syntax, spelling, punctuation, and word choice" to

[118] On rare exceptions if the burden is so much, it could perhaps result in stressed and burned out researchers, and accordingly have a negative impact on the result. However, even in these cases, it would be extremely difficult (if not impossible) to highlight administrative support as the sole reason that reduced the likelihood of stress and burnout.

[119] One explanation that demonstrates the generic nature of this task pertains to the required skillset for successful administrative support. It is argued that conducting this task does not necessarily require specific (academic) training and some of the skillset that improve administrative support include being proactive, communicative, curious, responsible with data sharing, supportive of cultural diversity and an active team-player (Garrido et al. 2019), none of which can be considered as specific research skills.

improving content, organisation and presentation of the text (Matarese & Shashok 2019, p. 4). These improvements minimise the likelihood of misunderstanding through improved clarity, and *support*[120] the communication of results (Morley 2013) or "*enhance* the quality of research reporting and speed up the publication process" [emphasis added] (Sharma 2018, p. 111), suggesting that they are not indispensable per say.

In terms of specificity, these tasks are conducted by skilful language experts who do not always need to understand the research context (Burrough-Boenisch 2019).[121] Even in cases of reports and manuscripts drafted by non-native users of a language, enhancements provided/suggested by language experts improve the fluency and not the scientific substance of these documents (Ito et al. 2019), implying that they cannot directly impact the status of results and conclusions. More importantly, however, the decision to accept or reject these improvements is always made by members of the core team (Matarese & Shashok 2018). Therefore, it will not always be possible for those contributing to writing/editorial support tasks to take full responsibility for their work because some of their suggestions may as well be ignored without their awareness.[122] Hence, writing/editorial support is neither an indispensable nor a specific task and deemed *insignificant* (table 10).

Writing assistance	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	16	0	0	16	4

[120] While writing/editorial support could lead to publication in a prestigious journal or the dissemination of the results more broadly than they otherwise would have been, it is reasonable to argue that whether research results are published or where they are published cannot influence conclusions or results. Even in humanities and social science disciplines where the successful articulation/communication of ideas are crucial, the task of writing assistance cannot change the status of results and conclusions.

[121] Even in humanities disciplines such as philosophy where used jargons are uncommon in ordinary parlance, qualified language editors can simply use a dictionary to find out what a specific term means or how it should be used in sentence structure and on that basis, they do not necessarily need to be a philosopher.

[122] Because these contributors are not part of the core team, their approval of the final version of the manuscript is not a prerequisite for the publication.

Table 10. The results of the scoping search for the task of writing assistance.

As analysing four tasks that traditionally do not merit authorship status showed, two of these tasks namely funding acquisition and supervision satisfy the threshold of significance. Accordingly, it should be possible to specifically recognise these tasks in CROTs.[123]

Candidate assessment criterion 21. Communication and correspondence with other contributors and editorial teams

Communication and correspondence is a task that connects the contributors of a project to one another, and also to editorial teams. This task involves reporting individual contributions during the submission process, coordinating revision/resubmission efforts and responding to queries about published manuscripts (Kremenak 2010). Those conducting this task ensure that "all coauthors agree with the submitted and all subsequent revised versions of the manuscript" (Sterken 2011, p. 203). Accurate reporting of individual contributions and effective correspondence with editorial teams as well as project members require an overall awareness of individual contributions and ethical concerns such as conflicting interests (McNutt et al. 2018). Therefore, regardless of discipline or context, correspondence and communication is an indispensable task in the publication process that comes with distinct responsibilities (Ludvigsson et al. 2018).

Although in contentious circumstance this task could become a non-routine task (e.g., in controversial situations such as authorship disputes, allegations of error/misconduct and retractions), since it only facilitates communication between parties, it does not make a direct and result-changing contribution to claims, data, results or conclusions. Even in cases where editors/peer-reviewers make suggestions that may affect content/conclusions, since

[123] It is worth noting that this does not mean that all non-author tasks should be specifically mentioned in CROTs. As demonstrated, some non-author tasks such as administrative support and writing/editorial assistance are insignificant. However, this criterion mentioned the *category* of non-author tasks, therefore the current analysis concludes that since some of these tasks such as supervision and funding acquisition are significant, it should be possible to recognise this group of tasks.

corresponding contributors only communicate reviewers' suggestions with the rest of the group, this task cannot be specific. Hence, this is an indispensable but generic task, and is deemed *insignificant* (table 11).[124]

Communication and correspondence	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	9	0	0	9	11

Table 11. The results of the scoping search for the task of communication and correspondence.

Candidate assessment criterion 22. Community engagement

When research involving human subjects is conducted across cultural, structural or economic boundaries, community engagement efforts (e.g., interacting with the community via workshops and meetings) ensure that instrumental objectives of the research are achieved without flouting moral ideals or harming communities (Reynolds & Sariola 2018). These efforts aim to ensure that mandatory research policies and available best practices are adapted to fit the specific and local circumstances of each project (De Weger et al. 2018; Kaiser et al. 2016; Patten et al. 2019). Without these efforts, projects may be found to have trespassed research norms and be interrupted or suspended (Holzer et al. 2014), which could erode communities' trust in science (Ahmed & Palermo 2010). Hence, this is an indispensable task.

In terms of its specificity, through facilitating the interaction between researchers and communities, this task directly affects "the well-being of the community" and their understanding of the research questions/content (Ahmed & Palermo 2010, p. 1383). This task enhances researchers' understanding regarding power dynamics, leadership, social/political expectations, values and norms about the inhabitants of the place where research is conducted

[124] Some journals do not send their decision about a manuscript to all authors and only contact the corresponding author. Although in these cases too, the corresponding author is assumed to naturally be interested in sharing the decision and detailed comments with all the other co-authors. Partial disclosure of correspondence with journals with other authors could be seen as a questionable practice and abuse of both the editorial team's and co-authors' trust.

(Israel et al. 1998). Since findings in community-based research are sometimes inseparable from the relationship between the participants and inquirers, by providing cultural and historical input about the host community (Guba & Lincoln 1989), community engagement efforts constructively affect the reported data, claims, results and conclusions. For instance, providing knowledge about host community's history/values may result in the development of solid data collection and data analysis techniques (Bracic 2018), both of which have a direct impact on the reported data, claims, results and conclusions. Therefore, this task is indispensable and specific, and is deemed *significant* (table 12).[125]

Community engagement	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	15	15	15	0	5

Table 12. The results of the scoping search for the task of community engagement.

Candidate assessment criterion 23. Creative efforts

Creative efforts in research generally entail the development of graphics, images and visualisations[126] that facilitate data analysis and communication of results (Andrienko & Andrienko 1997). In disciplines such as Geography (Zhong et al. 2012) and Astronomy, visual observations improve and/or enable data analysis (Aspaas & Pataki 2019). In Geosciences

[125] The importance of this task can also be portrayed via other principles. Once credit is due to this task, its inclusion can be further corroborated by Resnik's principle of *Education* (in terms of researchers' duties in "educating the public about science, raising the public's interest in science"), and the principle of *Social Responsibility* (in terms of "informing the public about the consequences of research"), both of which improve society's trust in science (Resnik 2005, p. 130). Furthermore, because this task improves the transparent communication of research objectives/methods it is required by the principle of *Openness*. Since it reduces the likelihood of biases and errors about the host community, it is required by the principle of *Carefulness*. It also reduces the likelihood of violating rights and dignity of research subjects (e.g., by providing information about communities' norms and values, research subjects are likely to be treated more respectfully), and on that basis, also required by the principle of *Respect for subjects*.

[126] Although research tasks in areas such as music, dance and literature may also involve creative efforts, because these tasks are conducted in the creative contexts of Arts and Humanities, they are not considered as a specific research task. The development of graphics, images and visualisations in non-creative contexts (e.g., STEM) is considered as creative because they are seen as creative in relation to other tasks.

"interpretations of geologic phenomena must be conveyed in a logical manner, and this most often requires visual representations" (Libarkin & Brick 2002, p. 449). Visualisations are vital in comprehending "vast amounts of data and information being produced from a multitude of sources" (Johnson et al. 2005, p. 5) and necessary for analysing the content of large databases (Borgman 2010). Furthermore, these efforts are central in science communication as they 'make visible what is not' (Allen 2018, p. 907). Accordingly, these efforts are among indispensable research tasks.

In terms of specificity, these efforts are "fundamental to understanding models of complex phenomena, such as multilevel models of human physiology from DNA to whole organs, multi-century climate shifts, international financial markets, or multidimensional simulations of airflow past a jet wing" (Johnson et al. 2005, p. 5). In areas such as Astronomy, the creation of visuals from observations facilitates obtaining "a great deal of information" from available research data (Barnes & Fluke 2008, p. 599). In Biophysics, accurate visualisations constructively impact research results by improving scientists' understanding of the transformation of research subjects such as cells (Science Daily 2020). Similarly, in Developmental Biology, "contextual visualisation of embryonic development is critical to elucidate the origins of malformations" (Tesařová et al. 2019, p. 1). These visualisations are indeed directly associated with research questions/content and constructively affect the status of results and conclusions. Hence, since these efforts are both indispensable and specific, they are deemed *significant* (table 13).

Creative efforts	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	16	16	16	0	4

Table 13. The results of the scoping search for the task of creative efforts.

Candidate assessment criterion 24. Data annotation

Data annotation involves attaching additional information (e.g., adding comments to data points within a dataset) to enrich data for further use/analysis or long-term preservation of data, both of which are gaining more weight in projects with intensive use of datasets (Navale & McAuliffe 2018). Depending on its purpose, data annotation could be an indispensable and specific, or a dispensable and generic task. For example, data annotation is an indispensable task in projects that use machine-learning to automate a necessary process for data analysis. In these contexts, data must be annotated by humans first so that machine-learning applications can imitate what humans did (Kazimzade & Miceli 2020). In these cases, data annotation is directly associated with the research question/content and requires specific trainings to enable data analysis (Boergens et al. 2017), hence, constructively affecting research results. Especially with an increase in data volumes and number of information sources, the manner in which data is annotated can affect decisions made by machine-learning applications and consequently, change the results of the analysis (Solis et al. 2019).

Nevertheless, in cases where annotations are used for archiving or keeping databases up to date (Kalra et al. 2012), this task is *not* necessary for achieving research results or conclusions of a specific project. For instance, if data is annotated solely for long-term preservation, discovery and reuse of other projects (Musen et al. 2015), then the task of data annotation is neither indispensable nor directly impacts the status of data, claims, results and conclusions of a *current* project.[127] On that basis, according to the available literature, indispensability and specificity of the task of data annotation are subject to change. Therefore, the status of this criterion is deemed *inconclusive* (table 14).

Data annotation	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible

[127] While the claim that 'they are not *always* indispensable and specific' could be made about all the tasks, in case of data annotation, examples in the literature do actually provide dispensable examples. if dispensable examples are observable after screening 20 items, they should be taken into account in this analysis.

Verdict (out of 20)	11	8	8	10	0

Table14. The results of the scoping search for the task of data annotation.

Candidate assessment criterion 25. Data curation

Similar to the task of data annotation, data curation could be indispensable and specific, or dispensable and generic. Sometimes data curation involves "discovering a data source(s) of interest, cleaning and transforming the new data, semantically integrating it with other local data sources, and deduplicating the resulting composite" to benefit *current* practices (Stonebraker et al. 2017, p. 1). In cases where dynamic datasets are being used, and data curation involves "continuous enrichment or updating" to keep the data fit for a current project (Lord et al. 2004, p.1), data curation is indeed a specific and result-changing task. For instance, in some Biology projects, data curation may result in the integration of thousands of data sources and improve the results of a range of projects that are studying a similar phenomenon (Stonebraker et al. 2017).

Other times, however, data curation facilitates meaningful and enduring access to data (Johnston et al. 2018) "beyond the lifespan and purpose of the project for which the data were collected" (Sun & Khoo 2016, p. 1). For instance, if data curation aims to enable long term preservation or optimisation for search engines (Lee & Stvilia 2017) to satisfy FAIR (Findable, Accessible, Interoperable, Reusable) data practices (Ulbricht et al. 2020)[128] or aims to keep "assets viable and shareable across fields" and for future generations (Ogburn 2010, p. 244), then it only improves archiving and preservation for *re-use* of data (Karasti et al. 2006), and cannot influence claims, results and conclusions of a *current* project. Hence, since the indispensability and specificity of this task are dependent on its scope/purpose (relevant to

[128] Even in cases where there is a mandate to publish data under FAIR principles, and data curation is a task among those that should be conducted for the current project, it would not be a result-changing task.

current or future projects)[129], it cannot be declared as a clear-cut significant task, and therefore, its status is deemed *inconclusive* (table 15).

Data curation	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	7	7	7	13	0

Table 15. The results of the scoping search for the task of data curation.

Candidate assessment criterion 26. Data warehousing

Data warehousing involves improving research data for long-term access (Kumar et al. 2016), and storing it in one place, without which managing access to huge volumes of data would be impossible (Chandra & Gupta 2018). Data warehousing enables data mining activities that may result in spawning future projects using diverse and multi-formatted data of finished projects (Mento & Rapple 2003). However, data warehousing improves data so that it "could be used for other purposes other than that of the original objectives of the study and/or for sharing with other groups" to ensure long-term availability and reusability (Conjares et al. 2016, p. 171). Accordingly, since this task improves long-term access[130] to data for future projects, it does not directly impact claims, data, results and conclusion of a *current* project. Hence, it cannot be considered as a specific task and is deemed *insignificant* (table 16).

Data warehousing	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	0	0	0	11	9

[129] While the claim that 'they are not *always* indispensable and specific' could be made about all the tasks, in case of data curation, examples in the literature do actually provide dispensable examples. if dispensable examples are observable after screening 20 items, they should be taken into account in this analysis.

[130] While improving long term access would be required by Resnik's principle of *Openness*, since *Credit* is the decisive principle in explicit recognition of tasks other principles would only become relevant once a task passes the significance threshold test.

Table 16. The results of the scoping search for the task of data warehousing.

Candidate assessment criterion 27. Education and training

Education and training efforts prepare researchers for conducting complex tasks. For instance, in areas such as Surgery where laboratory and simulation modules (Yadav et al. 2014) as well as specific devices (Gallagher et al. 2003) such as virtual reality head-mounted displays are used (Jensen & Konradsen 2018), or in Biomedical Engineering where conducting experiments would not be possible without knowing how to operate specific instruments (Bai et al. 2018), education and training are indispensable. Furthermore, in areas such as Life Sciences where the content evolves rapidly, researchers' previous knowledge are refreshed/updated regularly via training courses (Tammen et al. 2018).[131]

Although education and training activities might impact researchers' awareness about methods or influence their skills in using machinery/equipment, the practical application of the knowledge gained through education and training is not specific to a single project[132]; practical application of new knowledge and skills takes place across a whole range of distinct projects over the course of a researcher's working life. Furthermore, project members may not receive the necessary education and training to adequately undertake the tasks associated with a project during its lifecycle; the knowledge and skills necessary to meet the demands of a specific project may have been gained months or years in advance of the project itself (Rip 2004). On that basis, education and training tasks are not always directly associated with research content/questions of a specific project.[133] Furthermore, since it is ultimately up to researchers to

[131] The importance of this task is also emphasised by Resnik's principle of *Education.* This principle stresses that researchers should engage in various tasks such as "formal instruction, training, and mentoring" (Resnik 2005, p. 56). Resnik believes that education and training are so vital that the scientific "profession will grind to a halt" without it (Ibid.).

[132] Some training programs are provided in the form of "interactive 3D virtual learning environments through the Internet, reaching potentially large numbers of learners worldwide" (Chittaro & Ranon 2005, p. 3).

[133] If education and training tasks are to be explicitly acknowledged by CROTs, then every course/class that researchers have attended from the beginning of their professional career should be mentioned and acknowledged. One way or another, they have all been involved in improving researchers' skillset. Furthermore, every training has some prerequisites, and one cannot attend some without having attended others. Accordingly, explicit acknowledgement of education and training tasks that have

employ their learnt skills in research projects, those providing education and training can hardly take responsibility for research activities conducted by their trainees.[134] Hence, although this task is indispensable, since its specificity cannot be justified, it is deemed *insignificant* (table 17).

Education and training	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	12	0	0	12	8

Table 17. The results of the scoping search for the task of education and training.

Candidate assessment criterion 28. Enrolling patients for clinical trials

Although different enrolment strategies (e.g., in-person, online) might be required for various projects (e.g., depending on the target population, methods or phase of the project), projects that depend on clinical trials would simply not proceed without patient enrolment (Andrews et al. 2016; Rojas-Cordova & Bish 2018). Without successful clinical trials, various research projects focused on developing new drugs and treatment methods would come to a standstill (Dilts et al. 2010; Morano et al. 2017), making patient enrolment an indispensable task.

However, since the design of the enrolment protocol is part of the clinical trial design process (Cecchini et al. 2019), enrolment itself is a routine task that only involves following the provided protocol. Although those enrolling patients should be selected carefully (Gligorijevic et al., 2019), if the enrolment protocol is followed correctly and steadfastly, the task of enrolment only supports subjects' decision-making (Robertson et al. 2018) without the need to directly interact with research content/questions. Furthermore, the enrolment protocol includes all the

constructively affected the status of research and its conclusions would result in a meaningless regress that could go back to training and education received in primary school.

[134] For example, if a researcher attends a training course to improve their knowledge about statistics before engaging with a new project, the mentor/educator would only teach them statistics, without telling them what statistical model to use in their upcoming project. Even if educators/trainers provide an advice, they cannot be held responsible for the quality of their advice because it is ultimately up to each researcher to find a solution to problems in their research context. In cases when researchers' adequate/inadequate research skills lead to a change of results, it would be extremely difficult to distinguish the responsibilities of educators/trainers from that of researchers'

necessary steps for the enrolment process, which equally applies to all research subjects.[135] Accordingly, this task would only change results if those conducting it ignored the enrolment protocol, which is contrary to the definition of specificity and the condition of *constructive* contribution to research results. Moreover, since protocols are approved by research ethics committees, ignoring them is unethical and could have disciplinary consequences or legal ramifications such as having results nullified (also contrary to *constructive* contribution). On that basis, although the task of enrolling patients is indispensable, it cannot be considered as a specific task and is deemed *insignificant* (table 18).

Enrolling patients	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (This string resulted in 10 hits)	9	0	0	9	1

Table 18. The results of the scoping search for the task of enrolling patients for clinical trials.

Candidate assessment criterion 29. Translation

Translation is an essential task in areas such as Psychology and Anthropology where ethnic groups may be among subjects of empirical research (Okazaki & Sue 2016), or disciplines such as Political Sciences where policy and other resources used in different countries need translation to enable comparison (Burbidge & Cheeseman 2017; Mukhtarov et al. 2016). These efforts are sometimes described as "bridge-building", referring to the fact that the two sides (whatever that may be depending on the context, e.g., two cultures or countries) would not have been linked without translation and interpretation (Olohan 2017, p. 1).

In relation to its specificity, in cases where substantial translation and interpretation is required, because this task involves reading/listening in one language and writing/speaking in a different language (Shreve & Lacruz 2017), it is directly associated with research content and its quality

[135] This is perhaps why patient enrolment is delegated to (among others) a range of non-specialised contributors such as nonphysician staff members, and study nurses (Morgan et al. 2016).

(Hubscher-Davidson 2009), and impacts the status of claims, data, results and conclusions. For example, in qualitative research, due to translation's impact on the objectivity of research and its conclusions, this task involves both "understanding and interpreting" (Hansen 2010, p. 203) and hence, has a pivotal impact on claims, results and conclusions (Temple & Young 2004). Especially given the importance of interpretation and representation of the experiences of research subjects via translation (e.g., in social science research), this task has a direct impact on the validity of research results (van Nes et al. 2010). In humanities disciplines too, translation is so core to research and its results that sometimes various translations might be required to ensure that interpretations and conclusions are accurate (Schulte 2012). In theology, for example, anyone engaged translation "should, by necessity, be concerned with theological issues primarily as they relate to translation itself" (Arichea 1990, p. 40). On that basis, translation is both indispensable and specific, and deemed *significant* (table 19).

Translation	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	9	9	9	0	11

Table 19. The results of the scoping search for the task of translation.

Candidate assessment criterion 30. Legal support

Legal support is sought in situations where patents, intellectual property rights or any financial interests are at stake. For example, in areas such as Biotechnology and Pharmaceutical research where both companies and universities make significant financial investments, the economic attraction/appeal of research ideas are dependent on their legal status, hence necessitate seeking legal advice (Resnik 2007). Legal support is also sought when research results might have legal ramifications for a specific industry, e.g., exploring tobacco's harmful effects (Crosbie & Glantz 2014), in projects that investigate participants who are involved in illegal activities or projects where vulnerable participants (e.g., children, subjects with disability) are recruited

(Heesters et al. 2017).[136] In these cases, legal support is an indispensable task for achieving research objectives.

Although many research projects require legal advice and support, this task is not always directly associated with research questions/content. Depending on whether legal support is provided in an advisory/administrative form or as part and parcel of a research endeavour, this task may or may not affect the status of data, claims, results and conclusions. For instance, in the field of digital systems where legal support is considered as a non-technical contribution and only relevant in keeping trade secrets (Reid & Rhodes 2016), it *cannot* affect research results and conclusions. Similarly, in Biomedical and Health contexts where legal support protects projects from legal disputes and fines that may result from illegal sharing of data (Fienberg 1994), it is not realistic for this task to have a direct impact on research results or conclusions.[137] On the contrary, in cases where legal support affects drug safety (Zweig 2017), or in public-scientist partnerships where legal advisors are actively present throughout the research process (e.g., Flint-Michigan water crisis); the provided legal advice constructively affects the reported data, claims and results (Soleri et al. 2016). In Biotechnology and Genetic Engineering where legal and technical expertise cannot be easily separated (because technical views need legal argumentation), legal support constructively affects research results and its conclusions (Godt 2016). Hence, since the specificity of this task is dependent on its scope/purpose, it cannot be declared as a clear-cut significant task, and is deemed *inconclusive* (table 20).

Legal support	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible

[136] Furthermore, the importance of legal support is also shown by Resnik's principle of Legality. This principle mandates scientists to follow laws pertaining to their work (Resnik 2005).
[137] In its advisory/administrative form, this task is often conducted by non-core members such as research ethics committee members (some of whom should not be specifically recognised to keep their identity anonymous) (Douglas 2007; Lakeman & FitzGerald 2009), or universities'/laboratories' technology transfer offices (Resnik 2007). Both of these entities operate independent of research projects and only provide administrative/supportive advice.

Verdict (out of 20)	10	7	7	3	10

Table 20. The results of the scoping search for the task of legal support.

Candidate assessment criterion 31. Providing access to resources

Required resources for conducting research in different disciplines vary significantly, but in general, they can be any necessary component to perform a research effort and may include knowledge, finance, staff, experimental material, and information (Fink 2019). While some intellectual resources might be straightforward to distribute/share (e.g., sharing knowledge via protocols and publications), physical resources (e.g., equipment, laboratory space) are much more likely to be scarce and rationed. For example, in disciplines such as Astronomy, Astrophysics and Oceanography where specific instruments only exist in certain locations (Chang & Huang 2015), or in Chemistry and Biotechnology where laboratories with expensive and specialised equipment are so limited that they should be booked (months) in advance; failing to secure access to resources is a major barrier in achieving research objectives (McCarthy et al. 2018). As such, when projects require specific/scarce resources, research objectives are not achieved without access to these resources[138], making it an indispensable task.

Although indispensable, the task of providing access to resources facilitates/supports research without being necessarily associated with the research question or its content. In case of scarce and expensive resources (e.g., a unique telescope or laboratory equipment), the same resource could have been provided for a range of projects with different objectives and questions. Even in cases where providing access to resources requires a team of well-trained technicians/operators (e.g., accessing the Large Hadron Collider at CERN), unless these technicians are involved in research design, their contributions cannot directly impact the status of data, claims, results and

[138] Furthermore, the importance of providing access to resources is also highlighted by Resnik's principles of Openness and Opportunity as they both "imply an obligation to share resources" to improve scientists' access to "things they need in order to gather and analyze data" (Resnik 2005, p. 115).

conclusions of a particular project.[139] In using such resources, specific analyses that determine results are "done by individuals or in small groups of people" and not by technicians employed by organisations such as CERN that own resources (Birnholtz 2008, p. 10).[140] In-house technicians only support/facilitate the conduct of experiments that were designed by core members of other research teams. In other cases, providing access to resources could be a routine task with administrative components, e.g., improving access via digitalisation and promotion of library sources (Brown & Tucker 2013), a social task that involves "participation in academic research networks" (Curry & Lillis 2010, p. 282), or a generic task that entails facilitating access at an institutional level (Boardman 2009); none of which directly affect results and conclusions of a specific project.[141] On that basis, although indispensable, since providing access to resources is not a specific task, it is deemed *insignificant* (table 21).

Providing access to resources	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	11	0	0	11	9

Table 21. The results of the scoping search for the task of providing access to resources.

Candidate assessment criterion 32. Providing research samples

[139] Although incompetence or sabotage could have a direct negative impact on research results, since the condition of indispensability stipulated *constructive* contribution, negative impacts are not considered here.

[140] Furthermore, having access to scarce research resources is sometimes considered as a mere *privilege* that some researchers enjoy because of the position they hold or the location where they are based and does not always involve putting personal effort (Larkin 2016). This is a common concern in discussions about fostering research collaborations between the global north and south institutions, because unequal access of their researchers to resources creates power-imbalance and an unhealthy dynamic (Larkin 2016).

[141] It should be noted that within industry-academia collaborations where the industrial partner has some unique resources, this dynamic is slightly different in the sense that sharing resources could be beneficial for both the industry and academic partners (Albert et al. 2019). However, in these cases too, since industrial partners' resources are linked with their financial investments, they are not putting explicit and direct *human* effort into research. If some of their employees are involved in research, then these contributions are recognised differently (often through authorship and acknowledgement statements) but recognising them merely for providing access to resources (that are owned by a company), would be in odds with what is considered as a contributions made by humans.

With an increase in the number of complicated and multi-centre projects, the timely provision of high-quality bio-samples, or sample exchange has become essential to projects' success (Groeneveld et al. 2016). For instance, laboratory research in areas such as Pathology and Epidemiology is almost entirely dependent on receiving research samples and specimen from other sources, such that research in these areas would be halted without these samples (Mahjani et al. 2020; Snowdon et al. 2004). Hence, this is an indispensable task for the conduct of research.

Providing research samples involves several steps for the collection, processing and transferring of the specimen (Peplies 2010) beyond "mere administrative work" (Colledge et al. 2013, p. 3). The way these specimens are "collected, transported, stored, and analyzed impacts the quality and usefulness of the data they produce" (Laczin 2013, p. 6). Providing some samples (e.g., CNB[142] and open biopsy of cancer cells) might involve invasive surgeries that cannot always happen on demand, requiring a range of procedures and tasks to acquire, and also transfer in a way to suit the purpose of the specific project that they are intended for (Krishnan et al. 2018; Lim et al. 2007). Since the "selection of an appropriate and validated method" for these steps is carried out by those who provide research samples (Gong 2016, p. 140), this is a specific and result-changing task that is directly associated with research content and questions. Furthermore, in some projects, samples' quality affects the results of current research and require specific awareness of research questions and content. For example, in collecting a city's "rat urine metabolism samples" to control the spread of Leptospirosis bacteria (Yunita et al. 2020, p. 31), the task of providing samples cannot succeed without having a full understanding of the objectives, hypotheses, risks and possible conclusions. Hence, being indispensable and specific, this task is deemed *significant* (table 22).

[142] CNB (Core Needle Biopsy) involves cutting a core of tissue with a needle for inspection under a microscope. An open biopsy involves an incision for the same purpose.

Providing research samples	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	18	18	18	0	2

Table 22. The results of the scoping search for the task of providing research samples.

Candidate assessment criterion 33. Research Coordination

Research coordination is essential to ensure that a wide range of activities such as "managing grants and budgets, preparing regulatory submissions, writing study protocols, creating data collection forms, managing databases, developing recruiting plans, and supervising others" are successfully arranged (Biglari 2020, para 1). In large research groups with several supervisors, coordination is vital for the overall success of research and given the growing popularity of complex projects, likely to develop further in the future (Boud et al. 2014).

Although indispensable, the task of research coordination is not always specific. Depending on the adopted policies by higher education institutes or funding organisations, and the project dynamic, approaches to research coordination may vary. Sometimes coordination involves control mechanisms and micro-management of projects by coordinators (Wardenaar et al. 2014) who may delegate tasks and responsibilities (Cummings & Kiesler 2007), making it a specific and result-changing task. In these cases, research coordination allows facilitating knowledge integration across disciplines (Pelaez et al. 2018), discovering shared research goals, leveraging resources to build collaboration and leadership (LaValley et al. 2018) and accordingly, involved in making key decisions that directly impact claims and conclusions.

Alternatively, this task could rely on an organisational mould or blueprint for all projects, externally governed by funders (Wardenaar et al. 2014, p. 780), and accordingly, not directly associated with specific research questions/content. In these cases, coordination only promotes collaboration between countries/institutions (Van Pelt et al. 2017), engagement among members and deals with conflicts, both of which are valuable and indispensable but given the

wide scope and generic nature of these efforts (Behar-Horenstein et al. 2017), do not affect the status of claims, conclusions and result. In these examples, coordination efforts "can foster, but cannot create research advance and technology development" (Finkelstein 1996, p. 69). Hence, since the specificity of this task is dependent on the used approach, it cannot be declared as a clear-cut significant task, and therefore, its status is deemed *inconclusive* (table 23).

Research coordination	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	5	5	5	2	13

Table 23. The results of the scoping search for the task of coordination.

Candidate assessment criterion 34. Software programming

Software programs are used to control components such as devices and sensors (Aung 2007) or employed to process or analyse results, and can be anything from a few lines of code written by researchers (in commercial software packages) to unique software programs made for the purpose of a research project (Hettrick et al. 2014).[143] Software programming in research might aim to solve complex computational problems (e.g., parallel simulations of a physical phenomenon), support other applications (e.g., dataset management software), provide libraries for mathematical programming (e.g., linear algebra and symbolic computing) or build infrastructural support systems (e.g., messaging middleware) (Carver et al. 2016). In different sub-disciplines of Physics and life sciences, the understanding of complex systems requires "answering questions that neither theory nor experiment alone are equipped to answer" (Hasselbring et al. 2019, p. 2). Hence, in areas where software programming enables experimental and computational capabilities, this task is indispensable.[144]

[143] Other generic software such as commercial word processors, or web-browsers do not count as research software (Hettrick et al. 2014).

[144] Furthermore, since scientists are also increasingly expected to make the underpinning software (of their research) available to the research community to improve replicability (Gavaghan 2018), the significance of this task would also be highlighted by Resnik's principle of *Openness*.

Software programming is directly associated with research content/questions when it facilitates the exploration of unknown research/engineering phenomenon in inherently complex domains (Carver et al. 2016). In projects where large datasets are used, developing specific software affects research and its conclusions by reducing the likelihood of human error and improving reliability/validity of analyses (Davenport et al. 2020; Mohammed et al. 2014). An example that shows the specificity of this task to research results, pertains to the success of a group of scientists who won the Nobel prize in Chemistry in 2013. They used a software to analyse chemical reactions during photosynthesis, without which their results and conclusions would have been less precise and non-revolutionary (Tu et al. 2016). In contexts where computer models explore research phenomenon in real-time in constantly-changing conditions, even the maintenance of codes that were programmed earlier impacts results (Ibid.). Therefore, being both indispensable and specific, this task is deemed *significant* (table 24).

Software programming	Indispensable	Specific	Significant	Insignificant	Irrelevant/ Inaccessible
Verdict (out of 20)	9	9	9	0	11

Table 24. The results of the scoping search for the task of software programming.

4.3 Results

In this chapter, Resnik's principles were used to justify candidate assessment criteria from an ethical perspective. These principles provide a flexible framework of research ethics that in addition to promoting ethical conduct to researchers, can be used for evaluating CROTs. Using this framework, the 34 candidate assessment criteria were explored. After specifying the principle of *Credit* using the significance threshold test, five criteria were deemed unjustifiable, and four were deemed inconclusive, all of which were excluded from the assessment instrument. The remaining 25 criteria are deemed justified, and hence, make it to the final assessment instrument. Table. 25 shows the status of each criterion.

Issue	Criteria to assess CROTs	Status
Availability	1. Is the description of contributions to tasks published under Open Access licence?	Justified
	2. Do CROTs' developers provide translated versions of research tasks and their definitions in languages other than English?	Justified
Extensibility	3. Do CROTs developers collect and evaluate user feedback for future revisions?	Justified
Responsibility and accountability	4. Are there mechanisms to indicate individual and overlapping responsibilities concerning tasks conducted by two or more contributors?	Justified
	5. Are there mechanisms to indicate mentor-mentee relations and the subsequent responsibilities for mentors?	Justified
Usability	6. Are there adequate and straightforward instructions to guide researchers on how CROTs should be used?	Justified
	7. In their instructions for researchers, do CROTs require one person to be aware of individual contributions and in charge of correspondence with other contributors and the editorial team?	Justified
	8. Are there reasonably comprehensive instructions for adopters (e.g., journals, universities) that explain how CROTs should be implemented and used?	Justified
	9. In their instructions for adopters, is the use of CROTs for describing acknowledged contributions encouraged?	Justified
	10. In their instructions for adopters, do CROTs provide suggestions on how to represent outdated tasks and practices?	Justified
	11. In their instructions for adopters, do CROTs encourage seeking the confirmation of all contributors about listed contributions?	Justified
	12. Do CROTs allow linking contributions to digital identifiers?	Justified
	13. Are tasks linked to resolvable URIs?	Justified
Violations	14. In their instructions for researchers, do CROTs describe what is regarded as a violation while using them?	Justified
	15. In their instructions for researchers, do CROTs attempt to suggest possible solutions and best practices to minimise the likelihood of (common) violations?	Justified
Attribution	16. Within tasks that involve more than one contributor, is it possible to clarify the extent of their individual contributions?	Justified
	17. In clarifying the extent of contributions to tasks, is it possible to specify two or more contributors as equal?	Justified
	18. Is it possible to recognise the contributions of teams and groups?	Justified
	19. Do CROTs refrain from using percentages to specify contributors' share of the total credit?	Justified
	Recognition of tasks:	
	20. Tasks that would traditionally not merit authorship status (e.g., those mentioned in the acknowledgement section)	Justified

	21. Communication and correspondence with other contributors and editorial teams	Unjustified
	22. Community engagement	Justified
	23. Creative efforts	Justified
	24. Data annotation	Unjustified (Inconclusive)
	25. Data curation	Unjustified (Inconclusive)
	26. Data warehousing	Unjustified
	27. Education and training	Unjustified
	28. Enrolling patients for clinical trials	Unjustified
	29. Translation	Justified
	30. Legal support	Unjustified (Inconclusive)
	31. Providing access to resources	Unjustified
	32. Providing research samples	Justified
	33. Research Coordination	Unjustified (Inconclusive)
	34. Software programming	Justified

Table 25. Status of candidate assessment criteria using Resnik's principles

References

Ahmed, S. M., & Palermo, A.-G. S. (2010). Community Engagement in Research: Frameworks for Education and Peer Review. *American Journal of Public Health*, *100*(8), 1380–1387. https://doi.org/10.2105/AJPH.2009.178137

Aitchison, C., Catterall, J., Ross, P., & Burgin, S. (2012). 'Tough love and tears': Learning doctoral writing in the sciences. *Higher Education Research & Development*, *31*(4), 435–447. https://doi.org/10.1080/07294360.2011.559195

Akhabue, E., & Lautenbach, E. (2010). "Equal" Contributions and Credit: An Emerging Trend in the Characterization of Authorship. *Annals of Epidemiology*, *20*(11), 868–871. https://doi.org/10.1016/j.annepidem.2010.08.004

Albert, N. M., Chipps, E., Falkenberg Olson, A. C., Hand, L. L., Harmon, M., Heitschmidt, M. G., Klein, C. J., Lefaiver, C., & Wood, T. (2019). Fostering Academic-Clinical Research Partnerships. *JONA: The Journal of Nursing Administration*, *49*(5), 234–241. https://doi.org/10.1097/NNA.0000000000000744

Allen, W. L. (2018). Visual brokerage: Communicating data and research through visualisation. *Public Understanding of Science*, *27*(8), 906–922. https://doi.org/10.1177/0963662518756853

Alexander, L., & Moore, M. (2016). Deontological Ethics. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Winter 2016). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/win2016/entries/ethics-deontological/

Alphabet Inc. (2020). Google Scholar [Website]. https ://scholar.google.com/.

Anderson, M. S., Ronning, E. A., Vries, R. D., & Martinson, B. C. (2010). Extending the Mertonian Norms: Scientists' Subscription to Norms of Research. *The Journal of Higher Education*, *81*(3), 366–393. https://doi.org/10.1353/jhe.0.0095

Andrews, L., Kostelecky, K., Spritz, S., & Franco, A. (2016). Virtual Clinical Trials: One Step Forward, Two Steps Back. *Journal of Health Care Law and Policy*, *19*(2), 189–247.

Andrienko, G. L., & Andrienko, N. V. (1997). Research issues in intelligent data visualisation for exploration and communication. *CHI '97 Extended Abstracts on Human Factors in Computing Systems*, 40–41. https://doi.org/10.1145/1120212.1120242

Annunziata, S., & Giordano, A. (2014). Authorship problems in scientific literature and in nuclear medicine: The point of view of the young researcher. *European Journal of Nuclear Medicine and Molecular Imaging*, *41*(6), 1251–1254. https://doi.org/10.1007/s00259-014-2755-1

Arichea, D. C. (1990). Theology and Translation: The Implications of Certain Theological Issues to the Translation Task. In S. Philip C. (Ed.), *Bible translation and the spread of the church* (pp. 40–67). Brill Publications: Leiden.

Aspaas, P. P., & Pataki, K. (2019). *Did Astronomy Constitute a Denominationally Neutral Space within the Republic of Letters? An Outline for the Use of Visualization Tools in the Study of Astronomical Correspondence*. Böhlau Verlag. https://munin.uit.no/handle/10037/16768

Assante, M., Candela, L., Castelli, D., Cirillo, R., Coro, G., Frosini, L., Lelii, L., Mangiacrapa, F., Pagano, P., Panichi, G., & Sinibaldi, F. (2019). Enacting open science by D4Science. *Future Generation Computer Systems*, *101*, 555–563. https://doi.org/10.1016/j.future.2019.05.063

Aung, W. P. (2007). Analysis on Modeling and Simulink of DC Motor and its Driving System Used for Wheeled Mobile Robot. *International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering*, *1*(8), 8.

Austin, A. E., & Baldwin, R. G. (1991). *Faculty collaboration: Enhancing the quality of scholarship and teaching*. School of Education and Human Development, George Washington University. Washington DC.

Burrough-Boenisch, J. (2019). Do freelance editors for academic and scientific researchers seek acknowledgement? A cross-sectional study. *European Science Editing*, *45*(2). https://doi.org/10.20316/ESE.2019.45.18019

Bai, B., Wang, X., Meng, Q., Yan, J., & Zha, Y. (2018). *Teaching exploration and practice of medical laboratory instrument course in Biomedical Engineering*. 557–560. https://doi.org/10.2991/mmetss-18.2018.117

Barnes, D. G., & Fluke, C. J. (2008). Incorporating interactive three-dimensional graphics in astronomy research papers. *New Astronomy*, *13*(8), 599–605. https://doi.org/10.1016/j.newast.2008.03.008

Beauchamp, T. L., & Childress, J. F. (2009). *Principles of Biomedical Ethics*. Oxford University Press.

Bayles, M. D. (1986). Mid-level principles and justification. *Nomos*, 28, 49–67.

Behar-Horenstein, L. S., Potter, J. E., Prikhidko, A., Swords, S., Sonstein, S., & Kolb, H. R. (2017). Training Impact on Novice and Experienced Research Coordinators. *Qualitative Report (Online)*, *22*(12), 3118–3138.

Biglari, D. (2020). *Fundamentals of Research Coordination | School of Nursing at Johns Hopkins University*. Johns Hopkins School of Nursing. https://learn.nursing.jhu.edu/face-to-face/courses/research-coordinator/

Birnholtz, J. (2008). When Authorship Isn't Enough: Lessons from CERN on the Implications of Formal and Informal Credit Attribution Mechanisms in Collaborative Research. *Journal of Electronic Publishing*, *11*(1). https://doi.org/10.3998/3336451.0011.105

Boardman, P. C. (2009). Government centrality to university–industry interactions: University research centers and the industry involvement of academic researchers. *Research Policy*, *38*(10), 1505–1516. https://doi.org/10.1016/j.respol.2009.09.008

Boergens, K. M., Berning, M., Bocklisch, T., Bräunlein, D., Drawitsch, F., Frohnhofen, J., Herold, T., Otto, P., Rzepka, N., Werkmeister, T., Werner, D., Wiese, G., Wissler, H., & Helmstaedter, M. (2017). webKnossos: Efficient online 3D data annotation for connectomics. *Nature Methods*, *14*(7), 691–694. https://doi.org/10.1038/nmeth.4331

Borgman, C. L. (2010). *Scholarship in the Digital Age: Information, Infrastructure, and the Internet*. MIT Press.

Boud, D., Brew, A., Dowling, R., Kiley, M., McKenzie, J., Malfroy, J., Ryland, K., & Solomon, N. (2014). The coordination role in research education: Emerging understandings and dilemmas for

leadership. *Journal of Higher Education Policy and Management*, *36*(4), 440–454. https://doi.org/10.1080/1360080X.2014.916466

Boyer, S., Ikeda, T., Lefort, M.-C., Malumbres-Olarte, J., & Schmidt, J. M. (2017). Percentage-based Author Contribution Index: A universal measure of author contribution to scientific articles. *Research Integrity and Peer Review*, *2*(1), 18. https://doi.org/10.1186/s41073-017-0042-y

Bracic, A. (2018). For Better Science: The Benefits of Community Engagement in Research. *PS: Political Science & Politics*, *51*(03), 550–553. https://doi.org/10.1017/S1049096518000446

Brown, J. M., & Tucker, C. (2013). Expanding Library Support of Faculty Research: Exploring Readiness. *Portal: Libraries and the Academy*, *13*(3), 257–271. https://doi.org/10.1353/pla.2013.0019

Burbidge, D., & Cheeseman, N. (2017). Trust, Ethnicity and Integrity in East Africa: Experimental Evidence from Kenya and Tanzania. *The Journal of Race, Ethnicity, and Politics*, *2*(01), 88–123.

Carver, J. C., Hong, N. P. C., & Thiruvathukal, G. K. (2016). *Software Engineering for Science*. CRC Press.

Cecchini, M., Rubin, E. H., Blumenthal, G. M., Ayalew, K., Burris, H. A., Russell-Einhorn, M., Dillon, H., Lyerly, H. K., Reaman, G. H., Boerner, S., & LoRusso, P. M. (2019). Challenges with Novel Clinical Trial Designs: Master Protocols. *Clinical Cancer Research*, *25*(7), 2049–2057. https://doi.org/10.1158/1078-0432.CCR-18-3544

Chandra, P., & Gupta, M. K. (2018). Comprehensive survey on data warehousing research. *International Journal of Information Technology*, *10*(2), 217–224. https://doi.org/10.1007/s41870-017-0067-y

Chang, H.-W., & Huang, M.-H. (2016). The effects of research resources on international collaboration in the astronomy community. *Journal of the Association for Information Science and Technology*, *67*(10), 2489–2510. https://doi.org/10.1002/asi.23592

Chiang, K. (2003). Learning experiences of doctoral students in UK universities. *International Journal of Sociology and Social Policy*, *23*(1/2), 4–32. https://doi.org/10.1108/01443330310790444

Chittaro, L., & Ranon, R. (2007). Web3D technologies in learning, education and training: Motivations, issues, opportunities. *Computers & Education*, *49*(1), 3–18. https://doi.org/10.1016/j.compedu.2005.06.002

Colledge, F. M. A., Elger, B. S., & Shaw, D. M. (2013). "Conferring Authorship": Biobank Stakeholders' Experiences with Publication Credit in Collaborative Research. *PLOS ONE*, *8*(9), e76686. https://doi.org/10.1371/journal.pone.0076686

Conjares, A. E. L., Gerardo, B. G., & Medina, R. P. (2016). Implementation of Data Warehousing Tool with Mapping for Environmental Research. *International Journal of Computer Science Issues*, *13*(5), 171–177. https://doi.org/10.20943/01201605.171177

Conraths, B., & Smidt, H. (2005). *The Funding of University-Based Research and Innovation in Europe: An Exploratory Study* (p. 41) [EUA publications, European University Association]. https://immagic.com/eLibrary/ARCHIVES/GENERAL/EUA_EU/E050418C.pdf

Conte, M. L., Maat, S. L., & Omary, M. B. (2013). Increased co-first authorships in biomedical and clinical publications: A call for recognition. *The FASEB Journal*, *27*(10), 3902–3904. https://doi.org/10.1096/fj.13-235630

Cottey, A. (2016). Reducing Ethical Hazards in Knowledge Production. *Science and Engineering Ethics*, *22*(2), 367–389. https://doi.org/10.1007/s11948-015-9651-3

Coutinho, I. R. (2020). Listening and feeling doctoral students' perceptions of their doctoral supervision. The PhD students' point of view. *Advances in Social Sciences Research Journal*, *6*(12), 206–223. https://doi.org/10.14738/assrj.612.7573

Cox, A. M., & Verbaan, E. (2016). How academic librarians, IT staff, and research administrators perceive and relate to research. *Library & Information Science Research*, *38*(4), 319–326. https://doi.org/10.1016/j.lisr.2016.11.004

Crosbie, E., & Glantz, S. A. (2014). Tobacco industry argues domestic trademark laws and international treaties preclude cigarette health warning labels, despite consistent legal advice that the argument is invalid. *Tobacco Control*, *23*(3), e7–e7. https://doi.org/10.1136/tobaccocontrol-2012-050569

Crossref. (2020). *Funder Registry* [Website]. Crossref. https://www.crossref.org/services/funder-registry/

Cummings, J. N., & Kiesler, S. (2007). Coordination costs and project outcomes in multi-university collaborations. *Research Policy*, *36*(10), 1620–1634. https://doi.org/10.1016/j.respol.2007.09.001

Curry, M. J., & Lillis, T. M. (2010). Academic research networks: Accessing resources for English-medium publishing. *English for Specific Purposes*, *29*(4), 281–295. https://doi.org/10.1016/j.esp.2010.06.002

Davenport, J. H., Grant, J., & Jones, C. M. (2020). Data Without Software Are Just Numbers. *Data Science Journal*, *19*(1), 3. https://doi.org/10.5334/dsj-2020-003

De Weger, E., Van Vooren, N., Luijkx, K. G., Baan, C. A., & Drewes, H. W. (2018). Achieving successful community engagement: A rapid realist review. *BMC Health Services Research*, *18*(1), 285. https://doi.org/10.1186/s12913-018-3090-1

Dilts, D. M., Cheng, S. K., Crites, J. S., Sandler, A. B., & Doroshow, J. H. (2010). Phase III clinical trial development: A process of chutes and ladders. *Clinical Cancer Research: An Official Journal of the American Association for Cancer Research*, *16*(22), 5381–5389. https://doi.org/10.1158/1078-0432.CCR-10-1273

Douglas, T. M. (2007). Ethics committees and the legality of research. *Journal of Medical Ethics*, *33*(12), 732–736. https://doi.org/10.1136/jme.2007.020479

Elliott, K. C., Settles, I. H., Montgomery, G. M., Brassel, S. T., Cheruvelil, K. S., & Soranno, P. A. (2017). Honorary Authorship Practices in Environmental Science Teams: Structural and Cultural Factors and Solutions. *Accountability in Research*, *24*(2), 80–98. https://doi.org/10.1080/08989621.2016.1251320

Ellis, M. V. (2010). Bridging the Science and Practice of Clinical Supervision: Some Discoveries, Some Misconceptions. *The Clinical Supervisor*, *29*(1), 95–116. https://doi.org/10.1080/07325221003741910

Fienberg, S. E. (1994). Sharing Statistical Data in the Biomedical and Health Sciences: Ethical, Institutional, Legal, and Professional Dimensions. *Annual Review of Public Health*, *15*(1), 1–18. https://doi.org/10.1146/annurev.pu.15.050194.000245

Fink, G. (2019). Freedom of science. *Kybernetes*, *49*(7), 1935–1952. https://doi.org/10.1108/K-02-2019-0111

Finkelstein, A. (1996). Requirements engineering research: Coordination and infrastructure. *Requirements Engineering*, *1*(1), 63–69. https://doi.org/10.1007/BF01235766

Fontanarosa, P., Bauchner, H., & Flanagin, A. (2017). Authorship and Team Science. *JAMA*, *318*(24), 2433–2437. https://doi.org/10.1001/jama.2017.19341

Gallagher, A. G., Ritter, E. M., & Satava, R. M. (2003). Fundamental principles of validation, and reliability: Rigorous science for the assessment of surgical education and training. *Surgical Endoscopy And Other Interventional Techniques*, *17*(10), 1525–1529. https://doi.org/10.1007/s00464-003-0035-4

Garrido, R., Trowbridge, C. A., & Tamura, N. (2019). Ten Simple Rules for Providing Optimal Administrative Support to Research Teams." PLOS Computational Biology 15 (10): e1007292. https://doi.org/10.1371/journal.pcbi.1007292.

Gavaghan, D. (2018). Problems with the Current Approach to the Dissemination of Computational Science Research and Its Implications for Research Integrity. *Bulletin of Mathematical Biology*, *80*(12), 3088–3094. https://doi.org/10.1007/s11538-018-0499-y

Gisemba Bagaka's, J., Bransteter, I., Rispinto, S., & Badillo, N. (2015). Exploring Student Success in a Doctoral Program: The Power of Mentorship and Research Engagement. *International Journal of Doctoral Studies*, *10*, 323–342. https://doi.org/10.28945/2291

Gligorijevic, J., Gligorijevic, D., Pavlovski, M., Milkovits, E., Glass, L., Grier, K., Vankireddy, P., & Obradovic, Z. (2019). Optimizing clinical trials recruitment via deep learning. *Journal of the American Medical Informatics Association*, *26*(11), 1195–1202. https://doi.org/10.1093/jamia/ocz064

Godt, C. (2016). Experts and Politics in Patent Policy: The Final Report of the Expert Group on the Development and Implications of Patent Law in the Field of Biotechnology and Genetic Engineering of the European Commission, 17 May 2016. *IIC - International Review of Intellectual Property and Competition Law*, *47*(8), 960–980. https://doi.org/10.1007/s40319-016-0529-y

Gong, Y. (2016). Molecular Analysis of Breast Cancer in Cytology Samples. In B. Yang & J. Rao (Eds.), *Molecular Cytopathology* (pp. 139–152). Springer International Publishing. https://doi.org/10.1007/978-3-319-30741-1_8

Goodyear, R. K., Borders, L. D., Chang, C. Y., Guiffrida, D. A., Hutman, H., Kemer, G., Jr, C. E. W., & White, E. (2016). Prioritizing questions and methods for an international and interdisciplinary supervision research agenda: Suggestions by eight scholars. *The Clinical Supervisor*, *35*(1), 117–154. https://doi.org/10.1080/07325223.2016.1153991

Groeneveld, L. F., Gregusson, S., Guldbrandtsen, B., Hiemstra, S. J., Hveem, K., Kantanen, J., Lohi, H., Stroemstedt, L., & Berg, P. (2016). Domesticated Animal Biobanking: Land of Opportunity. *PLoS Biology*, *14*(7). https://doi.org/10.1371/journal.pbio.1002523

Guba, E. G., & Lincoln, Y. S. (1989). *Fourth Generation Evaluation*. SAGE.

Han, X., & Appelbaum, R. P. (2018). China's science, technology, engineering, and mathematics (STEM) research environment: A snapshot. *PLOS ONE*, *13*(4), e0195347. https://doi.org/10.1371/journal.pone.0195347

Hansen, G. (2010). Integrative description of translation process. In G. M. Shreve & E. Angelone (Eds.), *Translation and Cognition* (pp. 213–230). John Benjamins Publishing.

Hasselbring, W., Carr, L., Hettrick, S., Packer, H., & Tiropanis, T. (2019). FAIR and Open Computer Science Research Software. *ArXiv:1908.05986 [Cs]*. http://arxiv.org/abs/1908.05986

Heesters, A. M., Buchman, D. Z., Anstey, K. W., Bell, J. A. H., Russell, B. J., & Wright, L. (2017). Power of Attorney for Research: The Need for a Clear Legal Mechanism. *Public Health Ethics*, *10*(1), 100–104. https://doi.org/10.1093/phe/phw035

Hettrick, S., Antonioletti, M., Carr, L., Chue Hong, N., Crouch, S., De Roure, D., Emsley, I., Goble, C., Hay, A., Inupakutika, D., Jackson, M., Nenadic, A., Parkinson, T., Parsons, M. I., Pawlik, A., Peru, G., Proeme, A., Robinson, J., & Sufi, S. (2014). *UK Research Software Survey 2014* [Data set]. Zenodo. https://doi.org/10.5281/zenodo.14809

Hoekman, J., Scherngell, T., Frenken, K., & Tijssen, R. (2013). Acquisition of European research funds and its effect on international scientific collaboration. *Journal of Economic Geography*, *13*(1), 23–52. https://doi.org/10.1093/jeg/lbs011

Holzer, J. K., Ellis, L., & Merritt, M. W. (2014). Why We Need Community Engagement in Medical Research. *Journal of Investigative Medicine : The Official Publication of the American Federation for Clinical Research*, *62*(6), 851–855. https://doi.org/10.1097/JIM.0000000000000097

Horner Jennifer, & Minifie Fred D. (2011). Research Ethics III: Publication Practices and Authorship, Conflicts of Interest, and Research Misconduct. *Journal of Speech, Language, and Hearing Research*, *54*(1), S346–S362. https://doi.org/10.1044/1092-4388(2010/09-0263)

Hoser, N. (2013). Public funding in the academic field of nanotechnology: A multi-agent based model. *Computational and Mathematical Organization Theory*, *19*(2), 253–281. https://doi.org/10.1007/s10588-013-9158-x

Hosseini, M. (2020). Equal Co-authorship Practices: Review and Recommendations. *Science and Engineering Ethics*, *26*(3), 1133–1148. https://doi.org/10.1007/s11948-020-00183-8

Hosseini, M., & Bruton, S. V. (2020). A qualitative study of Equal Co-First Authorship. *Accountability in Research*, *0*(0), 1–25. https://doi.org/10.1080/08989621.2020.1776122

Hosseini, M., & Lewis, J. (2020). The norms of authorship credit: Challenging the definition of authorship in The European Code of Conduct for Research Integrity. *Accountability in Research*, *27*(2), 80–98. https://doi.org/10.1080/08989621.2020.1721288

Hubscher-Davidson, S. E. (2009). Personal diversity and diverse personalities in translation: A study of individual differences. *Perspectives*, *17*(3), 175–192. https://doi.org/10.1080/09076760903249380

Inspire. (2017). *Best Practices for registers and registries & Technical Guidelines for the INSPIRE register federation*. INSPIRE Maintenance and Implementation Group. http://inspire.ec.europa.eu/id/document/tg/registers-and-register-federation/1.0

International Committee of Medical Journal Editors. (2018). *ICMJE | Recommendations | Translations*. http://www.icmje.org/recommendations/translations/

International Committee of Medical Journal Editors. (2020). *ICMJE | Recommendations | Publishing and Editorial Issues Related to Publication in Medical Journals*. http://www.icmje.org/recommendations/browse/publishing-and-editorial-issues/

Israel, B. A., Schulz, A. J., Parker, E. A., & Becker, A. B. (1998). REVIEW OF COMMUNITY-BASED RESEARCH: Assessing Partnership Approaches to Improve Public Health. *Annual Review of Public Health*, *19*(1), 173–202. https://doi.org/10.1146/annurev.publhealth.19.1.173

Ito, T., Kuribayashi, T., Kobayashi, H., Brassard, A., Hagiwara, M., Suzuki, J., & Inui, K. (2019). Diamonds in the Rough: Generating Fluent Sentences from Early-Stage Drafts for Academic Writing Assistance. *ArXiv:1910.09180 [Cs]*. http://arxiv.org/abs/1910.09180

Jacobson, N., Butterill, D., & Goering, P. (2004). Organizational Factors that Influence University-Based Researchers' Engagement in Knowledge Transfer Activities. *Science Communication*, *25*(3), 246–259. https://doi.org/10.1177/1075547003262038

Jensen, L., & Konradsen, F. (2018). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies*, *23*(4), 1515–1529. https://doi.org/10.1007/s10639-017-9676-0

Joob, B., & Wiwanitkit, V. (2016). Authorship, credit, contribution and problems. *European Spine Journal*, *25*(3), 918–918. https://doi.org/10.1007/s00586-015-4351-x

Jones, L., & Milne, J. (2017). A practical guide to becoming a successful research site. *British Journal of Nursing*, *26*(15), S44–S48. https://doi.org/10.12968/bjon.2017.26.15.S44

Johnson, C., Moorhead, R., Munzner, T., Pfister, H., Rheingans, P., & Yoo, T. S. (2005). *NIH-NSF Visualization Research Challenges Report*. Institute of Electrical and Electronics Engineers. https://doi.org/10.1109/MCG.2006.44

Johnston, L. R., Carlson, J., Hudson-Vitale, C., Imker, H., Kozlowski, W., Olendorf, R., & Stewart, C. (2018). *How Important Are Data Curation Activities to Researchers? Gaps and Opportunities for Academic Libraries*. https://digitalcommons.unl.edu/libraryscience/392

Kaiser, B. L., Thomas, G. R., & Bowers, B. J. (2017). A Case Study of Engaging Hard-to-Reach Participants in the Research Process: Community Advisors on Research Design and Strategies (CARDS)®. *Research in Nursing & Health*, *40*(1), 70–79. https://doi.org/10.1002/nur.21753

Kalra, H., Simpson, R. J., Ji, H., Aikawa, E., Altevogt, P., Askenase, P., Bond, V. C., Borràs, F. E., Breakefield, X., Budnik, V., Buzas, E., Camussi, G., Clayton, A., Cocucci, E., Falcon-Perez, J. M., Gabrielsson, S., Gho, Y. S., Gupta, D., Harsha, H. C., … Mathivanan, S. (2012). Vesiclepedia: A Compendium for Extracellular Vesicles with Continuous Community Annotation. *PLOS Biology*, *10*(12), e1001450. https://doi.org/10.1371/journal.pbio.1001450

Kazimzade, G., & Miceli, M. (2020). Biased Priorities, Biased Outcomes: Three Recommendations for Ethics-oriented Data Annotation Practices. *Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society*, 71. https://doi.org/10.1145/3375627.3375809

Kremenak, N. (2010). Authorship of the Research Report: Perils and Responsibilities. *Journal of Prosthodontics*, *19*(5), 420–421. https://doi.org/10.1111/j.1532-849X.2010.00618.x

Krishnan, R. P., Ramani, P., Sherlin, H. J., Sukumaran, G., Ramasubramanian, A., Jayaraj, G., Don, K. R., & Santhanam, A. (2018). Surgical Specimen Handover from Operation Theater to Laboratory: A Survey. *Annals of Maxillofacial Surgery*, *8*(2), 234–238. https://doi.org/10.4103/ams.ams_51_18

Kumar, S., Singh, B., Kaur, G. (2016). Data Warehouse Security Issue. *International Journal of Advanced Research in Computer Science*, *7*(6), Article 6. https://doi.org/10.26483/ijarcs.v7i6.2750

Kumaran, S., Ijumba, N., & Kumaran, S. (2018). *Research Supervision Team: Structures, Responsibilities and the Collaborative Roles for supporting Interdisciplinary Research*. 157–161. https://doi.org/10.2991/erms-18.2018.29

Laczin, J. (2013). The Shift to a Centralized Lab Approach. *Applied Clinical Trials*, *22*(9), 6–7.

LaFollette, M. C. (1996). *Stealing Into Print: Fraud, Plagiarism, and Misconduct in Scientific Publishing*. University of California Press.

Lakeman, R., & FitzGerald, M. (2009). The Ethics of Suicide Research. *Crisis*, *30*(1), 13–19. https://doi.org/10.1027/0227-5910.30.1.13

Larivière, V., Desrochers, N., Macaluso, B., Mongeon, P., Paul-Hus, A., & Sugimoto, C. R. (2016). Contributorship and division of labor in knowledge production. *Social Studies of Science*, *46*(3), 417–435. https://doi.org/10.1177/0306312716650046

Larkin, A. (2016). Decolonizing and Delinking North–South Higher Education Partnerships: Imagining Possibilities for Global Social Justice. In L. Shultz & M. Viczko (Eds.), *Assembling and Governing the Higher Education Institution: Democracy, Social Justice and Leadership in Global Higher Education* (pp. 215–232). Palgrave Macmillan UK. https://doi.org/10.1057/978-1-137-52261-0_12

LaValley, M., Bowden, S., & Rohde, J. A. (2018). Challenges, Opportunities and Best Practices in Large-scale Project Management: The IARPC Model. *AGU Fall Meeting Abstracts*, *23*. http://adsabs.harvard.edu/abs/2018AGUFMPA23F1044L

Lee, A. (2019). *Successful Research Supervision: Advising students doing research*. Routledge.

Lee, D. J., & Stvilia, B. (2017). Practices of research data curation in institutional repositories: A qualitative view from repository staff. *PLOS ONE*, *12*(3), e0173987. https://doi.org/10.1371/journal.pone.0173987

Libarkin, J. C., & Brick, C. (2002). Research Methodologies in Science Education: Visualization and the Geosciences. *Journal of Geoscience Education*, *50*(4), 449–455. https://doi.org/10.5408/1089-9995-50.4.449

Lim, E. H., Zhang, S.-L., Yu, K., Nga, M.-E., Ahmed, D. A., Agasthian, T., Wong, P.-S., Chua, G.-C., Wong, D., Tan, L., Seto, K.-Y., Yap, W.-S., Low, S.-P., Khoo, K.-L., Chang, A., Ng, A., & Tan, P. (2007). An Alternative Approach to Determining Therapeutic Choices in Advanced Non-small Cell Lung Carcinoma (NSCLC): Maximizing the Diagnostic Procedure and the Use of Low-Volume Lung Biopsies. *Journal of Thoracic Oncology*, *2*(5), 387–396. https://doi.org/10.1097/01.JTO.0000268671.49378.c2

Lord, P., Macdonald, A., Lyon, L., & Giaretta, D. (2004). From Data Deluge to Data Curation. *In Proc 3th UK E-Science All Hands Meeting*, 371–375.

Ludvigsson, J., Lefebvre, P., & Nerup, J. (2018). It is time to restore Rules for Authorship of scientific publications. *Pediatric Diabetes*, *19*(3), 586–586. https://doi.org/10.1111/pedi.12572

Macfarlane, B. (2010). *Researching with Integrity: The Ethics of Academic Enquiry*. Routledge.

Maes, T., Perry, J., Alliji, K., Clarke, C., & Birchenough, S. N. R. (2019). Shades of grey: Marine litter research developments in Europe. *Marine Pollution Bulletin*, *146*, 274–281. https://doi.org/10.1016/j.marpolbul.2019.06.019

Mahjani, B., Dellenvall, K., Grahnat, A.-C. S., Karlsson, G., Tuuliainen, A., Reichert, J., Mahjani, C. G., Klei, L., De Rubeis, S., Reichenberg, A., Devlin, B., Hultman, C. M., Buxbaum, J. D., Sandin, S., & Grice, D. E. (2020). Cohort profile: Epidemiology and Genetics of Obsessive–compulsive disorder and chronic tic disorders in Sweden (EGOS). *Social Psychiatry and Psychiatric Epidemiology*. https://doi.org/10.1007/s00127-019-01822-7

Makarenkov, V., Rokach, L., & Shapira, B. (2019). Choosing the right word: Using bidirectional LSTM tagger for writing support systems. *Engineering Applications of Artificial Intelligence*, *84*, 1–10. https://doi.org/10.1016/j.engappai.2019.05.003

Marques, M., Woutersen-Windhouwer, S., & Tuuliniemi, A. (2019). Monitoring agreements with open access elements: Why article-level metadata are important. *Insights*, *32*(1), 35. https://doi.org/10.1629/uksg.489

Matarese, V., & Shashok, K. (2018). Improving the biomedical research literature: Insights from authors' editors can help journal editors define and refine their core competencies. *F1000Research*, *7*. https://doi.org/10.12688/f1000research.13760.2

Matarese, V., & Shashok, K. (2019). Transparent Attribution of Contributions to Research: Aligning Guidelines to Real-Life Practices. *Publications*, *7*(2), 24. https://doi.org/10.3390/publications7020024

McCarthy, I. P., Silvestre, B. S., von Nordenflycht, A., & Breznitz, S. M. (2018). A typology of university research park strategies: What parks do and why it matters. *Journal of Engineering and Technology Management*, *47*, 110–122. https://doi.org/10.1016/j.jengtecman.2018.01.004

McNutt, M. K., Bradford, M., Drazen, J. M., Hanson, B., Howard, B., Jamieson, K. H., Kiermer, V., Marcus, E., Pope, B. K., Schekman, R., Swaminathan, S., Stang, P. J., & Verma, I. M. (2018). Transparency in authors' contributions and responsibilities to promote integrity in scientific publication. *Proceedings of the National Academy of Sciences*, *115*(11), 2557–2560. https://doi.org/10.1073/pnas.1715374115

Mento, B., & Rapple, B. A. (2003). *Data Mining and Data Warehousing*. Association of Research Libraries.

Meriste, H., Parder, M.L., Lõuk, K., Simm, K., Lilles-Heinsar, L., Veski, L., Soone, M. Juurik, M. & Sutrop, M. (2016). *PRINTEGER project. Deliverable 2.3. Normative analysis of research integrity and misconduct*. https://printeger.eu/wp-content/uploads/2016/10/D2.3.pdf

Milne, D. (2007). An empirical definition of clinical supervision. *British Journal of Clinical Psychology*, *46*(4), 437–447. https://doi.org/10.1348/014466507X197415

Mitcham, C. (2010). *The Oxford Handbook of Interdisciplinarity*. Oxford University Press.

Moffatt, B. (2011). Responsible Authorship: Why Researchers Must Forgo Honorary Authorship. *Accountability in Research*, *18*(2), 76–90. https://doi.org/10.1080/08989621.2011.557297

Mohammed, E. A., Far, B. H., & Naugler, C. (2014). Applications of the MapReduce programming framework to clinical big data analysis: Current landscape and future trends. *BioData Mining*, *7*(1), 22. https://doi.org/10.1186/1756-0381-7-22

Mongeon, P., Smith, E., Joyal, B., & Lariviere, V. (2017). The rise of the middle author: Investigating collaboration and division of labor in biomedical research using partial alphabetical authorship. *PLOS ONE*, *12*(9). https://doi.org/10.1371/journal.pone.0184601

Morano, W. F., Khalili, M., Chi, D. S., Bowne, W. B., & Esquivel, J. (2018). Clinical studies in CRS and HIPEC: Trials, tribulations, and future directions—A systematic review. *Journal of Surgical Oncology*, *117*(2), 245–259. https://doi.org/10.1002/jso.24813

Morgan, S. E., Occa, A., Mouton, A., & Potter, J. (2017). The Role of Nonverbal Communication Behaviors in Clinical Trial and Research Study Recruitment. *Health Communication*, *32*(4), 461–469. https://doi.org/10.1080/10410236.2016.1140266

Morley, G. (2013). The Writer's Approach to Facilitating Research Communication: A Very Different Way of Engaging with Authors. In *Supporting Research Writing: Roles And Challenges In Multilingual Settings*, Edited by V. Matarese, 191–204. Cambridge, England: Chandos Publications. Chandos Information Professional Series.

Moustafa, K. (2016). Contributorships Are Not 'Weighable' to be Equal. *Trends in Biochemical Sciences*, *41*(5), 389–390. https://doi.org/10.1016/j.tibs.2016.03.001

Mukhtarov, F., de Jong, M., & Pierce, R. (2017). Political and ethical aspects in the ethnography of policy translation: Research experiences from Turkey and China. *Environment and Planning A: Economy and Space*, *49*(3), 612–630. https://doi.org/10.1177/0308518X16674935

Musen, M. A., Bean, C. A., Cheung, K.-H., Dumontier, M., Durante, K. A., Gevaert, O., Gonzalez-Beltran, A., Khatri, P., Kleinstein, S. H., O'Connor, M. J., Pouliot, Y., Rocca-Serra, P., Mustaine, E. E., & Tewksbury, R. (2009). Rainmakers: The Most Successful Criminal Justice Scholars and Departments In Research Grant Acquisition. *Journal of Criminal Justice Education*, *20*(1), 40–55. https://doi.org/10.1080/10511250802680993

Muthanna, A., & Alduais, A. (2020). A Thematic Review on Research Integrity and Research Supervision: Relationships, Crises and Critical Messages. *Journal of Academic Ethics*. https://doi.org/10.1007/s10805-020-09368-z

Nadal, K. L. (2016). The Intersection of Queer Theory and Empirical Methods: Visions for CLAGS, the Center for LGBTQ Studies. *WSQ: Women's Studies Quarterly*, *44*(3), 301–305. https://doi.org/10.1353/wsq.2016.0060

Navale, V., & McAuliffe, M. (2018). Long-term preservation of biomedical research data. *F1000Research*, *7*, 1353. https://doi.org/10.12688/f1000research.16015.1

Ogburn, J. L. (2010). The Imperative for Data Curation. *Portal: Libraries and the Academy*, *10*(2), 241–246. https://doi.org/10.1353/pla.0.0100

Okazaki, S., & Sue, S. (2016). *Methodological issues in assessment research with ethnic minorities* (p. 247). American Psychological Association. https://doi.org/10.1037/14805-015

Oliver, D. (2019). David Oliver: Does doctors' admin take up too much time? *BMJ*, *367*. https://doi.org/10.1136/bmj.l6381

Olohan, M. (2017). *Intercultural Faultlines: Research Models in Translation Studies: v. 1: Textual and Cognitive Aspects*. Routledge.

Opipari, V. P., Lumeng, J. C., Youmans, B., & Silverstein, F. (2019). Mandated Research Peer Review Positively Impacts Research Funding Success Rates for Young Investigators. *The Journal of Pediatrics*, *210*, 3–4. https://doi.org/10.1016/j.jpeds.2019.05.035

Overland, I., & Sovacool, B. K. (2020). The misallocation of climate research funding. *Energy Research & Social Science*, *62*, 101349. https://doi.org/10.1016/j.erss.2019.101349

Patten, C. A., Albertie, M. L., Chamie, C. A., Brockman, T. A., Gorfine, M., Nicholas, R., Bock, M. J., Okamoto, J. M., Penheiter, S. G., & Balls-Berry, J. E. (2019). Addressing community health needs through community engagement research advisory boards. *Journal of Clinical and Translational Science*, *3*(2–3), 125–128. https://doi.org/10.1017/cts.2019.366

Pérez, F., & María, J. (2017). *Success Factors in Funding Acquisition for Research Projects through Competitive Calls: A study of R&D Public Centres*. http://roderic.uv.es/handle/10550/58682

Pelaez, N., Anderson, T. R., Gardner, S. M., Yin, Y., Abraham, J. K., Bartlett, E. L., Gormally, C., Hurney, C. A., Long, T. M., Newman, D. L., Sirum, K., & Stevens, M. T. (2018). A Community-Building Framework for Collaborative Research Coordination across the Education and Biology Research Disciplines. *CBE—Life Sciences Education*, *17*(2), es2. https://doi.org/10.1187/cbe.17-04-0060

Peplies, J., Fraterman, A., Scott, R., Russo, P., & Bammann, K. (2010). Quality management for the collection of biological samples in multicentre studies. *European Journal of Epidemiology*, *25*(9), 607–617. https://doi.org/10.1007/s10654-010-9481-1

Pfirman, S., & Martin, P. J. S. (2017). Facilitating Interdisciplinary Scholars. In R. Frodeman (Ed.), *The Oxford Handbook of Interdisciplinarity* (Second edition, pp. 387–401). https://doi.org/10.1093/oxfordhb/9780198733522.013.47

Phan, P. H., Siegel, D. S., & Wright, M. (2005). Science parks and incubators: Observations, synthesis and future research. *Journal of Business Venturing*, *20*(2), 165–182. https://doi.org/10.1016/j.jbusvent.2003.12.001

Pogue, B. W. (2018). Grant Funding Needs Parallel the Start-Up Venture: An Analogy for Translational Research Success. *Journal of Biomedical Optics*, *23*(8), 080101. https://doi.org/10.1117/1.JBO.23.8.080101

Redman, B. K. (2013). Are Current Publication Standards Protecting the Integrity of the Scientific Record? In *RESEARCH MISCONDUCT POLICY IN BIOMEDICINE: BEYOND THE BAD-APPLE APPROACH* (pp. 59–78). MIT PRESS.

Reid, J. B., & Rhodes, D. H. (2016). *Digital System Models: An investigation of the non-technical challenges and research needs*. 10.

Rescognito (2020). https://rescognito.com/

Resnik, D. B. (2005). *The Ethics of Science: An Introduction*. New York: Routledge.

Resnik, D. (2007). *The price of truth, how money affects the norms of science*. Oxford university press.

Reynolds, L., & Sariola, S. (2018). The ethics and politics of community engagement in global health research. *Critical Public Health*, *28*(3), 257–268. https://doi.org/10.1080/09581596.2018.1449598

Rip, A. (2004). Strategic Research, Post-modern Universities and Research Training. *Higher Education Policy*, *17*(2), 153–166. https://doi.org/10.1057/palgrave.hep.8300048

Robertson, E. G., Wakefield, C. E., Signorelli, C., Cohn, R. J., Patenaude, A., Foster, C., Pettit, T., & Fardell, J. E. (2018). Strategies to facilitate shared decision-making about pediatric oncology clinical trial enrollment: A systematic review. *Patient Education and Counseling*, *101*(7), 1157–1174. https://doi.org/10.1016/j.pec.2018.02.001

Rockwell, S. (2002). Some thoughts on the ethics of research and publication. *RADIATION RESEARCH*, *157*(1), 1–2. https://doi.org/10.1667/0033-7587(2002)157[0001:STOTEO]2.0.CO;2

Rojas-Cordova, A., & Bish, E. K. (2018). *Optimal Patient Enrollment in Sequential Adaptive Clinical Trials with Binary Response* (SSRN Scholarly Paper ID 3234590). Social Science Research Network. https://doi.org/10.2139/ssrn.3234590

Sarna-Wojcicki, D., Perret, M., Eitzel, M. V., & Fortmann, L. (2017). Where Are the Missing Coauthors? Authorship Practices in Participatory Research. *Rural Sociology*, *82*(4), 713–746. https://doi.org/10.1111/ruso.12156

Schulte, R. (1996). Editorial: Literature and Humanities Programs Need Translation Courses in the Core Curriculum. *Translation Review*, *50*(1), 1–2. https://doi.org/10.1080/07374836.1996.10523675

Science Daily. (2020, February 14). *Computer simulations visualize how DNA converts cells into stem cells*. ScienceDaily. https://www.sciencedaily.com/releases/2020/02/200214134731.htm

Sharma, S. (2018). Professional medical writing support: The need of the day. *Perspectives in Clinical Research*, *9*(3), 111–112. https://doi.org/10.4103/picr.PICR_47_18

Shreve, G. M., & Lacruz, I. (2017). Aspects of a Cognitive Model of Translation. In *The Handbook of Translation and Cognition* (pp. 127–143). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119241485.ch7

Silva, J. A. T. da. (2011). The ethics of collaborative authorship. *EMBO Reports*, *12*(9), 889–893. https://doi.org/10.1038/embor.2011.161

Snowdon, C., Elbourne, D. R., & Garcia, J. (2004). Perinatal pathology in the context of a clinical trial: Attitudes of neonatologists and pathologists. *Archives of Disease in Childhood - Fetal and Neonatal Edition*, *89*(3), F204–F207. https://doi.org/10.1136/adc.2002.012732

Soleri, D., Long, J. W., Ramirez-Andreotta, M. D., Eitemiller, R., & Pandya‖, R. (2016). Finding pathways to more equitable and meaningful public-scientist partnerships. *Citizen Science: Theory and Practice. 1(1): 9*, *1*(1), Article 1. https://doi.org/10.5334/cstp.46

Solis, R., Pakbin, A., Akbari, A., Mortazavi, B. J., & Jafari, R. (2019). A human-centered wearable sensing platform with intelligent automated data annotation capabilities. *Proceedings of the International Conference on Internet of Things Design and Implementation*, 255–260. https://doi.org/10.1145/3302505.3310087

Sterken, C. (2011). Writing a Scientific Paper III. Ethical Aspects. *EAS Publications Series*, *50*, 173–282. https://doi.org/10.1051/eas/1150003

Stokols, D., Misra, S., Moser, R. P., Hall, K. L., & Taylor, B. K. (2008). The Ecology of Team Science: Understanding Contextual Influences on Transdisciplinary Collaboration. *American Journal of*

Preventive Medicine, *35*(2, Supplement), S96–S115. https://doi.org/10.1016/j.amepre.2008.05.003

Stonebraker, M., Bruckner, D., & Ilyas, I. F. (2017). *Data Curation at Scale: The Data Tamer System*. 10.

Sun, G., & Khoo, C. S. G. (2017). Social science research data curation: Issues of reuse. *Libellarium: Journal for the Research of Writing, Books, and Cultural Heritage Institutions*, *9*(2), Article 2. https://doi.org/10.15291/libellarium.v9i2.291

Tammen, S., Faux, R., Meiri, K., & Jacque, B. (2018). Collaborative Curriculum Design as a Framework for Designing Teacher Professional Development that Produces the Content Knowledge for Teaching the Life Sciences. *Journal of STEM Outreach*, *1*(1), 1–12. https://doi.org/10.15695/jstem/v1i1.2

Tanaka, A., Taguchi, I., Teragawa, H., Ishizaka, N., Kanzaki, Y., Tomiyama, H., Sata, M., Sezai, A., Eguchi, K., Kato, T., Toyoda, S., Ishibashi, R., Kario, K., Ishizu, T., Ueda, S., Maemura, K., Higashi, Y., Yamada, H., Ohishi, M., … Investigators, on behalf of the P. study. (2020). Febuxostat does not delay progression of carotid atherosclerosis in patients with asymptomatic hyperuricemia: A randomized, controlled trial. *PLOS Medicine*, *17*(4), e1003095. https://doi.org/10.1371/journal.pmed.1003095

Temple, B., & Alys Y. (2004). Qualitative Research and Translation Dilemmas. *Qualitative Research* 4 (2): 161–78. https://doi.org/10.1177/1468794104044430.

Tenzing (2020). GitHub. https://github.com/marton-balazs-kovacs/tenzing

Tesařová, M., Heude, E., Comai, G., Zikmund, T., Kaucká, M., Adameyko, I., Tajbakhsh, S., & Kaiser, J. (2019). An interactive and intuitive visualisation method for X-ray computed tomography data of biological samples in 3D Portable Document Format. *Scientific Reports*, *9*(1), 14896. https://doi.org/10.1038/s41598-019-51180-2

Titley, M. A., Snaddon, J. L., & Turner, E. C. (2017). Scientific research on animal biodiversity is systematically biased towards vertebrates and temperate regions. *PLOS ONE*, *12*(12), e0189577. https://doi.org/10.1371/journal.pone.0189577

Tu, H., Agrawal, R., & Menzies, T. (2020). The Changing Nature of Computational Science Software. *ArXiv:2003.05922 [Cs]*. http://arxiv.org/abs/2003.05922

Ulbricht, D., Elger, K., Radosavljevic, B., & Ott, F. (2020). *Long-tail data curation in the times of the FAIR Principles and Enabling FAIR Data – challenges and best practices from GFZ Data Services* [Other]. oral. https://doi.org/10.5194/egusphere-egu2020-16466

US National Library of Medicine. Number of authors per MEDLINE/PubMed citation (Updated May 15, 2020). http://www.nlm.nih.gov/bsd/authors1.html.

van Nes, F., Abma, T., Jonsson, H., & Deeg, D. (2010). Language differences in qualitative research: Is meaning lost in translation? *European Journal of Ageing*, *7*(4), 313–316. https://doi.org/10.1007/s10433-010-0168-y

van Pelt, T. I., Huntington, H. P., Romanenko, O. V., & Mueter, F. J. (2017). The missing middle: Central Arctic Ocean gaps in fishery research and science coordination. *Marine Policy*, *85*, 79–86. https://doi.org/10.1016/j.marpol.2017.08.008

Vasconcelos, S. M. R., & Roig, M. (2015). Prior Publication and Redundancy in Contemporary Science: Are Authors and Editors at the Crossroads? *SCIENCE AND ENGINEERING ETHICS*, *21*(5), 1367–1378. https://doi.org/10.1007/s11948-014-9599-8

Vasilevsky, N. A., Hosseini, M., Teplitzky, S., Ilik, V., Mohammadi, E., Schneider, J., Kern, B., Colomb, J., Edmunds, S. C., Gutzman, K., Himmelstein, D. S., White, M., Smith, B., O'Keefe, L., Haendel, M., & Holmes, K. L. (2020). Is authorship sufficient for today's collaborative research? A call for contributor roles. *Accountability in Research*. https://doi.org/10.1080/08989621.2020.1779591

Vehviläinen, S., & Löfström, E. (2016). 'I wish I had a crystal ball': Discourses and potentials for developing academic supervising. *Studies in Higher Education*, *41*(3), 508–524. https://doi.org/10.1080/03075079.2014.942272

Verhagen, J. V., Wallace, K. J., Collins, S. C., & Scott, T. R. (2003). QUAD system offers fair shares to all authors. *Nature*, *426*, 602. https://doi.org/10.1038/426602a

Wallis, J. C., & Borgman, C. L. (2011). Who is Responsible for Data? An Exploratory Study of Data Authorship, Ownership, and Responsibility. *Proceedings of the American Society for Information Science and Technology*, *48*, 1–10. https://doi.org/10.1002/meet.2011.14504801188

Wardenaar, T., de Jong, S. P. L., & Hessels, L. K. (2014). Varieties of research coordination: A comparative analysis of two strategic research consortia. *Science and Public Policy*, *41*(6), 780–792. https://doi.org/10.1093/scipol/scu008

World Association of Medical Editors. (2016). *Recommendations on Publication Ethics Policies for Medical Journals || WAME*. https://wame.org/recommendations-on-publication-ethics-policies-for-medical-journals

Yadav, Y., Parihar, V., Ratre, S., Kher, Y., & Iqbal, M. (2015). Microneurosurgical Skills Training. *Journal of Neurological Surgery Part A: Central European Neurosurgery*, *77*(02), 146–154. https://doi.org/10.1055/s-0034-1376190

Yunita, M. N., Agustono, B., & Purnama, M. T. E. (2020). Molecular Identification of Pathogenic Leptospirosis with Zoonotic Potential in Urban Rats (Rattus Rattus) in Banyuwangi District. *Bantara Journal of Animal Science*, *2*(1), Article 1. https://doi.org/10.32585/bjas.v2i1.639

Zhong, C., Wang, T., Zeng, W., & Müller Arisona, S. (2012). Spatiotemporal Visualisation: A Survey and Outlook. In S. M. Arisona, G. Aschwanden, J. Halatsch, & P. Wonka (Eds.), *Digital Urban Modeling and Simulation* (pp. 299–317). Springer. https://doi.org/10.1007/978-3-642-29758-8_16

Zweig, S. J. (2017). Selected Developments in Biotechnology Law and the Biotechnology Industry. *Biotechnology Law Report*, *36*(6), 269–271. https://doi.org/10.1089/blr.2017.29048.sjz

Chapter 5. Assessment of CROTs based on justified criteria

Towards identifying the strengths and weaknesses of major CROTs from an ethical perspective, this chapter uses the 25 justified criteria to compare CROTs. Justified criteria are subsumed under six categories including availability, extensibility, responsibility and accountability, usability, violations and attribution of credit. In each subsection of this chapter, all three CROTs are analysed in relation to one category. For the current analysis, the latest versions and supplementary materials about CROTs that were publicly available on their GitHub pages per August 2020 are used (Data2health, GitHub 2020; Dhtaxonomy, GitHub 2020; González-Bustamante, GitHub 2020).

5.1 Availability

Criterion 1. Is the description of contributions to tasks published under Open Access licence?

CRediT	**CRO**	**TaDiRAH**
Yes	Yes	Yes

Each of the CROTs uses a different version of Creative Commons licence, all of which allow for open access publication of contributions. CRediT uses Creative Commons Attribution 4.0, which "permits almost any use subject to providing credit and license notice" (González-Bustamante, GitHub 2020).

CRO uses Creative Commons Attribution 2.0, which allows free sharing and adaption as long as the license terms are followed (Data2health, GitHub 2020).

TaDiRAH is among the services provided by the DARIAH-EU consortium that uses Creative Commons Attribution 3.0 (DARIAH n.d.). This licence allows free sharing and adaption as long as the license terms are followed.

Criterion 2. Do CROTs' developers provide translated versions of research tasks and their definitions in languages other than English?

CRediT	CRO	TaDiRAH
No	No	Yes

Among the three CROTs only TaDiRAH provides translated versions of research tasks and their definitions in languages other than English. These translations include French, German and Spanish (Dhtaxonomy, GitHub 2020).

5.2 Extensibility

Criterion 3. Do CROTs developers collect and evaluate user feedback for future revisions?

CRediT	CRO	TaDiRAH
Yes	Yes	Yes

All three CROTs are developed and maintained by organisations that have put in place mechanisms to collect and evaluate user feedback. Furthermore, all three CROTs have experts who are in charge of maintaining and updating them.

CRediT is developed and maintained by CASRAI (Consortia Advancing Standards in Research Administration Information), which is a non-profit member initiative founded in 2006 in Ottawa in Canada and is overseen by a central Board of Directors. CASRAI provides a public forum to collect views and feedback about CRediT (https://forum.casrai.org/).[145]

CRO is supported by the National Centre for Data to Health (CD2H). Launched by the NIH (National Institute of Health in The US), the CD2H was founded in 2017 and is led by Oregon Health & Science University in Portland in The US. CD2H uses the *Issue Tracker* on GitHub to

[145] CASRAI has two dedicated chairs for the CRediT project, namely Ms. Liz Allen and Ms. Alison McGonagle-O'Connell (CASRAI 2020).

collect views and feedback about CRO (https://github.com/data2health/contributor-role-ontology/issues).[146]

TaDiRAH is supported by DARIAH (The Digital Research Infrastructure for the Arts and Humanities) network. Established as a European research infrastructure consortium, DARIAH was launched in 2014 and is currently active in 19 European countries. DARIAH uses the *Issue Tracker* on GitHub to collect views and feedback about TaDiRAH (https://github.com/dhtaxonomy/TaDiRAH/issues).[147]

5.3 Responsibility and accountability

Criterion 4. Are there mechanisms to indicate individual and overlapping responsibilities concerning tasks conducted by two or more contributors?

CRediT	**CRO**	**TaDiRAH**
No	No	No

None of the CROTs provides specific mechanisms to indicate individual and overlapping responsibilities in relation to tasks that involve more than one contributor.

Criterion 5. Are there mechanisms to indicate mentor-mentee relations and the subsequent responsibilities for mentors?

CRediT	**CRO**	**TaDiRAH**
No	No	No

None of the CROTs allows the indication of mentor-mentee relations between junior and senior contributors. Although both CRediT and CRO specifically recognise the task of Supervision, in the

[146] CD2H has a leadership board with three members namely Ms. Melissa Haendel, Ms. Julie McMurry and Ms. Shannon McWeeney (Data2health, GitHub 2020).
[147] Currently, TaDiRAH project has four coordinators including Ms. Luise Borek, Ms. Quinn Dombrowski, Ms. Jody Perkins, and Mr. Christof Schöch (Dhtaxonomy, GitHub 2020).

presence of several mentors and mentees, using this role alone would not always help in demarcating mentors' supervisory responsibilities in relation to their mentees.

5.4 Usability

Criterion 6. Are there adequate and straightforward instructions to guide researchers on how CROTs should be used?

CRediT	CRO	TaDiRAH
No	No	No

None of the three CROTs provides instructions to guide researchers on how they should be used.

Criterion 7. In their instructions for researchers, do CROTs require one person to be aware of individual contributions and in charge of correspondence with other contributors and the editorial team?

CRediT	CRO	TaDiRAH
No	No	No

Since none of the CROTs provides instructions to guide users, all three CROTs would respond negatively in this regard.

Criterion 8. Are there reasonably comprehensive instructions for adopters (e.g., journals, universities) that explain how CROTs should be implemented and used?

CRediT	CRO	TaDiRAH
Yes	No	No

Among the three CROTs, only CRediT provides the following instructions for one group of adopters (i.e., publishers). Under the heading of "How to implement CRediT" and the subheading of "For Publishers" on the CASRAI website, the following instructions are available:

"CRediT adoption can be achieved via a manual workflow outside of Submission and Peer Review systems, or through using a system with an existing CRediT integration. The roles given in the above taxonomy include, but are not limited to, traditional authorship roles. The roles are not intended to define what constitutes authorship, but instead to capture all the work that allows scholarly publications to be produced.

Recommendations for applying the CRediT taxonomy are:

- List all Contributions – All contributions should be listed, whether from those listed as authors or individuals named in acknowledgements;
- Multiple Roles Possible – Individual contributors can be assigned multiple roles, and a given role can be assigned to multiple contributors;
- Degree of Contribution Optional – Where multiple individuals serve in the same role, the degree of contribution can optionally be specified as 'lead', 'equal', or 'supporting';
- Shared Responsibility – Corresponding authors should assume responsibility for role assignment, and all contributors should be given the opportunity to review and confirm assigned roles;
- Make CRediT Machine Readable – CRediT tagged contributions should be coded in JATS xml v1.2
- For publishers to make CRediT machine readable and with full meta-data available, CRediT should be coded in JATS xml v1.2, described via this link: https://jats4r.org/credit-taxonomy" (CASRAI 2020, Paragraph 5).

Criterion 9. In their instructions for adopters, is the use of CROTs for describing acknowledged contributions encouraged?		
CRediT	**CRO**	**TaDiRAH**
Yes	No	No

Since CRO and TaDiRAH do not provide instructions for adopters, only CRediT's instructions can be analysed regarding this criterion. In its instructions to publishers, CRediT notes that attribution of credit should not be limited to authors' contributions and should also include individuals who are named in the acknowledgement section of publications:

> "List all Contributions – All contributions should be listed, whether from those listed as authors or individuals named in acknowledgements" (CASRAI 2020, Paragraph 5).

Criterion 10. In their instructions for adopters, do CROTs provide suggestions on how to represent outdated tasks and practices?

CRediT	**CRO**	**TaDiRAH**
No	No	No

Since CRO and TaDiRAH do not provide instructions for adopters, only CRediT's instructions can be analysed regarding this criterion. CRediT's instructions entail no suggestions on how to represent outdated tasks and practices.

Criterion 11. In their instructions for adopters, do CROTs encourage seeking the confirmation of all contributors about listed contributions?

CRediT	**CRO**	**TaDiRAH**
Yes	No	No

Since CRO and TaDiRAH do not provide instructions for adopters, only CRediT's instructions can be analysed regarding this criterion. In its instructions to publishers, CRediT stresses on giving a chance to *all contributors* to review and confirm assigned roles. This note implies that seeking confirmation should not remain limited to authors' and should also include individuals named in the acknowledgement section of publications:

"Corresponding authors should assume responsibility for role assignment, and all contributors should be given the opportunity to review and confirm assigned roles" (CASRAI 2020, Paragraph 5).

Criterion 12. Do CROTs allow linking contributions to digital identifiers?		
CRediT	**CRO**	**TaDiRAH**
Yes	Yes	Yes

According to the report published by the RDA/TDWG Working Group, it is technically possible to link contributors' data from all of the three CROTs to DOIs and ORCID accounts (Thessen et al. 2019). Among the three CROTs, CRediT has also developed badges (figure 33) to be used in users' ORCID profiles (Paglione 2015).

Figure 33. CRediT badges made for showing contributions on users ORCID profiles (González-Bustamante, GitHub 2020).

Criterion 13. Are tasks linked to resolvable URIs?		
CRediT	**CRO**	**TaDiRAH**
No	No	No

None of the CROTs links contributions to resolvable URIs. This is briefly discussed by a CRO user in issue tracker on GitHub (Haendel 2019, CRO Issue 14 - *Should contribution roles be object properties?*).

5.5 Violations

Criterion 14. In their instructions for researchers, do CROTs describe what is regarded as a violation while using them?

CRediT	CRO	TaDiRAH
No	No	No

None of the CROTs provides instructions to guide users or note prohibited practices elsewhere.

Criterion 15. In their instructions for researchers, do CROTs attempt to suggest possible solutions and best practices to minimise the likelihood of (common) violations?

CRediT	CRO	TaDiRAH
No	No	No

None of the CROTs provides instructions to guide users or note possible solutions and best practices elsewhere.

5.6 Attribution of credit

Criterion 16. Within tasks that involve more than one contributor, is it possible to clarify the extent of their individual contributions?

CRediT	CRO	TaDiRAH
Yes	No	No

Among the three CROTs, only CRediT provides the option to clarify the extent of contributions to tasks that involve more than one contributor. As can be seen in the below explanation provided by CRediT's developers, degrees of contributions can be specified with broad categories such as lead, equal or supporting:

"Degree of Contribution Optional – Where multiple individuals serve in the same role, the degree of contribution can optionally be specified as '*lead', 'equal', or 'supporting'*" [Emphasis added] (CASRAI 2020, Paragraph 5).

Criterion 17. In clarifying the extent of contributions to tasks, is it possible to specify two or more contributors as equal?

CRediT	**CRO**	**TaDiRAH**
Yes	No	No

Among the three CROTs, only CRediT provides the option to specify equal contributors:

"Degree of Contribution Optional – Where multiple individuals serve in the same role, the degree of contribution can optionally be specified as 'lead', *'equal'*, or 'supporting'" [Emphasis added] (CASRAI 2020, Paragraph 5).

Criterion 18. Is it possible to recognise the contributions of teams and groups?

CRediT	**CRO**	**TaDiRAH**
Yes	Yes	Yes

Although describing team contributions with CROTs is possible from a technical point of view, none of the CROTs are currently employed to describe collective contributions. As described by one of CRediT's chairs "it is technically possible [to describe teams' contributions] if the journal allows it" (A. McGonagle-O'Connell, personal communication, September 22, 2020). This note suggests that in cases where a team's name is in the byline but team's contributions are not described with CRediT roles (see figure 34), the decision to recognise collective contributions is up to the editors of the individual journal.

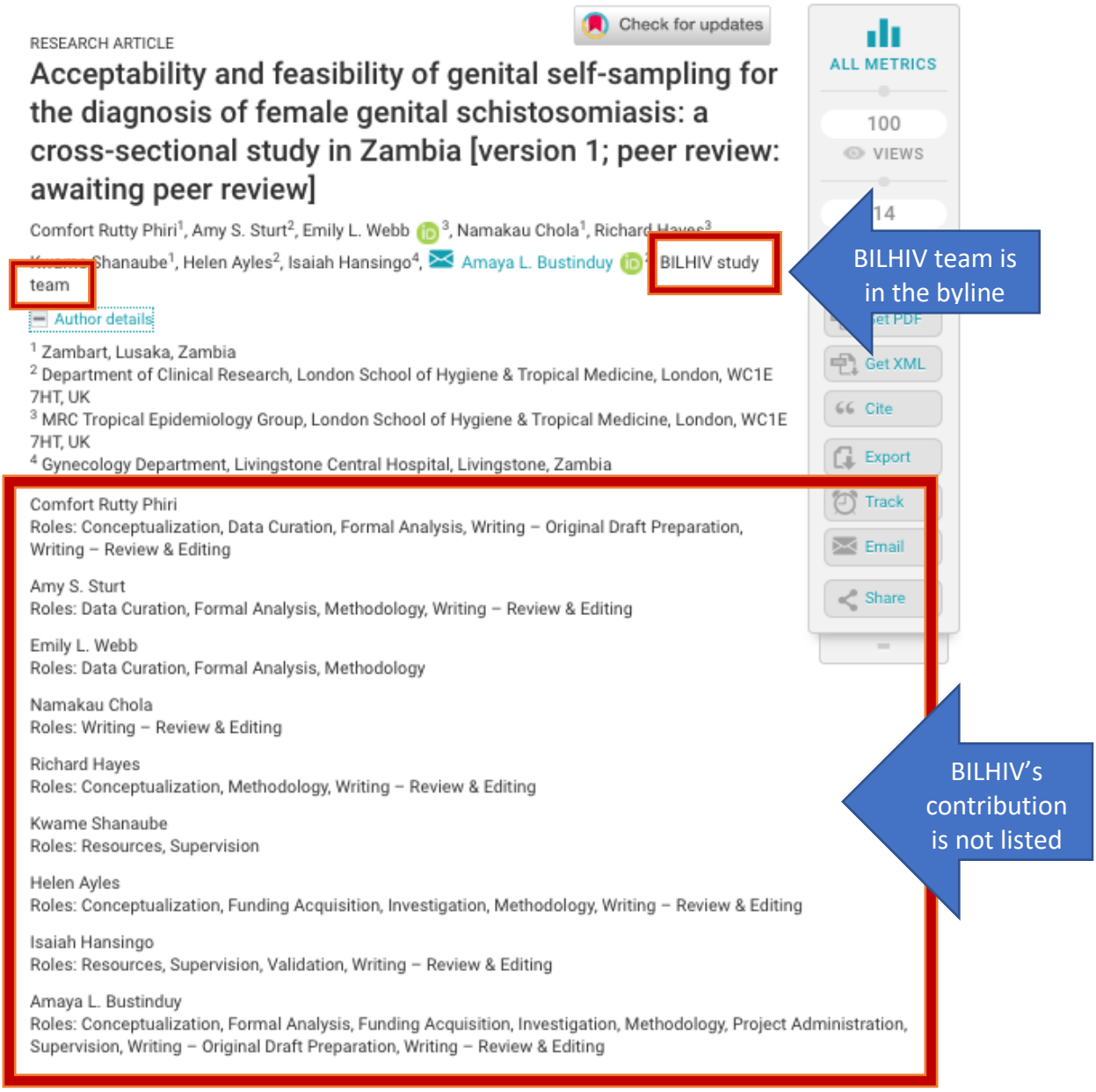


Figure 34. Although the BILHIV study team is mentioned in the byline, their contribution is not described with CRediT (Rutty Phiri et al. 2020).

Criterion 19. Do CROTs refrain from using percentages to specify contributors' share of the total credit?

CRediT	**CRO**	**TaDiRAH**
Yes	Yes	Yes

CRediT uses broad categories (i.e., lead, equal and support) to clarify the extent of contributions to tasks. CRO and TaDiRAH do not provide any means to clarify the extent of contributions.

Hence, all three CROTs would respond positively to this criterion.

Criteria 20-25. Recognition of tasks

This group of criteria consists of tasks that passed the significance threshold test. In order to check whether these tasks are explicitly recognised, the latest version of CROTs and their list of roles and activities are explored.[148] In this exploration, tasks that are explicitly mentioned by CROTs as an independent role/activity (e.g., the task of translation is one of the 40 activities within TaDiRAH) or those that are mentioned as part of a larger role/activity (e.g., within CrediT roles, the task of translation is mentioned under the subheading of Writing-original draft) are considered as explicitly recognised.

Criterion 20. Is it possible to recognise tasks that would traditionally not merit authorship status (e.g., those mentioned in the acknowledgement section)?

CRediT	**CRO**	**TaDiRAH**
Yes	Yes	Yes

In exploring different CROTs to check whether they recognise tasks that would traditionally not merit authorship status, the list of non-author tasks mentioned in the ICMJE guidelines is used as a reference (for a detailed description about why ICMJE guidelines are used please see the ethical justification of candidate assessment criterion 20 in section 4.2.6). In case one of the tasks noted by the ICMJE is explicitly recognised in CROTs, then the provided answer to this criterion would be positive. According to the ICMJE guidelines tasks that do not merit authorship status include:

I) Funding acquisition:

[148] It should be noted that different CROTs use a dissimilar terminology to refer to research tasks. For example, while CRediT and CRO describe research tasks with Roles (14 roles in CRediT and 54 roles in CRO, e.g., the role of formal analysis), in TaDiRAH, tasks are described with 40 activities (e.g., the activity of content analysis). Since researchers contribute to both roles and activities, in what follows they are considered as synonymous terms and no further distinction is made between them.

CRediT and CRO explicitly recognise this task and provide the same definition for it under their role of *Funding acquisition*[149]:

> "Acquisition of the financial support for the project leading to this publication" (CASRAI 2020, Paragraph 1).

TaDiRAH makes a specific mention of this task under the activity of *Project management*:

> "Project management involves activities such as developing a strategy and assessing risk for conducting a project, as well as task management activities, such as keeping a record of tasks, due dates, and other relevant information. It may include activities such as planning, documenting, *getting funding*, but also sending reminders and status reports. Project Management is related to Collaboration" [emphasis added] (TaDiRAH 2020, Paragraph 8).

II) Supervision

CRediT and CRO explicitly recognise this task and provide the same definition for it under their role of *Supervision*:

> "Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team" (CASRAI 2020, Paragraph 1).

TaDiRAH does not explicitly recognise the task of supervision.

III) Administrative support

[149] Since CRO has adopted and used all 14 CRediT roles, in some cases these two CROTs provide the same definition for a role.

CRediT and CRO explicitly recognise this task and provide the same definition for it under their role of *Project administration*:

> "Management and coordination responsibility for the research activity planning and execution" (CASRAI 2020, Paragraph 1).

Although TaDiRAH mentions some of the duties most often associated with administrative support such as planning, documenting and sending reminders under the activity of *Project management*, it does not explicitly recognise this task.

IV) Writing assistance, Technical editing, Language editing, and proofreading

CRediT and CRO specifically mention tasks that are relevant to text editing and provide the same definition for it under their role of *Writing – Review & editing*:

> "Preparation, creation and/or presentation of the published work by those from the original research group, specifically critical review, commentary or revision – including pre- or post-publication stages" (CASRAI 2020, Paragraph 1).

TaDiRAH notes the task of text editing under two different activities. These activities pertain to different degrees and types of editing. Under its *Editing* activity, TaDiRAH mentions the editing of different sources and mediums, including structural, layout and semantic editing of texts:

> "Editing refers to making structural, layout-related, semantic, or other information about a specific part of a document explicit by adding (inline or stand-off) markup to its transcription. This is typically part of the larger activity of scholarly editing of textual, musical, or other sources. It is based on a transcription of the document (the result of data recognition) and guided by a model of the document (the result of modelling)" (TaDiRAH 2020, Paragraph 3).

Furthermore, TaDiRAH mentions another type of editing that involves correcting errors in a written text under its *Cleanup* activity:

> "Data cleanup involves improving the quality of an existing digital object. This could include such things as correcting errors in a written text, errors in OCR results, debugging code, improving the quality of video, audio, or image file" (TaDiRAH 2020, Paragraph 3).

Consequently, since all three CROTs recognise at least one of the tasks that do not merit authorship status (CRediT and CRO recognise all four and TaDiRAH recognises two of them), it is concluded that all three respond positively to this criterion.

Criterion 21. Is it possible to recognise the task of community engagement?

CRediT	**CRO**	**TaDiRAH**
No	Yes	Yes

CRediT fails to recognise this task. While CRO captures this task under its role of *Community engagement* (Data2health, GitHub 2020), no definition is provided for it. TaDiRAH makes a specific mention of this task under its activity of *Community building*:

> "Community building is the activity of creating or enhancing a community with a common interest. It may include dissemination, teaching as well as advocating for specific activities, practices, or values" (TaDiRAH 2020, Paragraph 8).

Criterion 22. Is it possible to recognise creative efforts?

CRediT	**CRO**	**TaDiRAH**
Yes	Yes	Yes

As mentioned in section 4.2.6., creative efforts in research pertain to the development of graphics, images and visualisations. CRediT and CRO explicitly recognise these efforts and provide the same definition under the role of *Visualisation*:

> "Preparation, creation and/or presentation of the published work, specifically visualisation/data presentation" (CASRAI 2020, Paragraph 1).

Furthermore, CRO includes a role entitled *Modelling*, which in some contexts (e.g., Mathematics, Statistics) can be considered as a creative effort. However, a definition is not provided for this role.

TaDiRAH, explicitly recognises four activities that entail some form of creativity. The first one is *Visualisation*:

> "Visualisation refers to activities which serve to summarise and present in a graphical form, and to use such graphical forms analytically, that is to detect patterns, structures, or points of interest in the underlying data. Virtually any kind of data can be visualized, and the forms of visualisations can be images, maps, timelines, graphs, or tables, and the like. Relevant techniques include plotting and mapping" (TaDiRAH 2020, Paragraph 4).

The second activity is *Imaging* and includes tasks such as photography:

> "Imaging refers to the capture of texts, images, artefacts or spatial formations using optical means of capture. Imaging can be made in 2D or 3D, using various means (light, laser, infrared, ultrasound). Imaging usually does not lead to the identification of discrete semantic or structural units in the data, such as words or musical notes, which is something DataRecognition accomplishes. Imaging also includes scanning and digital photography" (TaDiRAH 2020, Paragraph 1).

The third activity is *Spatial analysis* and covers tasks such as geographical visualisations:

> "Spatial Analysis refers to the discovery of trends or patterns in data pertaining to spatial or geographical aspects of the data. Spatial analysis is often based on techniques of annotation of data, such as Georeferencing or Named Entity Recognition, and may lead to visualisation or modelling in the form of maps (see Modelling)" (TaDiRAH 2020, Paragraph 4).

The fourth activity is *Modelling* and covers tasks such as process visualisation and creating mind maps:

> "Modelling is the activity of creating an abstract representation of a complex phenomenon, usually in a machine-readable way, possibly in an interactive way (i.e., it includes "simulation"). Models become machine-readable when modelling produces a schema that describes the elements and the structure of an object of inquiry in an explicit way. Modelling can also refer to the activity of transforming or manipulating a digital object in such a way as to make it compatible with a previously constructed model or schema. Mapping, for instance, is an example of a spatial model. Workflow design is included as part of Modelling, using an object such as Process" (TaDiRAH 2020, Paragraph 4).

Criterion 23. Is it possible to recognise the task of translation?		
CRediT	**CRO**	**TaDiRAH**
Yes	Yes	Yes

CRediT and CRO explicitly recognise this task under their role of *Writing – Original draft*:

> "Preparation, creation and/or presentation of the published work, specifically writing the initial draft (*including substantive translation*)" [Emphasis added] (CASRAI 2020, Paragraph 1).

TaDiRAH includes a dedicated activity for this task titled *Translation*:

"Translation involves creating a new linguistic object based on a source document but written in a different language than the source. This applies to both natural languages and machine-readable programming languages" (TaDiRAH 2020, Paragraph 2).

Criterion 24. Is it possible to recognise the task of providing research samples?

CRediT	**CRO**	**TaDiRAH**
Yes	Yes	No

CRediT and CRO explicitly recognise this task and provide the same definition for it under their role of *Resources*:

"Provision of study materials, reagents, materials, patients, *laboratory samples*, animals, instrumentation, computing resources, or other analysis tools" [Emphasis added] (CASRAI 2020, Paragraph 1).

TaDiRAH does not explicitly recognise this task.

Criterion 25. Is it possible to recognise the task of software programming?

CRediT	**CRO**	**TaDiRAH**
Yes	Yes	Yes

CRediT and CRO explicitly recognise this task and provide the same definition for it under their role of *Software*:

"Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components" (CASRAI 2020; Paragraph 1).

Among CRO's roles, *Software* is one that entails a subset of fine-grained roles. In CRO's categorisation, Software is considered a "parent role" with five "child roles" (Data2health, GitHub 2020). Nevertheless, CRO does not provide a specific definition for these:

1. Software Architecture
2. Software Code Review or Testing
3. Software Design
4. Software Engineering
5. Software Programming

TaDiRAH explicitly recognises the task of Software programming under the activity of *Programming*:

> "Creation of code executable by a computer, that is creation of scripts or software. (This includes 'Prototyping', the creation of such code for testing or modelling purposes.) It is also closely related to the broader activity of tool development. Programming is separate from Encoding (enriching a document by making structural, layout-related, semantic, or other information about a specific part of a document explicit by adding markup to its transcription)" (TaDiRAH 2020, Paragraph 2).

5.7 Results

The provided comparison in this chapter shows the strengths and weaknesses of analysed CROTs in relation to 25 assessment criteria. This analysis makes no attempt to rank criteria in terms of their importance because raised issues might have lower/higher significance for different parties. For instance, while availability of roles and their definition in other languages might be a top priority for researchers working in international consortia, directors of publishing houses might find these translations less important than the provision of instructions for adopters. On that basis, while positive responses are added up to suggest an overall score for each of the

CROTs, these scores do not include the importance or weight of each criterion in relation to other criteria because this thesis includes no systematic analysis of the criteria's weight (for more details about the criterion's weight, see section 3.8.4).

Out of the 25 criteria, CRediT responds positively to 15 criteria, but TaDiRAH and CRO respond positively to only 11 criteria each (see table 26 for a summary of the analysis). Accordingly, the assessment instrument developed in this thesis suggests that among the three major CROTs, CRediT stands out as the option with the best score. In particular, as regards criteria about the attribution of credit and usability, CRediT scores better than other two CROTs. Regarding the criteria about attribution, by providing the option to clarify the extent of contributions to tasks and specify those who make equal contributions, CRediT facilitates a more accurate attribution of credit compared to other CROTs. Even though CRediT provides a shorter list of roles compared to the other two CROTs (14 unique roles), each role is described with clear and straightforward definitions. On the contrary, CRO provides no definitions for its unique roles (i.e., the 40 roles that are not covered by CRediT)[150], and TaDiRAH offers such long and complicated list of activities, objects and techniques that using them might even confuse expert users.[151] Furthermore, only CRediT provides formal instructions for adopters. Within these instructions, adopters are encouraged to recognise and list contributions that are mentioned in the acknowledgement sections. CRediT's instructions for adopters also highlight that listed contributions should be confirmed by all contributors.

Criterion	CRediT	CRO	TaDiRAH
Published under Open Access licence	Yes (CC 4.0)	Yes (CC 2.0)	Yes (CC 3.0)
Available in other languages than English	No	No	Yes (French, German and Spanish)
Collection and evaluation of users' feedback	Yes (CASRAI Forum)	Yes (Issue Tracker on GitHub)	Yes (Issue Tracker on GitHub)

[150] Since CRO is built on CRediT taxonomy (Ilik et al. 2018), it uses all of CRediT's roles and definitions, but it does not provide a definition for roles that are not part of CRediT.
[151] TaDiRAH requires fairly extensive knowledge of all the described research activities (40 unique activities), research objects (36 unique mediums, e.g., code, manuscript, map), and research techniques (34 unique techniques, e.g., brainstorming, debugging, scanning).

Indicate individual responsibilities within a large task	No	No	No
Indicate mentor-mentee relations	No	No	No
Instructions for researchers	No	No	No
• One contributor to know details of all individual contributions	No	No	No
• Describe what is considered as a violation	No	No	No
• Suggestions for possible solutions to violations	No	No	No
Instruction for adopters	Yes (For publishers)	No	No
• Encourage the recognition of acknowledged roles	Yes	No	No
• Suggestions on how to represent outdated tasks and practices	No	No	No
• Encourage asking all contributors to confirm listed contributions	Yes	No	No
Linking tasks to resolvable URIs	No	No	No
Link contributions to digital identifiers	Yes (DOI and ORCID)	Yes (DOI and ORCID)	Yes (DOI and ORCID)
Registering the extent of contributions	Yes (Lead/Supporting/ Equal contributor)	No	No
Registering two or more contributors as equal	Yes (Equal contributor)	No	No
Recognising team contributions	Yes	Yes	Yes
Refrain from using percentage-based models	Yes	Yes	Yes
Recognition of tasks			
Non-author tasks	Yes (Supervision, funding acquisition, administrative support, editing text)	Yes (Supervision, funding acquisition, administrative support, editing text)	Yes (Supervision, funding acquisition, editing text)
Community engagement	No	Yes (Community engagement)	Yes (Community building)

Creative efforts	Yes (Visualisation)	Yes (Visualisation, Modelling)	Yes (Visualisation, Imaging, Spatial analysis, Modelling)
Translation	Yes (Writing – Original draft)	Yes (Writing – Original draft)	Yes (Translation)
Provision of research samples	Yes (Resources)	Yes (Resources)	No
Software programming	Yes (Software)	Yes (Software Architecture; Software Code Review or Testing; Software Design; Software Engineering; Software Programming)	Yes (Programming)

Table 26. A summary of CROTs responses to the 24 justified criteria

References

Armoogum, S., & Li, X. (2019). Chapter 2—Big Data Analytics and Deep Learning in Bioinformatics With Hadoop. In A. K. Sangaiah (Ed.), *Deep Learning and Parallel Computing Environment for Bioengineering Systems* (pp. 17–36). Academic Press. https://doi.org/10.1016/B978-0-12-816718-2.00009-9

CASRAI. (2020). *CRediT - Contributor Roles Taxonomy*. CASRAI. https://casrai.org/credit/

DARIAH. (n.d.). TaDiRAH – Taxonomy of Digital Research Activities in the Humanities | DARIAH. *DARIAH Tools & Services*. https://www.dariah.eu/tools-services/tools-and-services/tools/tadirah-taxonomy-of-digital-research-activities-in-the-humanities/

Data2health. (2020). *Contributor Role Ontology.* GitHub. https://github.com/data2health/contributor-role-ontology

Dhtaxonomy. (2020). Taxonomy of Digital Research Activities in the Humanities. GitHub. https://github.com/dhtaxonomy/TaDiRAH

Floyd, S., Shanaube, K., Yang, B., Schaap, A., Griffith, S., Phiri, M., Macleod, D., Sloot, R., Sabapathy, K., Bond, V., Bock, P., Ayles, H., Fidler, S., Hayes, R., & Team, the H. 071 (PopART) study. (2020). HIV testing and treatment coverage achieved after 4 years across 14 urban and peri-urban communities in Zambia and South Africa: An analysis of findings from the HPTN 071 (PopART) trial. *PLOS Medicine*, *17*(4), e1003067. https://doi.org/10.1371/journal.pmed.1003067

González-Bustamante, B. (2020). *Bgonzalezbustamante/CRediT*. GitHub. https://github.com/bgonzalezbustamante/CRediT

Haendel, M. (2019). *Should contribution roles be object properties? · Issue #14 · data2health/contributor-role-ontology*. GitHub. https://github.com/data2health/contributor-role-ontology/issues/14

Ilik, V., Conlon, M., Triggs, G., White, M., Javed, M., Brush, M., Gutzman, K., Essaid, S., Friedman, P., Porter, S., Szomszor, M., Haendel, M. A., Eichmann, D., & Holmes, K. L. (2018). OpenVIVO: Transparency in Scholarship. *Frontiers in Research Metrics and Analytics*, *2*. https://doi.org/10.3389/frma.2017.00012

International Committee of Medical Journal Editors (2019). Recommendations for the conduct, reporting, editing, and publication of scholarly work in medical journals. Available online at: http://www.icmje.org/icmje-recommendations.pdf. Accessed: 27 May 2020.

Paglione, L. (2015, August 11). *Contributor recognition: An update on ORCID, Project CRedIT, and contributorship badges* [Text]. ORCID. https://orcid.org/blog/2015/08/11/contributor-recognition-update-orcid-project-credit-and-contributorship-badges

Rutty Phiri, C., Sturt, A. S., Webb, E. L., Chola, N., Hayes, R., Shanaube, K., Ayles, H., Hansingo, I., Bustinduy, A. L., & BILHIV study team. (2020). Acceptability and feasibility of genital self-sampling for the diagnosis of female genital schistosomiasis: A cross-sectional study in Zambia. *Wellcome Open Research*, *5*, 61. https://doi.org/10.12688/wellcomeopenres.15482.1

TaDiRAH. (2020). *Taxonomy of Digital Research Activities in the Humanities-Research activities*. TaDiRAH. http://tadirah.dariah.eu/vocab/index.php

Thessen, A. E., Woodburn, M., Koureas, D., Paul, D., Conlon, M., Shorthouse, D. P., & Ramdeen, S. (2019). Proper Attribution for Curation and Maintenance of Research Collections: Metadata Recommendations of the RDA/TDWG Working Group. *Data Science Journal*, *18*(1), 54. https://doi.org/10.5334/dsj-2019-054

Chapter 6. Recommendations for improving CROTs

After evaluating three major CROTs using the assessment instrument, this chapter provides individualised recommendations for improving each of them based on how they responded to the 25 criteria of the assessment instrument. Since adopters (e.g., publishers, universities) or researchers might have different priorities and expectations from CROTs, in providing recommendations, none of the criteria is given higher priority/urgency, and it is assumed that meeting all 25 criteria of the assessment instrument is desirable for all three CROTs. Taking this approach prevents favouring interests of a specific party over others, or providing recommendations that are biased towards the application of CROTs in a particular context (e.g., the use of CROTs in universities). Accordingly, in providing individualised recommendations, each criterion that received a negative response is seen as a potential area to improve.

It should be noted that this thesis did not aim to provide a complete technical solution with all the required steps about implementation of its recommendations. Accordingly, suggestions provided in this chapter should be considered as *possible directions* to improve CROTs in relation to criteria that they respond negatively to. This decision is motivated based on the following grounds:

- Providing complete solutions with all the involved steps for their implementation requires computer coding.
- In the absence of empirical evidence about how each of the CROTs are used in different contexts (e.g., how CRediT is used by universities), any complete technical solution lacks vital details about prerequisites and practical challenges faced by different adopters.
- Given that each of the CROTs are managed by expert groups, solutions have to be assessed and confirmed by these experts first.

6.1 Methodology for developing recommendations

Recommendations of this chapter aim to improve each of the CROTs in relation to the assessment criteria where they responded negatively. The results of the previous chapter showed that CRediT responded negatively to 10 criteria, and CRO and TaDiRAH responded negatively to 14 criteria. In providing recommendations for each of the CROTs, a two-step method is followed (figure 35).

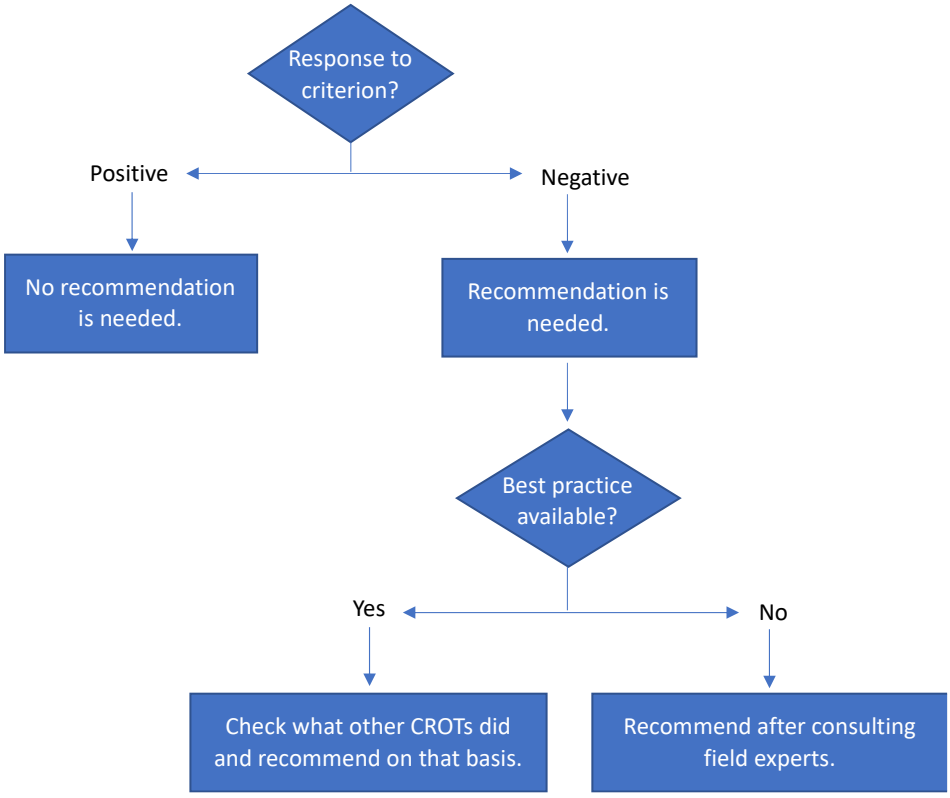


Figure 35. Methodology for providing recommendations.

If a criterion has received a positive response, no recommendation is provided. However, if a criterion has received a negative response, then other CROTs are checked to see whether any of them responds positively to the same criterion. If one of the CROTs responds positively, then their approach is used to provide recommendations for CROTs that respond negatively to that criterion.

If, however, the criterion in question is answered negatively by all three CROTs, then available technology and best practices in publication processes are explored to find the most suitable solution. In these cases, field experts are contacted to confirm the feasibility of recommendations. These experts are introduced by CROTs' developers[152] and were consulted between February and August 2020:

- CRediT: Richard Wynne
- CRO: Julien Colomb
- TaDiRAH: Gimena del Rio Riande[153]

Two experts were contacted via online communication systems (i.e., Zoom and Skype) and one was consulted via email. After being informed about the objectives of this thesis, they were asked about the feasibility of suggested recommendations. These experts confirmed that provided suggestions are feasible from a technical point of view and in some cases added useful suggestions. In sections where experts' recommendations are used, their names are mentioned in the text or in a footnote.

Furthermore, as mentioned in section 3.1, CRediT and CRO describe research tasks with Roles (14 roles in CRediT and 54 roles in CRO, e.g., the role of formal analysis), but in TaDiRAH, tasks are described with 40 activities (e.g., the activity of content analysis). In this chapter too, roles and activities are considered as synonymous terms and no further distinction is made between the two because researchers can contribute to both.

It should be noted that the order of recommendations does not imply priority or importance and merely reflects the sequence of criteria in the assessment instrument.

[152] While working on this thesis, I have been in contact with the developers of all three analysed CROTs and they have kindly put me in contact with experts who have ample work experience with their developed CROTs.

[153] In personal communication with Christof Schöch (TaDiRAH's coordinator), he noted a lack of capacity and resources for any further development or improvement of TaDiRAH in the foreseeable future. Nevertheless, Gimena del Rio Riande was contacted for checking the feasibility of suggestions.

6.2 CRediT

According to the results of the previous chapter, CRediT responds negatively to 10 criteria (see table 27).

Criterion	CRediT
Available in other languages than English	No
Indicate individual responsibilities within a large task	No
Indicate mentor-mentee relations	No
Instructions for researchers	No
• One contributor to know details of all individual contributions	No
• Describe what is considered as a violation	No
• Suggestions for possible solutions to violations	No
In instruction for adopters	
• Suggestions on how to represent outdated tasks and practices	No
Linking tasks to resolvable URIs	No
Recognition of tasks	
• Community engagement	No

Table 27. Criteria that CRediT responds negatively.

6.2.1 Translate roles and their definitions into languages other than English

CRediT's roles and their definitions are currently not available in any language other than English.

Suggestions for implementation:

Looking at the translated versions of TaDiRAH, French, German and Spanish seem to be languages that are widely used. Use could be made of the CRediT forum to announce a call to members of the community to translate these roles and their definitions into other languages. The same outlet could be used to find researchers to review and confirm provided translations.

6.2.2 Provide mechanisms to indicate individual and overlapping responsibilities about tasks that involve more than one contributor

CRediT's attribution of responsibilities should be improved using Resolvable URIs. As mentioned in section 4.2.4, linking contributions to resolvable URIs allows the inclusion of additional information about individual contributions in a prose format. One type of additional information could pertain to individual and overlapping responsibilities.

Suggestions for implementation:

In facilitating a clear delineation of responsibilities, CRediT's developers should link roles to resolvable URIs and encourage adopters to incorporate this option in their submission process. In (personal) communication with one of the field experts, Julien Colomb noted that currently an ill-conceived version of this recommendation is implemented by the journal of *eLife* (eLife 2017). As can be seen in figure 36, in addition to the possibility to choose one or more of the 14 standard roles for each contributor, a text box can also be used to add more information (so-called pretext) about contributions.

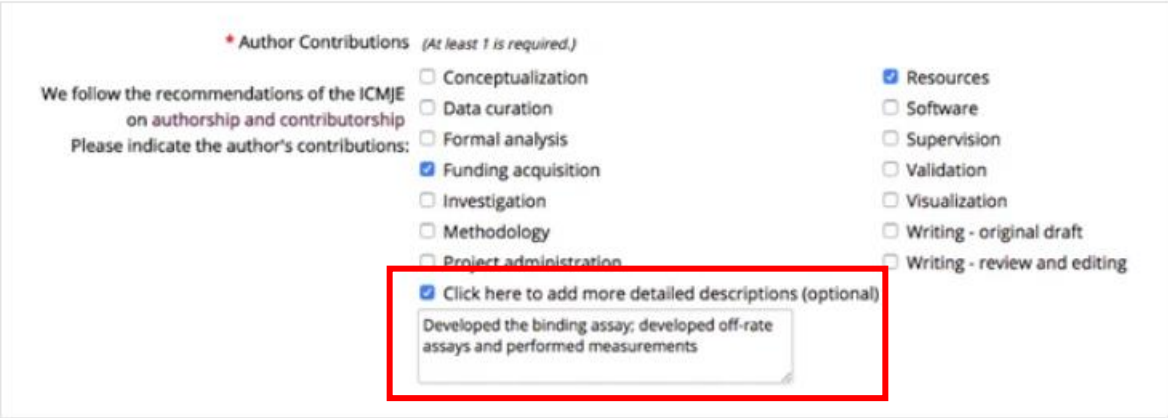


Figure 36. Clarification of users' contributions via CRediT roles and free text in the journal of eLife (eLife 2017).

However, since resolvable URIs are not incorporated into this workflow yet, information that is provided as a free text cannot be linked to specific roles.[154] Incorporating Resolvable URIs and ORCID ids into this workflow would lead to offering a separate text box for each role to include additional information about individual contributions. As the graphical prototype presented in figure 37 shows, resolvable URIs would allow the inclusion of additional information about each CRediT role that is associated with contributors. In the presented example in figure 37, the corresponding contributor has reported that Bert Gordijn contributed to Funding acquisition and Supervision. Accordingly, a text box appears underneath both roles and allows the inclusion of extra information about Bert Gordijn's contributions to these roles. For example, Bert Gordijn's role of *Funding acquisition* is further specified by the following prose description: *Bert Gordijn only invited partners to the consortia and allowed each to draft their own financial needs*. This description readily clarifies individual responsibilities in relation to the role of funding acquisition, and accordingly, financial accountabilities. For instance, in cases where involved partners make unjustified spending, Bert Gordijn cannot be held responsible, and only those who made unjustified spending would be held to account.

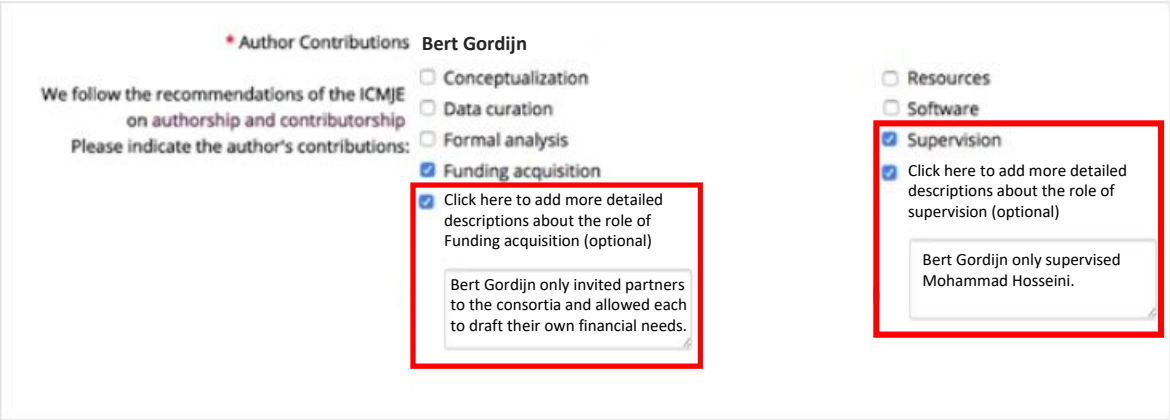


Figure 37. A graphical prototype based on eLife's submission workflow that shows how linking resolvable URIs could improve the indication of individual and overlapping responsibilities.

To ensure that this option is used correctly, CRediT's developers could add the following guidance in their instructions for researchers:

[154] Accordingly, once a paper is published, tasks are not clickable so as to show detailed information about their conduct. Ideally, it should be possible to click on a task and see a detailed account of individual contributions to that task.

In listing individual contributions to roles that are conducted by two or more contributors, the corresponding contributor should ensure that:

- Use is made of the pretext box to specify contributions such that individual responsibilities are as clear as possible. Specified contributions facilitate the accurate identification of individual responsibilities for flawed tasks and ensure a truthful reporting of contributions.

6.2.3 Provide mechanisms to indicate mentor-mentee relations

Currently, the only way to clarify mentors' responsibilities is via using CRediT's role of *Supervision*. However, in the presence of several mentors and mentees, using this role alone would not always help in demarcating mentors' supervisory responsibilities in relation to their mentees. One way of addressing this problem is to clarify mentor-mentee relations through contextualising the role of *Supervision* and indicating which researcher was being supervised by which mentor. Clarifying mentor-mentee relations should be promoted during the submission process, and facilitated via linking CRediT roles to resolvable URIs.

Suggestions for implementation:

The implementation of this recommendation would be fairly similar to what is mentioned in section 6.2.2, and is also validated by Julien Colomb. Linking CRediT roles to resolvable URIs allows embedding additional information about contributions. In this case, the text box that is linked to CRediT's role of *Supervision* could be used to mention mentees that are supervised by each mentor and ideally connect them via their ORCID ids. As can be seen in figure 38, the text box under the role of *Supervision* is used to clarify Bert Gordijn's supervisory responsibilities with the following text: *Bert Gordijn only supervised Mohammad Hosseini*. This text implies that if contributors other than Mohammad are proven to have made a mistake that is due to insufficient/inadequate supervision, Bert Gordijn cannot be held responsible.

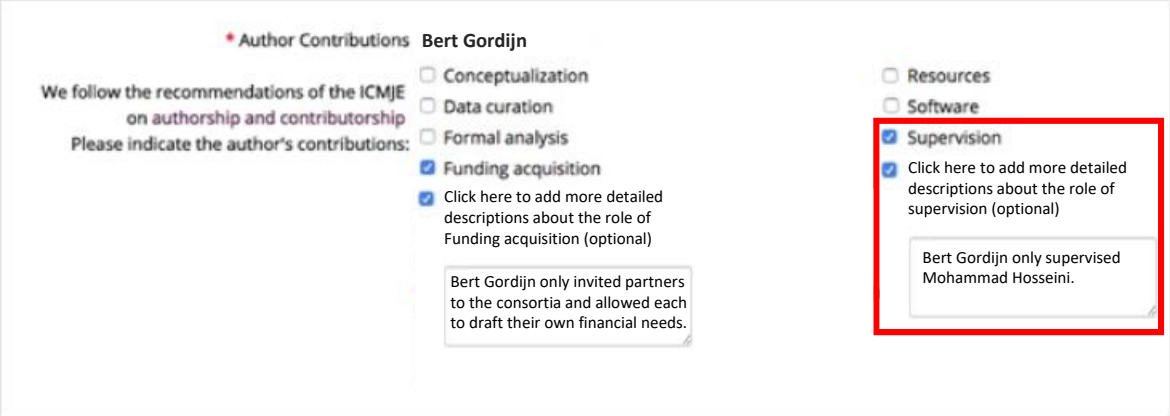


Figure 38. A graphical prototype of how linking resolvable URIs could improve the indication of mentor-mentee relations in the submission workflow (red box on the right).

To ensure that this option is used correctly, CRediT developers could add the following guidance in their instructions for researchers:

> In cases where more than one contributor is listed as a supervisor, the corresponding contributor should ensure that:
>
> - Use is made of the pretext box to clarify which supervisor is responsible for mentoring which junior researcher(s).

6.2.4 Provide adequate and straightforward instructions to guide researchers on how CRediT should be used

Currently, CRediT's developers do not provide instructions for researchers. As a result, in cases where adopters provide no instructions, users would either have to search for them elsewhere, or look at other journal articles that employ CRediT and speculate how CRediT should be used. Furthermore, sometimes the lack of providing instructions by CRediT's developers has led to the development of dissimilar and problematic instructions by different adopters (see Appendix C for specific examples).

Suggestions for implementation:

CRediT's chairs have published several articles that include instructions about CRediT and its use (e.g., Brand et al. 2015; Allen et al. 2019). Although these publications are useful for experts, it is

unlikely that an individual researcher or group of researchers will have the knowledge necessary to identify, read and understand the instructions embedded in these publications when submitting a manuscript. Therefore, CRediT's developers could extract the most useful pieces of information from these articles for the purpose of compiling instructions for researchers.

Additionally, once tasks are linked to resolvable URIs, adding instructions on how to describe individual and overlapping responsibilities (mentioned in section 6.2.2), and mentor-mentee relations (mentioned in section 6.2.3) would enrich CRediT's instructions for researchers. Another source that may be useful in developing instructions for researchers can be found in the guidelines provided by the University of Glasgow:

- "Lead Glasgow author responsible for capturing agreed roles of Glasgow authors
- Must choose from the CRediT options
- Allow ALL co-authors to review and confirm the roles
- Ensure information is provided to publisher
- If publisher does not request roles, include them in the narrative if possible
- If publisher does not include in paper, submit to researchenlighten@glasgow.ac.uk to have roles recorded on repository" (Casci & McCutcheon 2019, Slide 16).

6.2.5 In instructions for researchers, note that one contributor should know the details of all individual contributions

It is (usually) the corresponding contributor who is expected to know what every contributor did as part of a project or publication, and therefore, assumes responsibility for reporting individual contributions as part of the submission process (McNutt et al. 2018). In their instructions for publishers, CRediT developers highlight that the "Corresponding authors should assume responsibility for role assignment" (CASRAI 2020), but this note should also be reflected in their instructions for researchers.

Suggestions for implementation:

In their instructions to researchers, CRediT developers could use the same statement that is mentioned in their instructions to publishers:

- "Corresponding authors should assume responsibility for role assignment, and all contributors should be given the opportunity to review and confirm assigned roles" (CASRAI 2020, Paragraph 5).

6.2.6 In instructions for adopters, provide suggestions on how to represent outdated tasks and practices

CRediT's current instructions for publishers is the only example of instruction provided to adopters by the developer of one of the CROTs. These instructions address two issues that were required by the assessment framework, namely:

- Encouraging adopters to recognise acknowledged roles
- Encouraging adopters to ask all contributors to confirm listed contributions[155]

However, CRediT's current instructions for publishers fail to provide suggestions on how adopters should represent outdated tasks and practices.

Suggestions for implementation:

One suggestion is to provide a list of outdated research tasks with recommendation on how they should be described using current roles in CRediT (see table 28).[156]

Outdated task	**Current equivalent in CRediT**
Programming with punch cards	Software

Table 28. CROTs could provide suggestions for representing outdated tasks.

[155] During the expert consultation, Richard Wynne noted that this functionality is available for configuration in some submission systems such as Editorial Manager. That said, it is not always used by all journals.

[156] During the expert consultation, Julien Colomb mentioned that CASRAI used to have a public index for all the relevant research vocabulary but due to undisclosed reasons, this index has been deleted from their public library.

6.2.7 Link roles to resolvable URIs

As shown earlier in this chapter, linking contributions to resolvable URIs improves the attribution of responsibilities and clarifies mentor-mentee relations. Furthermore, given that the definition of CRediT roles are likely to change over time, using resolvable URIs would also allow clarifying which version of CRediT, and accordingly, which definition of tasks are used at any given publication.

Suggestions for implementation:

Linking tasks to resolvable URIs transforms CRediT roles into hyperlinks, which if clicked on, would show additional information about roles and those who contributed to them. As can be seen in the prototype presented in figure 39, by clicking on each role relevant information about the definition of that role, and other details that may be provided by the corresponding contributor will be shown. In the example shown in figure 39, by clicking on CRediT's role of *Conceptualisation*, readers can see the definition of this role and extra information about Anna Catharina Armond's contributions.

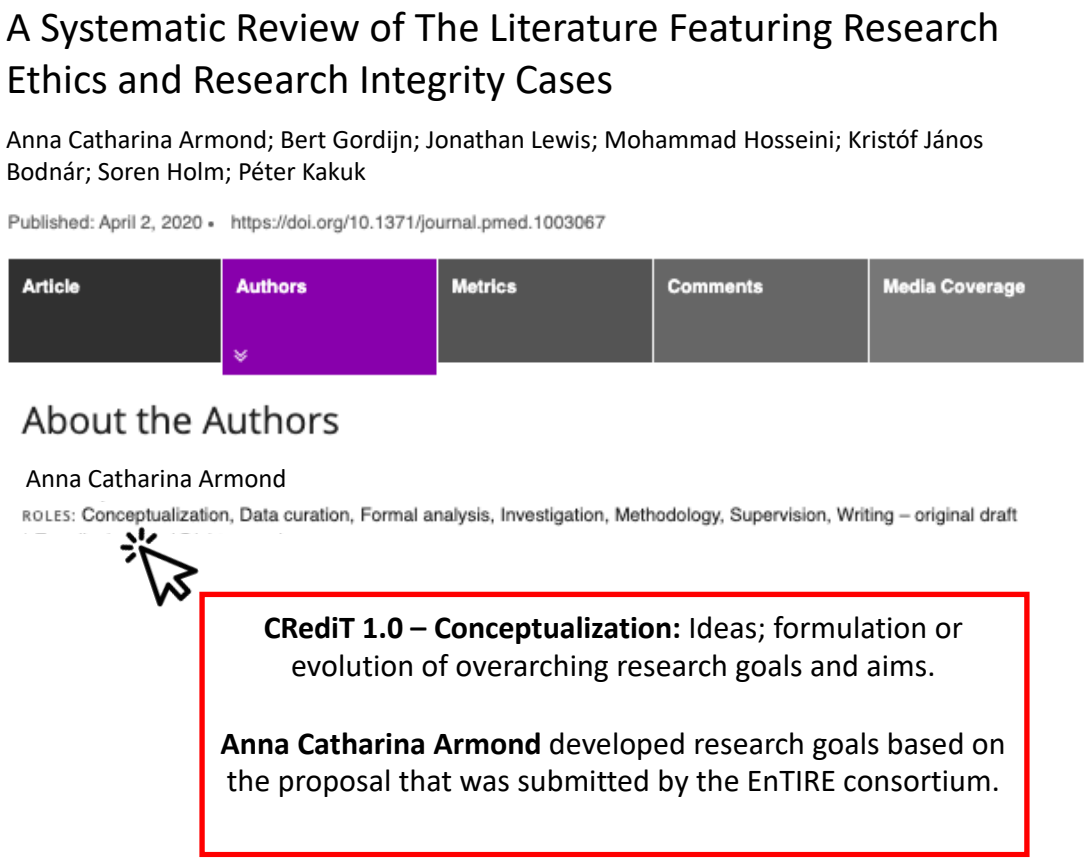


Figure 39. A graphical prototype about how linking resolvable URIs could impact the presentation of contributions in publications by clarifying the definition of roles and individual contributions (a different box would appear by clicking on each role).

As noted by Julien Colomb, from a technical point of view, the incorporation of resolvable URIs is perhaps one of the most complicated suggestions to implement. This feature would require the development of specific digital infrastructure to host and manage the additional information about contributions. While exploring involved complexities of incorporating resolvable URIs into CROTs is out of the scope of this thesis[157], the European Commission's Study on Persistent URIs (INSPIRE 2017) can be considered as a good starting point on how to incorporate resolvable URIs into CRediT.

6.2.8 In instructions for researchers, describe what is regarded as a violation

CRediT developers should provide descriptions that highlight prohibited practices and explain what is considered as a violation while using CRediT.

[157] As mentioned in the introductory note to this chapter, this thesis only provides direction without complete technical solutions and the required steps about implementation.

Suggestions for implementation:

Based on what is discussed in this research and provided examples on how CRediT is used in recent articles published by the journals of *PLOS Medicine* and *PLOS Biology*, the following recommendations could be used as some of the possible violations (i.e., representing a non-exhaustive list of violations entailing only those that were mentioned in this thesis) to mention in instructions for researchers:

- Failing to report all contributions accurately is unacceptable.
- The role of Supervision cannot be assigned to those who are not willing to accept supervisory responsibilities.
- In using broad categories to specify degrees of contribution, no more than one contributor should be specified as the lead contributor.

6.2.9 In instructions for researchers, provide possible solutions and best practices to prevent common violations

CRediT should offer solutions and best practices to prevent common violations such as credit misattribution. During expert consultation with Richard Wynne and Julien Colomb, applications such as Rescognito and Tenzing were mentioned as Open Access and free solutions specifically designed to improve CRediT's usability for researchers, and prevent common malpractices such as credit misattribution, and guest/ghost contributors.

Suggestions for implementation:

Based on what is discussed in this research and provided examples, introducing recent tools in instructions to researchers could be considered. The following note could be added to instructions for researchers:

All contributors to research and publications play a role in facilitating an accurate reflection of contributions:

- Contributions should be registered and communicated effectively during the project. Use could be made of templates such as Tenzing.
- Persistent identifiers should be used to improve the consistency and accuracy of registered contributions. Use could be made of platforms such as Rescognito to assign credit if contributions were not collected during the original publication workflow.

6.2.10 Recognise the task of community engagement

While CRO and TaDiRAH explicitly recognise the task of community engagement, this task is not recognised by CRediT. As mentioned in the justification of this task in section 4.2.6, community engagement is both indispensable and specific, and makes result-changing contributions to research. On that basis, it should be added to CRediT's current list of roles.

Suggestions for implementation:

Using the definition provided in TaDiRAH's activity of community building[158], and the provided explanation in section 4.2.6 about the scope and impact of this task on communities, the following title and definition seem in line with how this task could be recognised in CRediT:

> Community engagement
>
> Development, adaptation or communication of research material to interact/engage with communities, including (but not limited to) recruitment strategy and questionnaire design.

[158] This activity is defined as: "Community building is the activity of creating or enhancing a community with a common interest. It may include dissemination, teaching as well as advocating for specific activities, practices, or values" (TaDiRAH 2020, Paragraph 8).

6.3 CRO

According to the results of the previous chapter, CRO responds negatively to 14 criteria (see table 29).

Criterion	CRO
Available in other languages than English	No
Indicate individual responsibilities within a large task	No
Indicate mentor-mentee relations	No
Instructions for researchers	No
• Senior contributor to know details of individual contributions	No
• Describe what is considered as a violation	No
• Suggestions for possible solutions to violations	No
Instruction for adopters	No
• Encourage the recognition of acknowledged roles	No
• Suggestions on how to represent outdated tasks and practices	No
• Encourage asking all contributors to confirm listed contributions	No
Linking tasks to resolvable URIs	No
Registering the extent of contributions	No
Registering two or more contributors as equal	No

Table 29. Criteria that CRO responds negatively.

6.3.1 Translate roles and their definitions into languages other than English

CRO roles are currently not available in any language other than English.[159]

Suggestions for implementation:

Looking at the translated versions of TaDiRAH, French, German and Spanish seem to be languages that are widely used. To translate CRO roles, use could be made of professional communities where CRO developers and potential users are among active members. For example, FORCE11 is a well-established community of librarians, archivists, publishers and

[159] It should be noted that among the three CROTs, CRO is the only one that provides no definition for its roles even in English. Therefore, one prerequisite to fully apply the current recommendation is for CRO developers to provide a definition for each role. At the moment, it is only roles' titles that can be translated. Since this issue was not raised in the bottom-up investigation, this thesis does not include recommendations on how CRO should define current roles. That said, given that CRediT and TaDiRAH provide a definition for their roles and activities, they can be used by CRO developers as best practices.

research funders that organise regular conferences and courses on the topics related to scholarly communication and publications.[160] Alternatively, CRO developers could use the international community of scholars who are members of the VIVO community[161] and ask for their support in translating current roles to languages other than English.

6.3.2 Provide mechanisms to indicate individual and overlapping responsibilities about tasks that involve more than one contributor

CRO's attribution of responsibilities should be improved via linking roles to resolvable URIs.

Suggestions for implementation:

These suggestions would be similar to those mentioned in section 6.2.2.

6.3.3 Provide mechanisms to indicate mentor-mentee relations

Currently, in the presence of several mentors and mentees, using CRO's role of *Supervision* alone would not always help in demarcating mentors' supervisory responsibilities. One way of addressing this issue is to clarify mentor-mentee relations through contextualising the role of *Supervision* and indicating which researcher was being supervised by which mentor. Clarifying mentor-mentee relations should be promoted during the submission process, and facilitated via linking CRO roles to resolvable URIs.

Suggestions for implementation:

These suggestions would be similar to those mentioned in section 6.2.3.

[160] According to their members' directory, FORCE11 had more than 3200 members per August 2020: https://www.force11.org/community/members-directory
[161] According to their People's directory in Duraspace, VIVO community had more than 5000 members per August 2020: https://wiki.lyrasis.org/browsepeople.action

6.3.4 Provide adequate and straightforward instructions to guide researchers on how CRO should be used

Currently, CRO does not provide instructions for researchers. Accordingly, in cases where adopters provide no instructions, users would have to search for them elsewhere. As mentioned in section 6.2.4, this might result in the development of dissimilar and problematic instructions by different adopters.

Suggestions for implementation:

CRO chairs have published several articles that include information about CRO and its use (e.g., Ilik et al. 2018; Vasilevsky et al. 2020). Although these publications are useful for experts, it is unlikely that an individual researcher or group of researchers will have the knowledge necessary to identify, read and understand the instructions embedded in these publications when submitting a manuscript. Therefore, CRO's developers could extract the most useful pieces of information from these sources for the purpose of compiling their instructions for researchers.

6.3.5 In instructions for researchers, note that one contributor should know the details of all individual contributions

It is (usually) the corresponding contributor who knows what every contributor did and reports these during the submission process.

Suggestions for implementation:

In their instruction to researchers, CRO developers could use the statement that is mentioned in CRediT's instructions to publishers:

- "Corresponding authors should assume responsibility for role assignment, and all contributors should be given the opportunity to review and confirm assigned roles" (CASRAI 2020).

6.3.6 Provide instructions for adopters

CRO should provide instructions for different adopters such as publishers, universities and repositories.

Suggestions for implementation:

Developers of CRO could use CRediT's instructions for publishers as a starting point in compiling their own instructions for various adopters. Additionally, depending on how CRO is employed in different contexts, specific information should be included in these instructions.

6.3.7 In instructions for adopters, encourage the recognition of acknowledged roles

In their instructions for adopters, CRO developers should encourage the recognition of tasks that are mentioned in the acknowledgement section of publications.

Suggestions for implementation:

CRediT's instructions for publishers covers this issue with the following note, which can be adopted by CRO developers:

> "List all Contributions – All contributions should be listed, whether from those listed as authors or individuals named in acknowledgements" (CASRAI 2020).

6.3.8 In instructions for adopters, encourage asking all contributors to confirm listed contributions

In their instructions for adopters, CRO developers should encourage asking all contributors to confirm listed contributions.

Suggestions for implementation:

CRediT's instructions for publishers covers this issue with the following note, which can be adopted by CRO developers:

- "Corresponding authors should assume responsibility for role assignment, and all contributors should be given the opportunity to review and confirm assigned roles" (CASRAI 2020).

6.3.9 In instructions for adopters, provide suggestions on how to represent outdated tasks and practices

In their instructions to adopters, CRO developers should provide suggestions on how to represent outdated tasks.

Suggestions for implementation:

These suggestions would be similar to those mentioned in section 6.2.6.

6.3.10 Link roles to resolvable URIs

As shown in sections 6.2.2 and 6.2.3, using resolvable URIs improves the attribution of individual responsibilities, and also allows the clarification of mentor-mentee relations. Furthermore, using resolvable URIs would allow clarifying which version of CRO is used at any given publication.[162]

Suggestions for implementation:

These suggestions would be similar to those mentioned in section 6.2.7.

[162] Given that among the three analysed CROTs, CRO is the only one that has already been revised, this suggestion would be the most relevant for CRO.

6.3.11 In instructions for researchers, describe what is regarded as a violation while using CRO

CRO developers should provide descriptions that highlight prohibited practices and explain what is considered as a violation while using CRO.

Suggestions for implementation:

In the absence of specific information about how CRO is employed in different contexts[163], no suggestions could be provided for implementation of this recommendation. That being said, suggestions mentioned in section 6.2.7 could be used by CRO developers as well.

6.3.12 In instructions for researchers, provide possible solutions and best practices to prevent common violations

CRO should offer solutions and best practices to prevent common violations.

Suggestions for implementation:

CRO developers could explore applications that are specifically developed for CRediT (e.g., Tenzing and Rescognito) and check whether these would be suitable for CRO users as well. Additionally, depending on the reported examples of questionable/problematic use of CRO, CRO developers could introduce possible solutions and best practices to avoid common violations.

[163] CRO is not used by any publisher yet, and only used by repositories. Attempts were made to contact the only adopting repository (InvenioRDM) but they noted that COVID-19 has delayed the implementation of CRO into their platform and hence, they could not provide any specific details about how CRO is being used in practice.

6.3.13 Provide mechanisms to clarify the extent of contributions to tasks that involve more than one contributor

Although CRO borrows all of CRediT roles and their definitions, it has not adopted the functionality that allows the clarification of the extent of contributions to tasks.

Suggestions for implementation:

CRO's developers could use CRediT's software code that is freely available on their GitHub page to incorporate this mechanism into CRO.

6.3.14 Provide mechanisms to clarify equal contributions

CRO should also allow the recognition of equal contributions.

Suggestions for implementation:

CRO's developers could use CRediT's software code that is freely available on their GitHub page to clarify equal contributions.

6.4 TaDiRAH

According to the results of the previous chapter, TaDiRAH responds negatively to 14 criteria (see table 30).

Criterion	TaDiRAH
Indicate individual responsibilities within a large task	No
Indicate mentor-mentee relations	No
Instructions for researchers	No
• Senior contributor to know details of individual contributions	No
• Describe what is considered as a violation	No
• Suggestions for possible solutions to violations	No
Instruction for adopters	No
• Encourage the recognition of acknowledged roles	No

• Suggestions on how to represent outdated tasks and practices	No
• Encourage asking all contributors to confirm listed contributions	No
Linking tasks to resolvable URIs	No
Registering the extent of contributions	No
Registering two or more contributors as equal	No
Recognition of tasks	
• Provision of research samples	No

Table 30. Criteria that TaDiRAH responds negatively.

6.4.1 Provide mechanisms to indicate individual and overlapping responsibilities about tasks that involve more than one contributor

TaDiRAH's attribution of responsibilities should be improved with linking activities to resolvable URIs.

Suggestions for implementation:

These suggestions would be similar to those mentioned in section 6.2.2.

6.4.2 Provide mechanisms to indicate mentor-mentee relations

Currently, and due to the lack of a unique activity titled 'supervision', it would not always be possible to indicate mentor-mentee relations with TaDiRAH. Hence, TaDiRAH should explicitly recognise the task of supervision (a task that passed the test of threshold of significance and was deemed significant in section 4.2.6) and allow researchers to contextualise it using Resolvable URIs.

Suggestions for implementation:

In recognising the task of Supervision, TaDiRAH's developers could use the provided definition in CRediT:

> "Supervision – Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team" (CASRAI 2020).

Suggestions on how to use resolvable URIs to indicate mentor-mentee relations would be similar to those mentioned in section 6.2.3.

6.4.3 Provide adequate and straightforward instructions to guide researchers on how TaDiRAH should be used

Currently, TaDiRAH does not provide instructions for researchers. Accordingly, in cases where adopters provide no instructions, users would have to search for them elsewhere. As mentioned in section 6.2.4, this might result in the development of dissimilar and problematic instructions by different adopters.

Suggestions for implementation:

TaDiRAH chairs have published several articles that include information about TaDiRAH and its use (e.g., Borek et al. 2014; Borek et al. 2016). Although these publications are useful for experts, it is unlikely that an individual researcher or group of researchers will have the knowledge necessary to identify, read and understand the instructions embedded in these publications when submitting a manuscript. Therefore, TaDiRAH's developers could extract the most useful pieces of information from these sources for the purpose of compiling their instructions for researchers.

6.4.4 In instructions for researchers, note that one contributor should know the details of all individual contributions

It is (usually) the corresponding contributor who knows what every contributor did and reports these during the submission process.

Suggestions for implementation:

In their instruction to researchers, TaDiRAH developers could use the statement that is mentioned in CRediT's instructions to publishers:

- "Corresponding authors should assume responsibility for role assignment, and all contributors should be given the opportunity to review and confirm assigned roles" (CASRAI 2020).

6.4.5 Provide instructions for adopters

TaDiRAH should provide instructions for different adopters such as publishers, universities and repositories.

Suggestions for implementation:

Developers of TaDiRAH could also use CRediT's instructions for publishers as a starting point in compiling their own instructions for various adopters. Additionally, depending on how TaDiRAH is employed in different contexts, specific information should be included in these instructions.

6.4.6 In instructions for adopters, encourage the recognition of acknowledged roles

In their instructions for adopters, TaDiRAH developers should encourage the recognition of tasks that are mentioned in the acknowledgement section of publications.

Suggestions for implementation:

CRediT's instructions for publishers covers this issue with the following note, which can be adopted by TaDiRAH developers:

> "List all Contributions – All contributions should be listed, whether from those listed as authors or individuals named in acknowledgements" (CASRAI 2020).

6.4.7 In instructions for adopters, encourage asking all contributors to confirm listed contributions

In their instructions for adopters, TaDiRAH developers should encourage asking all contributors to confirm listed contributions.

Suggestions for implementation:

CRediT's instructions for publishers covers this issue with the following note, which can be adopted by TaDiRAH developers:

- "Corresponding authors should assume responsibility for role assignment, and all contributors should be given the opportunity to review and confirm assigned roles" (CASRAI 2020).

6.4.8 In instructions for adopters, provide suggestions on how to represent outdated tasks and practices

In their instructions to adopters, TaDiRAH developers should provide suggestions on how to represent outdated tasks.

Suggestions for implementation:

These suggestions would be similar to those mentioned in section 6.2.6.

6.4.9 Link activities to resolvable URIs

As shown in sections 6.2.2 and 6.2.3, using resolvable URIs improves the attribution of individual responsibilities, and also allows the clarification of mentor-mentee relations. Furthermore, using resolvable URIs would allow clarifying which version of TaDiRAH is used at any given publication.

Suggestions for implementation:

These suggestions would be similar to those mentioned in section 6.2.7.

6.4.10 In instructions for researchers, describe what is regarded as a violation while using TaDiRAH

TaDiRAH developers should provide descriptions that highlight prohibited practices and explain what is considered as a violation while using TaDiRAH.

Suggestions for implementation:

In the absence of specific information about how TaDiRAH is employed in different contexts, no suggestions could be provided for implementation of this recommendation. That being said, suggestions mentioned in section 6.2.7 could be used by TaDiRAH developers as well.

6.4.11 In instructions for researchers, provide possible solutions and best practices to prevent common violations

TaDiRAH should offer solutions and best practices to prevent common violations.

Suggestions for implementation:

TaDiRAH developers could explore applications that are specifically developed for CRediT (e.g., Tenzing and Rescognito) and check whether these would be suitable for TaDiRAH users as well. Additionally, during expert consultation with Gimena Del Rio Riande, applications such as TemaTres (TemaTres Vocabulary Server 2020) and TERESAH (TERESAH 2020) were mentioned as Open Access and free solutions that are compatible with TaDiRAH, and prevent common malpractices in the attribution of credit.

6.4.12 Provide mechanisms to clarify the extent of contributions to tasks that involve more than one contributor

Developers of TaDiRAH should provide mechanisms that allow users to clarify their extent of contributions to tasks.

Suggestions for implementation:

Developers of TaDiRAH could use CRediT's software code that is freely available on their GitHub page to incorporate this mechanism into the TaDiRAH.

6.4.13 Provide mechanisms to clarify equal contributions

TaDiRAH should allow the recognition of equal contributions.

Suggestions for implementation:

The same free software code that allows the clarification of the extent of contributions also allows clarifying equal contributions.

6.4.14 Recognise the task of providing research samples

While CRediT and CRO explicitly recognise the task of providing research samples, this task is not recognised by TaDiRAH. As mentioned in the justification of this task in section 4.2.6, providing research samples is a significant task. On that basis, it should be added to TaDiRAH's current list of activities.

Suggestions for implementation:

Using the definition provided in CRediT's role of resources[164], and provided explanation in section 4.2.6 about the scope of this task, the following title and definition seem in line with how this task could be recognised in TaDiRAH:

> Title: Provision of research samples
>
> Research samples refer to any digital item or physical specimen that is collected for further analysis. Samples could be gathered manually or automatically in a random or non-randomised manner.

6.5 Discussion

6.5.1 Areas with no best practice

In providing recommendations for criteria where all three CROTs respond negatively to the asked question (see table 31), tested and implemented solutions are unavailable. Hence, the provided suggestions for addressing these criteria should be considered in a cautious manner.

Criterion	CRediT	CRO	TaDiRAH
Indicate individual responsibilities within a large task	No	No	No
Indicate mentor-mentee relations	No	No	No
Instructions for researchers	No	No	No
• One contributor to know details of all individual contributions	No	No	No
• Describe what is considered as a violation	No	No	No
• Suggestions for possible solutions to violations	No	No	No

[164] This role is defined as: "Resources – Provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation, computing resources, or other analysis tools" (CASRAI 2020, Paragraph 5).

• Suggestions on how to represent outdated tasks and practices	No	No	No
Linking tasks to resolvable URIs	No	No	No

Table 31. Criteria where all three CROTs respond negatively to.

In particular, this chapter introduced linking roles/activities to resolvable URIs as a suggestion that can potentially address ethical issues in relation to responsibilities. Although the feasibility of this suggestion was also validated by experts, its implementation might face challenges that cannot be anticipated at this stage. For instance, we cannot know whether all involved parties (e.g., journal editors, corresponding contributors) would support this new addition to CROTs or whether this addition would be fully compatible with other services used by adopters.

6.5.2 Areas where researchers and adopters can/cannot make a difference

After analysing and comparing CROTs using the assessment instrument, one can distinguish between ethical issues that (given the available functionality of explored CROTs) might be preventable (e.g., by prompting users/adopters about ethical pitfalls), and those that cannot be addressed without further improvement and revision of CROTs. This difference can be explained with examples that show 1) what (cognisant) users can/are doing to take advantage of current options provided by some CROTs, and 2) what ethical issues cannot be currently resolved due to limitations of CROTs.

(1) – In relation to the clarification of supervisors' responsibilities, in CROTs such as CRediT and CRO where the task of supervision is explicitly recognised, in some cases it is possible to clarify mentor-mentee relations. For instance, Shin et al. (2020) published by *PLOS Biology* has nine contributors affiliated with two different institutions in South Korea, and, two contributors affiliated with a French institution. In this article only one contributor from each of the three institutions is identified as a supervisor, implying that one person supervised contributors affiliated with each university. Similarly, Shrestha et al. (2020) published by *PLOS Medicine* has

eight contributors, six of whom are affiliated with an Austrian University and two with an American institution. In this case too, only one contributor from each institution is identified as a supervisor.

Although (as this thesis suggested), CROTs should provide clear and straightforward instructions for researchers on how to use available functionality, examples like these show that even in the absence of such instructions, some researchers rely on common sense to use CROTs correctly. At the same time, other users have employed the role of supervision differently, such that mentor-mentee relations and the subsequent supervisory responsibilities are extremely difficult to identify. For instance, published by *PLOS Medicine,* Tanaka et al. (2020) has 23 contributors, 22 of whom are identified as supervisors. In such cases, it is almost impossible to find out what the role of each supervisor was, and in case of any allegations of misconduct, which supervisor could be held responsible for insufficient/inadequate supervision.

It should be noted that since in the above-mentioned examples there are both clear and unclear uses of CRediT's role of Supervision in the journal of *PLOS Medicine*, it seems that even adopters are not always aware/careful about how CROTs should be used in practice, or do not check reported contributions at all.

(2) – Tasks that are currently not recognised by CROTs exemplify issues that cannot be addressed without further development or revision of CROTs. For instance, CRediT does not explicitly recognise the task of Community Engagement. Consequently, in cases where some contributors are involved in this task, accurate recognition of their contributions is impossible (no matter how careful researchers are in using CRediT). Addressing this shortcoming requires revising CRediT, and all that researchers/adopters can do at the moment is to provide feedback to CRediT's developers. Similarly, without the incorporation of resolvable URIs, even the most cognisant and careful researchers may end up in situations where they do not have the means to provide an accurate account of individual and overlapping responsibilities about large tasks.

6.5.3 Instructions for researchers and adopters

None of the CROTs provides formal instructions for researchers, and only CRediT provides some instructions for one of the adopters (i.e., publishers). In developing instructions for different parties, the following factors are worthy of consideration:

- Instructions should be designed to minimise the likelihood of inconsistent and unethical application of CROTs. One way of achieving this goal is to use straightforward descriptions that prevent misunderstanding and alternative interpretations.
- Different instructions are required for researchers and different adopters such as journals, repositories and universities.
- As the example of the inadequate use of CRediT's role of *Supervision* showed, some tasks may need additional explanation to ensure that they are used correctly. Another such example that may require additional explanation to avoid confusion and inconsistent use pertains to revising/editing text (Writing – Review & Editing in CRediT and CRO, and Editing in TaDiRAH). Among those who claim to participate in the editing process, some may only leave a few comments and praise the work, while others may substantively revise the manuscript. Therefore, by clarifying what is considered as inadequate editing, CROTs could promote awareness and minimise the likelihood of misuse.

6.5.4 Mere provision of instructions do not necessarily result in improved practice

The development of instructions for researchers and adopters has various benefits. For instance, these instructions provide a reliable source about how CROTs should be used and could be translated into different languages, hence, improving the consistency of application and use. However, this chapter showed that even in cases where instructions are available, they are not always followed. An example that shows the lax attitude of adopters towards provided

instructions pertains to the use of CROTs in the acknowledgement section of publications. Although in their instructions for publishers, developers of CRediT specifically note that all contributions including those acknowledged should be listed using CRediT, Holocomb (2019) showed that this is not the case among *PLOS* journals that have adopted it (including the journals of *PLOS Medicine* and *PLOS Biology*). Examples like these show that merely providing or enhancing instructions would not necessarily improve practice.

References

Allen, L., O'Connell, A., & Kiermer, V. (2019). How can we ensure visibility and diversity in research contributions? How the Contributor Role Taxonomy (CRediT) is helping the shift from authorship to contributorship. *Learned Publishing*, *32*(1), 71–74. https://doi.org/10.1002/leap.1210

Borek, L., Dombrowski, Q., Perkins, J., & Schöch, C. (2014, July 14). *Scholarly Primitives Revisited: Towards a Practical Taxonomy of Digital Humanities Research Activities and Objects*. Digital Humanities Conference 2014, Lausanne, Switzerland. https://doi.org/10.5281/zenodo.10866

Borek, L., Dombrowski, Q., Perkins, J., & Schöch, C. (2016a). TaDiRAH: A Case Study in Pragmatic Classification. *Digital Humanities Quarterly*, *010*(1). http://digitalhumanities.org/dhq/vol/10/1/000235/000235.html

Brand, A., Allen, L., Altman, M., Hlava, M., & Scott, J. (2015). Beyond authorship: Attribution, contribution, collaboration, and credit. *Learned Publishing*, *28*(2), 151–155. https://doi.org/10.1087/20150211

Casci, T., & McCutcheon, V. (2019, October 18). *CRediT: Recognising author contributions to publications*. https://doi.org/10.5281/zenodo.3508624

CASRAI. (2020). *CRediT - Contributor Roles Taxonomy*. CASRAI. https://casrai.org/credit/

ELife. (2017). *Enabling the Contributor Roles Taxonomy for author contributions.* (2017, January 4). eLife Sciences Publications Limited. https://elifesciences.org/inside-elife/f39cfcf5/enabling-the-contributor-roles-taxonomy-for-author-contributions

GitHub, Data2health. (2020). *Contributor Role Ontology.* GitHub. https://github.com/data2health/contributor-role-ontology

GitHub, Dhtaxonomy. (2020). TaDiRAH. GitHub. https://github.com/dhtaxonomy/TaDiRAH

Heng, J., Lv, P., Zhang, Y., Cheng, X., Wang, L., Ma, D., & Liu, F. (2020). Rab5c-mediated endocytic trafficking regulates hematopoietic stem and progenitor cell development via Notch and AKT signaling. *PLOS Biology*, *18*(4), e3000696. https://doi.org/10.1371/journal.pbio.3000696

Holcombe, A. O. (2019). Contributorship, Not Authorship: Use CRediT to Indicate Who Did What. *Publications*, *7*(3), 48. https://doi.org/10.3390/publications7030048

Ilik, V., Conlon, M., Triggs, G., White, M., Javed, M., Brush, M., Gutzman, K., Essaid, S., Friedman, P., Porter, S., Szomszor, M., Haendel, M. A., Eichmann, D., & Holmes, K. L. (2018). OpenVIVO: Transparency in Scholarship. *Frontiers in Research Metrics and Analytics*, *2*. https://doi.org/10.3389/frma.2017.00012

INSPIRE. (2017). *Best Practices for registers and registries & Technical Guidelines for the INSPIRE register federation | INSPIRE*. https://inspire.ec.europa.eu/id/document/tg/registers-and-register-federation

Kaplan, F. (2015). A Map for Big Data Research in Digital Humanities. *Frontiers in Digital Humanities*, *2*. https://doi.org/10.3389/fdigh.2015.00001

McNutt, M. K., Bradford, M., Drazen, J. M., Hanson, B., Howard, B., Jamieson, K. H., Kiermer, V., Marcus, E., Pope, B. K., Schekman, R., Swaminathan, S., Stang, P. J., & Verma, I. M. (2018).

Transparency in authors' contributions and responsibilities to promote integrity in scientific publication. *Proceedings of the National Academy of Sciences*, *115*(11), 2557–2560. https://doi.org/10.1073/pnas.1715374115

Shin, W., Kim, K., Serraz, B., Cho, Y. S., Kim, D., Kang, M., Lee, E.-J., Lee, H., Bae, Y. C., Paoletti, P., & Kim, E. (2020). Early correction of synaptic long-term depression improves abnormal anxiety-like behavior in adult GluN2B-C456Y-mutant mice. *PLOS Biology*, *18*(4), e3000717. https://doi.org/10.1371/journal.pbio.3000717

Shrestha, N., Bacsa, B., Ong, H. L., Scheruebel, S., Bischof, H., Malli, R., Ambudkar, I. S., & Groschner, K. (2020). TRIC-A shapes oscillatory Ca2+ signals by interaction with STIM1/Orai1 complexes. *PLOS Biology*, *18*(4), e3000700. https://doi.org/10.1371/journal.pbio.3000700

Rescognito (2020). https://rescognito.com/

TaDiRAH. (2020). *Taxonomy of Digital Research Activities in the Humanities-Research activities*. TaDiRAH. http://tadirah.dariah.eu/vocab/index.php

Tanaka, A., Taguchi, I., Teragawa, H., Ishizaka, N., Kanzaki, Y., Tomiyama, H., Sata, M., Sezai, A., Eguchi, K., Kato, T., Toyoda, S., Ishibashi, R., Kario, K., Ishizu, T., Ueda, S., Maemura, K., Higashi, Y., Yamada, H., Ohishi, M., … Investigators, on behalf of the P. study. (2020). Febuxostat does not delay progression of carotid atherosclerosis in patients with asymptomatic hyperuricemia: A randomized, controlled trial. *PLOS Medicine*, *17*(4), e1003095. https://doi.org/10.1371/journal.pmed.1003095

TemaTres Vocabulary Server (2020). https://www.vocabularyserver.com/blog/tematres-integration-with-open-journal-system/

Tenzing (2020). GitHub. https://github.com/marton-balazs-kovacs/tenzing

TERESAH (2020). http://teresah.dariah.eu/

Vasilevsky, N. A., Hosseini, M., Teplitzky, S., Ilik, V., Mohammadi, E., Schneider, J., Kern, B., Colomb, J., Edmunds, S. C., Gutzman, K., Himmelstein, D. S., White, M., Smith, B., O'Keefe, L., Haendel, M., & Holmes, K. L. (2020). Is authorship sufficient for today's collaborative research? A call for contributor roles. *Accountability in Research*. https://doi.org/10.1080/08989621.2020.1779591

Chapter 7. Conclusion

7.1 Summary

This research had the following objectives:

1. Identify ethical issues of scholarly authorship
2. Develop an assessment instrument for the ethical evaluation of CROTs
3. Evaluate the three major CROTs from an ethical perspective
4. Provide recommendations for the improvement of these CROTs

This section provides a summary of the findings in relation to each of these objectives.

7.1.1 Identification of ethical issues of scholarly authorship

A review of the literature to identify the issues surrounding obligations, values or virtues with the reporting, authorship and publication of research results, led to the identification of 324 documents published between 1964 and 2018. A thorough analysis of this sample resulted in the discovery of ten ethical issues:

1) *Attribution of authorship*: the two main questions discussed here pertain to the type of recognition that different tasks deserve and the extent to which one must contribute to various tasks in order to deserve authorship status or a mention in the acknowledgement section of scholarly publications.

2) *Violations of norms of authorship*: this issue pertains to the precise nature and definition of violations of norms of authorship (e.g., the difference between questionable and fraudulent practices) and the best solutions for tackling them.

3) *Bias*: financial and non-financial conflict of interests are reported to be difficult to define and sometimes challenging to identify within scholarly publications. Different

types of non-financial conflict of interests include biased hypotheses, biased use of language, biased interpretation of results, biased image-correction and gender bias.

4) *Responsibility and accountability*: ethical questions raised about this issue include ambiguities in relation to individual and overlapping responsibilities in collaborative projects and challenges of clarifying mentors' supervisory responsibilities.

5) *Authorship order*: this issue relates to the criteria that should be used to list authors' names in publication bylines.

6) *Citation and referencing*: this issue is centred around how previously published materials are used/referred to within publications and the associated unethical practices, such as inaccurate citations and plagiarism.

7) *Definition of authorship*: discussions about this issue compare different authorship criteria and note ethical challenges of using them in practice.

8) *Publication strategy*: questionable practices to improve the visibility and success of publications are mentioned in these discussions (e.g., delayed/unverified publication of results).

9) *Originality*: discussions about this issue focus on the noteworthiness of results (in light of the extant literature and also as a standalone research item) for publication as a new item. When it comes to the publication of results based on datasets, the number of publications that can be extracted from a study/dataset is discussed.

10) *Sanctions*: discussions about this issue include questions about what types of sanctions should be imposed on those involved in violations of norms of authorship.

This review concluded that attitudes toward authorship change regularly and highlighted the development of CROTs as an innovation that exemplifies this trend. Nevertheless, it noted that

using CROTs for describing research tasks could contribute to ethical problems that are not yet fully explored. CROTs attribute credit and responsibilities based on the notion of contribution and accordingly, are prone to different ethical issues than those that are resulted from using definitions of authorship. Since only one study within the sample had highlighted some ethical challenges of using CRediT, the review suggested that CROTs should be explored more critically to highlight their strengths and weaknesses from an ethical perspective. Highlighting CROTs' strengths and weaknesses in capturing complexities of collaboration would help a range of parties (e.g., journal editors and research administrators to choose the most suitable model for their respective use case).

7.1.2 Development of an assessment instrument for an ethical evaluation of CROTs

In order to evaluate CROTs from an ethical perspective, this thesis developed an assessment instrument using a five-step process. The first three steps of this process involved a bottom-up approach to identify issues and concerns about CROTs from three sources and thereby develop candidate assessment criteria. A test of applicability in step four ensured that the candidate assessment criteria were relevant to the most recent publication practices. In the fifth step, candidate assessment criteria were justified from an ethical perspective using David Resnik's twelve principles of research ethics described in his 2005 book entitled *The Ethics of Science*. To specify Resnik's principle of Credit (Resnik 2005, p. 55) so as to improve its relevance for analysing tasks that should be specifically recognised by CROTs, this thesis developed a significance threshold test. This novel test facilitates the assessment of research tasks based on their indispensability for the conduct of research and their specificity. Tasks that pass this test are deemed significant, implying that they should be explicitly recognised by CROTs.

Based on this five-step analysis, an assessment instrument consisting of 25 criteria was finalised. These criteria were subsumed under six categories:

I) Availability (two criteria)

Criteria about availability relate to the extent to which CROTs are accessible for different members of the research community. These criteria demand the publication of contributions under an Open Access licence and the availability of tasks and their definitions in languages other than English.

II) Extensibility (one criterion)

The question raised here concerns whether CROTs have structures in place that facilitate the collection and evaluation of feedback for future revisions.

III) Responsibility and accountability (two criteria)

These criteria pertain to whether CROTs provide mechanisms for indicating individual and overlapping responsibilities about tasks, and mechanisms to specify mentor-mentee relations.

IV) Usability (eight criteria)

Six of these criteria concern the provision of adequate and straightforward instructions by CROTs. These criteria include the provision of instructions for researchers, including specific instructions for corresponding contributors. In their instructions for adopters, CROTs are expected to encourage adopting parties to use CROTs for describing tasks noted in the acknowledgement section of publications and also to ask all contributors to confirm listed contribution. Furthermore, CROTs are expected to provide suggestions on how to represent outdated tasks and practices.

Two other criteria relate to whether CROTs link tasks to resolvable URIs and whether individual contributions are linked to digital identifiers (e.g., DOI, ORCID).

V) Violations (two criteria)

These criteria are employed to determine whether CROTs clarify what constitutes a violation while using them and promote solutions and best practices that minimise the likelihood of common violations.

VI) Attribution of credit (10 criteria)

Among these criteria, six concern tasks that should be explicitly recognised in CROTs. These include non-author tasks (i.e., those that are mentioned in the acknowledgement section of publications), community engagement, translation, creative efforts, the provision of research samples and software programming.

Two criteria concern the provision of mechanisms that clarify the extent of contributions, and, specifically, equal contributions. The other criteria determine whether CROTs refrain from using percentages to show the extent of contributions and whether they allow for the recognition of team/group contributions.

7.1.3 Evaluation of the three major CROTs from an ethical perspective

Three CROTs were analysed using the assessment instrument. According to this assessment, CRediT scores better than CRO and TaDiRAH in relation to criteria about the attribution of credit and usability. Out of the 25 criteria, CRediT responded positively to 15, while TaDiRAH and CRO each responded positively to 11 criteria. The strengths and weaknesses of each of the CROTs can be summarised as follows:

CRediT

I) Availability

CRediT roles are published under an Open Access licence, allowing contributions to be publicly available to all readers. However, CRediT roles and their definitions are yet to be translated into languages other than English.

II) Extensibility

CRediT is supported by CASRAI and provides a forum, which users can use to ask questions and report feedback. Although CRediT has not been revised since its release in 2015, there are two chairpersons to monitor and evaluate feedback.

III) Responsibility and accountability

CRediT lacks mechanisms to clarify individual and overlapping responsibilities in cases where more than one contributor is involved in conducting a task. Furthermore, although CRediT explicitly recognises the task of supervision, it does not facilitate the clarification of supervisory responsibilities in cases where several supervisors are present.

IV) Usability

Among the three analysed CROTs, only CRediT offers brief instructions for publishers but it fails to provide instructions for researchers or other adopting parties such as universities. Furthermore, since CRediT roles are not linked to resolvable URIs, it is not possible to embed additional information about individual contributions or note the precise definition of roles at the time when they are used.

V) Violations

CRediT provides no descriptions to explain what is considered to be a violation. CRediT also fails to promote solutions and best practices to address common violations while using it.

VI) Attribution of credit

CRediT's set of 14 roles and their descriptions provide a reasonable basis for the specification of contributions to scholarly publications. A major advantage of CRediT

compared to other CROTs is that it allows users to specify the extent of contributions to tasks that involve more than one contributor (including equal contributions). Nevertheless, CRediT does not explicitly recognise the task of community engagement and fails to promote the recognition of team/group contributions.

CRO

I) Availability

CRO roles are published under an Open Access licence, allowing contributions to be publicly available to all readers but they are yet to be translated into languages other than English.

II) Extensibility

CRO is supported by the National Centre for Data to Health (part of the National Institute of Health in the US). Using the issue tracker on CRO's GitHub page, users can ask questions and provide suggestions. It has a leadership board with three members who monitor and evaluate feedback. Of the three CROTs, CRO is the only one that has been revised since its release.

III) Responsibility and accountability

Since CRO roles lack a definition, responsibilities cannot always be accurately distinguished. Furthermore, CRO offers no mechanisms to clarify individual and overlapping responsibilities in cases where more than one contributor is involved in conducting a task. Although CRO explicitly recognises the task of supervision, it does not facilitate the clarification of supervisory responsibilities in cases where several supervisors are present.

IV) Usability

CRO does not provide any instructions for researchers or adopters. Furthermore, since CRO roles are not linked to resolvable URIs, it is not possible to embed additional information about them.

V) Violations

CRO provides no descriptions to explain what is considered to be a violation. CRO also fails to promote solutions and best practices to address common violations while using it.

VI) Attribution of credit

CRO has more unique roles than other analysed CROTs. With its 54 roles, CRO recognises all the tasks that were mentioned in the assessment instrument. However, it does not provide a definition of its roles and is unable to clarify the extent of contributions to tasks. CRO also fails to promote the recognition of team/group contributions.

TaDiRAH

I) Availability

TaDiRAH's activities are published under an Open Access licence. Among the three analysed CROTs, only TaDiRHA provides translated versions of research tasks and their definitions in languages other than English (i.e., French, German and Spanish).

II) Extensibility

TaDiRAH is supported by the DARIAH consortia and has four coordinators who monitor and evaluate feedback. Using the issue tracker on TaDiRAH's GitHub page, users can ask questions and provide suggestions. Since its release in 2016, TaDiRAH has not been revised.

III) Responsibility and accountability

TaDiRAH does not provide mechanisms to clarify individual and overlapping responsibilities in cases where more than one contributor is involved in conducting a task. Furthermore, since TaDiRAH does not explicitly recognise the task of supervision, and lacks any other means to specify mentor-mentee relations, it is the weakest of the three CROTs in terms of clarifying supervisory responsibilities.

IV) Usability

TaDiRAH lacks instructions for researchers and adopters. Furthermore, since TaDiRAH's activities are not linked to resolvable URIs, it is not possible to embed additional information about individual contributions or note the precise definition of roles at the time when they are used.

V) Violations

TaDiRAH provides no descriptions to explain what is considered to be a violation. TaDiRAH also fails to promote solutions and best practices to address common violations while using it.

VI) Attribution of credit

TaDiRAH's list of 40 activities is accompanied with definitions that are by far the most detailed and elaborate among the three CROTs. This can be considered both as a strength (specific and clear) and weakness (not user-friendly, difficult and time-consuming to learn for researchers/adopters). TaDiRAH does not recognise the task of providing research samples and is unable to clarify the extent of contributions to tasks. It also fails to promote the recognition of team/group contributions.

7.1.4 Advancing recommendations for improving analysed CROTs

After evaluating the three CROTs using the assessment instrument and identifying their strengths and weaknesses, specific recommendations are provided for each:

CRediT

1. Recognise the task of community engagement.
2. Translate roles and their definitions into languages other than English.
3. Link roles to resolvable URIs.
4. Provide adequate and straightforward instructions to guide researchers on how CRediT should be used, and within these instructions,
    a. Note how individual and overlapping responsibilities should be indicated.
    b. Note how mentor-mentee relations should be clarified.
    c. Mention that one contributor (e.g., corresponding contributor) should know details of all individual contributions.
    d. Mention what is regarded as a violation while using CRediT.
    e. Introduce possible solutions and best practices to prevent common violations.
5. Improve instructions for adopters:
    a. Note how outdated research tasks should be presented with current roles.
    b. Encourage describing team/group contributions.

CRO

1. Provide a definition for the current roles.
2. Provide mechanisms to clarify the extent of contributions to tasks that involve more than one contributor.
3. Provide mechanisms to register equal contributions.
4. Translate roles and their (to be developed) definitions into languages other than English.

5. Provide adequate and straightforward instructions to guide researchers on how CRO should be used, and within these instructions,
    a. Note how individual and overlapping responsibilities should be indicated.
    b. Note how mentor-mentee relations should be clarified.
    c. Mention that one contributor (e.g., corresponding contributor) should know details of all individual contributions.
    d. Mention what is regarded as a violation while using CRO.
    e. Introduce possible solutions and best practices to prevent common violations.
6. Provide instructions for adopters and within these instructions,
    a. Encourage the recognition of contributions that are mentioned in the acknowledgement section of publications.
    b. Encourage asking all contributors to confirm listed contributions.
    c. Note how outdated research tasks should be presented with current roles.
    d. Encourage describing team/group contributions.
7. Link roles to resolvable URIs.

TaDiRAH

1. Recognise the task of providing research samples.
2. Provide mechanisms to clarify the extent of contribution to tasks that involve more than one contributor.
3. Provide mechanisms to register equal contributions.
4. Provide adequate and straightforward instructions to guide researchers on how TaDiRAH should be used, and within these instructions,
    a. Note how individual and overlapping responsibilities should be indicated.
    b. Note how mentor-mentee relations should be clarified.
    c. Mention that one contributor (e.g., corresponding contributor) should know details of all individual contributions.

d. Mention what is regarded as a violation while using TaDiRAH.

e. Introduce possible solutions and best practices to prevent common violations.

5. Provide instructions for adopters and within these instructions,

    a. Encourage the recognition of contributions that are mentioned in the acknowledgement section of publications.

    b. Encourage asking all contributors to confirm listed contributions.

    c. Note how outdated research tasks should be presented with current roles.

    d. Encourage describing team/group contributions.

6. Link activities to resolvable URIs.

7.2 Limitations

In relation to each of its objectives, this inquiry is restricted in the following manner.

7.2.1 Identification of ethical issues of scholarly authorship

Distinct ethical issues might be prevalent in individual disciplines or among different groups of researchers. Since this dissertation aimed to explore ethical issues of scholarly authorship (independent of the research area where they occur or their prevalence among a particular group of researchers), it does not explore the identified ethical issues per discipline or analyse their relevance to specific groups of researchers. However, some of the highlighted ethical issues might be more prevalent in particular disciplines. For example, financial conflict of interests are more likely to occur in research areas where academia-industry collaborations are more common. Consequently, the presented list of ethical issues might not equally apply to all research areas. Furthermore, it is reasonable to assume that different issues might be prevalent among different segments of the research community. For instance, researchers in different stages of their career tend to have different priorities. So researchers looking for stable jobs might be more likely to use questionable publication strategies that improve their articles'

visibility. Therefore, the presented list of ethical issues might not be equally relevant to different subdivisions of the research community.

7.2.2 Development of an assessment instrument for an ethical evaluation of CROTs

Challenges of using CROTs without authorship lists are not explored. In developing the assessment instrument, this dissertation has not explored issues that may arise when using CROTs without authorship lists. If CROTs were to be used without authorship lists, different ethical issues might occur. For example, since authors' names are used for citations and referencing, publishers and/or the scientific community would have to develop and adopt standards for using published items, which do not rely on first authors' names (e.g., Hosseini et al. 20XX) and are based on contributors' names. In that case, ethical issues might occur with regard to the selection of the contributor(s) whose name(s) should appear on in-text citations. Furthermore, due to the legal importance of the notion of authorship (authors can readily engage in litigation in relation to a publication whereas non-authors first have to prove that they have a legitimate claim to authorship), using CROTs without authorship lists could affect copyrights, intellectual property rights and the process via which these rights are assigned/challenged. None of these issues is explored in this thesis because currently CROTs are only used in parallel with authorship lists.

The weight of the assessment criteria is not explored. This thesis made no attempt to sort out the weight of the developed criteria relative to each other. In particular, since the assessment criteria were justified using Resnik's principles, giving more weight to a criterion would imply that a certain principle, with which that specific criterion was justified, ranks higher than those used to justify other criteria. This understanding of the 12 principles is inconsistent with the

stipulation provided by Resnik; specifically, that ranking the 12 principles is not possible.[165] He notes that even if ranking were possible, it requires details about specific cases. Since these details, including empirical evidence about the priorities of various parties in relation to the use of different CROTs (for more details see section 3.8.1 and 3.8.4), are currently lacking, this thesis cannot confirm the presence or absence of a hierarchy among the developed criteria.

The assessment instrument only explores ethical aspects involved in the specification of contributions to scholarly publications. Since CROTs are freely available on the internet and can be integrated into various credit attribution systems, some parties may employ CROTs for purposes other than the specification of contributions to scholarly publications. For instance, CROTs might be used to specify contributions to team efforts other than scholarly research (e.g., patent registration) or to specify contributions to collaboratively created digital items other than scholarly publications (e.g., music). Given its scope, this thesis has not explored ethical issues involved in the specification of contributions to non-scholarly efforts or the specification of contributions to digital items other than scholarly research publications.

The significance threshold test is a concept that could benefit from further development. This test is developed to justify tasks for the assessment instrument and only demonstrates a concept for exploring research tasks using means other than standard definitions of authorship or the notion of intellectual/non-intellectual contributions. The devised method to include or exclude tasks are also restraint by the limitations of Resnik's normative framework and the small sample size of the scoping search conducted in section 4.2.6.

[165] "Although I believe that some principles should be regarded as generally more important than others, I will not provide the reader with a ranking of the principles in terms of their priority because I do not believe that such a ranking is possible. Whether a given principle should override another principle (or principles) depends, in large part, on the details of the situation in which a conflict arises. In some circumstances a principle may be given high priority; in other circumstances it may be given a lower priority. Since there are so many different actual (and possible) cases where conflicts might arise, we simply cannot construct a ranking of the principles. Indeed, it would be misleading to construct such a ranking because this ranking would gloss over the important details of various cases" (Resnik 2005, p. 63).

7.2.3 Evaluation of CROTs from an ethical perspective

CROTs' current list of tasks are not explored. Some criteria within the assessment instrument enquire about the recognition of tasks that were claimed to be overlooked in credit attribution (e.g., community management) or tasks that were claimed to be under-credited (e.g., the provision of research samples). However, since none of the resources explored in chapter three noted tasks that should *not* be recognised by CROTs, no assessment criterion pertains to the relevance of CROTs' current list of tasks. Therefore, this thesis made no attempt to explore tasks mentioned in the analysed CROTs and whether their inclusion in CROTs is justified.

7.2.4 Advancing recommendations for improving CROTs

Suggestions for the implementation of recommendations for TaDiRAH and CRO are not as specific as those provided for CRediT. Since many publishers currently use CRediT, options for the implementation of provided recommendations (to improve CRediT) can be shown with better examples. This is because publishers integrate CROTs into their journals' submission processes, which are publicly accessible. Accordingly, after exploring the submission processes of *PLOS Medicine* and *PLOS Biology*, this thesis used graphical prototypes and specific examples to demonstrate how its recommendations to improve CRediT could be implemented (e.g., the prototypes for the implementation of resolvable URIs as demonstrated in figure 38 in section 6.2.2 and figure 39 in section 6.2.7). However, the same cannot be done for TaDiRAH and CRO because the adopting scientific institutions (e.g., CERN) and repositories (e.g., DARIAH) that currently use these CROTs do not publicly share details about how their internal databases are organised or how contributions to stored items are specified.[166] Hence, this thesis cannot offer specific examples or prototypes for the implementation of its recommendations for CRO and TaDiRAH.

[166] As mentioned in section 3.6, this is also the reason why the test of applicability only explored journals' submission processes.

Technical recommendations are not finalised solutions but only provide directions for improvement. Technical recommendations to address ethical concerns (e.g., link roles/activities to resolvable URIs) are based on available technologies that could be employed by CROTs. Although the feasibility of these recommendations has been confirmed by experts (more details in section 6.1), in the absence of the required programming skills to improve CROTs' software codes, suggestions on how to implement them remain at the level of graphical prototypes and possible directions for implementation. Additionally, other factors such as involved costs or the required time to implement these recommendations are not explored in this thesis.

7.3 Future research

This study suggests directions for future research in relation to its four different objectives.

7.3.1 Identification of ethical issues of scholarly authorship

Explore ethical issues per discipline or group of researchers. Future studies could use the ten ethical issues highlighted in the second chapter of this thesis to explore the prevalence of each issue within specific disciplines or gauge the prevalence of different issues among researchers in different stages of their career. These explorations could result in the development of a hierarchy of ethical issues based on e.g., the perceived importance or frequency of occurrence in specific disciplines. Accordingly, factors that contribute to each particular issue could be explored per discipline/context to suggest specific solutions to minimise the likelihood of their occurrence.

7.3.2 Development of an assessment instrument for an ethical evaluation of CROTs

Explore ethical issues of using CROTs without authorship lists. Future research could develop an assessment instrument that explores the ethical issues of using CROTs without authorship lists.

One of these issues could relate to the legal implications of doing away with authorship lists. Given the significance of the notion of authorship for copyrights and intellectual property rights, future studies could explore the possible tensions between satisfying legal obligations with regards to authorship and the ethics of adhering to the intended functions of CROTs. Another issue pertains to the complexities surrounding the identification of contributors to in in-text citations and reference lists (e.g., Hosseini et al. 20XX).

Furthermore, while authorship lists (that are not ordered alphabetically) readily indicate those with the highest degree of contribution (first author) and those responsible for the overall integrity of the work (last author), CROTs cannot currently address these issues on their own. Exploring the ethical implications of these shortcomings would be worthwhile. Towards that end, the methodology employed in this thesis to develop and justify the assessment criteria could be used as a framework. Upon finding documents that discuss ethical issues of using CROTs without authorship lists and developing candidate assessment criteria, a test of applicability could be used to determine the ethical and legal limits of employing CROTs without standard forms of author identification.

Explore whether creating a hierarchy of the assessment criteria is justifiable. Future research could explore the use of ethical frameworks that provide a hierarchical set of principles to justify candidate assessment criteria and thereby provide a means of 'action guidance'. In other words, the development of such ethical frameworks could provide the users of CROTs with a principled basis by which they are able to weigh and balance the competing ethical criteria in order to determine their relative ethical significance. Although many of the most recognised frameworks for research ethics and integrity (e.g., Beauchamp & Childress 2009; Macfarlane 2010) do not provide a hierarchy among their principles or values, the application of frameworks in other areas (e.g., social work) have operated on the basis of such a hierarchy (Landau & Osmo 2003; Page 2012).

Develop assessment criteria for using CROTs in contexts other than scholarly publications. Future research could inquire about using CROTs in other collaborative efforts (e.g., developing research proposals) and explore ethical issues involved in those contexts. These endeavours could use the employed methodology to develop and justify assessment criteria in this thesis as a framework to develop new assessment instruments.

Further develop/improve the significance threshold test and investigate tasks with a larger sample. Future research could use the significance threshold test to explore other contributions in scholarly projects from a conceptual perspective. For instance, after further specification, tasks that are reported to be underrepresented or inadequately recognised in specific disciplines could be explored with an improved version of the test. Future research could also explore whether the significance threshold test is compatible with normative frameworks other than Resnik's, or whether the methodology for excluding or including tasks could be improved. For instance, by expanding the sample size of the scoping search, future research could check what tasks are significant in the *majority* of cases and accordingly, advise a different system for analysing tasks' significance and including/excluding them in the assessment instrument.

7.3.3 Evaluation of CROTs from an ethical perspective

Explore CROTs' current list of roles. Future research could use the significance threshold test developed in this thesis to evaluate tasks currently listed in CROTs. Accordingly, suggestions could be provided about the possible adjustment/removal of tasks that do not pass the significance threshold test. These adjustments would improve the consistency of CROTs in relation to tasks that are explicitly recognised.

Explore the applicability of the developed assessment instrument to specific use cases and adjust criteria if necessary. Future research could explore the relevance of the assessment instrument developed in this thesis for specific use cases (e.g., publishers, repositories, universities). Accordingly, criteria that are deemed less relevant (or irrelevant) in specific contexts could be

removed or accorded a lower degree of normative weight. In contrast, it might be prudent to consider the ethical justifiability of extending some criteria depending on the context. In particular, criteria relating to the usability of CROTs could be revised depending on the specific function of CROTs for different stakeholders and user groups (e.g., a librarian in a repository who uses CROTs regularly or a researcher who uses CROTs upon submission of an article to a journal). For example, whilst publishers may consider 'instructions for researchers' to be an ethically significant criterion for the satisfactory employment of CROTs, repositories might accord significantly less ethical weight to such instructions . Again, simultaneously employing the assessment instrument developed in this thesis with a hierarchy of ethical criteria could provide different user groups with a principled basis to weigh and balance the competing ethical criteria and thereby facilitate and justify future revisions to CROTs in line with the particular interests, priorities and requirements of their respective stakeholders.

7.3.4 Advancing recommendations for improving CROTs

Consult adopters of CRO and TaDiRAH and develop prototypes for the implementation of technical recommendations. Thus far, CRO and TaDiRAH have only been adopted by institutions and repositories. Since the application of CROTs by institutions and repositories is not publicly visible, further consultation with these parties is required to investigate how CROTs are integrated into their processes and/or linked with other internal services/systems. Future research could use prototypes provided for the CRediT taxonomy to consult CRO and TaDiRAH adopters and explore possible challenges of implementing suggestions offered in this thesis. These efforts would potentially support the developers of these two CROTs with future revisions.

Explore options for finalised technical solutions. Future research can explore suggestions provided in this thesis in terms of their implementation with different programming solutions, involved costs, technical complexities and required time for completion/adoption. In

consultation with CROTs' developers, software programming experts could provide an assessment of possible options for the implementation of recommendations provided in this thesis.

References

Beauchamp, T. L., & Childress, J. F. (2009). *Principles of Biomedical Ethics*. Oxford University Press.

Landau, R., & Osmo, R. (2003). Professional and personal hierarchies of ethical principles. *International Journal of Social Welfare*, *12*(1), 42–49. https://doi.org/10.1111/1468-2397.00007

Macfarlane, B. (2010). *Researching with Integrity: The Ethics of Academic Enquiry*. Routledge.

Page, K. (2012). The four principles: Can they be measured and do they predict ethical decision making? *BMC Medical Ethics*, *13*(1), 10. https://doi.org/10.1186/1472-6939-13-10

Resnik, D. B. (2005). *The Ethics of Science: An Introduction*. New York: Routledge.

Appendix A – The full list of search strings and retrieved items for the focused literature review

String	Number of hits
"moral issue" OR “moral issues” AND "CRediT Taxonomy"	0
"ethical issue" OR “ethical issues” AND "CRediT Taxonomy"	11
"normative issues" OR "normative issue" AND "CRediT Taxonomy"	0
"moral concern" OR "moral concerns" AND "CRediT Taxonomy"	0
"ethical concern" OR "ethical concerns" AND "CRediT Taxonomy"	10
"normative concern" OR "normative concerns" AND "CRediT Taxonomy"	0
"moral problem" OR "moral problems" AND "CRediT Taxonomy"	0
"ethical problem" OR "ethical problems" AND "CRediT Taxonomy"	1
"normative problem" OR "normative problems" AND "CRediT Taxonomy"	0
"moral question" OR "moral questions" AND "CRediT Taxonomy"	0
"ethical question" OR "ethical questions" AND "CRediT Taxonomy"	2
"normative question" OR "normative questions" AND "CRediT Taxonomy"	0
"moral issue" OR “moral issues” AND "OpenVIVO"	0
"ethical issue" OR “ethical issues” AND "OpenVIVO"	4
"normative issues" OR "normative issue" AND "OpenVIVO"	0
"moral concern" OR "moral concerns" AND "OpenVIVO"	0
"ethical concern" OR "ethical concerns" AND "OpenVIVO"	1
"normative concern" OR "normative concerns" AND "OpenVIVO"	0
"moral problem" OR "moral problems" AND "OpenVIVO"	0
"ethical problem" OR "ethical problems" AND "OpenVIVO"	1
"normative problem" OR "normative problems" AND "OpenVIVO"	0
"moral question" OR "moral questions" AND "OpenVIVO"	0
"ethical question" OR "ethical questions" AND "OpenVIVO"	0
"normative question" OR "normative questions" AND "OpenVIVO"	0
"moral issue" OR “moral issues” AND "TaDiRAH”	0
"ethical issue" OR “ethical issues” AND "TaDiRAH”	3
"normative issues" OR "normative issue" AND "TaDiRAH”	0
"moral concern" OR "moral concerns" AND "TaDiRAH”	0
"ethical concern" OR "ethical concerns" AND "TaDiRAH”	3
"normative concern" OR "normative concerns" AND "TaDiRAH”	0
"moral problem" OR "moral problems" AND "TaDiRAH”	0
"ethical problem" OR "ethical problems" AND "TaDiRAH”	0
"normative problem" OR "normative problems" AND "TaDiRAH”	0
"moral question" OR "moral questions" AND "TaDiRAH”	0
"ethical question" OR "ethical questions" AND "TaDiRAH”	3
"normative question" OR "normative questions" AND "TaDiRAH”	0
"moral issue" OR “moral issues” AND "contributor role ontology"	0
"ethical issue" OR “ethical issues” AND "contributor role ontology"	4
"normative issues" OR "normative issue" AND "contributor role ontology"	0
"moral concern" OR "moral concerns" AND "contributor role ontology"	0
"ethical concern" OR "ethical concerns" AND "contributor role ontology"	1
"normative concern" OR "normative concerns" AND "contributor role ontology"	0
"moral problem" OR "moral problems" AND "contributor role ontology"	0

"ethical problem" OR "ethical problems" AND "contributor role ontology"	1
"normative problem" OR "normative problems" AND "contributor role ontology"	0
"moral question" OR "moral questions" AND "contributor role ontology"	0
"ethical question" OR "ethical questions" AND "contributor role ontology"	0
"normative question" OR "normative questions" AND "contributor role ontology"	0
"moral issue" OR “moral issues” AND "contributor role taxonomy"	0
"ethical issue" OR “ethical issues” AND "contributor role taxonomy"	4
"normative issues" OR "normative issue" AND "contributor role taxonomy"	0
"moral concern" OR "moral concerns" AND "contributor role taxonomy"	0
"ethical concern" OR "ethical concerns" AND "contributor role taxonomy"	4
"normative concern" OR "normative concerns" AND "contributor role taxonomy"	0
"moral problem" OR "moral problems" AND "contributor role taxonomy"	0
"ethical problem" OR "ethical problems" AND "contributor role taxonomy"	0
"normative problem" OR "normative problems" AND "contributor role taxonomy"	0
"moral question" OR "moral questions" AND "contributor role taxonomy"	0
"ethical question" OR "ethical questions" AND "contributor role taxonomy"	1
"normative question" OR "normative questions" AND "contributor role taxonomy"	0
Total	54

Table 32. The full list of search strings and retrieved items for the focused literature review.

Appendix B[167] - The full list of items explored for the focused literature review

1. (Hosseini & Gordijn 2020)

This is the published version of the review of the literature that was presented in the second chapter of the current dissertation. Introduced issues in this document were already explored in section 3.2 and relevant criteria are developed on that basis.

2. (Murphy 2018)

Label: Attribution

This article introduces the CRediT taxonomy as a response to the new challenges posed by collaborative science, especially in life sciences. It notes that using CRediT "team members can be credited in order to express the skills and responsibilities they have exercised in the production of the work" (Murphy 2018, p. 761). It provides no further insights that could be framed as an ethical criterion to assess CROTs.

3. (Kumar 2018)

This article reports on the use of CRediT by the journals of *CELL* and *PLOS* and provides statistics about the number of published papers that made use of CRediT in describing author roles. It notes "there remains an issue with authors' awareness of the CRediT taxonomy. A survey of 147 corresponding authors in *Cell Reports* for papers published in 2017 found that 73% had not used CRediT, with 63% reporting to be 'not aware of the option' [55]. Fourteen percent of the respondents still preferred the use of a different method of author contributions" (Kumar 2018, p. 7). Since authors' awareness or use of CROTs could depend on a range of issues (e.g., visibility in journal's author guidelines, enforcement in the submission process or personal/disciplinary awareness of new trends in scholarly publishing) this issue cannot be framed as an ethical criterion to assess CROTs.

[167] All items in this Appendix are included in the reference list of chapter three.

4. (Barnes et al. 2019)

Label: Attribution

> "While the CRediT taxonomy system specify roles of authors, it does not provide guidance on when an individual qualifies to be an author" (Barnes et al. p. 7).

This section notes the lack of guidance about the attribution of authorship status in using CRediT. Although, authors raise a valid point, it should be noted that CRediT was never intended/designed to solve the issue of assigning authorship. In fact, developers of CRediT have specifically clarified this issue in one of their early publications that introduced CRediT and noted: "these roles are not intended to define what constitutes authorship. Rather, the roles are intended to apply to all those who contribute to research that results in scholarly published works" (Brand et al. 2015, p. 153). Therefore, no new criterion can be developed based on this section.

5. (Hustler 2020)

This article introduces CRediT as a solution to address concerns about the attribution of credit to large projects "which ensures that all contributors receive appropriate recognition" (Hustler 2020, p. 51). It provides no further insights that could be framed as an ethical criterion to assess CROTs.

6. (Radford et al. 2018)

This article explores researchers' use of online tools and platforms to create, cultivate, and manage scholarly identity, and OpenVIVO is mentioned as one such platform. It provides no further insights that could be framed as an ethical criterion to assess CROTs.

7. (Smiraglia 2017)

This paper analyses the domain of knowledge organisation and compares submitted papers and presented discussions in two relevant workshops held in 2015 and 2017. It mentions a paper on

TaDiRAH as one of the presented items in 2017 but provides no further insights that could be framed as an ethical criterion to assess CROTs.

8. (DIGHUMLAB 2016)

This document reports on an advisory board meeting of DIGHUMLAB community in Denmark. One of the discussed items in this meeting pertained to using TaDiRAH vocabulary as a solution that allows the classification of tools and objects in the field of digital humanities. It provides no further insights that could be framed as an ethical criterion to assess CROTs.

9. (Wodtke 2018)

This article introduces TaDiRAH as a new technological development that can benefit publishers and provide “brief annotations of online publishing platforms available for scholarly use" (Wodtke, p. 9). It provides no further insights that could be framed as an ethical criterion to assess CROTs.

10. (Driver 2014)

This thesis (for a Master’s degree in Education) introduces TaDiRAH as a tool that addresses specific concerns in relation to “enrichment, annotation, analysis, and interpretation” of resources within the field of digital humanities (Driver 2014, p. 38). It provides no further insights that could be framed as an ethical criterion to assess CROTs.

11. (Bacalexi & Skarsouli 2017)

Label: Usability

> “According to the TaDiRAH (Taxonomy of Digital Research Activities in the Humanities) terminology, designing is ’the development of a user interface with which the user is able to interact […]’, including ‘the user experience’, i.e., ‘the person’s perceptions of the practical aspects such as utility, ease of use, and efficiency’. As far as we are concerned, efficiency is of crucial importance, and therefore sophistication is to be banned, even

though it sometimes corresponds with the actual data model" (Bacalexi & Skarsouli 2017, p. 6).

This section notes practicality, ease of use and efficiency among requirements of a digital interface. Being easy to use and understand for everyone refers to the usability of CROTs. Complex and non-intuitive CROTs could be seen as discriminatory against those who may be incapable of understanding or using them. In analysing Vasilevski et al. (2020) the issue being practical was mentioned and subsequently a criterion was developed.[168]

12. (Yang et al. 2019)

This article aims to identify terms for annotating nutritional epidemiologic research output. For this purpose, it reviews available ontology terms and creates a taxonomic hierarchy for the field. Contributor Role Ontology and VIVO ontology for research discovery are introduced as ontologies relevant to the collection of "supplementary (meta) data" (Yang et al., p. 21). It provides no further insights that could be framed as an ethical criterion to assess CROTs.

13. (Eriksson 2018)

This article explores the issue of increasing number of authors per paper and makes two suggestions pertinent to bibliometric measurements and hiring processes to limit incentives for being an author on as many papers as possible. It briefly mentions CRediT as a positive development that that provides better incentive structures in academia, and as a tool which should be "implemented more broadly by journals" (Eriksson 2018, p. 4). It provides no further insights that could be framed as an ethical criterion to assess CROTs.

14. (Gureev et al. 2020)

[168] The developed criterion: Are there adequate and straightforward instructions to guide researchers on how CROTs should be used?

This article explores various forms of abusive authorship. It briefly mentions CRediT taxonomy and some journals that have adopted it to “describes the possible types of author contributions” (Gureev et al. 2020, p. 227). It provides no further insights that could be framed as an ethical criterion to assess CROTs.

15. (Setchell 2019)

This books chapter is about research integrity and on the section about authorship, it introduces Brand et al. (2015) among resources suitable for “further reading” on this topic (Setchell 2019, p. 41). It provides no further insights that could be framed as an ethical criterion to assess CROTs.

16. (Stark 2017)

This book chapter is about Journal peer-review processes and the CRediT taxonomy is suggested as a helpful tool “for standardizing descriptive terms and thus helping to make author contributions more comparable" (Stark 2017, p. 21). It provides no further insights that could be framed as an ethical criterion to assess CROTs.

17. (Atkins 2016)

Label: Authorship order

> “More finely-grained information [about contributors’ specific roles in the project] will help make the ordering of authors less important and will facilitate a shift in focus for tenure and promotion committees – and other evaluators – away from how many times an individual is a first-or last-named author and toward their specific contributions to the scholarly record” (Atkins 2016, Paragraph 4).

This section mentions the benefits of using CRediT, one of which is that it makes authors’ order irrelevant in evaluations. It contains no further issue in relation to CROTs that could be framed as an ethical criterion.

18. (O’Connell & Harp 2017)

Label: Attribution

> "Thus far, the taxonomy in Cell Press papers has applied only to authors. Other contributors are mentioned in Acknowledgments sections" (O'Connell & Harp 2017, p. 56).

In using CRediT, *Cell Press* only registers author contributions and does not register contributions made by non-authors such as those who are listed in the acknowledgement section. Given that CROTs aim to capture all contributions, it is necessary to recognise contributions that are mentioned in the acknowledgement section as well. In analysing the results of the focused literature review (section 3.4), the issue of incorporating CROTs into acknowledgement section of journals was mentioned and subsequently two criteria were developed.[169]

Label: Attribution

> "Throughout the course of the pilot we did encounter some questions: Should we allow prose descriptions in addition to taxonomy terms?" (O'Connell & Harp 2017, p. 56).

Whether prose description (or any additional description of tasks beyond the standard roles provided by CROTs) should be allowed or not, is a question that relates to concerns about attribution. Although prose descriptions may improve the applicability of CROTs to different areas of research, they are prone to inconsistent use and application. Indeed, inconsistencies and variations in how contributions are understood and registered in using prose descriptions was one challenge of using contributorship statements (Craig, 2018), and one of the reasons why CROTs with standard roles were developed in the first place. Hence, (any) prose description defeats the purpose of using standard roles. Furthermore, if roles and definitions provided by CROTs cover all the important tasks involved in the conduct and publication of research, prose descriptions would not be required. Hence, developing new criterion is not necessary.

[169] The developed criteria: Are there reasonably comprehensive instructions for journals that explain how CROTs should be used and that note common pitfalls of employing them in major submission workflows? AND, In their instructions for adopters, is the use of CROTs for describing acknowledged contributions encouraged?

19. (Aries Systems 2017)

This is an introductory flyer that notes how the CRediT taxonomy is integrated into the Aries System's Editorial Manager platform and mentions no issues that could be framed as an ethical criterion to assess CROTs.

20. (**Aries Systems 2018)**

This is an introductory video that shows how the CRediT taxonomy is integrated into the Aries System's Editorial Manager platform and mentions no issues that could be framed as an ethical criterion to assess CROTs.

21. (Koller 2018)

This article reports on the use of CRediT by The Journal of Bone and Joint Surgery (JBJS) and provides statistics about the most listed roles among the published papers. It mentions no issues that could be framed as an ethical criterion to assess CROTs.

22. (Craig, Hosseini & O'Connell 2019)

Label: Attribution

> "The role called 'Software' was believed to be too general. Software design, software testing, software documentation, software development, software maintenance, etc. are all quite different from each other, but CRediT taxonomy consolidates all of them into one category" (Craig, Hosseini & O'Connell 2019, Paragraph 7).[170]

This section notes that given the range of tasks involved in the development, use and maintenance of software programs, the role called 'Software' should be more granular. It is reasonable to argue that all tasks necessary for the publication of research have different components. For instance, while the current definition of data analysis in the CRediT taxonomy

[170] The current definition of the role of Software in CRediT is: "Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components" (Casrai 2020).

is: “Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data” (CASRAI 2020, Paragraph 1), this role may involve various tasks such as drawing inference, subgroup analysis, defining objective outcome, determination of statistical significance, providing the analysis and presenting results (Northern Illinois University 2005). On that basis, the raised issue does not seem to be valid, and the development of a new criterion would be unnecessary.

23. (Holcombe 2019a)

Label: Attribution

> “While the original CRediT standard recommended a binary contribution facility, whereby contributors either did or did not fulfil each of the contributor roles, there has been some discussion about whether contributor role models need to also capture some information about the extent of the contribution” (Holcombe 2019a, p. 8).

This section is about attribution and whether the extent of contributions should be captured by CROTs. In analysing the review of literature on ethical issues of scholarly authorship, the issue of clarifying the extent of contributions was mentioned (section 3.2.1) and subsequently a criterion was developed.[171] Hence, the development of a new criterion is not necessary.

24. (Holcombe 2019b)

This article reflects the viewpoints of a Professor in Psychology on why CRediT should be adopted by more journals, and its use promoted in more disciplines. It mentions no issues that could be framed as an ethical criterion to assess CROTs.

25. (Holcombe 2019a)

[171] The developed criterion: Within tasks that involve more than one contributor, is it possible to clarify the extent of their contributions?

This article was among items that were retrieved from focused literature review and was analysed in section 3.3.2.

26. (Allen et al. 2012)

Label: Violations

> "Documenting contributions doesn't solve everything - authors can mislead or lie - but it helps. At Annals, all correspondence goes to all authors, which can also be helpful in identifying misconduct" (Allen et al. 2012, p. 12).

This section notes one form of violation while using the CROTs, that entails misleading or lying about contributions. It also reports a precautionary measure taken by the journal of Annals of Internal Medicine to mitigate this problem. This issue was discussed in section 3.3.2 and subsequently a criterion was developed.[172] Hence, the development of a new criterion is not necessary.

Label: Usability

> "Requirements of the taxonomy: Must be easy for everyone to use and understand" (Allen et al. 2012, p. 17).

Being easy to use and understand for everyone refers to the usability of CROTs. Complex CROTs could be seen as discriminatory against those who may be incapable of understanding or using them. This issue was also noted by Vasilevsky et al. (2020) and subsequently in section 3.4 a criterion was developed.[173] Hence, the development of a new criterion is not necessary.

27. (Kerridge 2018)

[172] The developed criterion: In their instructions for researchers, do CROTs describe what is regarded as a violation while using them?

[173] The developed criterion: Are there adequate and straightforward instructions to guide researchers on how CROTs should be used?

This blog post introduces CRediT and explains how it was developed and notes how it helps various stakeholders such as authors, publishers, universities, funders and bibliometricians. It mentions no issues that could be framed as an ethical criterion to assess CROTs.

28. (Coko Foundation 2019)

This blog post is an announcement about the implementation of CRediT into CalTech's Wormbase Micropublications platform and mentions no issues that could be framed as an ethical criterion to assess CROTs.

29. (The academy of medical sciences 2016)

Label: Usability

> "We conclude that a standard system for describing individual author contributions to publications is essential, and should incorporate the following features: Guidelines on how to allocate contributions in a transparent and consensually agreed manner" (The academy of medical sciences 2016, p. 33).

This section notes the importance of providing guidelines on how to use CROTs in allocating the contributions. This issue was also mentioned by Vasilevsky et al. (2020) and subsequently in section 3.4 a criterion was developed.[174] Hence, the development of a new criterion is not necessary.

30. (Guglielmi 2018)

This article is about various forms of contribution and reports the results of a survey that asked respondents about the contribution types that deserve authorship credit. It contains no issues that could be framed as an ethical criterion to assess CROTs.

[174] The developed criterion: Are there adequate and straightforward instructions to guide researchers on how CROTs should be used?

31. (Brand et al. 2015)

This article is a publicity piece about CRediT, which describes how it was developed and names the organisations that were involved and support it. It contains no issues that could be framed as an ethical criterion to assess CROTs.

32. (Allen et al. 2014)

This article is a publicity piece about CRediT, which describes how it was developed and names the organisations that were involved and support it. It contains no issues that could be framed as an ethical criterion to assess CROTs.

33. (Kingsley 2017)

This blog post explains challenges and opportunities for a wider uptake of Open Access publications and briefly introduces CRediT. It contains no issues that could be framed as an ethical criterion to assess CROTs.

34. (Holmes et al. 2019)

This poster describes the required workflow of a research project which involves various technical components (e.g., data warehousing, software development) and makes a distinction between technical, institutional and cultural motivations for contribution to such projects. It contains no issues that could be framed as an ethical criterion to assess CROTs.

35. (Ilik et al. 2018)

Label: Usability

> "OpenVIVO has an open text box for entering new contribution roles. The roles that are added as text will eventually be examined and evaluated by the ontology team for inclusion in the CRO" (Illik et al 2018, p. 8).

This journal article reports on history, and available options in OpenVIVO. It argues that in considering the importance of disciplinary differences and evolution of tasks in research, the CRO remains open to extending roles which is necessary to cope with the evolution of scientific methods and contributions. The requirement to be extensible was also discussed by Allen et al. (2012) and a criterion was developed accordingly.[175] Hence, the development of a new criterion is not necessary.

36. (Adie 2017)

This blog post reports on a workshop that happened during FORCE11 conference in Berlin. It suggests crediting relevant contributions such as those who were involved in conducting technical tasks, but it does not provide any specific examples.[176] It contains no issues that could be framed as an ethical criterion to assess CROTs.

37. (Gutzman et al. 2016)

This poster introduces several projects that enable the collection and dissemination of contributor and attribution data to various stakeholders. It contains no issues that could be framed as an ethical criterion to assess CROTs.

38. (Borek et al. 2016a)

This article describes the development of TaDiRAH and explains the bottom-up approach that was used within this process. Given its historical and explanatory nature, it contains no issues that could be framed as an ethical criterion to assess CROTs.

39. (Borek et al. 2014)

[175] The developed criterion: Do CROTs developers collect and evaluate user feedback for future revisions?
[176] It is worth noting that exploring specific tasks such as technical tasks within all areas of research is out of the scope of this thesis. Future research might be necessary to analyse this branch of research and find tasks that are currently not covered by CROTs.

This presentation describes the development of TaDiRAH and mentions used references and approach within this process. Given its historical and explanatory nature, it contains no issues that could be framed as an ethical criterion to assess CROTs.

40. (Dombrowski et al. 2014)

This blog post describes the development of TaDiRAH and mentions the rationale for its development and future plans for collaboration with other projects. Given its historical and explanatory nature, it contains no issues that could be framed as an ethical criterion to assess CROTs.

41. (Perkins et al. 2014)

This conference paper describes the development process of TaDiRAH and mentions past and future plans to use this taxonomy in conjunction with other projects. Given its historical and explanatory nature, it contains no issues that could be framed as an ethical criterion to assess CROTs.

Items mentioned during the annual CASRAI meetings

1. CASRAI Reconnect, June 2018 (University of Glasgow, Glasgow, Scotland)

Label: Usability

> "There is an ongoing challenge that corresponding author has to figure out and assign the roles, but this is also a criticism of old/current system - there should be no author for which the corresponding author doesn't know their contribution" (CASRAI Reconnect 2018 meeting notes, p. 12).

This section notes that in using CRediT, the corresponding author assigns the roles to ensure that individual contributors are recognised. The importance of mentioning this issue in instructions to researchers was mentioned in Atkins (2016) and a criterion was developed on that basis.[177]

2. CASRAI Reconnect June 2019 (Ulster University, Belfast, Northern Ireland)

Label: Attribution

> "Question - does CRediT include the % contribution made by each author to each category?
>
> Answer - this isn't included in the standard but some publishers have added this in their implementation and others have added the options of 'led' or 'contributed to' - these are optional parts of CRediT" (CASRAI Reconnect 2019 meeting notes, p. 2).

This question concerns clarification of the degree of contribution made by individuals to various tasks. Clarifying the extent of contribution was addressed in section 3.3.1 and a criterion was developed on that basis.[178] Hence, the development of a new criterion is not necessary.

Label: Attribution

> "CRediT might not work well outside the sciences, however it is felt that it wouldn't take much updating/developing to make it work for Arts and Humanities" (CASRAI Reconnect 2019 meeting notes, p. 3).

This note mentions CRediT's shortcomings in capturing roles relevant to Arts and Humanities disciplines, which can be subsumed under the issue of attribution. Since no example (of a role that is currently not captured) is provided, it is not possible to develop a specific criterion on the basis of this note.[179]

Label: Violations

[177] Developed criterion: Is it possible to recognise the task of communication and correspondence with other contributors and editorial teams?

[178] The developed criterion: Within tasks that involve more than one contributor, is it possible to clarify the extent of their contributions?

[179] It is worth noting that exploring relevant roles within the Arts and Humanities is out of the scope of this thesis. Future research might be necessary to analyse this branch of research and find tasks that are currently not covered by CROTs.

> "If supervisors want to take the credit for their students work they still will and CRediT won't change that" (CASRAI Reconnect 2019 meeting notes, p. 3).

This note pertains to one form of violation while using the CROTs that entails the misattribution of credit. This issue was discussed in section 3.3.2 and subsequently a relevant criterion was developed.[180] Hence, the development of a new criterion is not necessary.

[180] The developed criterion: Are there reasonably comprehensive documents for researchers that describe what is considered as a violation while using the CROTs?

Appendix C – Disparity in CRediT guidelines of *PLOS* journals

In what follows two specific examples are mentioned to demonstrate the provision of inconsistent and problematic instructions by different journals that have adopted CRediT.

I) In their instructions on how to use CRediT, *PLOS Medicine* note:

> "You will enter all author contributions in the submission system if your manuscript is selected for peer review. Provide at minimum one contribution for each author, and use the CRediT taxonomy to describe each contribution. Read the policy and the full list of roles.[181]
>
> *To qualify for authorship, all contributors must meet at least one of the seven core contributions (conceptualization, methodology, software, validation, formal analysis, investigation, data curation), as well as at least one of the writing contributions (original draft preparation, review and editing).* Authors may also satisfy the other remaining contributions; however, these alone will not qualify them for authorship.
>
> Contributions will be published with the final article, and they should accurately reflect contributions to the work. The submitting author is responsible for completing this information at full submission, and we expect that all authors will have reviewed, discussed, and agreed to their individual contributions ahead of this time.
>
> All authors will be contacted via email upon Full Submission to ensure that they are aware of and approve the submission of the manuscript, its content, authorship, and order of authorship. Articles will not be published unless all authors have provided their assent to publication" [Emphasis added] (PLOS Medicine 2020, Paragraph. 7).

[181] The sentence coloured in blue is a hyperlink and by clicking on it, these instructions are opened: "The contributions of all authors must be described. PLOS has adopted the CRediT Taxonomy to describe each author's individual contributions to the work. The submitting author is responsible for providing the contributions of all authors at submission. We expect that all authors will have reviewed, discussed, and agreed to their individual contributions ahead of this time. Contributions will be published with the final article, and they should accurately reflect contributions to the work" (PLOS Medicine 2020, Paragraph 4).

These instructions are problematic because they link CRediT roles to authorship criteria (an action that is explicitly discouraged by developers of CRediT in one of their early publications[182]). Furthermore, they are confusing[183] and inconsistent[184] with other adopted guidelines of the same journal.

II) The journal of *PLOS Biology*, provides shorter instructions but these are still problematic in the sense that they link CRediT roles to the ICMJE authorship criteria in an inaccurate manner[185]:

> "You will enter all author contributions in the submission system if your manuscript is selected for peer review. Provide at minimum one contribution for each author, and use the CRediT taxonomy to describe each contribution. Read the policy and the full list of roles.[186]

These two examples demonstrate that many issues can go wrong when CRediT's developers do not provide instructions for users. Mentioned inconsistencies and inaccuracies show that even

[182] In introducing CRediT roles and classification of tasks, its developers note: "the classification includes, but is not limited to, traditional authorship roles. That is, *these roles are not intended to define what constitutes authorship"* [Emphasis added] (Brand et al. 2015, p. 153).

[183] This is confusing because while the first paragraph notes that at least one contribution should be provided per author, the second paragraph notes that all contributors must meet at least one of the seven core contributions, AND, one of the writing contributions. In other words, it is not clear whether each author should contribute to one or two tasks.

[184] While PLOS Medicine makes a reference to the ICMJE criteria, in their instructions about how CRediT must be used, they interpret ICMJE criteria inaccurately. If authors are linked with a minimum of one contribution, authorship status is likely assigned to some who do not necessarily meet the ICMJE's criteria. ICMJE criteria requires authors to make "1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND 2. Drafting the work or revising it critically for important intellectual content" (ICMJE 2020, p. 2). On that basis, even if CRediT roles were to be used for identifying who should be an author, for a contributor to meet authorship criteria they should be linked with at least two contributions, one of which should always be a writing related task (as described in PLOS Medicine's second paragraph of instructions to researchers).

[185] In their instructions on how CRediT should be used, they require each author to be linked with a minimum of *one contribution,* which if followed, would result in assigning authorship status to those who do not necessarily meet the ICMJE's criteria. ICMJE criteria requires authors to make "1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND 2. Drafting the work or revising it critically for important intellectual content" (ICMJE 2020, p. 2). On that basis, even if CRediT roles were to be used for identifying who should be an author, for a contributor to meet authorship criteria they should be linked with at least two contributions, one of which should always be a writing related task.

[186] The sentence coloured in blue is a hyperlink and by clicking on it, these instructions are opened: "The contributions of all authors must be described. PLOS has adopted the CRediT Taxonomy to describe each author's individual contributions to the work. The submitting author is responsible for providing the contributions of all authors at submission. We expect that all authors will have reviewed, discussed, and agreed to their individual contributions ahead of this time. Contributions will be published with the final article, and they should accurately reflect contributions to the work" (PLOS Medicine 2020, Paragraph 4).

journals that are owned by the same publisher can interpret CROTs in different ways and provide recommendations that compromise their other adopted guidelines (in this case ICMJE authorship guidelines). On that basis, CRediT's developers should provide adequate and straightforward recommendations for researchers.

Appendix D – The full list of items explored for the scoping search

In this appendix, the results of the scoping search for the 18 analysed tasks described in section 4.2.6 are presented. Tables are colour-coded to improve readability. Grey colour is used in cases where sources were deemed irrelevant or were inaccessible.

1. Task of funding acquisition *(Significant)*

On 30th of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "funding acquisition" included (table 33):

Resource	Title	Indispensability	Specificity	Verdict
(Hoekman et al. 2013)	Acquisition of European research funds and its effect on international scientific collaboration	Indispensable	Specific	Significant
(Allen et al. 2014)	Publishing: Credit where credit is due	Attribution of credit to Funding acquisition		
(Pizzolato et al. 2017)	Comparison of six electromyography acquisition setups on hand movement classification tasks	Hand movement classification tasks		
(McNutt et al. 2018)	Transparency in authors' contributions and responsibilities to promote integrity in scientific publication	How to recognise funders' contribution transparently		
(Brand et al. 2015)	Beyond authorship: attribution, contribution, collaboration, and credit	Attribution of credit to Funding acquisition		
(Han & Appelbaum 2018)	China's science, technology, engineering, and mathematics (STEM) research environment: A snapshot	Indispensable	Specific	Significant
(Raj et al. 2016)	Longitudinal Analysis of Gender Differences in Academic Productivity among Medical Faculty across 24 Medical Schools in the United States	Indispensable	Specific	Significant
(Ehrhardt Mustaine & Tewksbury 2009)	Rainmakers: The Most Successful Criminal Justice Scholars and Departments In Research Grant Acquisition	Indispensable	Specific	Significant
(Assante et al. 2019)	Enacting open science by D4Science	Indispensable	Specific	Significant

(Kacetl & Klímová 2019)	Use of Smartphone Applications in English Language Learning—A Challenge for Foreign Language Education	The importance of funds for learning a foreign language		
(Klein & Falk-Krzesinski 2017)	Interdisciplinary and collaborative work: Framing promotion and tenure practices and policies	Attribution of credit to Funding acquisition		
(Wallach et al. 2018)	Reproducible research practices, transparency, and open access data in the biomedical literature, 2015–2017	Indispensable	Specific	Significant
(Larivière & Costas 2016)	How Many Is Too Many? On the Relationship between Research Productivity and Impact	Indispensable	Specific	Significant
(Fong & wilhite 2017)	Authorship and citation manipulation in academic research	Indispensable	Specific	Significant
(Besselaar & Sandström 2017)	Vicious circles of gender bias, lower positions, and lower performance: Gender differences in scholarly productivity and impact	Indispensable	Specific	Significant
(Titley et al. 2017)	Scientific research on animal biodiversity is systematically biased towards vertebrates and temperate regions	Indispensable	Specific	Significant
(Hornstein & Eisenberger 2017)	Unpacking the buffering effect of social support figures: Social support attenuates fear acquisition	Acquisition of fear		
(Brodny & Tutak 2019)	Analysing the Utilisation Effectiveness of Mining Machines Using Independent Data Acquisition Systems: A Case Study	Acquisition of data		
(Basley et al. 2017)	Perceived conflict of interest in health science partnerships	Indispensable	Specific	Significant
(Terämä et al. 2016)	Beyond Academia – Interrogating Research Impact in the Research Excellence Framework	Indispensable	Specific	Significant

Table 33. Items retrieved for the task of funding acquisition.

2. Task of supervision *(Significant)*

On 30th of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND “supervision” included (table 34):

Resource	**Title**	**Indispensability**	**Specificity**	**Verdict**
(McNeill & Beyens 2013)	Offender Supervision in Europe	Supervising criminals		

(Muthanna & Alduais 2020)	A Thematic Review on Research Integrity and Research Supervision: Relationships, Crises and Critical Messages	Indispensable	Specific	Significant
(Leite et al. 2012)	Profile of the Researchers with Productivity Grants in the Brazilian National Research Council (CNPq) of the Physical Education Area	Indispensable	Specific	Significant
(Witton 1973)	Academics and Student Supervision: Apprenticeship or Exploitation?	Indispensable	Specific	Significant
(Lampert 1985)	How Do Teachers Manage to Teach? Perspectives on Problems in Practice	Supervision in elementary schools		
(Miller 1977)	Supervision in social work	Supervision in social work		
(Coutinho 2020)	Listening and feeling doctoral students' perceptions of their doctoral supervision. The PhD doctoral students' point of view.	Indispensable	Specific	Significant
(Riley & Hunter 2009)	Mapping Landscapes for Performance as Research	Indispensable	Specific	Significant
(Lambie & Vaccaro 2011)	Doctoral Counselor Education Students' Levels of Research Self-Efficacy, Perceptions of the Research Training Environment, and Interest in Research	Indispensable	Specific	Significant
(Gonsalvez et al. 2011)	The Objectives Approach to Clinical Supervision: Towards Integration and Empirical Evaluation	Indispensable	Specific	Significant
(Ashkanasy et al. 2016)	Understanding the High Performance Workplace	Indispensable	Specific	Significant
(Gisemba Bagaka's et al. 2015)	Exploring Student Success in a Doctoral Program: The Power of Mentorship and Research Engagement	Indispensable	Specific	Significant
(Davis 1938)	Project in Research in Universities: Preparation for Elementary School Supervision.	Supervision in elementary schools		
(Rutherford 2011)	Adult Supervision Required	Children supervision		
(Chiang 2003)	Learning experiences of doctoral students in UK universities	Indispensable	Specific	Significant
(Cameron & Spreitzer 2011)	The Oxford Handbook of Positive Organizational Scholarship	Indispensable	Specific	Significant
(Flowerdew & Li 2009)	Writing in Foreign Language Contexts: Learning, Teaching, and Research	Indispensable	Specific	Significant
(Austin & Baldwin 1991)	Faculty Collaboration: Enhancing the Quality of Scholarship and Teaching. ASHE-ERIC Higher Education	Indispensable	Specific	Significant

(Lipton & Steinhardt 2018)	Troubling Trends in Machine Learning Scholarship	Supervision in deep learning training
(Coomans 2010)	Methods of Human Rights Research: A Primer	International supervision mechanisms in the field of human rights

Table 34. Items retrieved for the task of supervision.

3. Task of administrative support *(Insignificant)*

On 30th of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "administrative support" included (table 35):

Resource	**Title**	**Indispensability**	**Specificity**	**Verdict**
(Pan & Hovde 2010)	Professional Development for Academic Librarians: Needs, Resources, and Administrative Support	Indispensable	Generic	Insignificant
(Gigante & Firestone 2008)	Administrative support and teacher leadership in schools implementing reform	Administrative support for special education teachers		
(Conley & You 2017)	Key influences on special education teachers' intentions to leave: The effects of administrative support and teacher team efficacy in a mediational model	Administrative support in schools		
(Maton et al. 2000)	African American college students excelling in the sciences: College and postcollege outcomes in the Meyerhoff Scholars Program	Indispensable	Generic	Insignificant
(Blevins et al. 2010)	Collaborative research between clinicians and researchers: a multiple case study of implementation	Indispensable	Generic	Insignificant
(Phan et al. 2005)	Science parks and incubators: observations, synthesis and future research	Dispensable		Insignificant
(Pfirman & Martin 2010)	The Oxford Handbook of Interdisciplinarity	Indispensable	Generic	Insignificant
(Paoline & Lambert 2012)	The Issue of Control in Jail: The Effects of Professionalism, Detainee Control, and Administrative Support on Job Stress, Job Satisfaction, and Organizational Commitment among Jail Staff	Administrative support in jails		

(Frost & Fukami 1997)	Teaching Effectiveness in the Organizational Sciences: Recognizing and Enhancing the Scholarship of Teaching	No Access		
(Steinert & McLeod 2006)	From Novice to Informed Educator: The Teaching Scholars Program for Educators in the Health Sciences	Dispensable		Insignificant
(Elgren & Hensel 2006)	Undergraduate Research Experiences: Synergies between Scholarship and Teaching	Dispensable		Insignificant
(Stokols et al. 2008)	The Ecology of Team Science: Understanding Contextual Influences on Transdisciplinary Collaboration	Indispensable	Generic	Insignificant
(Johnson et al. 2010)	An Innovative Program to Train Health Sciences Researchers to be Effective Clinical and Translational-Research Mentors	Dispensable		Insignificant
(Jacobson et al. 2004)	Organizational Factors that Influence University-Based Researchers' Engagement in Knowledge Transfer Activities	Indispensable	Generic	Insignificant
(Louis et al. 1989)	Entrepreneurs in Academe: An Exploration of Behaviors among Life Scientists	Dispensable		Insignificant
(Lancaster et al. 2014)	Faculty Development Program Models to Advance Teaching and Learning Within Health Science Programs	Indispensable	Generic	Insignificant
(Lane et al. 2015)	New linked data on research investments: Scientific workforce, productivity, and public value	Indispensable	Generic	Insignificant
(Abu-Rish et al. 2012)	Current trends in interprofessional education of health sciences students: A literature review	Indispensable	Generic	Insignificant
(Etzkowitz 1938)	Entrepreneurial Scientists and Entrepreneurial Universities in American Academic Science	Indispensable	Generic	Insignificant
(Sapolsky 2014)	Science and the Navy: The History of the Office of Naval Research	Indispensable	Generic	Insignificant

Table 35. Items retrieved for the task of administrative support.

4. Task of writing/editorial support *(Insignificant)*

On 30th of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "writing support" included (table 36):

Resource	**Title**	**Indispensability**	**Specificity**	**Verdict**

(Corcoran 2019)	Addressing the “Bias Gap”: A Research-Driven Argument for Critical Support of Plurilingual Scientists’ Research Writing	Dispensable		Insignificant
(Tysick & Babb 2006)	Perspectives on … Writing Support for Junior Faculty Librarians: A Case Study	A library's effort to improve writing		
(Makarenkov et al. 2019)	Choosing the right word: Using bidirectional LSTM tagger for writing support systems	Dispensable		Insignificant
(Catterall et al. 2011)	Pedagogical Approaches that Facilitate Writing in Postgraduate Research Candidature in Science and Technology	Dispensable		Insignificant
(Sharma 2018)	Professional medical writing support: The need of the day	Dispensable		Insignificant
(Aitchison et al. 2012)	‘Tough love and tears’: learning doctoral writing in the sciences	Dispensable		Insignificant
(O’Brien et al. 2018)	Machine Translation and Self-post-editing for Academic Writing Support: Quality Explorations	No Access		
(Castelló et al. 2017)	Spanish and UK post-PhD researchers: writing perceptions, well-being and productivity	Dispensable		Insignificant
(Marchington & Burd 2014)	Author attitudes to professional medical writing support	Dispensable		Insignificant
(Das & Das 2018)	Knowledge and attitudes of Indian surgeons regarding professional medical writing support	Dispensable		Insignificant
(Cope et al. 2013)	Science in Writing: Learning Scientific Argument in Principle and Practice	Dispensable		Insignificant
(Bazerman 2009)	Handbook of Research on Writing: History, Society, School, Individual, Text	History of writing		
(Spence et al. 2018)	Independent investigator incubator (I3): a comprehensive mentorship program to jumpstart productive research careers for junior faculty	Dispensable		Insignificant
(Carter 2011)	Doctorate as genre: supporting thesis writing across campus	Dispensable		Insignificant
(Blair 2016)	Writing a Graduate Thesis or Dissertation	Dispensable		Insignificant
(Ho 2017)	Navigating scholarly writing and international publishing: Individual agency of Taiwanese EAL doctoral students	Dispensable		Insignificant

(Wallace et al. 2004)	Introduction: Does writing promote learning in science?	The impact of writing on learning		
(Murphy et al. 2014)	Constructing Our Identities through a Writing Support Group: Bridging from Doctoral Students to Teacher Educator Researchers	Dispensable		Insignificant
(Simpson 2012)	The Problem of Graduate-Level Writing Support: Building a Cross-Campus Graduate Writing Initiative	Dispensable		Insignificant
(Strobl et al. 2019)	Digital support for academic writing: A review of technologies and pedagogies	Dispensable		Insignificant

Table 36. Items retrieved for the task of writing/editorial support.

5. Task of communication and correspondence *(Insignificant)*

On 31st of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "journal correspondence"[187] included (table 37):

Resource	**Title**	**Indispensability**	**Specificity**	**Verdict**
(Donnelly 2015)	Adolphe Quetelet, social physics and the average men of science, 1796–1874	Indispensable	Generic	Insignificant
(Sterken 2011)	Writing a Scientific Paper III. Ethical Aspects	Indispensable	Generic	Insignificant
(Van der Straeten & Louckx 2020)	Sociology in Great Little Belgium	History of sociology		
(Mazliak 2019)	What would be Belgium without probability and probability without Belgium? Paul Mansion and the scientific approach of randomness	Indispensable	Generic	Insignificant
(Donnelly 2014)	The Other Average Man: Science Workers in Quetelet's Belgium	Indispensable	Generic	Insignificant
(LaPierre, 2004)	Carleton, Ph. D. 3 A Neuroscience Book Review (with a Primer of Terms and Concepts) By Aline LaPierre, Psy. D. 5 The Genomic Science Foundation of Body …	A Neuroscience Book Review		

[187] This search string is slightly different from the originally suggested string (i.e., scholar* research* scien* AND "communication and correspondence") because that would not yield many relevant results.

(Lorente 2020)	International lexicon of aesthetics	About art critics		
(Price 2003)	Moving Clinical Work into Research: Study Preparation, Design, and Implementation	About body psychotherapy		
(Heule & Ye 2015)	Linguet's Lettre du Mandarin, a Forgotten Apology for the Jesuits: The Mandarin Wei Zheng as a Model	Personal communication between authors in the past		
(Watts 2015)	Philosophical Intelligence: Letters, Print, and Experiment during Napoleon's Continental Blockade	Personal communication between authors in the past		
(Lee et al. 2010)	How to write a scholarly book review for publication in a peer-reviewed journal: a review of the literature	How to write a book review		
(Boettger & Lam 2013)	An Overview of Experimental and Quasi-Experimental Research in Technical Communication Journals (1992–2011)	Correspondence analysis		
Goldacre et al. 2019)	COMPare: a prospective cohort study correcting and monitoring 58 misreported trials in real time	Indispensable	Generic	Insignificant
(Curry & Lillis 2014)	Strategies and tactics in academic knowledge production by multilingual scholars	Indispensable	Generic	Insignificant
(Zhou et al. 2017)	Correspondence: Reply to 'Analytical flaws in a continental-scale forest soil microbial diversity study'	Indispensable	Generic	Insignificant
(Biondi-Zoccai et al. 2005)	A simple hint to improve Robinson and Dickersin's highly sensitive PubMed search strategy for controlled clinical trials	Letter about another paper		
(Ray 2016)	An expanded approach to evaluating open access journals	No Access		
(Sattelmeyer 2014)	Thoreau's Reading: A Study in Intellectual History with Bibliographical Catalogue	Indispensable	Generic	Insignificant
(Huang et al. 2016)	Correspondence analysis of bio-refractory compounds degradation and microbiological community distribution in anaerobic filter for coking wastewater treatment	Chemical correspondence		
(Blencowe et al. 2020)	Author response to: Comment on: Systematic review of the introduction and evaluation of	Indispensable	Generic	Insignificant

	magnetic augmentation of the lower oesophageal sphincter for gastro-oesophageal reflux disease			

Table 37. Items retrieved for the task of communication and correspondence.

6. Task of community engagement *(Significant)*

On 26th of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "community engagement" included (table 38):

Resource	**Title**	**Indispensability**	**Specificity**	**Verdict**
(Ahmed & Palermo 2010)	Community Engagement in Research: Frameworks for Education and Peer Review	Indispensable	Specific	Significant
(Lavery et al. 2010)	Towards a framework for community engagement in global health research	Indispensable	Specific	Significant
(O'Meara & Jeager 2019)	Preparing future faculty for community engagement	Community engagement in higher education		
(Westfall et al. 2009)	Practice-based Research is Community Engagement	Indispensable	Specific	Significant
(MacQueen et al. 2015)	Evaluating community engagement in global health research: the need for metrics	Indispensable	Specific	Significant
(Morin et al. 2016)	The State of Community Engagement in Graduate Education: Reflecting on 10 Years of Progress	Community engagement in higher education		
(Reynolds & Sariola 2018)	The ethics and politics of community engagement in global health research	Indispensable	Specific	Significant
(David-Chavez & Gavin 2018)	A global assessment of Indigenous community engagement in climate research	Indispensable	Specific	Significant
(Bortolin 2011)	Serving ourselves: how the discourse on Community engagement privileges the university over the community	No Access		
(King et al. 2014)	Community engagement and the human infrastructure of global health research	Indispensable	Specific	Significant
(Tindana et al. 2007)	Grand Challenges in Global Health: Community Engagement in Research in Developing Countries	Indispensable	Specific	Significant
(Eder et al. 2014)	A Logic Model for Community Engagement within the CTSA	Indispensable	Specific	Significant

	Consortium: Can We Measure What We Model?			
(Tindana et al. 2015)	Community engagement strategies for genomic studies in Africa: a review of the literature	Indispensable	Specific	Significant
(Brackmann 2015)	Community Engagement in a Neoliberal Paradigm	Community engagement in higher education		
(Elsabbagh et al. 2014)	Community engagement and knowledge translation: Progress and challenge in autism research	Indispensable	Specific	Significant
(Bowen et al. 2010)	When Suits Meet Roots: The Antecedents and Consequences of Community Engagement Strategy	Indispensable	Specific	Significant
(Molyneux & Bull 2013)	Consent and Community Engagement in Diverse Research Contexts: Reviewing and Developing Research and Practice: Participants in the Community Engagement and Consent Workshop, Kilifi, Kenya, March 2011	Indispensable	Specific	Significant
(Szilagyi et al. 2014)	Evaluating Community Engagement in an Academic Medical Center	Indispensable	Specific	Significant
(Bracic 2018)	For Better Science: The Benefits of Community Engagement in Research	Indispensable	Specific	Significant
(Collie 2011)	Cities of the imagination: Science fiction, urban space, and community engagement in urban planning	Community engagement in urban planning		

Table 38. Items retrieved for the task of community engagement.

7. Task of creative efforts *(Significant)*

On 31st of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "creative visualisation"[188] included (table 39):

Resource	Title	Indispensability	Specificity	Verdict
(Allen 2018)	Visual brokerage: Communicating data and research through visualisation	Indispensable	Specific	Significant

[188] This search string is slightly different from the originally suggested string (i.e., scholar* research* scien* AND "creative efforts") because that would not yield many relevant results.

(Sun et al. 2020)	Visualisation of epidemiological map using an Internet of Things infectious disease surveillance platform	Indispensable	Specific	Significant
(Grainger et al. 2016)	Environmental data visualisation for non-scientific contexts: Literature review and design framework	Indispensable	Specific	Significant
(Sheppard & Sizek 2009)	The ethics of Google Earth: Crossing thresholds from spatial data to landscape visualisation	Indispensable	Specific	Significant
(Fleer 2019)	Scientific Playworlds: a Model of Teaching Science in Play-Based Settings	Teaching visualisation to children		
(Green et al. 2020)	Chapter 10 Disadvantaged Children's Creative Visualisation of Possible Futures	Teaching visualisation to children		
(Borgman 2010)	Scholarship in the Digital Age: Information, Infrastructure, and the Internet	Indispensable	Specific	Significant
(Franz et al. 2016)	Cytoscape.js: a graph theory library for visualisation and analysis	Indispensable	Specific	Significant
(Tesařová et al. 2019)	An interactive and intuitive visualisation method for X-ray computed tomography data of biological samples in 3D Portable Document Format	Indispensable	Specific	Significant
(Dahl et al. 2001)	The importance of visualisation in concept design	Artistic Visualisation		
(Bowen 2016)	Alan Turing: Virtuosity and visualisation	Visualisation in design		
(Kara 2015)	Creative Research Methods in the Social Sciences: A Practical Guide	Indispensable	Specific	Significant
(Chigbu 2019)	Visually Hypothesising in Scientific Paper Writing: Confirming and Refuting Qualitative Research Hypotheses Using Diagrams	Indispensable	Specific	Significant
(Erduran & Dagher 2014)	Reconceptualizing Nature of Science for Science Education	Indispensable	Specific	Significant
(Won et al. 2019)	Interactive Immersive Virtual Reality to Enhance Students' Visualisation of Complex Molecules	Indispensable	Specific	Significant
(Pettit et al. 2011)	Identifying strengths and weaknesses of landscape visualisation for effective communication of future alternatives	Indispensable	Specific	Significant

(Kokol et al. 2016)	Creating a Self-Plagiarism Research Topic Typology through Bibliometric Visualisation	Indispensable	Specific	Significant
(Challenor & Ma 2019)	A Review of Augmented Reality Applications for History Education and Heritage Visualisation	Indispensable	Specific	Significant
(Gatto 2015)	Making research useful : current challenges and good practices in data visualisation	Indispensable	Specific	Significant
(Davies & Gilbert 2003)	Modelling: Promoting Creativity while Forging Links between Science Education and Design and Technology Education	Indispensable	Specific	Significant

Table 39. Items retrieved for the task of creative efforts.

8. Task of data annotation *(Inconclusive)*

On 25th of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "data annotation" included (table 40):

Resource	**Title**	**Indispensability**	**Specificity**	**Verdict**
(Musen et al. 2015)	The center for expanded data annotation and retrieval	Dispensable		Insignificant
(Wolstencraft et al. 2011)	RightField: embedding ontology annotation in spreadsheets	Dispensable		Insignificant
(Wilkinson et al. 2016)	The FAIR Guiding Principles for scientific data management and stewardship	Dispensable		Insignificant
(Lacourse et al. 2020)	Massive online data annotation, crowdsourcing to generate high quality sleep spindle annotations from EEG data	Indispensable	Generic	Insignificant
(Boergens et al. 2019)	webKnossos: efficient online 3D data annotation for connectomics	Indispensable	Specific	Significant
(Sun et al. 2010)	Community cyberinfrastructure for Advanced Microbial Ecology Research and Analysis: the CAMERA resource	Indispensable	Specific	Significant
(Kalra et al. 2012)	Vesiclepedia: A Compendium for Extracellular Vesicles with Continuous Community Annotation	Dispensable		Insignificant
(Yu et al. 2015)	ChIPseeker: an R/Bioconductor package for ChIP peak annotation, comparison and visualization	Indispensable	Specific	Significant

(Hinrichs & Krauwer 2014)	The CLARIN Research Infrastructure: Resources and Tools for e-Humanities Scholars	Indispensable	Specific	Significant
(Heidorn 2008)	Shedding Light on the Dark Data in the Long Tail of Science	Dispensable		Insignificant
(Leonelli 2016)	Data-centric biology: A philosophical study	No Access		
(Simon et al. 2017)	Linked data annotation without the pointy brackets: Introducing Recogito 2	Dispensable		Insignificant
(Noy et al. 2009)	BioPortal: ontologies and integrated data resources at the click of a mouse	Dispensable		Insignificant
(Macmullen 2005)	Annotation as Process, Thing, and Knowledge: Multi-domain studies of structured data annotation	Indispensable	Specific	Significant
(Cocos 2017)	Crowd control: Effectively utilizing unscreened crowd workers for biomedical data annotation	Indispensable	Generic	Insignificant
(Karimova et al. 2017)	Promoting Semantic Annotation of Research Data by Their Creators: A Use Case with B2NOTE at the End of the RDM Workflow	No Access		
(Guellil et al. 2018)	SentiALG: Automated Corpus Annotation for Algerian Sentiment Analysis	Indispensable	Generic	Insignificant
(Karam et al. 2016)	A Terminology Service Supporting Semantic Annotation, Integration, Discovery and Analysis of Interdisciplinary Research Data	Indispensable	Specific	Significant
(Whetzel et al. 2006)	The MGED Ontology: a resource for semantics-based description of microarray experiments	Indispensable	Specific	Significant
(Amin et al. 2009)	An informatics supported web-based data annotation and query tool to expedite translational research for head and neck malignancies	Indispensable	Specific	Significant

Table 40. Items retrieved for the task of data annotation.

9. Task of data curation *(Inconclusive)*

On 31st of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND “data curation” included (table 41):

Resource	Title	Indispensability	Specificity	Verdict
(Ogburn 2010)	The Imperative for Data Curation	Dispensable		Insignificant
(Heidorn 2011)	The Emerging Role of Libraries in Data Curation and E-science	Dispensable		Insignificant
(Walters 2009)	Data Curation Program Development in U.S. Universities: The Georgia Institute of Technology Example	Dispensable		Insignificant
(Choudhury 2008)	Case Study in Data Curation at Johns Hopkins University	Mixed		
(Palmer et al. 2013)	Foundations of Data Curation: The Pedagogy and Practice of "Purposeful Work" with Research Data	Dispensable		Insignificant
(Cragin et al. 2007)	An Educational Program on Data Curation	Dispensable		Insignificant
(Christian et al. 2018)	Operationalizing the Replication Standard: A Case Study of the Data Curation and Verification Workflow for Scholarly Journals	Dispensable		Insignificant
(Grondin et al. 2016)	Advancing Exposure Science through Chemical Data Curation and Integration in the Comparative Toxicogenomics Database	Indispensable	Specific	Significant
(Choudhury 2010)	Data curation: An ecological perspective	Dispensable		Insignificant
(Lee & Stvilia 2017)	Practices of research data curation in institutional repositories: A qualitative view from repository staff	Dispensable		Insignificant
(Scaramozzino et al. 2012)	A Study of Faculty Data Curation Behaviors and Attitudes at a Teaching-Centered University	Dispensable		Insignificant
(Witt 2008)	Institutional Repositories and Research Data Curation in a Distributed Environment	Dispensable		Insignificant
(Weber et al. 2012)	Current Trends and Future Directions in Data Curation Research and Education	Mixed		
(Witt et al. 2009)	Constructing Data Curation Profiles	Dispensable		Insignificant
(McLure et al. 2014)	Data Curation: A Study of Researcher Practices and Needs	Dispensable		Insignificant
(Jahnke & Asher, nd.)	The Problem of Data: Data Management and Curation Practices Among University Researchers	Indispensable	Specific	Significant
(Poole 2015)	How has your science data grown? Digital curation and the	Mixed		

	human factor: a critical literature review			
(Lynch 2014)	The next generation of challenges in the curation of scholarly data	Mixed		
(Fourches et al. 2015)	Curation of chemogenomics data	Indispensable	Specific	Significant
(Munoz & Renear 2011)	Issues in Humanities Data Curation	Dispensable		Insignificant

Table 41. Items retrieved for the task of data curation.

10. Task of data warehousing *(Insignificant)*

On 31st of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "data warehousing" included (table 42):

Resource	**Title**	**Indispensability**	**Specificity**	**Verdict**
(Park 2006)	An empirical investigation of the effects of data warehousing on decision performance	Dispensable		Insignificant
(Chandra & Gupta 2018)	Comprehensive survey on data warehousing research	Dispensable		Insignificant
(March & Hevner 2007)	Integrated decision support systems: A data warehousing perspective	Dispensable		Insignificant
(Nicholson 2006)	The basis for bibliomining: Frameworks for bringing together usage-based data mining and bibliometrics through data warehousing in digital library services	Dispensable		Insignificant
(Nemati et al. 2002)	Knowledge warehouse: an architectural integration of knowledge management, decision support, artificial intelligence and data warehousing	Data warehousing in business		
(Triplet & Butler 2014)	A review of genomic data warehousing systems	Dispensable		Insignificant
(Watson et al. 2002)	The benefits of data warehousing: why some organizations realize exceptional payoffs	Data warehousing in business		
(Moscoso-Zea et al. 2018)	A Holistic View of Data Warehousing in Education	Dispensable		Insignificant

(Ratner & Gad 2018)	Data warehousing organization: Infrastructural experimentation with educational governance	Data warehousing in the education sector		
(McCusker et al. 2009)	Semantic web data warehousing for caGrid	Dispensable		Insignificant
(Wyllie & Davies 2015)	Role of data warehousing in healthcare epidemiology	Dispensable		Insignificant
(Aji et al. 2013)	Hadoop-GIS: A High Performance Spatial Data Warehousing System over MapReduce	Dispensable		Insignificant
(Singh & Singh 2010)	A Descriptive Classification of Causes of Data Quality Problems in Data Warehousing	Dispensable		Insignificant
(Santos et al. 2019)	Enhancing Big Data Warehousing for Efficient, Integrated and Advanced Analytics	Data warehousing in system engineering		
(Costa & Santos 2018)	Evaluating Several Design Patterns and Trends in Big Data Warehousing Systems	Data warehousing in system engineering		
(Bonchi et al. 2001)	Web log data warehousing and mining for intelligent web caching	Dispensable		Insignificant
(Ang & Teo 2000)	Management issues in data warehousing: insights from the Housing and Development Board	Data warehousing in a public organisation in Singapore (Housing and Development Board)		
(Sirinivasa & Prasad 2010)	Text Analytics to Data Warehousing	Data warehousing in business		
(Tseng & Chou 2006)	The concept of document warehousing for multi-dimensional modeling of textual-based business intelligence	Data warehousing in business		
(Arnott & Pervan 2005)	A critical analysis of decision support systems research	Data warehousing in business		

Table 42. Items retrieved for the task of data warehousing.

11. Task of education and training *(Insignificant)*

On 31st of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND “education and training” included (table 43):

Resource	Title	Indispensability	Specificity	Verdict
(Roco 2003)	Converging science and technology at the nanoscale:	Indispensable	Generic	Insignificant

	opportunities for education and training			
(Gallagher et al. 2003)	Fundamental principles of validation, and reliability: rigorous science for the assessment of surgical education and training	Indispensable	Generic	Insignificant
(Jensen & Konradsen 2018)	A review of the use of virtual reality head-mounted displays in education and training	Indispensable	Generic	Insignificant
(Edirippulige & Armfield 2017)	Education and training to support the use of clinical telehealth: A review of the literature	Indispensable	Generic	Insignificant
(Chittaro & Ranon 2007)	Web3D technologies in learning, education and training: Motivations, issues, opportunities	Indispensable	Generic	Insignificant
(Iacopino 2007)	The Influence of "New Science" on Dental Education: Current Concepts, Trends, and Models for the Future	Indispensable	Generic	Insignificant
(Santich 2004)	The study of gastronomy and its relevance to hospitality education and training	Education and training in the hospitality sector		
(Santora et al. 2013)	A Model for Progressive Mentoring in Science and Engineering Education and Research	Education and training in mentoring		
(Badat 2010)	The Challenges of Transformation in Higher Education and Training Institutions in South Africa	Education and training in Higher Education and Training Institutions		
(Aspry et al. 2018)	Medical Nutrition Education, Training, and Competencies to Advance Guideline-Based Diet Counseling by Physicians: A Science Advisory From the American Heart Association	Indispensable	Generic	Insignificant
(Schneider 2017)	Promoting the Entrepreneurial Success of Women Entrepreneurs Through Education and Training	Education and training in Entrepreneurship		
(Freedman et al. 2018)	[Letter to the Editor] The need for improved education and training in research antibody usage and validation practices	Indispensable	Generic	Insignificant
(Lutfiyya et al. 2016)	Reflections From the Intersection of Health Professions Education and Clinical Practice: The State of the Science of Interprofessional	Indispensable	Generic	Insignificant

	Education and Collaborative Practice			
(Hidayat & Budiatma 2018)	Education and Job Training on Employee Performance	The effects of Education and training on Employee Work Achievement		
(Surr et al. 2017)	Effective Dementia Education and Training for the Health and Social Care Workforce: A Systematic Review of the Literature	Indispensable	Generic	Insignificant
(Weinstein 2008)	Finding science in the school body: Reflections on transgressing the boundaries of science education and the social studies of science	Education and training in schools		
(Bush et al. 2006)	On Hiring Science Faculty with Education Specialties for Your Science (Not Education) Department	Indispensable	Generic	Insignificant
(Ayonmike et al. 2015)	Towards Quality Technical Vocational Education and Training (Tvet) Programmes in Nigeria: Challenges and Improvement Strategies	Education and training in third level education		
(Straus et al. 2015)	Education and training for implementation science: our interest in manuscripts describing education and training materials	Indispensable	Generic	Insignificant
(Vhurumuku & Mokeleche 2009)	The nature of science and indigenous knowledge systems in South Africa, 2000–2007: A critical review of the research in science education	Education and training in science education		

Table 43. Items retrieved for the task of training and education.

12. Task of enrolling patients for clinical trials *(Insignificant)*

On 6th of February 2021, items shown in Google Scholar using scholar* research* scien* AND "enrolling patients for clinical trials" included[189] (table 44):

Resource	Title	Indispensability	Specificity	Verdict
(Cimino et al. 2018)	Copy number profiling across glioblastoma populations has implications for clinical trial design	Indispensable	Generic	Insignificant

[189] This string resulted in only 10 hits

(Gligorijevic et al. 2019)	Optimizing clinical trials recruitment via deep learning	Indispensable	Generic	Insignificant
(McCabe 2005)	Open Access to Trials Register	Indispensable	Generic	Insignificant
(Andrews et al. 2017)	Virtual Clinical Trials: One Step Forward, Two Steps Back	Indispensable	Generic	Insignificant
(Krishnan 2005)	Unregistered Trials Are Unethical	Indispensable	Generic	Insignificant
(Passiglia et al. 2020)	Treatment of advanced non-small-cell lung cancer: The 2019 AIOM (Italian Association of Medical Oncology) clinical practice guidelines	Indispensable	Generic	Insignificant
(Antonelli 2012)	Where Is the European Pharma Industry Going?	No Access		
(Koenig & McArthur 2005)	Case 8: Absentminded and "Walking Like a Drunk"	Indispensable	Generic	Insignificant
(Hosseini & Gordijn 2020)	A review of the literature on ethical issues related to scientific authorship	Indispensable	Generic	Insignificant
(Trowell et al. 2020)	How Good Are Controlled Attenuation Parameter Scores from Fibroscan to Assess Steatosis, NASH, and Fibrosis?	Indispensable	Generic	Insignificant

Table 44. Items retrieved for the task of enrolling patients for clinical trials.

13. Task of translation *(Significant)*

On 31st of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "translation" included (table 45):

Resource	**Title**	**Indispensability**	**Specificity**	**Verdict**
(Holmes 1988)	The name and nature of translation studies	Indispensable	Specific	Significant
(Kaiser 2014)	The integrity of science – Lost in translation?	Science integrity		
(Shreve & Lacruz 2017)	Aspects of a Cognitive Model of Translation	Indispensable	Specific	Significant
(Tirkkonen-Condit et al. 2008)	The translation process - interplay between literal rendering and a search for sense	Indispensable	Specific	Significant
(Hansen 2010)	Integrative description of translation processes	Indispensable	Specific	Significant
(Shreve & Diamond 2016)	Cognitive neurosciences and cognitive translation studies	Indispensable	Specific	Significant

	About the information processing paradigm			
(Bowker & Ciro 2019)	Machine Translation and Global Research: Towards Improved Machine	The use of machine translation		
(Budiwati et al. 2019)	DBMS-KU Interpolation for WMT19 News Translation Task	Indispensable	Specific	Significant
(Tymoczko 2005)	Trajectories of Research in Translation Studies	Indispensable	Specific	Significant
(Mukhamedov 2020)	Translation concepts of "the Leipzig school" scholars	The concept of translation		
(Graham et al. 2018)	Moving knowledge into action for more effective practice, programmes and policy: protocol for a research programme on integrated knowledge translation	Translation of research into practice		
(Vandepitte 2013)	Research competences in translation studies	Researchers' competencies in translation studies		
(Albir et al. 2015)	A retrospective and prospective view of translation research from an empirical, experimental, and cognitive perspective: the TREC network	Research on translation		
(Arichea 1990)	Theology and Translation: The Implications of Certain Theological Issues to the Translation Task	Indispensable	Specific	Significant
(Green & Glasgow 2006)	Evaluating the Relevance, Generalization, and Applicability of Research: Issues in External Validation and Translation Methodology	Translation of research into practice		
(Wang et al. 2020)	NJUNLP's Machine Translation System for CCMT-2020 Uighur → Chinese Translation Task	The use of machine translation		
(Palmer & Neumann 2002)	The Information Work of Interdisciplinary Humanities Scholars: Exploration and Translation	Translation of interdisciplinary research into practice		
(Hubscher-Davidson 2009)	Personal diversity and diverse personalities in translation: a study of individual differences	Indispensable	Specific	Significant
(Barch et al. 2012)	The Clinical Translation of a Measure of Gain Control: The Contrast-Contrast Effect Task	Translation of research into practice		
(Saldanha & O'Brien 2014)	Research Methodologies in Translation Studies	Methodologies in translation studies		

Table 45. Items retrieved for the task of translation.

14. Task of legal support *(Significant)*

On 7th of February 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "legal support" included (table 46):

Resource	Title	Indispensability	Specificity	Verdict
(McKnight et al. 2002)	The impact of initial consumer trust on intentions to transact with a web site: a trust building model	Exploring a website that offers legal advice		
(Doberneck et al. 2010)	From Rhetoric to Reality: A Typology of Publically Engaged Scholarship	Indispensable	Specific	Significant
(Crosbie & Glantz 2014)	Tobacco industry argues domestic trademark laws and international treaties preclude cigarette health warning labels, despite consistent legal advice that the argument is invalid	Indispensable	Specific	Significant
(Skinns 2009)	'I'm a Detainee; Get Me Out of Here': Predictors of Access to Custodial Legal Advice in Public and Privatized Police Custody Areas in England and Wales	Legal advice for detainees		
(Burns & Hutchinson 2009)	The impact of "empirical facts" on legal scholarship and legal research training	Teaching law		
(Okoli et al. 2014)	Wikipedia in the eyes of its beholders: A systematic review of scholarly research on Wikipedia readers and readership	Using Wikipedia for obtaining legal information		
(Sukumar et al. 2016)	How the timing of police evidence disclosure impacts custodial legal advice	The impact of the time of disclosing information on the quality of legal advice		
(Fox et al. 2010)	Community legal advice centres and networks: a process evaluation	Community Legal Advice Centres and Networks		
(Fernández-Molina et al. 2020)	University copyright/scholarly communication offices: Analysis of their services and staff profile	Indispensable	Specific	Significant
(Sandvig et al. 2014)	Auditing Algorithms: Research Methods for Detecting Discrimination on Internet Platforms	Indispensable	Specific	Significant
(McKnight et al. 2004)	Dispositional Trust and Distrust Distinctions in Predicting High- and Low-Risk Internet Expert Advice Site Perceptions	Exploring websites that offers legal advice		
(Sox & Rennie 2006)	Research Misconduct, Retraction, and Cleansing the	Indispensable	Generic	Insignificant

	Medical Literature: Lessons from the Poehlman Case			
(Codó & Garrido 2011)	Ideologies and practices of multilingualism in bureaucratic and legal advice encounters	Legal support for immigrants in Spain		
(Peters 2013)	Realizing Utopia as a Scholarly Endeavour	Indispensable	Specific	Significant
(Raddad & El-Seoudi 2012)	Providing legal advice and objectives of Islamic law	Indispensable	Generic	Insignificant
(Duffy et al. 2012)	Older people and legal advice – the need for joined up and creative approaches	Legal support for elderly		
(Flynn & Hodgson 2017)	Access to Justice and Legal Aid: Comparative Perspectives on Unmet Legal Need	Access to legal support for citizens		
(Glass et al. 2011)	Unpacking Faculty Engagement: The Types of Activities Faculty Members Report as Publicly Engaged Scholarship During Promotion and Tenure	Indispensable	Specific	Significant
(Senek et al. 2020)	Mesothelioma: exploring gender differences in time to diagnosis, seeking legal advice and occupational risk	Indispensable	Generic	Insignificant
(Wilkie & Moore 2003)	Scholarly Research in Marketing: Exploring the "4 Eras" of Thought Development	Indispensable	Specific	Significant

Table 46. Items retrieved for the task of legal support.

15. Task of providing access to resources *(Insignificant)*

On 25th of January 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "providing access to resources" included (table 47):

Resource	**Title**	**Indispensability**	**Specificity**	**Verdict**
(Burg et al. 2008)	Creating University Spin-Offs: A Science-Based Design Perspective	Indispensable	Generic	Insignificant
(Fry & Talja 2007)	The intellectual and social organization of academic fields and the shaping of digital resources	Indispensable	Generic	Insignificant
(Curry & Lillis 2010)	Academic research networks: Accessing resources for English-medium publishing	Indispensable	Generic	Insignificant

(Pomerantz 2006)	Google Scholar and 100 Percent Availability of Information	Indispensable	Generic	Insignificant
(Rosenstock et al. 2020)	Inclusive and adaptive business models for climate-smart value creation	Access to resources in business		
(McNeill et al. 2006)	Social Environment and Physical activity: A review of concepts and evidence	Access to resources in different social contexts		
(Chassanoff & Altman 2020)	Curation as "Interoperability With the Future": Preserving Scholarly Research Software in Academic Libraries	Indispensable	Generic	Insignificant
(Boardman 2009)	Government centrality to university–industry interactions: University research centers and the industry involvement of academic researchers	Indispensable	Generic	Insignificant
(Clement et al. 2020)	The Supervisory Role of Life Science Research Faculty: The Missing Link to Diversifying the Academic Workforce?	Indispensable	Generic	Insignificant
(Mierzecka 2019)	The Role of Academic Libraries in Scholarly Communication. A Meta-Analysis of Research	No Access		
(Brown & Tucker 2013)	Expanding Library Support of Faculty Research: Exploring Readiness	Indispensable	Generic	Insignificant
(Bernstein et al. 2010)	Toward a scientist-educator model of teaching psychology.	Access to resources in education		
(Roemer & Borchardt 2015)	Altmetrics and the Role of Librarians	Indispensable	Generic	Insignificant
(Nicholson & Kiel 2004)	Breakthrough board performance: how to harness your board's intellectual capital	Access to resources in business		
(Choi 2011)	Usefulness of social tagging in organizing and providing access to the web: An analysis of indexing consistency and quality	Indispensable	Generic	Insignificant
(Vasileiadou & Vliegenthart 2009)	Research productivity in the era of the internet revisited	Indispensable	Generic	Insignificant
(Berti 2018)	Open Educational Resources in Higher Education	Access to resources in higher education		
(Moller & Crick 2018)	A university-based model for supporting computer science curriculum reform	Access to resources in higher education		
(Willett 2016)	Making, Makers, and Makerspaces: A Discourse Analysis of Professional Journal	Access to resources in makerspaces		

	Articles and Blog Posts about Makerspaces in Public Libraries	
(Roberts 2015)	Lateral Violence in Nursing: A Review of the Past Three Decades	Access to resources in nursing practices

Table 47. Items retrieved for the task of providing access to resources.

16. Task of providing research samples *(Significant)*

On 7th of February 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "providing research samples" included (table 48):

Resource	**Title**	**Indispensability**	**Specificity**	**Verdict**
(Dowd et al. 2016)	Broadly Neutralizing Activity of Zika Virus-Immune Sera Identifies a Single Viral Serotype	Indispensable	Specific	Significant
(Ratajczak et al. 2012)	A novel view of paroxysmal nocturnal hemoglobinuria pathogenesis: more motile PNH hematopoietic stem/progenitor cells displace normal HSPCs from their niches in bone marrow due to defective adhesion, enhanced migration and mobilization in response to erythrocyte-released sphingosine-1 phosphate gradient	Indispensable	Specific	Significant
(Sun & Li 1999)	A pollen record of the last 37 ka in deep sea core 17940 from the northern slope of the South China Sea	Indispensable	Specific	Significant
(Horng & Wu 2020)	How behaviors on social network sites and online social capital influence social commerce intentions	Sample of Facebook users		
(Sun et al. 1999)	Pollen distribution in hemipelagic surface sediments of the South China Sea and its relation to modern vegetation distribution	Indispensable	Specific	Significant
(Horng et al. 2016)	How behaviors on social network sites and online social capital influence social commerce: the case of Facebook	Sample of Facebook users		
(Elss et al. 2006)	Influence of technological processing on apple aroma	Indispensable	Specific	Significant

	analysed by high resolution gas chromatography–mass spectrometry and on-line gas chromatography-combustion/pyrolysis-isotope ratio mass spectrometry			
(Jiang et al. 2019)	Circular RNAs as diagnostic biomarkers in gastric cancer: A meta-analysis review	Indispensable	Specific	Significant
(Cudjoe et al. 2009)	Investigation of the Effect of the Extraction Phase Geometry on the Performance of Automated Solid-Phase Microextraction	Indispensable	Specific	Significant
(Inagaki et al. 2003)	Analysis of intra-uterine cytokine concentration and matrix-metalloproteinase activity in women with recurrent failed embryo transfer	Indispensable	Specific	Significant
(Dang 2018)	Investigation of Herbicide Resistance in Oriental Mustard (Sisymbrium orientale L.) in Australia	Indispensable	Specific	Significant
(Mohamed et al. 2020)	Animal Biopolymer-Plant Biomass Composites: Synergism and Improved Sorption Efficiency	Indispensable	Specific	Significant
(West et al. 2014)	Acquired ASXL1 mutations are common in patients with inherited GATA2 mutations and correlate with myeloid transformation	Indispensable	Specific	Significant
(Lim et al. 2007)	An Alternative Approach to Determining Therapeutic Choices in Advanced Non-small Cell Lung Carcinoma (NSCLC): Maximizing the Diagnostic Procedure and the Use of Low-Volume Lung Biopsies	Indispensable	Specific	Significant
(Fu et al. 2003)	Influence of phenyl-trisilanol polyhedral silsesquioxane on properties of epoxy network glasses	Indispensable	Specific	Significant
(Abe et al. 2014)	Lymphatic Involvement in the Disappearance of Steroidogenic Cells from the Corpus Luteum during Luteolysis	Indispensable	Specific	Significant
(Rafiq et al. 2012)	XmAb-5574 antibody demonstrates superior antibody-dependent cellular cytotoxicity as compared with CD52- and CD20-targeted	Indispensable	Specific	Significant

	antibodies in adult acute lymphoblastic leukemia cells			
(Marino et al. 2011)	Quantification of total mercury in liver and heart tissue of Harbor Seals (Phoca vitulina) from Alaska USA	Indispensable	Specific	Significant
(Gallo et al. 2020)	Genetic diversity, population structure, and immigration, in a partially hunted puma population of south-central Argentina	Indispensable	Specific	Significant
(Dang et al. 2019)	Cross-resistance to diflufenican and picolinafen and its inheritance in oriental mustard (Sisymbrium orientale L.)	Indispensable	Specific	Significant

Table 48. Items retrieved for the task of providing research samples.

17. Task of coordination *(Inconclusive)*

On 7th of February 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "coordination" included (table 49):

Source	**Title**	**Indispensability**	**Specificity**	**Verdict**
(van Pelt et al. 2017)	The missing middle: Central Arctic Ocean gaps in fishery research and science coordination	Indispensable	Generic	Insignificant
(Li & Liu 2006)	Supply chain coordination with quantity discount policy	Supply chain coordination		
(Cummings & Kiesler 2007)	Coordination costs and project outcomes in multi-university collaborations	Mixed		
(Quinn & Dutton 2005)	Coordination as Energy-in-Conversation	Indispensable	Generic	Insignificant
(Chan et al. 2004)	Coordination of Pricing and Inventory Decisions: A Survey and Classification	Supply chain coordination		
(Scott Kelso et al. 1983)	A "Dynamic Pattern" Perspective on the Control and Coordination of Movement	Coordination of movement		
(Yan et al. 2011)	Product distribution and coordination strategies in a multi-channel context	Coordination of product distribution		
(Kotha et al. 2012)	Bridging the Mutual Knowledge Gap: Coordination and the Commercialization of University Science	Mixed		
(Heuer 1996)	Chapter 3 Coordination	Coordination as a concept		

(Li & Wang 2007)	Coordination mechanisms of supply chain systems	Supply chain coordination		
(Chen & Suslick 1993)	One-dimensional coordination polymers: Applications to material science	Chemical coordination		
(Tsay & Agrawal 2004)	Modeling Conflict and Coordination in Multi-Channel Distribution Systems: A Review	Supply chain coordination		
(Burton & Obel 2018)	The science of organizational design: fit between structure and coordination	Indispensable	Specific	Significant
(Alexander 1993)	Interorganizational Coordination: Theory and Practice	Mixed		
(Mendonca & Cowan 2010)	Decision-making coordination and efficient reasoning techniques for feature-based configuration	Indispensable	Specific	Significant
(Gazi & Fidan 2006)	Coordination and Control of Multi-agent Dynamic Systems: Models and Approaches	Coordination of systems		
(Drabek 2018)	Community Processes: Coordination	Community response coordination		
(Trein et al. 2020)	Policy Coordination and Integration: A Research Agenda	Policy coordination		
(Arshinder et al. 2008)	Supply chain coordination: Perspectives, empirical studies and research directions	Supply chain coordination		
(Visser 2003)	Developmental coordination disorder: a review of research on subtypes and comorbidities	Coordination of movement		

Table 49. Items retrieved for the task of coordination.

18. Task of software programming *(Significant)*

On 7th of February 2021, items shown in the first two pages of Google Scholar using scholar* research* scien* AND "software programming" included (table 50):

Resource	**Title**	**Indispensability**	**Specificity**	**Verdict**
(Lin 2019)	Research on the teaching management of track and field web course based on software programming method	Teaching management		
(Abah & Tennyson 2019)	Effectively Matching Programming Languages to Computer Science Introductory Teaching Paradigms Research	Indispensable	Specific	Significant

(Zins 2007)	Classification schemes of Information Science: Twenty-eight scholars map the field	A taxonomy of information science		
(Miljanovic & Bradbury 2018)	A Review of Serious Games for Programming	Games in software programming		
(Sancho-Thomas et al. 2009)	Learning teamwork skills in university programming courses	Teaching software programming		
(Gjonaj 2007)	Analysis on Modeling and Simulink of DC Motor and its Driving System Used for Wheeled Mobile Robot	Indispensable	Specific	Significant
(Carpenter et al. 2012)	A call for bioimaging software usability	Indispensable	Specific	Significant
(Keung 2015)	BlueJ UML Software System	No Access		
(Brown 2009)	Getting Excited About Software Programming	Computer software in game programming		
(Calatrava Arroyo et al. 2021)	A Pilot Experience with Software Programming Environments as a Service for Teaching Activities	Indispensable	Specific	Significant
(Denaxas et al. 2017)	Methods for enhancing the reproducibility of biomedical research findings using electronic health records	Use software programming principles to improve reproducibility		
(Fessakis et al. 2013)	Problem solving by 5–6 years old kindergarten children in a computer programming environment: A case study	Software programming for kids		
(Wright & Wagner 2008)	The Systems Biology Research Tool: evolvable open-source software	Indispensable	Specific	Significant
(Kafai & Peppler 2011)	Youth, Technology, and DIY: Developing Participatory Competencies in Creative Media Production	Software programming in education		
(Nazir et al. 2020)	Potential environmental impacts of wind energy development: A global perspective	Indispensable	Specific	Significant
(Munos 2006)	Can open-source R&D reinvigorate drug research?	Indispensable	Specific	Significant
(Brand et al. 2015)	Beyond authorship: attribution, contribution, collaboration, and credit	Attribution of credit		
(Mohammed et al. 2014)	Applications of the MapReduce programming framework to clinical big data analysis: current landscape and future trends	Indispensable	Specific	Significant

(Boudreau 2011)	Let a Thousand Flowers Bloom? An Early Look at Large Numbers of Software App Developers and Patterns of Innovation	The effects of adding apps to handheld computers		
(Khan 2020)	Importance of customized (task oriented) software tools for biomedical applications	Indispensable	Specific	Significant

Table 50. Items retrieved for the task of software programming.

References

Abah, O., & Tennyson, M. (2019). Effectively Matching Programming Languages to Computer Science Introductory Teaching Paradigms Research. *Scholars Week*. https://digitalcommons.murraystate.edu/scholarsweek/Spring2019/GeneralPosters/1

Abe, H., Al-zi'abi, M. O., Sekizawa, F., Acosta, T. J., Skarzynski, D. J., & Okuda, K. (2014). Lymphatic Involvement in the Disappearance of Steroidogenic Cells from the Corpus Luteum during Luteolysis. *PLOS ONE*, *9*(2), e88953. https://doi.org/10.1371/journal.pone.0088953

Abu-Rish, E., Kim, S., Choe, L., Varpio, L., Malik, E., White, A. A., Craddick, K., Blondon, K., Robins, L., Nagasawa, P., Thigpen, A., Chen, L.-L., Rich, J., & Zierler, B. (2012). Current trends in interprofessional education of health sciences students: A literature review. *Journal of Interprofessional Care*, *26*(6), 444–451. https://doi.org/10.3109/13561820.2012.715604

Ahmed, S. M., & Palermo, A.-G. S. (2010). Community Engagement in Research: Frameworks for Education and Peer Review. *American Journal of Public Health*, *100*(8), 1380–1387. https://doi.org/10.2105/AJPH.2009.178137

Aitchison, C., Catterall, J., Ross, P., & Burgin, S. (2012). 'Tough love and tears': Learning doctoral writing in the sciences. *Higher Education Research & Development*, *31*(4), 435–447. https://doi.org/10.1080/07294360.2011.559195

Aji, A., Wang, F., Vo, H., Lee, R., Liu, Q., Zhang, X., & Saltz, J. (2013). Hadoop-GIS: A High Performance Spatial Data Warehousing System over MapReduce. *Proceedings of the VLDB Endowment International Conference on Very Large Data Bases*, *6*(11). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3814183/

Albir, A. H., Alves, F., Dimitrova, B. E., & Lacruz, I. (2015). A retrospective and prospective view of translation research from an empirical, experimental, and cognitive perspective: The TREC network. *Translation & Interpreting*, *7*(1), 5-25–25. https://doi.org/10.12807/t&i.v7i1.343

Alexander, E. R. (1993). Interorganizational Coordination: Theory and Practice. *Journal of Planning Literature*, *7*(4), 328–343. https://doi.org/10.1177/088541229300700403

Allen, L., Scott, J., Brand, A., Hlava, M., & Altman, M. (2014). Publishing: Credit where credit is due. *Nature News*, *508*(7496), 312. https://doi.org/10.1038/508312a

Allen, W. L. (2018). Visual brokerage: Communicating data and research through visualisation. *Public Understanding of Science*, *27*(8), 906–922. https://doi.org/10.1177/0963662518756853

Amin, W., Kang, H. P., Egloff, A. M., Singh, H., Trent, K., Ridge-Hetrick, J., Seethala, R. R., Grandis, J., & Parwani, A. V. (2009). An informatics supported web-based data annotation and query tool to expedite translational research for head and neck malignancies. *BMC Cancer*, *9*(1), 396. https://doi.org/10.1186/1471-2407-9-396

Andrews, L., Kostelecky, K., Spritz, S., & Franco, A. (2017). Virtual Clinical Trials: One Step Forward, Two Steps Back. *Journal of Health Care Law and Policy*, *19*(2), 189.

Ang, J., & Teo, T. S. H. (2000). Management issues in data warehousing: Insights from the Housing and Development Board. *Decision Support Systems*, *29*(1), 11–20. https://doi.org/10.1016/S0167-9236(99)00085-8

Antonelli, M. (2012). Where Is the European Pharma Industry Going? In V. Costigliola (Ed.), *Healthcare Overview: New Perspectives* (pp. 245–248). Springer Netherlands. https://doi.org/10.1007/978-94-007-4602-2_13

Arichea, D. C. (1990). Theology and Translation: The Implications of Certain Theological Issues to the Translation Task. *Bible Translation and the Spread of the Church*, 40–67. https://doi.org/10.1163/9789004318182_005

Arnott, D., & Pervan, G. (2005). A critical analysis of decision support systems research. *Journal of Information Technology*, *20*(2), 67–87. https://doi.org/10.1057/palgrave.jit.2000035

Arshinder, Kanda, A., & Deshmukh, S. G. (2008). Supply chain coordination: Perspectives, empirical studies and research directions. *International Journal of Production Economics*, *115*(2), 316–335. https://doi.org/10.1016/j.ijpe.2008.05.011

Ashkanasy, N. M., Bennett, R. J., & Martinko, M. J. (2016). *Understanding the High Performance Workplace: The Line Between Motivation and Abuse*. Routledge.

Aspry, K. E., Van Horn Linda, Carson Jo Ann S., Wylie-Rosett Judith, Kushner Robert F., Lichtenstein Alice H., Devries Stephen, Freeman Andrew M., Crawford Allison, & Kris-Etherton Penny. (2018). Medical Nutrition Education, Training, and Competencies to Advance Guideline-Based Diet Counseling by Physicians: A Science Advisory From the American Heart Association. *Circulation*, *137*(23), e821–e841. https://doi.org/10.1161/CIR.0000000000000563

Assante, M., Candela, L., Castelli, D., Cirillo, R., Coro, G., Frosini, L., Lelii, L., Mangiacrapa, F., Pagano, P., Panichi, G., & Sinibaldi, F. (2019). Enacting open science by D4Science. *Future Generation Computer Systems*, *101*, 555–563. https://doi.org/10.1016/j.future.2019.05.063

Austin, A. E., & Baldwin, R. G. (1991). *Faculty Collaboration: Enhancing the Quality of Scholarship and Teaching. ASHE-ERIC Higher Education Report No. 7, 1991*. ERIC Clearinghouse on Higher Education, George Washington University, One Dupont Circle, Suite 630, Washington, DC 20036 ($17. https://eric.ed.gov/?id=ED346805

Ayonmike, C. S., Okwelle, P. C., & Okeke, B. C. (2015). Towards Quality Technical Vocational Education and Training (Tvet) Programmes in Nigeria: Challenges and Improvement Strategies. *Journal of Education and Learning*, *4*(1), 25–34.

Badat, S. (2010). *The Challenges of Transformation in Higher* (p. 37) [Commissioned report]. Development Bank of Southern Africa. https://www.dhet.gov.za/summit/Docs/2010Docs/The%20Challenges%20of%20Transformation%20in%20Higher%20Eduaction%20and%20Training%20Institutions%20in%20South%20Africa.pdf

Barch, D. M., Carter, C. S., Dakin, S. C., Gold, J., Luck, S. J., MacDonald, A., III, Ragland, J. D., Silverstein, S., & Strauss, M. E. (2012). The Clinical Translation of a Measure of Gain Control: The Contrast-Contrast Effect Task. *Schizophrenia Bulletin*, *38*(1), 135–143. https://doi.org/10.1093/schbul/sbr154

Bazerman, C. (2009). *Handbook of Research on Writing: History, Society, School, Individual, Text*. Lawrence Erlbaum Associates, Taylor and Francis Group.

Bernstein, D. J., Addison, W., Altman, C., Hollister, D., Komarraju, M., Prieto, L., Rocheleau, C. A., & Shore, C. (2010). Toward a scientist-educator model of teaching psychology. In *Undergraduate*

education in psychology: A blueprint for the future of the discipline (pp. 29–45). American Psychological Association. https://doi.org/10.1037/12063-002

Berti, M. (2018). Open Educational Resources in Higher Education. *Issues and Trends in Learning Technologies*, *6*(1), Article 1. https://doi.org/10.2458/azu_itet_v6i1_berti

Besley, J. C., McCright, A. M., Zahry, N. R., Elliott, K. C., Kaminski, N. E., & Martin, J. D. (2017). Perceived conflict of interest in health science partnerships. *PLOS ONE*, *12*(4), e0175643. https://doi.org/10.1371/journal.pone.0175643

Besselaar, P. van den, & Sandström, U. (2017). Vicious circles of gender bias, lower positions, and lower performance: Gender differences in scholarly productivity and impact. *PLOS ONE*, *12*(8), e0183301. https://doi.org/10.1371/journal.pone.0183301

Biondi-Zoccai, G. G., Agostoni, P., Abbate, A., Testa, L., & Burzotta, F. (2005). A simple hint to improve Robinson and Dickersin's highly sensitive PubMed search strategy for controlled clinical trials. *International Journal of Epidemiology*, *34*(1), 224–225. https://doi.org/10.1093/ije/dyh311

Blair, L. (2016). Writing a Graduate Thesis or Dissertation. In *Writing a Graduate Thesis or Dissertation*. Brill Sense. https://brill.com/view/title/37861

Blencowe, N. S., Kirkham, E. N., Main, B. G., Jones, K. J. B., & Blazeby, J. M. (2020). Author response to: Comment on: Systematic review of the introduction and evaluation of magnetic augmentation of the lower oesophageal sphincter for gastro-oesophageal reflux disease. *British Journal of Surgery*, *107*(7), e210–e210. https://doi.org/10.1002/bjs.11565

Blevins, D., Farmer, M. S., Edlund, C., Sullivan, G., & Kirchner, J. E. (2010). Collaborative research between clinicians and researchers: A multiple case study of implementation. *Implementation Science*, *5*(1), 76. https://doi.org/10.1186/1748-5908-5-76

Boardman, P. C. (2009). Government centrality to university–industry interactions: University research centers and the industry involvement of academic researchers. *Research Policy*, *38*(10), 1505–1516. https://doi.org/10.1016/j.respol.2009.09.008

Boergens, K. M., Berning, M., Bocklisch, T., Bräunlein, D., Drawitsch, F., Frohnhofen, J., Herold, T., Otto, P., Rzepka, N., Werkmeister, T., Werner, D., Wiese, G., Wissler, H., & Helmstaedter, M. (2017). webKnossos: Efficient online 3D data annotation for connectomics. *Nature Methods*, *14*(7), 691–694. https://doi.org/10.1038/nmeth.4331

Boettger, R. K., & Lam, C. (2013). An Overview of Experimental and Quasi-Experimental Research in Technical Communication Journals (1992–2011). *IEEE Transactions on Professional Communication*, *56*(4), 272–293. https://doi.org/10.1109/TPC.2013.2287570

Bonchi, F., Giannotti, F., Gozzi, C., Manco, G., Nanni, M., Pedreschi, D., Renso, C., & Ruggieri, S. (2001). Web log data warehousing and mining for intelligent web caching. *Data & Knowledge Engineering*, *39*(2), 165–189. https://doi.org/10.1016/S0169-023X(01)00038-6

Borgman, C. L. (2010). *Scholarship in the Digital Age: Information, Infrastructure, and the Internet*. MIT Press.

Bortolin, K. (2011). Serving ourselves: How the discourse on Community engagement privileges the university over the community. *Michigan Journal of Community Service Learning*, *18*(1), 49–59.

Boudreau, K. J. (2011). Let a Thousand Flowers Bloom? An Early Look at Large Numbers of Software App Developers and Patterns of Innovation. *Organization Science*, *23*(5), 1409–1427. https://doi.org/10.1287/orsc.1110.0678

Bowen, F., Newenham-Kahindi, A., & Herremans, I. (2010). When Suits Meet Roots: The Antecedents and Consequences of Community Engagement Strategy. *Journal of Business Ethics*, *95*(2), 297–318. https://doi.org/10.1007/s10551-009-0360-1

Bowen, J. (2016, July 12). *Alan Turing: Virtuosity and visualisation*. Electronic Visualisation and the Arts. https://doi.org/10.14236/ewic/EVA2016.40

Bowker, L., & Ciro, J. B. (2019). *Machine Translation and Global Research: Towards Improved Machine Translation Literacy in the Scholarly Community*. Emerald Group Publishing.

Bracic, A. (2018). For Better Science: The Benefits of Community Engagement in Research. *American Political Science Association*, *51*(03), 550–553. https://doi.org/10.1017/S1049096518000446

Brackmann, S. M. (2015). Community Engagement in a Neoliberal Paradigm. *Journal of Higher Education Outreach and Engagement*, *19*(4), 115–146.

Brand, A., Allen, L., Altman, M., Hlava, M., & Scott, J. (2015). Beyond authorship: Attribution, contribution, collaboration, and credit. *Learned Publishing*, *28*. https://doi.org/10.1087/20150211

Brodny, J., & Tutak, M. (2019). Analysing the Utilisation Effectiveness of Mining Machines Using Independent Data Acquisition Systems: A Case Study. *Energies*, *12*(13), 2505. https://doi.org/10.3390/en12132505

Brown, J. M., & Tucker, C. (2013). Expanding Library Support of Faculty Research: Exploring Readiness. *Libraries and the Academy*, *13*(3), 257–271. https://doi.org/10.1353/pla.2013.0019

Brown, R. (2009). *Getting Excited About Software Programming [Presentation]*. Microsoft Tech Ed 2009, Queensland University of Technology, Australia. https://eprints.qut.edu.au/29427/

Budiwati, S. D., Siagian, A. H. A. M., Fatyanosa, T. N., & Aritsugi, M. (2019). DBMS-KU Interpolation for WMT19 News Translation Task. *Proceedings of the Fourth Conference on Machine Translation (Volume 2: Shared Task Papers, Day 1)*, 141–146. https://doi.org/10.18653/v1/W19-5309

Burg, E. V., Romme, A. G. L., Gilsing, V. A., & Reymen, I. M. M. J. (2008). Creating University Spin-Offs: A Science-Based Design Perspective*. *Journal of Product Innovation Management*, *25*(2), 114–128. https://doi.org/10.1111/j.1540-5885.2008.00291.x

Burns, K., & Hutchinson, T. (2009). The impact of “empirical facts” on legal scholarship and legal research training. *The Law Teacher*, *43*(2), 153–178. https://doi.org/10.1080/03069400903004236

Burton, R. M., & Obel, B. (2018). The science of organizational design: Fit between structure and coordination. *Journal of Organization Design*, *7*(1), 5. https://doi.org/10.1186/s41469-018-0029-2

Bush, S. D., Pelaez, N. J., Rudd, J. A., Stevens, M. T., Williams, K. S., Allen, D. E., & Tanner, K. D. (2006). On Hiring Science Faculty with Education Specialties for Your Science (Not Education)

Department. *CBE—Life Sciences Education*, *5*(4), 297–305. https://doi.org/10.1187/cbe.06-09-0189

Calatrava Arroyo, A., Ramos Montes, M., & Segrelles Quilis, J. D. (2021). A Pilot Experience with Software Programming Environments as a Service for Teaching Activities. *Applied Sciences*, *11*(1), 341. https://doi.org/10.3390/app11010341

Cameron, K. S., & Spreitzer, G. M. (2011). *The Oxford Handbook of Positive Organizational Scholarship*. Oxford University Press.

Carpenter, A. E., Kamentsky, L., & Eliceiri, K. W. (2012). A call for bioimaging software usability. *Nature Methods*, *9*(7), 666–670. https://doi.org/10.1038/nmeth.2073

Carter, S. (2011). Doctorate as genre: Supporting thesis writing across campus. *Higher Education Research & Development*, *30*(6), 725–736. https://doi.org/10.1080/07294360.2011.554388

Castelló, M., McAlpine, L., & Pyhältö, K. (2017). Spanish and UK post-PhD researchers: Writing perceptions, well-being and productivity. *Higher Education Research & Development*, *36*(6), 1108–1122. https://doi.org/10.1080/07294360.2017.1296412

Catterall, J., Ross, P., Aitchison, C., & Burgin, S. (2011). Pedagogical Approaches that Facilitate Writing in Postgraduate Research Candidature in Science and Technology. *Journal of University Teaching & Learning Practice*, *8*(2). https://ro.uow.edu.au/jutlp/vol8/iss2/7

Challenor, J., & Ma, M. (2019). A Review of Augmented Reality Applications for History Education and Heritage Visualisation. *Multimodal Technologies and Interaction*, *3*(2), 39. https://doi.org/10.3390/mti3020039

Chan, L. M. A., Shen, Z. J. M., Simchi-Levi, D., & Swann, J. L. (2004). Coordination of Pricing and Inventory Decisions: A Survey and Classification. In D. Simchi-Levi, S. D. Wu, & Z.-J. Shen (Eds.), *Handbook of Quantitative Supply Chain Analysis: Modeling in the E-Business Era* (pp. 335–392). Springer US. https://doi.org/10.1007/978-1-4020-7953-5_9

Chandra, P., & Gupta, M. K. (2018). Comprehensive survey on data warehousing research. *International Journal of Information Technology*, *10*(2), 217–224. https://doi.org/10.1007/s41870-017-0067-y

Chassanoff, A., & Altman, M. (2020). Curation as "Interoperability With the Future": Preserving Scholarly Research Software in Academic Libraries. *Journal of the Association for Information Science and Technology*, *71*(3), 325–337. https://doi.org/10.1002/asi.24244

Chen, C.-T., & Suslick, K. S. (1993). One-dimensional coordination polymers: Applications to material science. *Coordination Chemistry Reviews*, *128*(1), 293–322. https://doi.org/10.1016/0010-8545(93)80036-5

Chiang, K. (2003). Learning experiences of doctoral students in UK universities. *International Journal of Sociology and Social Policy*, *23*(1/2), 4–32. https://doi.org/10.1108/01443330310790444

Chigbu, U. E. (2019). Visually Hypothesising in Scientific Paper Writing: Confirming and Refuting Qualitative Research Hypotheses Using Diagrams. *Publications*, *7*(1), 22. https://doi.org/10.3390/publications7010022

Chittaro, L., & Ranon, R. (2007). Web3D technologies in learning, education and training: Motivations, issues, opportunities. *Computers & Education*, *49*(1), 3–18. https://doi.org/10.1016/j.compedu.2005.06.002

Choi, Y. (2011). *Usefulness of social tagging in organizing and providing access to the web: An analysis of indexing consistency and quality* [PhD Thesis]. University of Illinois.

Choudhury, G. S. (2008). Case Study in Data Curation at Johns Hopkins University. *Library Trends*, *57*(2), 211–220. https://doi.org/10.1353/lib.0.0028

Choudhury, S. (2010). Data curation: An ecological perspective. *C&RL News*, 194–196.

Christian, T.-M. L., Lafferty-Hess, S., Jacoby, W. G., & Carsey, T. M. (2018). *Operationalizing the Replication Standard: A Case Study of the Data Curation and Verification Workflow for Scholarly Journals*. SocArXiv. https://doi.org/10.31235/osf.io/cfdba

Cimino, P. J., McFerrin, L., Wirsching, H.-G., Arora, S., Bolouri, H., Rabadan, R., Weller, M., & Holland, E. C. (2018). Copy number profiling across glioblastoma populations has implications for clinical trial design. *Neuro-Oncology*, *20*(10), 1368–1373. https://doi.org/10.1093/neuonc/noy108

Clement, L., Leung, K. N., Lewis, J. B., & Saul, N. M. (2020). The Supervisory Role of Life Science Research Faculty: The Missing Link to Diversifying the Academic Workforce? *Journal of Microbiology & Biology Education*, *21*(1). https://doi.org/10.1128/jmbe.v21i1.1911

Cocos, A., Qian, T., Callison-Burch, C., & Masino, A. J. (2017). Crowd control: Effectively utilizing unscreened crowd workers for biomedical data annotation. *Journal of Biomedical Informatics*, *69*, 86–92. https://doi.org/10.1016/j.jbi.2017.04.003

Codó, E., & Garrido, M. R. (2011). Ideologies and practices of multilingualism in bureaucratic and legal advice encounters. *Sociolinguistic Studies*, *4*. https://doi.org/10.1558/sols.v4i2.297

Collie, N. (2011). Cities of the imagination: Science fiction, urban space, and community engagement in urban planning. *Futures*, *43*(4), 424–431. https://doi.org/10.1016/j.futures.2011.01.005

Conley, S., & You, S. (2017). Key influences on special education teachers' intentions to leave: The effects of administrative support and teacher team efficacy in a mediational model. *Educational Management Administration & Leadership*, *45*(3), 521–540. https://doi.org/10.1177/1741143215608859

Coomans, F., Grünfeld, F., & Kamminga, M. T. (2010). Methods of Human Rights Research: A Primer. *Human Rights Quarterly*, *32*(1), 179–186.

Cope, B., Kalantzis, M., Abd-El-Khalick, F., & Bagley, E. (2013). Science in Writing: Learning Scientific Argument in Principle and Practice. *E-Learning and Digital Media*, *10*(4), 420–441. https://doi.org/10.2304/elea.2013.10.4.420

Corcoran, J. (2019). Addressing the "Bias Gap": A Research-Driven Argument for Critical Support of Plurilingual Scientists' Research Writing. *Written Communication*, *36*(4), 538–577. https://doi.org/10.1177/0741088319861648

Costa, C., & Santos, M. Y. (2018). Evaluating Several Design Patterns and Trends in Big Data Warehousing Systems. In J. Krogstie & H. A. Reijers (Eds.), *Advanced Information Systems*

Engineering (pp. 459–473). Springer International Publishing. https://doi.org/10.1007/978-3-319-91563-0_28

Coutinho, I. C. R. (2020). Listening and feeling doctoral students' perceptions of their doctoral supervision. The PhD students' point of view. *Advances in Social Sciences Research Journal*. https://doi.org/10.14738/assrj.612.7573

Cragin, M. H., Heidorn, P. B., Palmer, C. L., & Smith, L. C. (2007, June 25). *An Educational Program on Data Curation*. 2007 STS Conference. https://www.ideals.illinois.edu/handle/2142/3493

Crosbie, E., & Glantz, S. A. (2014). Tobacco industry argues domestic trademark laws and international treaties preclude cigarette health warning labels, despite consistent legal advice that the argument is invalid. *Tobacco Control*, *23*(3), e7–e7. https://doi.org/10.1136/tobaccocontrol-2012-050569

Cudjoe, E., Vuckovic, D., Hein, D., & Pawliszyn, J. (2009). Investigation of the Effect of the Extraction Phase Geometry on the Performance of Automated Solid-Phase Microextraction. *Analytical Chemistry*, *81*(11), 4226–4232. https://doi.org/10.1021/ac802524w

Cummings, J. N., & Kiesler, S. (2007). Coordination costs and project outcomes in multi-university collaborations. *Research Policy*, *36*(10), 1620–1634. https://doi.org/10.1016/j.respol.2007.09.001

Curry, M. J., & Lillis, T. (2014). Strategies and tactics in academic knowledge production by multilingual scholars. *Education Policy Analysis Archives*. https://doi.org/10.14507/epaa.v22n32.2014

Curry, M. J., & Lillis, T. M. (2010). Academic research networks: Accessing resources for English-medium publishing. *English for Specific Purposes*, *29*(4), 281–295. https://doi.org/10.1016/j.esp.2010.06.002

Dahl, D. W., Chattopadhyay, A., & Gorn, G. J. (2001). The importance of visualisation in concept design. *Design Studies*, *22*(1), 5–26. https://doi.org/10.1016/S0142-694X(99)00028-9

Dang, Hue T., Malone, J. M., Gill, G., & Preston, C. (2019). Cross-resistance to diflufenican and picolinafen and its inheritance in oriental mustard (Sisymbrium orientale L.). *Pest Management Science*, *75*(1), 195–203. https://doi.org/10.1002/ps.5087

Dang, Hue Thi. (2018). *Investigation of herbicide resistance in oriental mustard (Sisymbrium orientale L.) in Australia* [Thesis, University of Adelaide, School of Agriculture, Food and Wine]. https://digital.library.adelaide.edu.au/dspace/handle/2440/118239

Das, N., & Das, S. (2018). Knowledge and attitudes of Indian surgeons regarding professional medical writing support. *Perspectives in Clinical Research*, *9*(3), 127–132. https://doi.org/10.4103/picr.PICR_88_17

David-Chavez, D. M., & Gavin, M. C. (2018). A global assessment of Indigenous community engagement in climate research. *Environmental Research Letters*, *13*(12). https://doi.org/10.1088/1748-9326/aaf300

Davies, T., & Gilbert, J. (2003). Modelling: Promoting Creativity while Forging Links between Science Education and Design and Technology Education. *Canadian Journal of Science,*

Mathematics and Technology Education, *3*(1), 67–82. https://doi.org/10.1080/14926150309556552

Davis, M. D. (1938). Project in Research in Universities: Preparation for Elementary School Supervision. Bulletin, 1937, No. 18. In *Office of Education, United States Department of the Interior*. Office of Education, United States Department of the Interior. https://eric.ed.gov/?id=ED542577

Denaxas, S., Direk, K., Gonzalez-Izquierdo, A., Pikoula, M., Cakiroglu, A., Moore, J., Hemingway, H., & Smeeth, L. (2017). Methods for enhancing the reproducibility of biomedical research findings using electronic health records. *BioData Mining*, *10*(1), 31. https://doi.org/10.1186/s13040-017-0151-7

Doberneck, D. M., Glass, C. R., & Schweitzer, J. (2010). From Rhetoric to Reality: A Typology of Publically Engaged Scholarship. *Journal of Higher Education Outreach and Engagement*, *14*(4), 5–35.

Donnelly, K. (2014). The Other Average Man: Science Workers in Quetelet's Belgium. *History of Science*, *52*(4), 401–428. https://doi.org/10.1177/0073275314559331

Donnelly, K. (2015). *Adolphe Quetelet, Social Physics and the Average Men of Science, 1796–1874*. Routledge.

Dowd, K. A., DeMaso, C. R., Pelc, R. S., Speer, S. D., Smith, A. R. Y., Goo, L., Platt, D. J., Mascola, J. R., Graham, B. S., Mulligan, M. J., Diamond, M. S., Ledgerwood, J. E., & Pierson, T. C. (2016). Broadly Neutralizing Activity of Zika Virus-Immune Sera Identifies a Single Viral Serotype. *Cell Reports*, *16*(6), 1485–1491. https://doi.org/10.1016/j.celrep.2016.07.049

Drabek, T. E. (2018). Community Processes: Coordination. In H. Rodríguez, W. Donner, & J. E. Trainor (Eds.), *Handbook of Disaster Research* (pp. 521–549). Springer International Publishing. https://doi.org/10.1007/978-3-319-63254-4_25

Duffy, J., Basu, S., & Pearson, K. C. (2012). Older people and legal advice – the need for joined up and creative approaches. *Journal of Social Welfare and Family Law*, *34*(1), 31–47. https://doi.org/10.1080/09649069.2012.675463

Eder, M. M., Carter-Edwards, L., Hurd, T. C., Rumala, B. B., & Wallerstein, N. (2013). A Logic Model for Community Engagement within the CTSA Consortium: Can We Measure What We Model? *Academic Medicine : Journal of the Association of American Medical Colleges*, *88*(10), 1430–1436. https://doi.org/10.1097/ACM.0b013e31829b54ae

Edirippulige, S., & Armfield, N. (2017). Education and training to support the use of clinical telehealth: A review of the literature. *Journal of Telemedicine and Telecare*, *23*(2), 273–282. https://doi.org/10.1177/1357633X16632968

Elgren, T., & Hensel, N. (2006). Undergraduate Research Experiences: Synergies between Scholarship and Teaching. *Peer Review*, *8*(1), 4–7.

Elsabbagh, M., Yusuf, A., Prasanna, S., Shikako-Thomas, K., Ruff, C. A., & Fehlings, M. G. (2014). Community engagement and knowledge translation: Progress and challenge in autism research. *Autism*, *18*(7), 771–781. https://doi.org/10.1177/1362361314546561

Elss, S., Preston, C., Appel, M., Heckel, F., & Schreier, P. (2006). Influence of technological processing on apple aroma analysed by high resolution gas chromatography–mass spectrometry

and on-line gas chromatography-combustion/pyrolysis-isotope ratio mass spectrometry. *Food Chemistry*, *98*(2), 269–276. https://doi.org/10.1016/j.foodchem.2005.06.011

Erduran, S., & Dagher, Z. R. (2014). Reconceptualizing Nature of Science for Science Education. In S. Erduran & Z. R. Dagher (Eds.), *Reconceptualizing the Nature of Science for Science Education: Scientific Knowledge, Practices and Other Family Categories* (pp. 1–18). Springer Netherlands. https://doi.org/10.1007/978-94-017-9057-4_1

Etzkowitz, H. (1983). Entrepreneurial Scientists and Entrepreneurial Universities in American Academic Science. *Minerva*, *21*(2/3), 198–233.

Fernández-Molina, J.-C., Martínez-Ávila, D., & Silva, E. G. (2020). University copyright/scholarly communication offices: Analysis of their services and staff profile. *The Journal of Academic Librarianship*, *46*(2), 102133. https://doi.org/10.1016/j.acalib.2020.102133

Fessakis, G., Gouli, E., & Mavroudi, E. (2013). Problem solving by 5–6 years old kindergarten children in a computer programming environment: A case study. *Computers & Education*, *63*, 87–97. https://doi.org/10.1016/j.compedu.2012.11.016

Fleer, M. (2019). Scientific Playworlds: A Model of Teaching Science in Play-Based Settings. *Research in Science Education*, *49*(5), 1257–1278. https://doi.org/10.1007/s11165-017-9653-z

Flowerdew, J., & Li, Y. (2009). The globalization of scholarship: Studying Chinese scholars writing for international publication. In R. Manchon (Ed.), *Writing in Foreign Language Contexts: Learning, Teaching, and Research* (pp. 156–187). Multilingual Matters.

Flynn, A., & Hodgson, J. (2017). *Access to Justice and Legal Aid: Comparative Perspectives on Unmet Legal Need*. Bloomsbury Publishing.

Fong, E. A., & Wilhite, A. W. (2017). Authorship and citation manipulation in academic research. *PLOS ONE*, *12*(12), e0187394. https://doi.org/10.1371/journal.pone.0187394

Fourches, D., Muratov, E., & Tropsha, A. (2015). Curation of chemogenomics data. *Nature Chemical Biology*, *11*(8), 535–535. https://doi.org/10.1038/nchembio.1881

Fox, C., Moorhead, R. L., Sefton, M., & Wong, K. (2010). *Community legal advice centres and networks: A process evaluation*. Legal Services Commission. https://doi.org/10/CLACNProcessEvaluationFull.pdf>

Franz, M., Lopes, C. T., Huck, G., Dong, Y., Sumer, O., & Bader, G. D. (2016). Cytoscape.js: A graph theory library for visualisation and analysis. *Bioinformatics*, *32*(2), 309–311. https://doi.org/10.1093/bioinformatics/btv557

Freedman, L. P., Gibson, M. C., Bradbury, A. R. M., Buchberg, A. M., Davis, D., Dolled-Filhart, M. P., Lund-Johansen, F., & Rimm, D. L. (2016). [Letter to the Editor] The need for improved education and training in research antibody usage and validation practices. *BioTechniques*, *61*(1), 16–18. https://doi.org/10.2144/000114431

Frost, P. J., & Fukami, C. V. (1997). Teaching Effectiveness in the Organizational Sciences: Recognizing and Enhancing the Scholarship of Teaching. *Academy of Management Journal*, *40*(6), 1271–1281. https://doi.org/10.5465/257033

Fry, J., & Talja, S. (2007). The intellectual and social organization of academic fields and the shaping of digital resources. *Journal of Information Science*, *33*(2), 115–133. https://doi.org/10.1177/0165551506068153

Fu, B. X., Namani, M., & Lee, A. (2003). Influence of phenyl-trisilanol polyhedral silsesquioxane on properties of epoxy network glasses. *Polymer*, *44*(25), 7739–7747. https://doi.org/10.1016/j.polymer.2003.09.033

Gallagher, A. G., Ritter, E. M., & Satava, R. M. (2003). Fundamental principles of validation, and reliability: Rigorous science for the assessment of surgical education and training. *Surgical Endoscopy And Other Interventional Techniques*, *17*(10), 1525–1529. https://doi.org/10.1007/s00464-003-0035-4

Gallo, O., Castillo, D. F., Godinho, R., & Casanave, E. B. (2020). Genetic diversity, population structure, and immigration, in a partially hunted puma population of south-central Argentina. *Journal of Mammalogy*, *101*(3), 766–778. https://doi.org/10.1093/jmammal/gyaa039

Gatto, M. A. C. (2015). Making research useful: Current challenges and good practices in data visualisation. *Reuters Institute*. https://ora.ox.ac.uk/objects/uuid:526114c2-8266-4dee-b663-351119249fd5

Gazi, V., & Fidan, B. (2007). Coordination and Control of Multi-agent Dynamic Systems: Models and Approaches. In E. Şahin, W. M. Spears, & A. F. T. Winfield (Eds.), *Swarm Robotics* (pp. 71–102). Springer. https://doi.org/10.1007/978-3-540-71541-2_6

Gigante, N. A., & Firestone, W. A. (2008). Administrative support and teacher leadership in schools implementing reform. *Journal of Educational Administration*, *46*(3), 302–331. https://doi.org/10.1108/09578230810869266

Gisemba Bagaka's, J., Bransteter, I., Rispinto, S., & Badillo, N. (2015). Exploring Student Success in a Doctoral Program: The Power of Mentorship and Research Engagement. *International Journal of Doctoral Studies*, *10*, 323–342. https://doi.org/10.28945/2291

Gjonaj, M. (2007). Analysis on Modeling and Simulink of DC Motor and its Driving System Used for Wheeled Mobile Robot. *International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering*, *1*(8), 1141–1148.

Glass, C. R., Doberneck, D. M., & Schweitzer, J. H. (2011). Unpacking Faculty Engagement:The Types of Activities Faculty Members Report as Publicly Engaged Scholarship During Promotion and Tenure. *Journal of Higher Education Outreach and Engagement*, *15*(1), 7–29.

Gligorijevic, J., Gligorijevic, D., Pavlovski, M., Milkovits, E., Glass, L., Grier, K., Vankireddy, P., & Obradovic, Z. (2019). Optimizing clinical trials recruitment via deep learning. *Journal of the American Medical Informatics Association*, *26*(11), 1195–1202. https://doi.org/10.1093/jamia/ocz064

Goldacre, B., Drysdale, H., Dale, A., Milosevic, I., Slade, E., Hartley, P., Marston, C., Powell-Smith, A., Heneghan, C., & Mahtani, K. R. (2019). COMPare: A prospective cohort study correcting and monitoring 58 misreported trials in real time. *Trials*, *20*(1), 118. https://doi.org/10.1186/s13063-019-3173-2

Gonsalvez, C. J., Oades, L. G., & Freestone, J. (2002). The Objectives Approach to Clinical Supervision: Towards Integration and Empirical Evaluation. *Australian Psychologist*, *37*(1), 68–77. https://doi.org/10.1080/00050060210001706706

Graham, I. D., Kothari, A., McCutcheon, C., Angus, D., Banner, D., Bucknall, T., Dunn, S., Gagnon, M., Gifford, W., Godfrey, C., Holmes, B., Horsley, T., Hutchinson, A. M., Jull, J., Law, S., MacLeod, M., McLean, R. K. D., Mrklas, K., Nguyen, T., … On behalf of the Integrated Knowledge

Translation Research Network Project Leads. (2018). Moving knowledge into action for more effective practice, programmes and policy: Protocol for a research programme on integrated knowledge translation. *Implementation Science*, *13*(1), 22. https://doi.org/10.1186/s13012-017-0700-y

Grainger, S., Mao, F., & Buytaert, W. (2016). Environmental data visualisation for non-scientific contexts: Literature review and design framework. *Environmental Modelling & Software*, *85*, 299–318. https://doi.org/10.1016/j.envsoft.2016.09.004

Green, L., Stevenson, K. J., & Allmark, P. (2020). Disadvantaged Children's Creative Visualisation of Possible Futures. In J. I. Lane (Ed.), *Tracing Behind the Image An Interdisciplinary Exploration of Visual Literacy* (Vol. 133, pp. 116–133). Brill Rodopi. https://doi.org/10.1163/9789004438392_012

Green, L. W., & Glasgow, R. E. (2006). Evaluating the Relevance, Generalization, and Applicability of Research: Issues in External Validation and Translation Methodology. *Evaluation & the Health Professions*, *29*(1), 126–153. https://doi.org/10.1177/0163278705284445

Grondin, C. J., Davis Allan Peter, Wiegers Thomas C., King Benjamin L., Wiegers Jolene A., Reif David M., Hoppin Jane A., & Mattingly Carolyn J. (2016). Advancing Exposure Science through Chemical Data Curation and Integration in the Comparative Toxicogenomics Database. *Environmental Health Perspectives*, *124*(10), 1592–1599. https://doi.org/10.1289/EHP174

Guellil, I., Adeel, A., Azouaou, F., & Hussain, A. (2018). SentiALG: Automated Corpus Annotation for Algerian Sentiment Analysis. In J. Ren, A. Hussain, J. Zheng, C.-L. Liu, B. Luo, H. Zhao, & X. Zhao (Eds.), *Advances in Brain Inspired Cognitive Systems* (pp. 557–567). Springer International Publishing. https://doi.org/10.1007/978-3-030-00563-4_54

Han, X., & Appelbaum, R. P. (2018). China's science, technology, engineering, and mathematics (STEM) research environment: A snapshot. *PLOS ONE*, *13*(4), e0195347. https://doi.org/10.1371/journal.pone.0195347

Hansen, G. (2010). Integrative description of translation processes. In G. M. Shreve & E. Angelone (Eds.), *Translation and Cognition*. John Benjamins Publishing.

Heidorn, P. B. (2008). Shedding Light on the Dark Data in the Long Tail of Science. *Library Trends*, *57*(2), 280–299. https://doi.org/10.1353/lib.0.0036

Heidorn, P. B. (2011). The Emerging Role of Libraries in Data Curation and E-science. *Journal of Library Administration*, *51*(7–8), 662–672. https://doi.org/10.1080/01930826.2011.601269

Heuer, H. (1996). Chapter 3 Coordination. In H. Heuer & S. W. Keele (Eds.), *Handbook of Perception and Action* (Vol. 2, pp. 121–180). Academic Press. https://doi.org/10.1016/S1874-5822(06)80006-X

Heule, F., & Ye, S. (2015). Linguet's Lettre du Mandarin, a Forgotten Apology for the Jesuits: The Mandarin Wei Zheng as a Model. *Journal of Early Modern Christianity*, *2*(2), 257–280. https://doi.org/10.1515/jemc-2015-0008

Hidayat, R., & Budiatma, J. (2018). Education and job training on employee performance. *International Journal of Social Sciences and Humanities*, *2*(1), 171–181. https://doi.org/10.29332/ijssh.v2n1.140

Hinrichs, E., & Krauwer, S. (2014). The CLARIN Research Infrastructure: Resources and Tools for eHumanities Scholars. *Proceedings of the Ninth International Conference on Language Resources and Evaluation (LREC-2014)*, 1525–1531.

Ho, M. (2017). Navigating scholarly writing and international publishing: Individual agency of Taiwanese EAL doctoral students. *Journal of English for Academic Purposes*, *27*, 1–13. https://doi.org/10.1016/j.jeap.2017.02.004

Hoekman, J., Scherngell, T., Frenken, K., & Tijssen, R. (2013). Acquisition of European research funds and its effect on international scientific collaboration. *Journal of Economic Geography*, *13*(1), 23–52. https://doi.org/10.1093/jeg/lbs011

Holmes, J. S. (1988). The name and nature of translation studies. In J. S. Holmes (Ed.), *Translated!: Papers on Literary Translation and Translation Studies.* (p. 13). Rodopi.

Horng, S.-M., & Wu, C.-L. (2020). How behaviors on social network sites and online social capital influence social commerce intentions. *Information & Management*, *57*(2), 103176. https://doi.org/10.1016/j.im.2019.103176

Horng, S.-M., Wu, C.-L., & Liang, T.-P. (2016). How behaviors on social network sites and online social capital influence social commerce: The case of Facebook. *PACIS 2016 Proceedings*. https://aisel.aisnet.org/pacis2016/295

Hornstein, E. A., & Eisenberger, N. I. (2017). Unpacking the buffering effect of social support figures: Social support attenuates fear acquisition. *PLOS ONE*, *12*(5), e0175891. https://doi.org/10.1371/journal.pone.0175891

Hosseini, M., & Gordijn, B. (2020). A review of the literature on ethical issues related to scientific authorship. *Accountability in Research*, *27*(5), 284–324. https://doi.org/10.1080/08989621.2020.1750957

Huang, Y., Hou, X., Liu, S., & Ni, J. (2016). Correspondence analysis of bio-refractory compounds degradation and microbiological community distribution in anaerobic filter for coking wastewater treatment. *Chemical Engineering Journal*, *304*, 864–872. https://doi.org/10.1016/j.cej.2016.05.142

Hubscher-Davidson, S. E. (2009). Personal diversity and diverse personalities in translation: A study of individual differences. *Studies in Translation Theory and Practice*, *17*(3), 175–192. https://doi.org/10.1080/09076760903249380

Iacopino, A. M. (2007). The Influence of "New Science" on Dental Education: Current Concepts, Trends, and Models for the Future. *Journal of Dental Education*, *71*(4), 450–462. https://doi.org/10.1002/j.0022-0337.2007.71.4.tb04296.x

Inagaki, N., Stern, C., McBain, J., Lopata, A., Kornman, L., & Wilkinson, D. (2003). Analysis of intra-uterine cytokine concentration and matrix-metalloproteinase activity in women with recurrent failed embryo transfer. *Human Reproduction*, *18*(3), 608–615. https://doi.org/10.1093/humrep/deg139

Jacobson, N., Butterill, D., & Goering, P. (2004). Organizational Factors that Influence University-Based Researchers' Engagement in Knowledge Transfer Activities. *Science Communication*, *25*(3), 246–259. https://doi.org/10.1177/1075547003262038

Jahnke, L. M., & Asher, A. (nd.). *The Problem of Data: Data Management and Curation Practices Among University Researchers • CLIR*. CLIR. https://www.clir.org/pubs/reports/pub154/problem-of-data/

Jensen, L., & Konradsen, F. (2018). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies*, *23*(4), 1515–1529. https://doi.org/10.1007/s10639-017-9676-0

Jiang, F., Hong, F., Shah, M. W., & Shen, X. (2019). Circular RNAs as diagnostic biomarkers in gastric cancer: A meta-analysis review. *Pathology - Research and Practice*, *215*(6), 152419. https://doi.org/10.1016/j.prp.2019.04.011

Johnson, M. O., Subak, L. L., Brown, J. S., Lee, K. A., & Feldman, M. D. (2010). An Innovative Program to Train Health Sciences Researchers to be Effective Clinical and Translational-Research Mentors. *Academic Medicine : Journal of the Association of American Medical Colleges*, *85*(3), 484–489. https://doi.org/10.1097/ACM.0b013e3181cccd12

Kacetl, J., & Klímová, B. (2019). Use of Smartphone Applications in English Language Learning—A Challenge for Foreign Language Education. *Education Sciences*, *9*(3), 179. https://doi.org/10.3390/educsci9030179

Kafai, Y. B., & Peppler, K. A. (2011). Youth, Technology, and DIY: Developing Participatory Competencies in Creative Media Production. *Review of Research in Education*, *35*(1), 89–119. https://doi.org/10.3102/0091732X10383211

Kaiser, M. (2014). The integrity of science – Lost in translation? *Best Practice & Research Clinical Gastroenterology*, *28*(2), 339–347. https://doi.org/10.1016/j.bpg.2014.03.003

Kalra, H., Simpson, R. J., Ji, H., Aikawa, E., Altevogt, P., Askenase, P., Bond, V. C., Borràs, F. E., Breakefield, X., Budnik, V., Buzas, E., Camussi, G., Clayton, A., Cocucci, E., Falcon-Perez, J. M., Gabrielsson, S., Gho, Y. S., Gupta, D., Harsha, H. C., … Mathivanan, S. (2012). Vesiclepedia: A Compendium for Extracellular Vesicles with Continuous Community Annotation. *PLOS Biology*, *10*(12), e1001450. https://doi.org/10.1371/journal.pbio.1001450

Kara, H. (2015). *Creative Research Methods in the Social Sciences: A Practical Guide*. Policy Press.

Karam, N., Müller-Birn, C., Gleisberg, M., Fichtmüller, D., Tolksdorf, R., & Güntsch, A. (2016). A Terminology Service Supporting Semantic Annotation, Integration, Discovery and Analysis of Interdisciplinary Research Data. *Datenbank-Spektrum*, *16*(3), 195–205. https://doi.org/10.1007/s13222-016-0231-8

Karimova, Y., Castro, J. A., da Silva, J. R., Pereira, N., & Ribeiro, C. (2017). Promoting Semantic Annotation of Research Data by Their Creators: A Use Case with B2NOTE at the End of the RDM Workflow. In E. Garoufallou, S. Virkus, R. Siatri, & D. Koutsomiha (Eds.), *Metadata and Semantic Research* (pp. 112–122). Springer International Publishing. https://doi.org/10.1007/978-3-319-70863-8_11

Keung, W. J. (2015). BlueJ UML Software System. *Creative and Literary Works in Non-Textual Form*. https://scholars.cityu.edu.hk/en/publications/bluej-uml-software-system(0bf48d88-2bdb-4f72-881b-7b06aa5cca84).html

Khan, H. A. (2020). Importance of customized (task oriented) software tools for biomedical applications. *Bioinformation*, *16*(1), 30–33. https://doi.org/10.6026/97320630016030

King, K. F., Kolopack, P., Merritt, M. W., & Lavery, J. V. (2014). Community engagement and the human infrastructure of global health research. *BMC Medical Ethics*, *15*(1), 84. https://doi.org/10.1186/1472-6939-15-84

Klein, J. T., & Falk-Krzesinski, H. J. (2017). Interdisciplinary and collaborative work: Framing promotion and tenure practices and policies. *Research Policy*, *46*(6), 1055–1061. https://doi.org/10.1016/j.respol.2017.03.001

Koenig, M. A., & McArthur, J. (2005). Case 8: Absentminded and "Walking Like a Drunk." *Medscape General Medicine*, *7*(1), 64.

Kokol, P., Završnik, J., Železnik, D., & Vošner, H. B. (2016). Creating a Self-Plagiarism Research Topic Typology through Bibliometric Visualisation. *Journal of Academic Ethics*, *14*(3), 221–230. https://doi.org/10.1007/s10805-016-9258-6

Kotha, R., George, G., & Srikanth, K. (2012). Bridging the Mutual Knowledge Gap: Coordination and the Commercialization of University Science. *Academy of Management Journal*, *56*(2), 498–524. https://doi.org/10.5465/amj.2010.0948

Krishnan, E. (2005). Unregistered Trials Are Unethical. *PLoS Medicine*, *2*(2). https://doi.org/10.1371/journal.pmed.0020048

Lacourse, K., Yetton, B., Mednick, S., & Warby, S. C. (2020). Massive online data annotation, crowdsourcing to generate high quality sleep spindle annotations from EEG data. *Scientific Data*, *7*(1), 190. https://doi.org/10.1038/s41597-020-0533-4

Lambie, G. W., & Vaccaro, N. (2011). Doctoral Counselor Education Students' Levels of Research Self-Efficacy, Perceptions of the Research Training Environment, and Interest in Research. *Counselor Education and Supervision*, *50*(4), 243–258. https://doi.org/10.1002/j.1556-6978.2011.tb00122.x

Lampert, M. (1985). How Do Teachers Manage to Teach? Perspectives on Problems in Practice. *Harvard Educational Review*, *55*(2), 178–195. https://doi.org/10.17763/haer.55.2.56142234616x4352

Lancaster, J. W., Stein, S. M., MacLean, L. G., Amburgh, J. V., & Persky, A. M. (2014). Faculty Development Program Models to Advance Teaching and Learning Within Health Science Programs. *American Journal of Pharmaceutical Education*, *78*(5). https://doi.org/10.5688/ajpe78599

Lane, J. I., Owen-Smith, J., Rosen, R. F., & Weinberg, B. A. (2015). New linked data on research investments: Scientific workforce, productivity, and public value. *Research Policy*, *44*(9), 1659–1671. https://doi.org/10.1016/j.respol.2014.12.013

LaPierre, A. (2004). Neuroscience Book Review. *The USA Body Psychotherapy Journal*, *3*(2), 18.

Larivière, V., & Costas, R. (2016). How Many Is Too Many? On the Relationship between Research Productivity and Impact. *PLOS ONE*, *11*(9), e0162709. https://doi.org/10.1371/journal.pone.0162709

Lavery, J. V., Tinadana, P. O., Scott, T. W., Harrington, L. C., Ramsey, J. M., Ytuarte-Nuñez, C., & James, A. A. (2010). Towards a framework for community engagement in global health research. *Trends in Parasitology*, *26*(6), 279–283. https://doi.org/10.1016/j.pt.2010.02.009

Lee, A. D., Green, B. N., Johnson, C. D., & Nyquist, J. (2010). How to write a scholarly book review for publication in a peer-reviewed journal: A review of the literature. *The Journal of Chiropractic Education*, *24*(1), 57–69. https://doi.org/10.7899/1042-5055-24.1.57

Lee, D. J., & Stvilia, B. (2017). Practices of research data curation in institutional repositories: A qualitative view from repository staff. *PLOS ONE*, *12*(3), e0173987. https://doi.org/10.1371/journal.pone.0173987

Leite, B. D., Oliveira, E. A., Queiroz, I. N., Martelli, D. R., Oliveira, M. C., & Júnior, H. M. (2012). Profile of the Researchers with Productivity Grants in the Brazilian National Research Council (CNPq) of the Physical Education Area. *Motricidade*, *8*(3), 90–98. https://doi.org/10.6063/motricidade.8(3).1160

Leonelli, S. (2016). *Data-Centric Biology: A Philosophical Study*. University of Chicago Press.

Li, J., & Liu, L. (2006). Supply chain coordination with quantity discount policy. *International Journal of Production Economics*, *101*(1), 89–98. https://doi.org/10.1016/j.ijpe.2005.05.008

Li, X., & Wang, Q. (2007). Coordination mechanisms of supply chain systems. *European Journal of Operational Research*, *179*(1), 1–16. https://doi.org/10.1016/j.ejor.2006.06.023

Lim, E. H., Zhang, S.-L., Yu, K., Nga, M.-E., Ahmed, D. A., Agasthian, T., Wong, P.-S., Chua, G.-C., Wong, D., Tan, L., Seto, K.-Y., Yap, W.-S., Low, S.-P., Khoo, K.-L., Chang, A., Ng, A., & Tan, P. (2007). An Alternative Approach to Determining Therapeutic Choices in Advanced Non-small Cell Lung Carcinoma (NSCLC): Maximizing the Diagnostic Procedure and the Use of Low-Volume Lung Biopsies. *Journal of Thoracic Oncology*, *2*(5), 387–396. https://doi.org/10.1097/01.JTO.0000268671.49378.c2

Lin, W. (2019). Research on the teaching management of track and field web course based on software programming method. *Cluster Computing*, *22*(6), 15037–15048. https://doi.org/10.1007/s10586-018-2495-2

Lipton, Z. C., & Steinhardt, J. (2018). Troubling Trends in Machine Learning Scholarship. *ArXiv*. http://arxiv.org/abs/1807.03341

Lorente, J. P. (2020). Art Critic. *International Lexicon Of Aesthetics*. https://doi.org/10.7413/18258630083

Louis, K. S., Blumenthal, D., Gluck, M. E., & Stoto, M. A. (1989). Entrepreneurs in Academe: An Exploration of Behaviors among Life Scientists. *Administrative Science Quarterly*, *34*(1), 110–131. https://doi.org/10.2307/2392988

Lutfiyya, M. N., Brandt, B. F., & Cerra, F. (2016). Reflections From the Intersection of Health Professions Education and Clinical Practice: The State of the Science of Interprofessional Education and Collaborative Practice. *Academic Medicine*, *91*(6), 766–771. https://doi.org/10.1097/ACM.0000000000001139

Lynch, C. (2014). The next generation of challenges in the curation of scholarly data. In J. M. Ray (Ed.), *Research Data Management: Practical Strategies for Information Professionals* (pp. 395–409). Purdue University Press.

Macmullen, W. J. (2005). *Annotation as process, thing, and knowledge: Multi-domain studies of structured data annotation*. in ASIST Annual Meeting, (Charlotte, NC, 2005), ASIST, in review.

MacQueen, K. M., Bhan, A., Frohlich, J., Holzer, J., Sugarman, J., & the Ethics Working Group of the HIV Prevention Trials Network. (2015). Evaluating community engagement in global health research: The need for metrics. *BMC Medical Ethics*, *16*(1), 44. https://doi.org/10.1186/s12910-015-0033-9

Makarenkov, V., Rokach, L., & Shapira, B. (2019). Choosing the right word: Using bidirectional LSTM tagger for writing support systems. *Engineering Applications of Artificial Intelligence*, *84*, 1–10. https://doi.org/10.1016/j.engappai.2019.05.003

March, S. T., & Hevner, A. R. (2007). Integrated decision support systems: A data warehousing perspective. *Decision Support Systems*, *43*(3), 1031–1043. https://doi.org/10.1016/j.dss.2005.05.029

Marchington, J. M., & Burd, G. P. (2014). Author attitudes to professional medical writing support. *Current Medical Research and Opinion*, *30*(10), 2103–2108. https://doi.org/10.1185/03007995.2014.939618

Marino, K. B., Hoover-Miller, A., Conlon, S., Prewitt, J., & O'Shea, S. K. (2011). Quantification of total mercury in liver and heart tissue of Harbor Seals (Phoca vitulina) from Alaska USA. *Environmental Research*, *111*(8), 1107–1115. https://doi.org/10.1016/j.envres.2011.07.010

Maton, K. I., Hrabowski, F. A., & Schmitt, C. L. (2000). African American college students excelling in the sciences: College and postcollege outcomes in the Meyerhoff Scholars Program. *Journal of Research in Science Teaching*, *37*(7), 629–654. https://doi.org/10.1002/1098-2736(200009)37:7<629::AID-TEA2>3.0.CO;2-8

Mazliak, L. (2019). *What would be Belgium without probability and probability without Belgium ? Paul Mansion and the scientific approach of randomness*. https://hal.archives-ouvertes.fr/hal-02044340

McCabe, S. (2005). Open Access to Trials Register. *PLOS Medicine*, *2*(2), e49. https://doi.org/10.1371/journal.pmed.0020049

McCusker, J. P., Phillips, J. A., Beltrán, A. G., Finkelstein, A., & Krauthammer, M. (2009). Semantic web data warehousing for caGrid. *BMC Bioinformatics*, *10*(10), S2. https://doi.org/10.1186/1471-2105-10-S10-S2

McKnight, D. H., Kacmar, C. J., & Choudhury, V. (2004). Dispositional Trust and Distrust Distinctions in Predicting High- and Low-Risk Internet Expert Advice Site Perceptions. *E-Service Journal*, *3*(2), 35–58. https://doi.org/10.2979/esj.2004.3.2.35

McKnight, H. D., Choudhury, V., & Kacmar, C. (2002). The impact of initial consumer trust on intentions to transact with a web site: A trust building model. *The Journal of Strategic Information Systems*, *11*(3), 297–323. https://doi.org/10.1016/S0963-8687(02)00020-3

McLure, M., Level, A. V., Cranston, C. L., Oehlerts, B., & Culbertson, M. (2014). Data Curation: A Study of Researcher Practices and Needs. *Portal: Libraries and the Academy*, *14*(2), 139–164. https://doi.org/10.1353/pla.2014.0009

McNeill, F., & Beyens, K. (2013). *Offender Supervision in Europe*. Palgrave Macmillan.

McNeill, L. H., Kreuter, M. W., & Subramanian, S. V. (2006). Social Environment and Physical activity: A review of concepts and evidence. *Social Science & Medicine*, *63*(4), 1011–1022. https://doi.org/10.1016/j.socscimed.2006.03.012

McNutt, M. K., Bradford, M., Drazen, J. M., Hanson, B., Howard, B., Jamieson, K. H., Kiermer, V., Marcus, E., Pope, B. K., Schekman, R., Swaminathan, S., Stang, P. J., & Verma, I. M. (2018). Transparency in authors' contributions and responsibilities to promote integrity in scientific publication. *Proceedings of the National Academy of Sciences*, *115*(11), 2557–2560. https://doi.org/10.1073/pnas.1715374115

Mendonca, M., & Cowan, D. (2010). Decision-making coordination and efficient reasoning techniques for feature-based configuration. *Science of Computer Programming*, *75*(5), 311–332. https://doi.org/10.1016/j.scico.2009.12.004

Mierzecka, A. (2019). The Role of Academic Libraries in Scholarly Communication. A Meta-Analysis of Research. *Studia Medioznawcze*, *20*(1), 99–112.

Miljanovic, M. A., & Bradbury, J. S. (2018). A Review of Serious Games for Programming. In S. Göbel, A. Garcia-Agundez, T. Tregel, M. Ma, J. Baalsrud Hauge, M. Oliveira, T. Marsh, & P. Caserman (Eds.), *Serious Games* (pp. 204–216). Springer International Publishing. https://doi.org/10.1007/978-3-030-02762-9_21

Miller, I. (1977). Review of Supervision in Social Work [Review of *Review of Supervision in Social Work*, by A. Kadushin]. *Social Service Review*, *51*(2), 366–368.

Mohamed, M. H., Udoetok, I. A., & Wilson, L. D. (2020). Animal Biopolymer-Plant Biomass Composites: Synergism and Improved Sorption Efficiency. *Journal of Composites Science*, *4*(1), 15. https://doi.org/10.3390/jcs4010015

Mohammed, E. A., Far, B. H., & Naugler, C. (2014). Applications of the MapReduce programming framework to clinical big data analysis: Current landscape and future trends. *BioData Mining*, *7*(1), 22. https://doi.org/10.1186/1756-0381-7-22

Moller, F., & Crick, T. (2018). A university-based model for supporting computer science curriculum reform. *Journal of Computers in Education*, *5*(4), 415–434. https://doi.org/10.1007/s40692-018-0117-x

Molyneux, S., & Bull, S. (2013). Consent and Community Engagement in Diverse Research Contexts: Reviewing and Developing Research and Practice: Participants in the Community Engagement and Consent Workshop, Kilifi, Kenya, March 2011. *Journal of Empirical Research on Human Research Ethics*, *8*(4), 1–18. https://doi.org/10.1525/jer.2013.8.4.1

Morin, S. M., Jaeger, A. J., & O'Meara, K. (2016). The State of Community Engagement in Graduate Education: Reflecting on 10 Years of Progress. *Journal of Higher Education Outreach and Engagement*, *20*(1), 151–156.

Moscoso-Zea, O., Paredes-Gualtor, J., & LujáN-Mora, S. (2018). A Holistic View of Data Warehousing in Education. *IEEE*, *6*, 64659–64673. https://doi.org/10.1109/ACCESS.2018.2876753

Mukhamedov, A. (2020). Translation concepts of "The Leipzig School" scholars. *European Journal of Research and Reflection in Educational Sciences*, *8*(4), 1.

Munos, B. (2006). Can open-source R&D reinvigorate drug research? *Nature Reviews Drug Discovery*, *5*(9), 723–729. https://doi.org/10.1038/nrd2131

Munoz, T., & Renear, A. (2011). *Issues in Humanities Data Curation*.

Murphy, S., McGlynn-Stewart, M., & Ghafouri, F. (2014). Constructing Our Identities through a Writing Support Group: Bridging from Doctoral Students to Teacher Educator Researchers. *Studying Teacher Education*, *10*(3), 239–254. https://doi.org/10.1080/17425964.2014.949656

Musen, M. A., Bean, C. A., Cheung, K.-H., Dumontier, M., Durante, K. A., Gevaert, O., Gonzalez-Beltran, A., Khatri, P., Kleinstein, S. H., O'Connor, M. J., Pouliot, Y., Rocca-Serra, P., Sansone, S.-A., Wiser, J. A., & and the CEDAR team. (2015). The center for expanded data annotation and retrieval. *Journal of the American Medical Informatics Association*, *22*(6), 1148–1152. https://doi.org/10.1093/jamia/ocv048

Mustaine, E. E., & Tewksbury, R. (2009). Rainmakers: The Most Successful Criminal Justice Scholars and Departments In Research Grant Acquisition. *Journal of Criminal Justice Education*, *20*(1), 40–55. https://doi.org/10.1080/10511250802680993

Muthanna, A., & Alduais, A. (2020). A Thematic Review on Research Integrity and Research Supervision: Relationships, Crises and Critical Messages. *Journal of Academic Ethics*. https://doi.org/10.1007/s10805-020-09368-z

Nazir, M. S., Ali, N., Bilal, M., & Iqbal, H. M. N. (2020). Potential environmental impacts of wind energy development: A global perspective. *Current Opinion in Environmental Science & Health*, *13*, 85–90. https://doi.org/10.1016/j.coesh.2020.01.002

Nemati, H. R., Steiger, D. M., Iyer, L. S., & Herschel, R. T. (2002). Knowledge warehouse: An architectural integration of knowledge management, decision support, artificial intelligence and data warehousing. *Decision Support Systems*, *33*(2), 143–161. https://doi.org/10.1016/S0167-9236(01)00141-5

Nicholson, G. J., & Kiel, G. C. (2004). Breakthrough board performance: How to harness your board's intellectual capital[1]. *Corporate Governance: The International Journal of Business in Society*, *4*(1), 5–23. https://doi.org/10.1108/14720700410521925

Nicholson, S. (2006). The basis for bibliomining: Frameworks for bringing together usage-based data mining and bibliometrics through data warehousing in digital library services. *Information Processing & Management*, *42*(3), 785–804. https://doi.org/10.1016/j.ipm.2005.05.008

Noy, N. F., Shah, N. H., Whetzel, P. L., Dai, B., Dorf, M., Griffith, N., Jonquet, C., Rubin, D. L., Storey, M.-A., Chute, C. G., & Musen, M. A. (2009). BioPortal: Ontologies and integrated data resources at the click of a mouse. *Nucleic Acids Research*, *37*(suppl_2), W170–W173. https://doi.org/10.1093/nar/gkp440

O'Brien, S., Simard, M., & Goulet, M.-J. (2018). Machine Translation and Self-post-editing for Academic Writing Support: Quality Explorations. In J. Moorkens, S. Castilho, F. Gaspari, & S. Doherty (Eds.), *Translation Quality Assessment: From Principles to Practice* (pp. 237–262). Springer International Publishing. https://doi.org/10.1007/978-3-319-91241-7_11

Ogburn, J. L. (2010). The Imperative for Data Curation. *Portal: Libraries and the Academy*, *10*(2), 241–246. https://doi.org/10.1353/pla.0.0100

Okoli, C., Mehdi, M., Mesgari, M., Nielsen, F. Å., & Lanamäki, A. (2014). Wikipedia in the eyes of its beholders: A systematic review of scholarly research on Wikipedia readers and readership. *Journal of the Association for Information Science and Technology*, *65*(12), 2381–2403. https://doi.org/10.1002/asi.23162

O'Meara, K., & Jeager, A. J. (2019). Preparing future faculty for community engagement. In L. R. Sandmann & D. O. Jones (Eds.), *Building the Field of Higher Education Engagement: Foundational Ideas and Future Directions* (p. N/A). Stylus Publishing, LLC.

Palmer, C. L., & Neumann, L. J. (2002). The Information Work of Interdisciplinary Humanities Scholars: Exploration and Translation. *The Library Quarterly*, *72*(1), 85–117. https://doi.org/10.1086/603337

Palmer, C., Weber, N. M., Renear, A. H., & Muñoz, T. (2013). Foundations of Data Curation: The Pedagogy and Practice of "Purposeful Work" with Research Data. *Archives Journal*, *3*. https://www.ideals.illinois.edu/handle/2142/78099

Pan, J., & Hovde, K. (2010). Professional Development for Academic Librarians: Needs, Resources, and Administrative Support. *Chinese Librarianship*, *29*, 9.

Paoline, E. A., & Lambert, E. G. (2012). The Issue of Control in Jail: The Effects of Professionalism, Detainee Control, and Administrative Support on Job Stress, Job Satisfaction, and Organizational Commitment among Jail Staff. *American Journal of Criminal Justice*, *37*(2), 179–199. https://doi.org/10.1007/s12103-011-9128-0

Park, Y.-T. (2006). An empirical investigation of the effects of data warehousing on decision performance. *Information & Management*, *43*(1), 51–61. https://doi.org/10.1016/j.im.2005.03.001

Passiglia, F., Pilotto, S., Facchinetti, F., Bertolaccini, L., Del Re, M., Ferrara, R., Franchina, T., Malapelle, U., Menis, J., Passaro, A., Ramella, S., Rossi, G., Trisolini, R., & Novello, S. (2020). Treatment of advanced non-small-cell lung cancer: The 2019 AIOM (Italian Association of Medical Oncology) clinical practice guidelines. *Critical Reviews in Oncology/Hematology*, *146*, 102858. https://doi.org/10.1016/j.critrevonc.2019.102858

Peters, A. (2013). Realizing Utopia as a Scholarly Endeavour. *European Journal of International Law*, *24*(2), 533–552. https://doi.org/10.1093/ejil/cht022

Pettit, C. J., Raymond, C. M., Bryan, B. A., & Lewis, H. (2011). Identifying strengths and weaknesses of landscape visualisation for effective communication of future alternatives. *Landscape and Urban Planning*, *100*(3), 231–241. https://doi.org/10.1016/j.landurbplan.2011.01.001

Pfirman, S., & Martin, P. J. S. (2010). Facilitating interdisciplinary scholars. In C. Mitcham (Ed.), *The Oxford Handbook of Interdisciplinarity* (pp. 387–403). Oxford University Press.

Phan, P. H., Siegel, D. S., & Wright, M. (2005). Science parks and incubators: Observations, synthesis and future research. *Journal of Business Venturing*, *20*(2), 165–182. https://doi.org/10.1016/j.jbusvent.2003.12.001

Pizzolato, S., Tagliapietra, L., Cognolato, M., Reggiani, M., Müller, H., & Atzori, M. (2017). Comparison of six electromyography acquisition setups on hand movement classification tasks. *PLOS ONE*, *12*(10), e0186132. https://doi.org/10.1371/journal.pone.0186132

Pomerantz, J. (2006). Google Scholar and 100 Percent Availability of Information. *Information Technology and Libraries*, *25*(2), 52–56. https://doi.org/10.6017/ital.v25i2.3331

Poole, A. H. (2015). How has your science data grown? Digital curation and the human factor: a critical literature review. *Archival Science*, *15*(2), 101–139. https://doi.org/10.1007/s10502-014-9236-y

Price, C. (2003). Moving Clinical Work into Research: Study Preparation, Design, and Implementation. *United States Association for Body Psychotherapy Journal*, *2*(1), 33–36.

Quinn, R. W., & Dutton, J. E. (2005). Coordination as Energy-in-Conversation. *Academy of Management Review*, *30*(1), 36–57. https://doi.org/10.5465/amr.2005.15281422

Raddad, A. Z. M., & El-Seoudi, A. W. M. M. (2012). Providing legal advice and objectives of Islamic law. *Advances in Natural and Applied Sciences*, *6*(8), 1532–1537.

Rafiq, S., Cheney, C., Mo, X., Jarjoura, D., Muthusamy, N., & Byrd, J. C. (2012). XmAb-5574 antibody demonstrates superior antibody-dependent cellular cytotoxicity as compared with CD52- and CD20-targeted antibodies in adult acute lymphoblastic leukemia cells. *Leukemia*, *26*(7), 1720–1722. https://doi.org/10.1038/leu.2012.40

Raj, A., Carr, P. L., Kaplan, S. E., Terrin, N., Breeze, J. L., & Freund, K. M. (2016). Longitudinal Analysis of Gender Differences in Academic Productivity among Medical Faculty across 24 Medical Schools in the United States. *Academic Medicine : Journal of the Association of American Medical Colleges*, *91*(8), 1074–1079. https://doi.org/10.1097/ACM.0000000000001251

Ratajczak, J., Kucia, M., Mierzejewska, K., Liu, R., Kim, C. H., Natarajan, N., Sharma, V., Miller, D. M., Maciejewski, J., & Ratajczak, M. Z. (2012). A novel view of paroxysmal nocturnal hemoglobinuria pathogenesis: More motile PNH hematopoietic stem/progenitor cells displace normal HSPCs from their niches in bone marrow due to defective adhesion, enhanced migration and mobilization in response to erythrocyte-released sphingosine-1 phosphate gradient. *Leukemia*, *26*(7), 1722–1725. https://doi.org/10.1038/leu.2012.46

Ratner, H., & Gad, C. (2019). Data warehousing organization: Infrastructural experimentation with educational governance. *Organization*, *26*(4), 537–552. https://doi.org/10.1177/1350508418808233

Ray, M. (2016). An Expanded Approach to Evaluating Open Access Journals. *Journal of Scholarly Publishing*, *47*(4), 307–327. https://doi.org/10.3138/jsp.47.4.307

Reynolds, L., & Sariola, S. (2018). The ethics and politics of community engagement in global health research. *Critical Public Health*, *28*(3), 257–268. https://doi.org/10.1080/09581596.2018.1449598

Riley, S. R., & Hunter, L. (2009). *Mapping Landscapes for Performance as Research: Scholarly Acts and Creative Cartographies*. Palgrave Macmillan.

Roberts, S. J. (2015). Lateral Violence in Nursing: A Review of the Past Three Decades. *Nursing Science Quarterly*, *28*(1), 36–41. https://doi.org/10.1177/0894318414558614

Roco, M. C. (2003). Converging science and technology at the nanoscale: Opportunities for education and training. *Nature Biotechnology*, *21*(10), 1247–1249. https://doi.org/10.1038/nbt1003-1247

Roemer, R. C., & Borchardt, R. (2015). Altmetrics and the Role of Librarians. *Library Technology Reports*, *51*(5), 31–37.

Rosenstock, T. S., Lubberink, R., Gondwe, S., Manyise, T., & Dentoni, D. (2020). Inclusive and adaptive business models for climate-smart value creation. *Current Opinion in Environmental Sustainability*, *42*, 76–81. https://doi.org/10.1016/j.cosust.2019.12.005

Rutherford, M. B. (2011). *Adult Supervision Required: Private Freedom and Public Constraints for Parents and Children*. Rutgers University Press.

Saldanha, G., & O'Brien, S. (2014). *Research Methodologies in Translation Studies*. Routledge.

Sancho-Thomas, P., Fuentes-Fernández, R., & Fernández-Manjón, B. (2009). Learning teamwork skills in university programming courses. *Computers & Education*, *53*(2), 517–531. https://doi.org/10.1016/j.compedu.2009.03.010

Sandvig, C., Hamilton, K., Karahalios, K., & Langbort, C. (2014). Auditing Algorithms: Research Methods for Detecting Discrimination on Internet Platforms. *Data and Discrimination: Converting Critical Concerns into Productive Inquiry*, 23.

Santich, B. (2004). The study of gastronomy and its relevance to hospitality education and training. *International Journal of Hospitality Management*, *23*(1), 15–24. https://doi.org/10.1016/S0278-4319(03)00069-0

Santora, K. A., Mason, E. J., & Sheahan, T. C. (2013). A Model for Progressive Mentoring in Science and Engineering Education and Research. *Innovative Higher Education*, *38*(5), 427–440. https://doi.org/10.1007/s10755-013-9255-2

Santos, M. Y., Costa, C., Galvão, J., Andrade, C., Pastor, O., & Marcén, A. C. (2019). Enhancing Big Data Warehousing for Efficient, Integrated and Advanced Analytics. In C. Cappiello & M. Ruiz (Eds.), *Information Systems Engineering in Responsible Information Systems* (pp. 215–226). Springer International Publishing. https://doi.org/10.1007/978-3-030-21297-1_19

Sapolsky, H. M. (2014). *Science and the Navy: The History of the Office of Naval Research*. Princeton University Press.

Sattelmeyer, R. (2014). *Thoreau's Reading: A Study in Intellectual History with Bibliographical Catalogue*. Princeton University Press.

Scaramozzino, J. M., Ramírez, M. L., & McGaughey, K. J. (2012). A Study of Faculty Data Curation Behaviors and Attitudes at a Teaching-Centered University | Scaramozzino | College & Research Libraries. *College and Research Libraries*, *73*(4). https://doi.org/10.5860/crl-255

Schneider, K. (2017). Promoting the Entrepreneurial Success of Women Entrepreneurs Through Education and Training. *Science Journal of Education*, *5*(2), 50. https://doi.org/10.11648/j.sjedu.20170502.13

Scott Kelso, J. A., Tuller, B., & Harris, K. S. (1983). A "Dynamic Pattern" Perspective on the Control and Coordination of Movement. In P. F. MacNeilage (Ed.), *The Production of Speech* (pp. 137–173). Springer. https://doi.org/10.1007/978-1-4613-8202-7_7

Senek, M., Robertson, S., Tod, A., & Squibb, M. (2020). Mesothelioma: Exploring gender differences in time to diagnosis, seeking legal advice and occupational risk. *Cancer Nursing Practice*. https://doi.org/10.7748/cnp.2020.e1745

Sharma, S. (2018). Professional medical writing support: The need of the day. *Perspectives in Clinical Research*, *9*(3), 111–112. https://doi.org/10.4103/picr.PICR_47_18

Sheppard, S. R. J., & Cizek, P. (2009). The ethics of Google Earth: Crossing thresholds from spatial data to landscape visualisation. *Journal of Environmental Management*, *90*(6), 2102–2117. https://doi.org/10.1016/j.jenvman.2007.09.012

Shreve, G. M., & Diamond, B. J. (2016). Cognitive neurosciences and cognitive translation studies: About the information processing paradigm. *Border Crossings*, 141–168.

Shreve, G. M., & Lacruz, I. (2017). Aspects of a Cognitive Model of Translation. In *The Handbook of Translation and Cognition* (pp. 127–143). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119241485.ch7

Simon, R., Barker, E., Isaksen, L., & CaÑamares, P. D. S. (2017). Linked Data Annotation Without the Pointy Brackets: Introducing Recogito 2. *Journal of Map & Geography Libraries*, *13*(1), 111–132. https://doi.org/10.1080/15420353.2017.1307303

Simpson, S. (2012). The Problem of Graduate-Level Writing Support: Building a Cross-Campus Graduate Writing Initiative. *Journal of the Council of Writing Program Administrators*, *36*(1), 242.

Singh, R., & Singh, K. (2010). A Descriptive Classification of Causes of Data Quality Problems in Data Warehousing. *Computer Science*. /paper/A-Descriptive-Classification-of-Causes-of-Data-in-Singh-Singh/a0b303955e1d05f8338b426111392ee749ac1a60

Skinns, L. (2009). 'I'm a Detainee; Get Me Out of Here': Predictors of Access to Custodial Legal Advice in Public and Privatized Police Custody Areas in England and Wales. *The British Journal of Criminology*, *49*(3), 399–417. https://doi.org/10.1093/bjc/azp002

Sox, H. C., & Rennie, D. (2006). Research Misconduct, Retraction, and Cleansing the Medical Literature: Lessons from the Poehlman Case. *Annals of Internal Medicine*, *144*(8), 609–613. https://doi.org/10.7326/0003-4819-144-8-200604180-00123

Spence, J. P., Buddenbaum, J. L., Bice, P. J., Welch, J. L., & Carroll, A. E. (2018). Independent investigator incubator (I3): A comprehensive mentorship program to jumpstart productive research careers for junior faculty. *BMC Medical Education*, *18*(1), 186. https://doi.org/10.1186/s12909-018-1290-3

Srinivasa, K., & Prasad, N. (2010). Text Analytics to Data Warehousing. *International Journal on Computer Science and Engineering*, *2*(6), 2201–2207.

Steinert, Y., & McLeod, P. J. (2006). From Novice to Informed Educator: The Teaching Scholars Program for Educators in the Health Sciences. *Academic Medicine*, *81*(11), 969–974. https://doi.org/10.1097/01.ACM.0000242593.29279.be

Sterken, C. (2011). Writing a Scientific Paper III. Ethical Aspects. *EAS Publications Series*, *50*, 173–282. https://doi.org/10.1051/eas/1150003

Stokols, D., Misra, S., Moser, R. P., Hall, K. L., & Taylor, B. K. (2008). The Ecology of Team Science: Understanding Contextual Influences on Transdisciplinary Collaboration. *American Journal of Preventive Medicine*, *35*(2, Supplement), S96–S115. https://doi.org/10.1016/j.amepre.2008.05.003

Straus, S. E., Sales, A., Wensing, M., Michie, S., Kent, B., & Foy, R. (2015). Education and training for implementation science: Our interest in manuscripts describing education and training materials. *Implementation Science*, *10*(1), 136. https://doi.org/10.1186/s13012-015-0326-x

Strobl, C., Ailhaud, E., Benetos, K., Devitt, A., Kruse, O., Proske, A., & Rapp, C. (2019). Digital support for academic writing: A review of technologies and pedagogies. *Computers & Education*, *131*, 33–48. https://doi.org/10.1016/j.compedu.2018.12.005

Sukumar, D., Hodgson, J. S., & Wade, K. A. (2016). How the timing of police evidence disclosure impacts custodial legal advice. *The International Journal of Evidence & Proof*, *20*(3), 200–216. https://doi.org/10.1177/1365712716643548

Sun, G., Trung, N. V., Hoi, L. T., Hiep, P. T., Ishibashi, K., & Matsui, T. (2020). Visualisation of epidemiological map using an Internet of Things infectious disease surveillance platform. *Critical Care*, *24*(1), 400. https://doi.org/10.1186/s13054-020-03132-w

Sun, S., Chen, J., Li, W., Altintas, I., Lin, A., Peltier, S., Stocks, K., Allen, E. E., Ellisman, M., Grethe, J., & Wooley, J. (2011). Community cyberinfrastructure for Advanced Microbial Ecology Research and Analysis: The CAMERA resource. *Nucleic Acids Research*, *39*(suppl_1), D546–D551. https://doi.org/10.1093/nar/gkq1102

Sun, X., & Li, X. (1999). A pollen record of the last 37 ka in deep sea core 17940 from the northern slope of the South China Sea. *Marine Geology*, *156*(1), 227–244. https://doi.org/10.1016/S0025-3227(98)00181-9

Sun, X., Li, X., & Beug, H.-J. (1999). Pollen distribution in hemipelagic surface sediments of the South China Sea and its relation to modern vegetation distribution. *Marine Geology*, *156*(1), 211–226. https://doi.org/10.1016/S0025-3227(98)00180-7

Surr, C. A., Gates, C., Irving, D., Oyebode, J., Smith, S. J., Parveen, S., Drury, M., & Dennison, A. (2017). Effective Dementia Education and Training for the Health and Social Care Workforce: A Systematic Review of the Literature. *Review of Educational Research*, *87*(5), 966–1002. https://doi.org/10.3102/0034654317723305

Szilagyi, P. G., Shone, L. P., Dozier, A. M., Newton, G. L., Green, T., & Bennett, N. M. (2014). Evaluating Community Engagement in an Academic Medical Center. *Academic Medicine*, *89*(4), 585–595. https://doi.org/10.1097/ACM.0000000000000190

Terämä, E., Smallman, M., Lock, S. J., Johnson, C., & Austwick, M. Z. (2016). Beyond Academia – Interrogating Research Impact in the Research Excellence Framework. *PLOS ONE*, *11*(12), e0168533. https://doi.org/10.1371/journal.pone.0168533

Tesařová, M., Heude, E., Comai, G., Zikmund, T., Kaucká, M., Adameyko, I., Tajbakhsh, S., & Kaiser, J. (2019). An interactive and intuitive visualisation method for X-ray computed tomography data of biological samples in 3D Portable Document Format. *Scientific Reports*, *9*(1), 14896. https://doi.org/10.1038/s41598-019-51180-2

Tindana, P., de Vries, J., Campbell, M., Littler, K., Seeley, J., Marshall, P., Troyer, J., Ogundipe, M., Alibu, V. P., Yakubu, A., Parker, M., & as members of the H3A Working Group on Ethics. (2015). Community engagement strategies for genomic studies in Africa: A review of the literature. *BMC Medical Ethics*, *16*(1), 24. https://doi.org/10.1186/s12910-015-0014-z

Tindana, P. O., Singh, J. A., Tracy, C. S., Upshur, R. E. G., Daar, A. S., Singer, P. A., Frohlich, J., & Lavery, J. V. (2007). Grand Challenges in Global Health: Community Engagement in Research in Developing Countries. *PLOS Medicine*, *4*(9), e273. https://doi.org/10.1371/journal.pmed.0040273

Tirkkonen-Condit, S., Mäkisalo, J., & Immonen, S. (2008). The translation process—Interplay between literal rendering and a search for sense. *Across Languages and Cultures*, *9*(1), 1–15. https://doi.org/10.1556/Acr.9.2008.1.1

Titley, M. A., Snaddon, J. L., & Turner, E. C. (2017). Scientific research on animal biodiversity is systematically biased towards vertebrates and temperate regions. *PLOS ONE*, *12*(12), e0189577. https://doi.org/10.1371/journal.pone.0189577

Trein, P., Biesbroek, R., Bolognesi, T., Cejudo, G. M., Duffy, R., Hustedt, T., & Meyer, I. (2020). Policy Coordination and Integration: A Research Agenda. *Public Administration Review*, *n/a*(n/a). https://doi.org/10.1111/puar.13180

Triplet, T., & Butler, G. (2014). A review of genomic data warehousing systems. *Briefings in Bioinformatics*, *15*(4), 471–483. https://doi.org/10.1093/bib/bbt031

Trowell, J., Alukal, J., Zhang, T., Liu, L., Maheshwari, A., Yoo, H. Y., & Thuluvath, P. J. (2020). How Good Are Controlled Attenuation Parameter Scores from Fibroscan to Assess Steatosis, NASH, and Fibrosis? *Digestive Diseases and Sciences*. https://doi.org/10.1007/s10620-020-06269-4

Tsay, A. A., & Agrawal, N. (2004). Modeling Conflict and Coordination in Multi-Channel Distribution Systems: A Review. In D. Simchi-Levi, S. D. Wu, & Z.-J. Shen (Eds.), *Handbook of Quantitative Supply Chain Analysis: Modeling in the E-Business Era* (pp. 557–606). Springer US. https://doi.org/10.1007/978-1-4020-7953-5_13

Tseng, F. S. C., & Chou, A. Y. H. (2006). The concept of document warehousing for multi-dimensional modeling of textual-based business intelligence. *Decision Support Systems*, *42*(2), 727–744. https://doi.org/10.1016/j.dss.2005.02.011

Tymoczko, M. (2005). Trajectories of Research in Translation Studies. *Meta : Journal Des Traducteurs / Meta: Translators' Journal*, *50*(4), 1082–1097. https://doi.org/10.7202/012062ar

Tysick, C., & Babb, N. (2006). Perspectives on … Writing Support for Junior Faculty Librarians: A Case Study. *The Journal of Academic Librarianship*, *32*(1), 94–100. https://doi.org/10.1016/j.acalib.2005.10.005

Van Pelt, T. I., Huntington, H. P., Romanenko, O. V., & Mueter, F. J. (2017). The missing middle: Central Arctic Ocean gaps in fishery research and science coordination. *Marine Policy*, *85*, 79–86. https://doi.org/10.1016/j.marpol.2017.08.008

Vandepitte, S. (2013). Research competences in translation studies. *Babel*, *59*(2), 125–148. https://doi.org/10.1075/babel.59.2.01van

Vanderstraeten, R., & Louckx, K. (2020). Sociology in Great Little Belgium. *The American Sociologist*, *51*(2), 101–123. https://doi.org/10.1007/s12108-020-09447-z

Vasileiadou, E., & Vliegenthart, R. (2009). Research productivity in the era of the internet revisited. *Research Policy*, *38*(8), 1260–1268. https://doi.org/10.1016/j.respol.2009.06.005

Vhurumuku, E., & Mokeleche, M. (2009). The nature of science and indigenous knowledge systems in South Africa, 2000–2007: A critical review of the research in science education. *African Journal of Research in Mathematics, Science and Technology Education*, *13*(sup1), 96–114. https://doi.org/10.1080/10288457.2009.10740664

Visser, J. (2003). Developmental coordination disorder: A review of research on subtypes and comorbidities. *Human Movement Science*, *22*(4), 479–493. https://doi.org/10.1016/j.humov.2003.09.005

Wallace, C. S., Hand, B. B., & Prain, V. (2004). Introduction: Does writing promote learning in science? In C. S. Wallace, B. B. Hand, & V. Prain (Eds.), *Writing and Learning in the Science Classroom* (pp. 1–8). Springer Science & Business Media.

Wallach, J. D., Boyack, K. W., & Ioannidis, J. P. A. (2018). Reproducible research practices, transparency, and open access data in the biomedical literature, 2015–2017. *PLOS Biology*, *16*(11), e2006930. https://doi.org/10.1371/journal.pbio.2006930

Walters, T. O. (2009). Data Curation Program Development in U.S. Universities: The Georgia Institute of Technology Example. *International Journal of Digital Curation*, *4*(3), 83–92. https://doi.org/10.2218/ijdc.v4i3.116

Wang, D., Liu, Z., Jiang, Q., Sun, Z., Huang, S., & Chen, J. (2020). NJUNLP's Machine Translation System for CCMT-2020 Uighur $$\rightarrow $$Chinese Translation Task. In Junhui Li & A. Way (Eds.), *Machine Translation* (pp. 76–82). Springer. https://doi.org/10.1007/978-981-33-6162-1_7

Watson, H. J., Goodhue, D. L., & Wixom, B. H. (2002). The benefits of data warehousing: Why some organizations realize exceptional payoffs. *Information & Management*, *39*(6), 491–502. https://doi.org/10.1016/S0378-7206(01)00120-3

Watts, I. P. (2015). Philosophical Intelligence: Letters, Print, and Experiment during Napoleon's Continental Blockade. *Isis*, *106*(4), 749–770. https://doi.org/10.1086/684807

Weber, N. M., Palmer, C. L., & Chao, T. C. (2012). Current Trends and Future Directions in Data Curation Research and Education. *Journal of Web Librarianship*, *6*(4), 305–320. https://doi.org/10.1080/19322909.2012.730358

Weinstein, M. (2008). Finding science in the school body: Reflections on transgressing the boundaries of science education and the social studies of science. *Science Education*, *92*(3), 389–403. https://doi.org/10.1002/sce.20267

West, R. R., Hsu, A. P., Holland, S. M., Cuellar-Rodriguez, J., & Hickstein, D. D. (2014). Acquired ASXL1 mutations are common in patients with inherited GATA2 mutations and correlate with myeloid transformation. *Haematologica*, *99*(2), 276–281. https://doi.org/10.3324/haematol.2013.090217

Westfall, J. M., Fagnan, L. J., Handley, M., Salsberg, J., McGinnis, P., Zittleman, L. K., & Macaulay, A. C. (2009). Practice-based Research is Community Engagement. *The Journal of the American Board of Family Medicine*, *22*(4), 423–427. https://doi.org/10.3122/jabfm.2009.04.090105

Whetzel, P. L., Parkinson, H., Causton, H. C., Fan, L., Fostel, J., Fragoso, G., Game, L., Heiskanen, M., Morrison, N., Rocca-Serra, P., Sansone, S.-A., Taylor, C., White, J., & Stoeckert, C. J., Jr. (2006). The MGED Ontology: A resource for semantics-based description of microarray experiments. *Bioinformatics*, *22*(7), 866–873. https://doi.org/10.1093/bioinformatics/btl005

Wilkie, W. L., & Moore, E. S. (2003). Scholarly Research in Marketing: Exploring the "4 Eras" of Thought Development. *Journal of Public Policy & Marketing*, *22*(2), 116–146. https://doi.org/10.1509/jppm.22.2.116.17639

Wilkinson, M. D., Dumontier, M., Aalbersberg, Ij. J., Appleton, G., Axton, M., Baak, A., Blomberg, N., Boiten, J.-W., da Silva Santos, L. B., Bourne, P. E., Bouwman, J., Brookes, A. J., Clark, T., Crosas, M., Dillo, I., Dumon, O., Edmunds, S., Evelo, C. T., Finkers, R., … Mons, B. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, *3*(1), 160018. https://doi.org/10.1038/sdata.2016.18

Willett, R. (2016). Making, Makers, and Makerspaces: A Discourse Analysis of Professional Journal Articles and Blog Posts about Makerspaces in Public Libraries. *The Library Quarterly*, *86*(3), 313–329. https://doi.org/10.1086/686676

Witt, M. (2008). Institutional Repositories and Research Data Curation in a Distributed Environment. *Library Trends*, *57*(2), 191–201. https://doi.org/10.1353/lib.0.0029

Witt, M., Carlson, J., Brandt, D. S., & Cragin, M. H. (2009). Constructing Data Curation Profiles. *International Journal of Digital Curation*, *4*(3), 93–103. https://doi.org/10.2218/ijdc.v4i3.117

Witton, R. (1973). Academics and Student Supervision: Apprenticeship or Exploitation? *The Australian and New Zealand Journal of Sociology*, *9*(3), 70–73. https://doi.org/10.1177/144078337300900322

Wolstencroft, K., Owen, S., Horridge, M., Krebs, O., Mueller, W., Snoep, J. L., du Preez, F., & Goble, C. (2011). RightField: Embedding ontology annotation in spreadsheets. *Bioinformatics*, *27*(14), 2021–2022. https://doi.org/10.1093/bioinformatics/btr312

Won, M., Mocerino, M., Tang, K.-S., Treagust, D. F., & Tasker, R. (2019). Interactive Immersive Virtual Reality to Enhance Students' Visualisation of Complex Molecules. In M. Schultz, S. Schmid, & G. A. Lawrie (Eds.), *Research and Practice in Chemistry Education: Advances from the 25th IUPAC International Conference on Chemistry Education 2018* (pp. 51–64). Springer. https://doi.org/10.1007/978-981-13-6998-8_4

Wright, J., & Wagner, A. (2008). The Systems Biology Research Tool: Evolvable open-source software. *BMC Systems Biology*, *2*(1), 55. https://doi.org/10.1186/1752-0509-2-55

Wyllie, D., & Davies, J. (2015). Role of data warehousing in healthcare epidemiology. *Journal of Hospital Infection*, *89*(4), 267–270. https://doi.org/10.1016/j.jhin.2015.01.005

Yan, R., Guo, P., Wang, J., & Amrouche, N. (2011). Product distribution and coordination strategies in a multi-channel context. *Journal of Retailing and Consumer Services*, *18*(1), 19–26. https://doi.org/10.1016/j.jretconser.2010.09.001

Yu, G., Wang, L.-G., & He, Q.-Y. (2015). ChIPseeker: An R/Bioconductor package for ChIP peak annotation, comparison and visualization. *Bioinformatics*, *31*(14), 2382–2383. https://doi.org/10.1093/bioinformatics/btv145

Zhou, J., Deng, Y., Shen, L., Wen, C., Yan, Q., Ning, D., Qin, Y., Xue, K., Wu, L., He, Z., Voordeckers, J. W., Van Nostrand, J. D., Buzzard, V., Michaletz, S. T., Enquist, B. J., Weiser, M. D., Kaspari, M., Waide, R., Yang, Y., & Brown, J. H. (2017). Correspondence: Reply to 'Analytical flaws in a continental-scale forest soil microbial diversity study.' *Nature Communications*, *8*(1), 15583. https://doi.org/10.1038/ncomms15583

Zins, C. (2007). Classification schemes of Information Science: Twenty-eight scholars map the field. *Journal of the American Society for Information Science and Technology*, *58*(5), 645–672. https://doi.org/10.1002/asi.20506