

Article

# Transparent Attribution of Contributions to Research: Aligning Guidelines to Real-Life Practices

Valerie Matarese <sup>1</sup> and Karen Shashok <sup>2,\*</sup>

<sup>1</sup> Authors' editor and Editorial consultant, Via Roma 10, 31020 Vidor (TV), Italy; [vmatarese@uptoit.org](mailto:vmatarese@uptoit.org)

<sup>2</sup> Translator and Editorial consultant, C./Compositor Ruiz Aznar 12 2-A, 18008 Granada, Spain

\* Correspondence: [kshashok@kshashok.com](mailto:kshashok@kshashok.com)

Received: 8 February 2019; Accepted: 29 March 2019; Published: 3 April 2019



**Abstract:** Research studies, especially in the sciences, may benefit from substantial non-author support without which they could not be completed or published. The term “contributorship” was coined in 1997 to recognize all contributions to a research study, but its implementation (mostly in biomedical reports) has been limited to the inclusion of an “Author Contributions” statement that omits other contributions. To standardize the reporting of contributions across disciplines, irrespective of whether a given contribution merits authorship or acknowledgment, the Contributor Roles Taxonomy (CRediT) was launched in 2014. Our assessment, however, shows that in practice, CRediT is a detailed authorship classification that risks denying appropriate credit for persons who contribute as non-authors. To illustrate the shortcomings in CRediT and suggest improvements, in this article we review key concepts of authorship and contributorship and examine the range of non-author contributions that may (or may not) be acknowledged. We then briefly describe different types of editorial support provided by (non-author) translators, authors' editors and writers, and explain why it is not always acknowledged. Finally, we propose two new CRediT taxa and revisions to three existing taxa regarding both technical and editorial support, as a small but important step to make credit attribution more transparent, accurate and open.

**Keywords:** accountability; acknowledgment; author; authors' editor; contributor; CRediT; editing; ethics; translation; writing

## 1. Introduction

Openness in research publishing is valued by readers, beneficial for authors and other contributors, and useful to researchers, research evaluators and funders. Critical questions that academic researchers and professionals in research publication are raising about traditional editorial and publishing practices (see, for example, other articles in *Publications* and [1]) are a clear sign that stakeholders in research publishing increasingly value openness, especially open peer review, open access and open data [2]. Now that research dissemination is digital and global, how research is performed, written and shared has changed in important ways since pre-internet times, and further progress aimed at optimizing rigor, transparency and openness can be anticipated.

Calls for more openness have stimulated awareness that many research publication policies are based on tradition, habit and widely held but unverified assumptions, rather than on knowledge about current incentives, motivations, processes and outcomes [3]. In the context of continuing efforts to challenge assumptions that inform publication policies and ethics, much attention has focused on authorship criteria, and many recommendations have been made to guide the attribution of authorship and the acknowledgment of non-author contributors (e.g., [4,5]). A relatively recent attempt to systematize how the many different contributions to published research are recognized is the Contributor Roles Taxonomy (CRediT; <https://casrai.org/credit/>). CRediT was devised to permit,

in a machine-readable manner, the specification of specialized capacities that different persons bring to a study, in any scientific discipline, irrespective of whether a given contribution merits authorship or not [6].

But our analysis suggests that CRediT, launched in 2014, is essentially a detailed authorship classification in conflict with how contributorship was initially conceived [7], and that its implementation risks depriving non-author contributors of due credit. Here, we briefly review key concepts of authorship and contributorship, examine the range of non-author contributions that may (or may not) be acknowledged in research reports, and describe the types of non-author editorial contributions to research that we are most familiar with through our own work as professional authors' editors [8–13] and translators. (Readers should note here that we are writing from our individual standpoint and combined experience of several decades.) We then scrutinize CRediT and identify some of its potential pitfalls. To close, we offer solutions to these shortcomings along with recommendations for making credit attribution more transparent, accurate and open. Our suggestions are intended as a starting point for further conversations about ways to make all contributions to research transparent.

## 2. Authors, Contributors and Acknowledges

The first formal authorship criteria for research articles were issued in 1988 by the International Committee of Medical Journal Editors (ICMJE) [4], following numerous "calls for attention to standards for authorship" in the US research setting (reviewed in [14]). The ICMJE criteria, eventually adopted by many biomedical research journals, also served as the basis for recommendations devised in other disciplines. Authorship criteria today are produced by scientific societies, funders, professional associations, publishers and academic institutions. According to a large multidisciplinary survey, authorship definitions are more common in the sciences than in the humanities, and more likely to appear in journals' instructions to authors than in disciplinary societies' ethics codes [15]. The authors suggested that variations among policies may create confusion and hinder good authorship practices. In fact, studies in different academic settings have revealed deficiencies in the knowledge of authorship criteria (e.g., in [16,17]), lack of agreement about them [18], and noncompliance for various reasons [19–22]. Furthermore, in collaborative studies, each person's relative contribution is difficult for the research team to determine and for others to understand [23]. As a result, authorship disputes remain a troublesome issue [19,24–27].

Because of problems with full and fair attribution, in 1997 Rennie and colleagues at *JAMA* (an ICMJE member journal) proposed "contributorship" [7]:

We argue for a radical conceptual and systematic change ... We propose dropping the outmoded notion of author in favor of the more useful and realistic one of *contributor*. This requires disclosure to readers of the contributions made to the research and to the manuscript by the contributors, so they can accept both credit and responsibility. (emphasis in the original)

The proposal was adopted by many biomedical journals and some journals in other disciplines, but not in a standardized way. Importantly, authorship was not abandoned (contributors who meet authorship criteria continue to be named in the byline); instead journals added a new section on "Author Contributions" at the end of articles to provide information on the specific roles of each author.

In 2004, the ICMJE issued guidance on the use of the Acknowledgments section of research articles to recognize support received from non-author contributors [28]:

All contributors who do not meet the criteria for authorship should be listed in an acknowledgments section. Examples of those who might be acknowledged include a person who provided purely technical help, writing assistance, or a department chair who provided only general support. ... Financial and material support should also be acknowledged.

The Acknowledgments section they referred to had been an optional and occasional part of research articles for at least 100 years, but became a regular feature after the 1960s [29]. According to Cronin, “Functionally, acknowledgements convey public gratitude for often private gestures of assistance which contributed in some meaningful way to the research or scholarship being reported” [30] (p. 19). He emphasized that acknowledgments “are not trivial, meta-textual flourishes [but] quasi formal records of often significant intellectual influences” [30] (p. 98). The Acknowledgments section is currently used by authors to publicly recognize persons who contributed to the reported research in a way that does not merit authorship but without which the study could not have been completed and published.

Text analyses of Acknowledgments sections have identified several recurrent types of non-author contributions, including financial, conceptual, instrumental-technical, moral, and editorial [30,31]. Studies of the frequency of acknowledgments of these non-author roles across disciplines and countries have provided a wealth of information on researchers’ practices and how these have evolved over time. In general, acknowledgments have increased in most disciplines, but there are wide disciplinary, cultural, linguistic and journal-specific differences [31–34]. For example, of 2707 articles published in *Psychological Review*, 10% to 24% had acknowledgments in the first five decades of the 1900s, while this proportion exceeded 90% in the last three decades [31]. About 56% of 335,000 computer science articles in the CiteSeer database (published in 1990–2004) had acknowledgments [35]. Analyses of research articles in the hard and life sciences found that most had acknowledgments [32–34]. Studies in different disciplines reported that acknowledgments to editorial support were present in about 10% of the articles examined [31–34]. An analysis of more than 1 million acknowledgments indexed in Web of Science in 2015 found that technical support was most often acknowledged by authors in the fields of chemistry, physics and engineering, while feedback from colleagues was most often acknowledged by social scientists [36].

Because there are no broadly accepted guidelines on which non-author contributions merit acknowledgment, it would be misguided to base inferences about the frequency or prevalence of these contributions on the numbers of explicit acknowledgments in samples of published research articles. Whether or not a paper has an Acknowledgments section and which contributions are listed or omitted depend largely on existing practices within disciplines, at journals and among researchers. The absence of an acknowledgment does not necessarily mean that the study did not benefit from important non-author support. There may have been additional contributions (by technicians, statisticians or editorial support professionals), but the authors may have preferred not to acknowledge them, or may not have been aware of any reason to do so. As for contributors, emerging evidence from surveys of professional authors’ editors and translators shows that many (especially those working in disciplines other than the life sciences) do not consider acknowledgment necessary or even desirable, for a variety of reasons (see Section 3 and [37,38]).

At present, then, despite efforts to encourage appropriate credit and accountability for non-authors, a number of factors make openness about non-author contributions a concept that is not valued equally across the spectrum of research publishing actors:

- (1) Compliance with institutional or editorial guidelines is essentially voluntary for byline authors.
- (2) Editorial policies vary among journals, publishers and disciplines, and byline authors are not always aware of these differences.
- (3) Institutions, journal editors and publishers seem mostly unable to verify or enforce compliance.
- (4) Non-author contributors have different expectations and practices, and may be unaware of editorial policies that encourage or require acknowledgment for contributions to the research or its written report.
- (5) Contributors such as statisticians—and especially authors’ editors and translators—are often self-employed and serve as externally contracted consultants. Unlike byline authors, they are mostly free from pressure to publish because their career success does not depend on bibliometric performance indicators. So they may have little motivation to maximize the appearance of their

name in the published research record, and little inclination to request public credit for their work if they believe their clients might find this issue awkward, intrusive or inappropriate. On the other hand, some may request or require acknowledgment for transparency or in the hope that their name will be noticed by potential clients.

### 3. Editorial Support for Research Reports

Non-author professionals who contribute to the text in ways that, although sometimes substantial, do not merit authorship have little power to require acknowledgment, and under certain circumstances some may actually prefer not to be named [37]. These situations particularly involve people who provide various types of professional writing assistance, here termed “editorial support”. As noted above, the fact that this support is not always acknowledged does not mean that it is rarely used.

Although no data are publicly available on the number of research articles that benefit from editorial support before acceptance, these services are described in a large body of literature going back over 50 years (reviewed in [13]). Editorial support for research communication—excluding “convenience editing”, i.e., editorial help from authors’ friends or native-English-speaking colleagues as a favor [39]—involves professional editing, translation and writing. (For more information, see “Types of language services” at <https://www.metmeetings.org/en/how-to-choose-a-language-professional:799>).

Editors who help researchers and other authors make their manuscripts ready for submission and peer review are called “authors’ editors” [8], and they provide different types, or “levels”, of editing as needed [13] (pp. 33–49), [40]. *Language editing* is mainly done to correct grammar, syntax, spelling, punctuation, and word choice. *Substantive editing* aims to improve the content and organization of the text, in addition to correcting language errors. *Developmental editing*, in research publishing, involves advising authors on how to strengthen data presentation, text structure and organization, and how to avoid major problems with the writing that are likely to lead, or have already led, to rejection [41].

Researchers unable to write fluently in the language of publication (usually English) rely on translation. Sometimes, editing is done in the process of translation to correct internal inconsistencies or contradictions in the original material, or to ensure that the translated text is free from syntactic or stylistic features that readers might find distracting or inappropriate [42,43]. Irrespective of whether a text will be translated, edited or both, the work can only begin on an advanced draft, because authors’ editors and translators do not produce the initial draft. Editorial support professionals who do produce the original draft from researchers’ protocols and data are called “writers” (e.g., medical writers or technical writers); their drafts are critically reviewed, amended and commented on by the researchers, who collaborate with the writer to produce the final version [5,44]. To ensure that authors retain intellectual responsibility for the content and to avoid ghostwriting, medical writers’ associations have issued professional practice guidelines [5,45,46].

Why aren’t authors’ editors, translators and writers systematically acknowledged for their editorial support? Insight on the reasons comes from discussions among professionals in the field, most recently at the 14th meeting of Mediterranean Editors and Translators (<https://www.metmeetings.org/en/programme:1071>) in October 2018. A moderated panel discussion [37] and a report on a survey of 131 freelance authors’ editors [38] revealed that acknowledgment is often eschewed by these professionals. For example, because they lack control over the manuscript after they complete their work (i.e., they lack “last-look rights”), many editors and translators are concerned that changes made after their input has ended will not be representative of the quality of their own contributions. Additionally, because acknowledgment may be seen as an endorsement of the conclusions, they may prefer not to have their name associated with the publication. Researcher-authors themselves may prefer not to acknowledge that they had writing help, as this might be seen (by research evaluators and funders) as a weakness rather than as a positive sign that they have access to resources and support. Researchers in the humanities and social sciences, where rhetorical skills are especially important in making written arguments persuasive and logical, may feel conflicted about publicly acknowledging

editorial support [38]. These are all potentially rich areas for additional research that could shed more light on the roles of editorial support professionals and their interactions with texts and authors.

Even though editorial support professionals may opt to forego public acknowledgment and researchers may prefer not to acknowledge them, several guidelines from the research publishing community encourage their acknowledgment—although they do not always specify which wording or terms are preferable. For example, since 2004 the ICMJE has recommended acknowledging “writing assistance” [28]. The current version of the Council of Science Editors’ “White Paper on Promoting Integrity in Scientific Journal Publications” also recommends acknowledging “writing assistance” [47]. The online *AMA Manual of Style* ([www.amamanualofstyle.com](http://www.amamanualofstyle.com); Section 5.2.1) is more explicit, stating that acknowledgments “should identify anyone who has made substantial intellectual contributions to manuscripts but does not meet the criteria for authorship, including medical writers and author’s editors”; it notes that *JAMA* requires such disclosure and provides an example on how this should be done.

So, while editorial support is often involved in producing manuscripts submitted to journals, these contributions are not always apparent. The absence of information about editorial support may leave stakeholders in research publishing unaware of the sometimes substantive nature of these contributions, and may lead readers to assume that the named authors alone carried out all the reporting and writing tasks needed to produce the published text. Unfortunately, one new initiative to improve disclosure and assign credit openly may perpetuate the same misconceptions, as explained in the next two sections.

#### 4. The Contributor Roles Taxonomy: Promises and Pitfalls

In the context of differing authorship and contributorship practices across disciplines, Harvard University and Wellcome Trust organized an invitation-only meeting in 2012 to look for ways to standardize attribution, especially by harnessing the semantic abilities of the web [48]. One goal was to enable automatic tracking of contributions, to facilitate analyses of different roles in research and ultimately support promotion and funding decisions. A working group was formed to develop a standardized taxonomy of “roles and contributions in scholarly publications”, and their preliminary efforts were based on text analyses of the Author Contributions and Acknowledgments sections in mostly biomedical research articles. The outcome of these consultations was the Contributor Roles Taxonomy (CRediT), which establishes 14 taxa (terms and short definitions) [49]. It was assessed in a survey of life science researchers and reportedly received positive feedback [49], but the survey data were not provided. The revised version [6] comprises the following “roles”: conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing—original draft, writing—review and editing, visualization, supervision, project administration, and funding acquisition.

Although CRediT has not yet been formally tested for accuracy or validity, it has been implemented or endorsed by several well-known actors in the research publishing community. For example, it has been integrated into Editorial Manager ([https://www.ariessys.com/wp-content/uploads/CRediT-FAQ\\_8.5x11.pdf](https://www.ariessys.com/wp-content/uploads/CRediT-FAQ_8.5x11.pdf)), a manuscript submission software for journals produced by Aries Systems. In August 2018, this software house was acquired by Elsevier [50], making this publisher the de facto owner of CRediT. Currently, Aries software is used by Elsevier and other publishers such as Wiley, Taylor&Francis, Wolters Kluwer, and Springer Nature (<https://www.ariessys.com/software/editorial-manager/>), so CRediT is now optionally available to over 10,600 academic journals [51] (p. 41) in a broad range of disciplines. In addition, CRediT is implemented in ReView software (<http://rivervalleytechnologies.com/review-intuitive-and-powerful-peer-review/>). By late 2018, about 120 journals and publishing platforms had adopted CRediT [52]. At the time of writing, CRediT had been endorsed by the US National Academy of Sciences [53] and *Science* [54].

Some journals publish CRediT roles in their articles (Figure 1, Figure S1). Other journals collect CRediT data without publishing them, and still others have chosen not to use CRediT

([http://www.nasonline.org/about-nas/Transparency\\_Author\\_Contributions.html](http://www.nasonline.org/about-nas/Transparency_Author_Contributions.html)). Use by authors can be obligatory or optional, but authors tend to avoid it when it is voluntary [55]. The producers of CRediT claim it “describes the typical range of ‘contributions’ to scholarly published output for biomedical and science (sic) more broadly [and is] practical and easy to understand while minimizing the potential for misuse” (<https://casrai.org/credit/>). It “includes, but is not limited to, traditional authorship roles”, “capture[s] all the work that allows scholarly publications to be produced”, and can be applied to contributors “named in acknowledgements” (<https://casrai.org/credit/> and [6]). These claims do not seem to be entirely true, as explained below.



Article

## Grades of Openness: Open and Closed Articles in Norway

Susanne Mikki \* , Øyvind L. Gjesdal and Tormod E. Strømme

University of Bergen Library, University of Bergen, 5007 Bergen, Norway; oyvind.gjesdal@uib.no (Ø.L.G.); tormod.stromme@uib.no (T.E.S.)

\* Correspondence: susanne.mikki@uib.no; Tel.: +47-909-082-66

Received: 29 August 2018; Accepted: 19 November 2018; Published: 22 November 2018



Publications 2018, 6, 46

10 of 12

**Supplementary Materials:** Data are openly available on BORA (<https://bora.uib.no/handle/1956/18308>). The code used to scrape data from Google Scholar is available on GitHub [17].

**Author Contributions:** Conceptualization: S.M., T.E.S., and Ø.L.G.; methodology: S.M. and Ø.L.G.; validation: S.M., T.E.S., and Ø.L.G.; formal analysis: S.M.; writing—original draft preparation: S.M.; writing—review and editing: T.E.S.; visualization: S.M.

**Funding:** This work is a result of our project Frie, vitenskapelige publikasjoner (Free, scholarly publications), funded by the National Library of Norway (Ref a68f29d9).

**Acknowledgments:** We thank Hemed Ali Al Ruwehy for some of the data preparation and Ingrid Cutler and Irene Eikefjord for reading and discussing the manuscript.

**Conflicts of Interest:** The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of the data; in the writing of the manuscript; or in the decision to publish the results.

**Figure 1.** Example of CRediT roles presented by taxa at the end of an article (DOI: 10.3390/publications6040046). Top, extract of page 1; bottom, extract of page 10 with taxa in the “Author Contributions” section (red bar).

First, as implemented in Editorial Manager, CRediT is only applicable to byline authors; none of the roles can be assigned to acknowledgees (i.e., contributors named in the Acknowledgments). Moreover, CRediT ignores at least three types of non-author contributors (Table 1) and induces named authors to attribute these roles to themselves, thus creating the potential for contradictory or misleading information to be passed on to readers and research evaluators.

**Table 1.** Three taxa of the Contributor Roles Taxonomy [6] that marginalize non-author contributors, and suggestions for improvement.

Status	Term	Definition
<i>Selected CRediT taxa</i>		
Current	Investigation	Conducting a research and investigation process, specifically performing the experiments or data/evidence collection
Current	Writing—Original Draft	Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation)
Current	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
<i>Proposed revisions and additions</i>		
Revised	Investigation	Conducting a research and investigation process, specifically performing the experiments or data/evidence collection, as an author named in the byline
New	Technical support	Experimental procedures, laboratory management, animal husbandry, instrumental expertise, statistical support, clinical support, graphic work, and other skilled activities done as a non-author named in the acknowledgments
Revised	Drafting the manuscript *	Writing a preliminary version of the manuscript, by an author named in the byline or non-author named in the acknowledgments
Revised	Critical review and approval of the manuscript, as author §	Critical review with commenting or revising the manuscript, and approval of the version submitted for peer review and accepted for publication, by an author named in the byline
New	Translating or editing the manuscript, as non-author	Translation or editing of the authors' manuscript, by a non-author translator or editor named in the acknowledgments

\* Replaces "Writing—Original Draft"; § Replaces "Writing—Review & Editing".

One non-author role that, in CRediT, is difficult if not impossible to attribute transparently and accurately is technical support. CRediT enables authors to claim credit for the roles of "Resources" (e.g., obtaining samples, providing animals or patients), "Investigation" (e.g., performing experiments), and "Formal analysis" (e.g., statistical analysis). Yet it does not permit authors (i.e., contributors named in the byline) to attribute these roles to non-author contributors, who may have done most or all of the technical work (e.g., handling resources, doing experiments, and analyzing data). According to the ICMJE criteria, "substantial contributions to ... acquisition ... of data" (i.e., experimentation) are insufficient for authorship if not accompanied by involvement in writing the manuscript, approving it and agreeing to be accountable for it [56]. This potentially confusing situation is illustrated by the often-cited example of the fictitious Dr. Colleen May, a neurologist who did 500 hours of clinical work for a study but only merited acknowledgment [57]. In the CRediT system, authors in a similar case would be able to claim credit for the roles of "Resources" (recruiting patients) and "Investigation" (examining patients) even if they made small contributions to these tasks, but to readers it would appear as if they alone had done this work. A similar situation arises when independent statistical analysis is used: CRediT will either fail to identify any author as responsible for this task, or will attribute "Formal analysis" to authors who may (or may not) have handled any statistical calculations—albeit not the type of full analysis likely to be outsourced to an expert. In these cases also, CRediT may fail to accurately identify the persons who did the actual work.

A second problematic feature of CRediT involves two taxa that relate to the text of research reports. One is "Writing—original draft", defined as "Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation)". The term "substantive translation" is not defined in translation reference books (e.g., [58–60]), although it has appeared sporadically, with variable meanings, in scholarly texts. The definition of this taxon is therefore not easy to apprehend, and in fact evinces a lack of understanding of translation, because translation always requires a source text and therefore cannot be considered part of the process of writing the

initial draft. In our experience, professional translators do not describe their work as “substantive” because that would suggest that “unsubstantive” translation is also an option; even for apparently simple texts, good translation requires high-level language, writing and editing skills together with an understanding of the purpose of the material and its intended readership. The other problematic taxon is “Writing—review and editing”. The wording used to identify this task is potentially confusing for two reasons. The term “review” is often assumed to refer to peer review—an activity coordinated by journals with external experts, not carried out by the authors themselves. The term “editing”, in research publishing, is often used for work done by authors’ editors (before acceptance of a manuscript) and journals’ copy editors (after acceptance). CRediT, once again, limits the attribution of both these roles to authors, as is made clear in the definition: “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” (emphasis added). It is unclear to us how authors could realistically claim credit for revision or editing in the post-publication stage, since publication usually signals the end of the authors’ work on an article. Few research publication venues today allow authors to modify an article once it has been published, unless a correction or erratum notice is needed, or a new version of record is issued.

As currently defined, these two taxa on manuscript writing, revision and translation make it difficult or impossible to accurately and transparently identify the sometimes substantial contributions of those who work with authors. Specifically, the increasingly important roles of authors’ editors and translators in research publishing are overlooked in the current CRediT system, as is the role of writers in generating an initial draft for further development and revision with the byline authors.

Our analysis of these three taxa shows that CRediT is only about authorship, not contributorship. It characterizes authors’ roles in detail, but at the risk of denying appropriate credit for persons who contribute as non-authors. This creates a potential conflict between the stated scope of CRediT (all contributions) and its current iteration (more detailed information, but only regarding authorship), to the detriment of other important contributors. This issue was acknowledged in personal communications between one of us (V.M.) and the CRediT team [61]. One possible cause for this shortcoming is the lack of involvement, in the development of CRediT, of professionals who normally perform non-author contributor roles. Thus the current CRediT system may induce researcher-authors to unintentionally yet misleadingly shift credit for certain tasks from the people who did the work to people named in the byline as authors. Ironically then, CRediT may prevent contributors such as technicians, statisticians, research assistants, and professionals who provide editorial support from receiving appropriate credit for their work.

## 5. A More Granular Contributorship Taxonomy for Fair, Open Attribution

For CRediT to become a tool that accurately apportions due credit for all types of contributions to research, it should be further developed and refined with input from non-profit scientific and professional associations, as a safeguard against features designed to favor the commercial interests of software or publishing companies. First and foremost, it should become equally adroit at correctly identifying both byline authors and non-author contributors (acknowledgees). This would require modifications to its implementation in Editorial Manager and ReView. In practice, implementation would benefit by preferring, in published reports, presentation by taxa (Figure S1A,D–F) instead of by author (Figure S1B,C,G,H).

The changes we propose would enable the taxonomy to fulfill its initial aim, namely to “capture all the work that allows scholarly publications to be produced” including that done by contributors “named in acknowledgements”. As we argue above, revision is needed for the sake of openness and transparency, and to allow full disclosure along with public credit and accountability for non-author contributors to research. Greater transparency about research and publication processes would, we believe, help to maintain the public’s trust in science.

We propose revising three existing roles and adding two new ones to more accurately identify both author and non-author contributions (Table 1).

- For *technical support*, we propose (i) characterizing the “Investigation” role as an author activity by adding “as an author named in the byline”, and (ii) adding a new “Technical support” role to report, for example, laboratory, clinical or field work done by persons named in the acknowledgments.
- For *writing the original draft*, we propose changing the “Writing—Original Draft” role to “Drafting the manuscript” and specifying in the definition that this may be done by either an author named in the byline or a non-author named in the acknowledgments. Importantly, the potentially confusing term “substantive translation” should be deleted from the definition.
- For *revising the draft*, we propose replacing “Writing—Review & Editing” with “Critical review and approval of the manuscript, as author”. We also recommend removing the words “pre- and post-publication stages” from the definition, for the reasons explained above.
- Finally, we propose adding a new category, “Translating or editing the manuscript”, as a non-author role, and specifying in the definition that this role is acknowledged.

Importantly, these changes clearly distinguish between authors’ revisions of the manuscript and changes to the manuscript made by a non-author editor or translator. This distinction is important because authors alone have control of the content of the manuscript: it is the authors who approve the final version for submission and the one that is published, whereas non-author contributors do not have this responsibility. Furthermore, non-author contributors should not be held accountable for the content; thus their contributions need to be credited differently from those of authors. The changes we suggest aim to facilitate recognition of and accountability for the work done by non-author contributors in a way that openly and accurately reports the nature and extent of their contribution, whether limited or substantial.

## 6. Moving Forward to Accurate, Open Allocation of Credit

CRedit is well intentioned but flawed, and should be revised to reflect as many real-life contributions to research as possible. The changes we propose here, although small, would make the allocation of credit and responsibility for editorial and technical support substantially more transparent, and would reflect current real-world practices more accurately. However, more work could be done, especially to obtain input from non-author contributors. First and foremost, CRedit should be applicable not only to byline authors but to all contributors, as it was initially conceived. If this cannot be achieved, the ability of the CRedit taxa to accurately and transparently reflect all contributors to published research will remain limited.

CRedit has been endorsed by some research publishing experts, and the list of journals using it seems to be increasing. Although there are hopes that it will remove ambiguities about specific contributions and preempt potential authorship conflicts [53,62–64], evidence for these outcomes is lacking at present. Before CRedit data are used to study authorship trends, evaluate researchers, or make funding and promotion decisions, empirical research is needed to determine how accurate and meaningful the data are. Authors’ self-attributed CRedit roles may be inflated, as research on authorship disclosure has shown that binary (yes/no) tick boxes lead authors to choose more roles than they declare in free-text statements of authorship [65,66].

A comparison of CRedit with guidance from medical writers’ associations yields interesting insights. The guideline “Good Publication Practice for Communicating Company-Sponsored Medical Research” explains how to transparently acknowledge medical writers and other editorial professionals [5], while the “Joint Position Statement on the Role of Professional Medical Writers” provides criteria for distinguishing between the roles of authors and contributors of non-author editorial support [46,67]. These guidelines are clear and straightforward to implement, and have been widely accepted by stakeholders in health science research publication and ethics (e.g., <https://www.ismpp.org/gpp3-endorsements>). Their success is due in large part to the labor-intensive

but ultimately effective process of drafting, consultation and revision involving non-author contributors together with journal editors, industry representatives and publication policy experts. A similar effort may help CRediT to achieve its goals.

The ICMJE recommendations also make room for writing assistance in the Acknowledgments section [56]. Although it is not known whether this has increased the frequency of such acknowledgments, it has probably raised authors' awareness that gatekeepers and readers expect and value transparency. In our experience it has also encouraged writing and editing professionals to request or require acknowledgment for their work, at least in manuscripts submitted to biomedical journals that implement ICMJE's advice. Whether guidelines such as the ICMJE recommendations and CRediT have a direct impact on how researchers document non-author contributions in the published record is an area that awaits further study. Perhaps further along, a new taxon could even be considered for journal peer reviewers, who also make important contributions (sometimes, but not always, acknowledged) to the final quality of published research reports.

Unfortunately, in disciplines other than biomedicine there are few shared spaces such as professional organizations, meetings, conferences or projects where editorial support professionals, researchers and policy makers (e.g., publishers, funders and universities) can work together to develop guidelines for accurate, transparent attribution of credit—and responsibility—to non-author collaborators. We would thus like to close with a final suggestion aimed at stimulating further conversations about ways to make all contributions to research transparent. Moving forward, policies aimed at ensuring openness, transparency and accountability in disclosing non-author contributions would benefit from consultation with authors' editors and translators, as well as early career researchers, research assistants, technicians, and statisticians. Ultimately, whether the whole truth is told about contributions to the published research record depends on all actors reaching a consensus on the best ways to report everyone's roles honestly, ethically and openly.

**Supplementary Materials:** The following is available online at <http://www.mdpi.com/2304-6775/7/2/24/s1>, Figure S1: The varied ways CRediT roles (taxa) are presented in research article PDFs. Red bars, CRediT roles; blue bars, additional information about contributions. CRediT roles may appear on the first or second page (A,B), or at the end of the article (C–H). In some journals, the roles are within the Acknowledgments section (H). The roles are presented either by taxa (A,D–F) or by author (B,C,G,H). In some articles, roles are accompanied by free text with additional information, especially about the authors' approval of the final manuscript (C,D). Sometimes taxa names are altered, for example by substituting the second writing taxon with the word "Review" when an editor is acknowledged (D) or by combining the two writing taxa into a single one called "Writing" (H). In articles that acknowledge non-author technical support, graphic art work, medical writing or editing, the authors may also claim CRediT roles for these activities (C,G), or they may not (D,F). In some cases, CRediT roles are assigned to both authors and acknowledgees (E). The presentation of CRediT taxa in HTML versions may be different; in *PLoS One* for example, they are in the byline instead of in the Author Contributions section at the end of the article (E). These examples were found in PubMed Central with the search string "(conceptualization AND "formal analysis") AND 2016[dp]:2019[dp]", alone or with "(English[ack] OR revising[ack] OR translation[ack] OR revised[ack] OR language[ack] OR "medical writing"[ack])", and applying the filter "open access".

**Author Contributions:** Conceptualization, V.M. and K.S.; methodology, V.M. and K.S.; formal analysis, V.M. and K.S.; investigation, V.M. and K.S.; writing—original draft preparation, V.M. and K.S.; writing—review & editing, V.M. and K.S.; visualization, V.M.

**Funding:** This research received no external funding.

**Acknowledgments:** We thank Joy Burrough-Boenisch, Tom Lang and Katharine O'Moore-Klopf for helpful presubmission feedback on an earlier version of this manuscript. We thank our three peer reviewers for pointing out areas where the text needed clarification.

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

1. Hames, I. The changing face of peer review. *Sci. Ed.* **2014**, *1*, 9–12. [[CrossRef](#)]
2. National Academies of Sciences, Engineering, and Medicine. *Open Science by Design: Realizing a Vision for 21st Century Research*; The National Academies Press: Washington, DC, USA, 2018; ISBN 978-0-309-47627-0.
3. Tennant, J.P. The state of the art in peer review. *FEMS Microbiol. Lett.* **2018**, *365*, fny204. [[CrossRef](#)] [[PubMed](#)]

4. International Committee of Medical Journal Editors. Uniform requirements for manuscripts submitted to biomedical journals. *Ann. Intern. Med.* **1988**, *108*, 258–265. [[CrossRef](#)]
5. Battisti, W.P.; Wager, E.; Baltzer, L.; Bridges, D.; Cairns, A.; Carswell, C.I.; Citrome, L.; Gurr, J.A.; Mooney, L.A.; Moore, B.J.; et al. Good Publication Practice for Communicating Company-Sponsored Medical Research: GPP3. *Ann. Intern. Med.* **2015**, *163*, 461–464. [[CrossRef](#)]
6. Brand, A.; Allen, L.; Altman, M.; Hlava, M.; Scott, J. Beyond authorship: Attribution, contribution, collaboration, and credit. *Learn. Publ.* **2015**, *28*, 151–155. [[CrossRef](#)]
7. Rennie, D.; Yank, V.; Emanuel, L. When authorship fails. A proposal to make contributors accountable. *JAMA* **1997**, *278*, 579–585. [[CrossRef](#)]
8. Tacker, M.M. Author's editors: Catalysts of scientific publishing. *CBE Views* **1980**, *3*, 3–11.
9. Shashok, K. Author's editors: Facilitators of science information transfer. *Learn. Publ.* **2001**, *14*, 113–121. [[CrossRef](#)]
10. Burrough-Boenisch, J. Shapers of published NNS research articles. *J. Second Lang. Writ.* **2003**, *12*, 223–243. [[CrossRef](#)]
11. Burrough-Boenisch, J.; Matarese, V. The authors' editor: Working with authors to make drafts fit for purpose. In *Supporting Research Writing: Roles and Challenges in Multilingual Settings*; Matarese, V., Ed.; Chandos: Oxford, UK, 2013; pp. 173–189. ISBN 978-1-84334-666-1.
12. Shashok, K. Authors' editors in the 21st century: Promoters of publication quality and efficiency. *Eur. Sci. Ed.* **2014**, *40*, 60–62.
13. Matarese, V. *Editing Research: The Author Editing Approach to Providing Effective Support to Writers of Research Papers*; Information Today: Medford, NJ, USA, 2016; ISBN 978-157387531-8.
14. Huth, E.J. Authorship standards: Progress in slow motion. *CBE Views* **1997**, *20*, 127–132. Available online: <http://www.councilscienceeditors.org/wp-content/uploads/v20n4p127-132.pdf> (accessed on 20 January 2019).
15. Bošnjak, L.; Marušić, A.A. Prescribed practices of authorship: Review of codes of ethics from professional bodies and journal guidelines across disciplines. *Scientometrics* **2012**, *93*, 751. [[CrossRef](#)]
16. Pignatelli, B.; Maisonneuve, H.; Chapuis, F. Authorship ignorance: Views of researchers in French clinical settings. *J. Med. Ethics* **2005**, *31*, 578–581. [[CrossRef](#)]
17. Rajasekaran, S.; Lo, A.; Aly, A.R.; Ashworth, N. Honorary authorship in postgraduate medical training. *Postgrad. Med. J.* **2015**, *91*, 501–507. [[CrossRef](#)]
18. Kassis, T. How do research faculty in the biosciences evaluate paper authorship criteria? *PLoS ONE* **2017**, *12*, e0183632. [[CrossRef](#)]
19. Nylenna, M.; Fagerbakk, F.; Kierulf, P. Authorship: Attitudes and practice among Norwegian researchers. *BMC Med. Ethics* **2014**, *15*, 53–58. [[CrossRef](#)]
20. Smith, E.; Hunt, M.; Master, Z. Authorship ethics in global health research partnerships between researchers from low or middle income countries and high income countries. *BMC Med. Ethics* **2014**, *15*, 42. [[CrossRef](#)]
21. Logan, J.M.; Bean, S.B.; Myers, A.E. Author contributions to ecological publications: What does it mean to be an author in modern ecological research? *PLoS ONE* **2017**, *12*, e0179956. [[CrossRef](#)]
22. Artino, A.R., Jr.; Driessen, E.W.; Maggio, L.A. Ethical shades of gray: International frequency of scientific misconduct and questionable research practices in health professions education. *Acad. Med.* **2019**, *94*, 76–84. [[CrossRef](#)]
23. Shen, H.-W.; Barabási, A.-L. Collective credit allocation in science. *Proc. Natl. Acad. Sci. USA* **2014**, *111*, 12325–12330. [[CrossRef](#)]
24. Marušić, A.; Bošnjak, L.; Jerončić, A. A systematic review of research on the meaning, ethics and practices of authorship across scholarly disciplines. *PLoS ONE* **2011**, *6*, e23477. [[CrossRef](#)] [[PubMed](#)]
25. Seeman, J.I.; House, M.C. Authorship issues and conflict in the U.S. academic chemical community. *Account. Res.* **2015**, *22*, 346–383. [[CrossRef](#)] [[PubMed](#)]
26. Faulkes, Z. Resolving authorship disputes by mediation and arbitration. *BMC Res. Integr. Peer Rev.* **2018**, *3*, 12. [[CrossRef](#)] [[PubMed](#)]
27. Rivera, H. Fake peer review and inappropriate authorship are real evils. *J. Korean Med. Sci.* **2019**, *34*, e6. [[CrossRef](#)]
28. ICMJE. Uniform Requirements for Manuscripts Submitted to Biomedical Journals. Writing and Editing for Biomedical Publication. 2004. Available online: [http://www.icmje.org/recommendations/archives/2004\\_urm.pdf](http://www.icmje.org/recommendations/archives/2004_urm.pdf) (accessed on 20 January 2019).

29. Bazerman, C. Modern evolution of the experimental report in physics: Spectroscopic articles in *Physical Review*, 1893–1980. *Soc. Stud. Sci.* **1984**, *14*, 163–196. [CrossRef]
30. Cronin, B. *The Scholar's Courtesy: The Role of Acknowledgement in the Primary Communication Process*; Taylor Graham: London, UK, 1995; ISBN 0947568662. Available online: <http://garfield.library.upenn.edu/cronin/cronin2part1.pdf> and <http://garfield.library.upenn.edu/cronin/cronin2part2.pdf> (accessed on 20 January 2019).
31. Cronin, B.; Shaw, D.; La Barre, K. A cast of thousands: Coauthorship and subauthorship collaboration in the 20th century as manifested in the scholarly journal literature of psychology and philosophy. *J. Am. Soc. Inf. Sci.* **2003**, *54*, 855–871. [CrossRef]
32. Salager-Meyer, F.; Alcaraz Ariza, M.A.; Pabón Berbesí, M. “Backstage” solidarity in Spanish- and English-written medical research papers: Publication context and the acknowledgment paratext. *J. Am. Soc. Inf. Sci. Technol.* **2009**, *60*, 307–317. [CrossRef]
33. Alcaraz, M.A. Acknowledgments in neurology research articles: A contrastive study (English—Spanish). *Fachsprache* **2014**, *36*, 115–124. [CrossRef]
34. Méndez, D.I.; Alcaraz, M.A. Exploring acknowledgement practices in English-medium astrophysics research papers: Implications on authorship. *Revista de Lenguas para Fines Específicos* **2015**, *21*, 132–159. [CrossRef]
35. Giles, C.L.; Council, I.G. Who gets acknowledged: Measuring scientific contributions through automatic acknowledgment indexing. *Proc. Natl. Acad. Sci. USA* **2004**, *101*, 17599–17604. [CrossRef]
36. Paul-Hus, A.; Díaz-Faes, A.A.; Sainte-Marie, M.; Desrochers, N.; Costas, R.; Larivière, V. Beyond funding: Acknowledgement patterns in biomedical, natural and social sciences. *PLoS ONE* **2017**, *12*, e0185578. [CrossRef]
37. Baldwin, W.; Fernández Núñez, M.; Senior, J.; Sotejeff-Wilson, K.; Matarese, V. Acknowledgments in the eyes of scholars using language services: Perceptions of language professionals. Panel discussion. In Proceedings of the 14th annual meeting of Mediterranean Editors and Translators (METM19), Girona, Spain, 4–6 October 2018; Available online: <https://www.metmeetings.org/en/acknowledgments-in-the-eyes-of-scholars-using-language-services:1131> (accessed on 20 January 2019).
38. Burrough-Boenisch, J. Do freelance editors for academic and scientific researchers seek acknowledgement? Findings from a cross-sectional study. *Eur. Sci. Ed.* **2019**, *45*, in press.
39. Willey, I.; Tanimoto, K. “Convenience editing” in action: Comparing English teachers’ and medical professionals’ revisions of a medical abstract. *Engl. Specif. Purp.* **2012**, *31*, 249–260. [CrossRef]
40. Burrough-Boenisch, J. Defining and describing editing. In *Supporting Research Writing: Roles and Challenges in Multilingual Settings*; Matarese, V., Ed.; Chandos: Oxford, UK, 2013; pp. 141–155. ISBN 978-1-84334-666-1.
41. Matarese, V. Collaborative research writing: Developmental editing with an underlying educational vein. In *Supporting Research Writing: Roles and Challenges in Multilingual Settings*; Matarese, V., Ed.; Chandos: Oxford, UK, 2013; pp. 221–235. ISBN 978-1-84334-666-1.
42. Shashok, K.; Kerans, M.E. Translating the unedited science manuscript: Who fixes what shortcomings? In *Proceedings of the First International Conference on Specialized Translation*; Chabás, J., Cases, M., Gaser, R., Eds.; Universitat Pompeu Fabra: Barcelona, Spain, 2001; pp. 101–104.
43. Bennett, K. The translator as cultural mediator in research publication. In *Supporting Research Writing: Roles and Challenges in Multilingual Settings*; Matarese, V., Ed.; Chandos: Oxford, UK, 2013; pp. 93–106. ISBN 978-1-84334-666-1.
44. Morley, G. 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*; Matarese, V., Ed.; Chandos: Oxford, UK, 2013; pp. 191–204. ISBN 978-1-84334-666-1.
45. Jacobs, A.; Wager, E. European Medical Writers Association (EMWA) guidelines on the role of medical writers in developing peer-reviewed publications. *Curr. Med. Res. Opin.* **2005**, *21*, 317–321. [CrossRef]
46. AMWA-EMWA-ISMP Joint Position Statement on the Role of Professional Medical Writers. January 2017. Available online: [https://cdn.ymaws.com/www.amwa.org/resource/resmgr/about\\_amwa/JointPositionStatement.Profe.pdf](https://cdn.ymaws.com/www.amwa.org/resource/resmgr/about_amwa/JointPositionStatement.Profe.pdf) (accessed on 20 January 2019).
47. Council of Science Editors. White Paper on Promoting Integrity in Scientific Journal Publications. 2018. Available online: <https://www.councilscienceeditors.org/resource-library/editorial-policies/white-paper-on-publication-ethics/2-2-authorship-and-authorship-responsibilities/#223> (accessed on 20 January 2019).

48. Hames, I. *Report on the International Workshop on Contributorship and Scholarly Attribution*; Harvard University and the Wellcome Trust: Cambridge, MA, USA, 16 May 2012; Available online: [http://projects.iq.harvard.edu/files/attribution\\_workshop/files/iwcsa\\_report\\_final\\_18sept12.pdf](http://projects.iq.harvard.edu/files/attribution_workshop/files/iwcsa_report_final_18sept12.pdf) (accessed on 20 January 2019).
49. Allen, L.; Scott, J.; Brand, A.; Altman, M.; Hlava, M. Publishing: Credit where credit is due. *Nature* **2014**, *508*, 312–313. [CrossRef]
50. McKenzie, L. Mixed reception to latest Elsevier acquisition. 2018. Available online: <http://www.insidehighered.com/quicktakes/2018/08/07/mixed-reception-latest-elsevier-acquisition> (accessed on 20 January 2019).
51. Johnson, R.; Watkinson, A.; Mabe, M. *The STM Report: An Overview of Scientific and Scholarly Publishing*, 5th ed.; International Association of Scientific, Technical and Medical Publishers: The Hague, The Netherlands, 2018; Available online: [https://www.stm-assoc.org/2018\\_10\\_04\\_STM\\_Report\\_2018.pdf](https://www.stm-assoc.org/2018_10_04_STM_Report_2018.pdf) (accessed on 20 January 2019).
52. Allen, L.; O’Connell, A.; Kiermar, V. How can we ensure visibility and diversity in research contributions? How the Contributor Role Taxonomy (CRediT) is helping the shift from authorship to contributorship. *Learn. Publ.* **2019**, *32*, 71–74. [CrossRef]
53. McNutt, M.K.; Bradford, M.; Drazen, J.M.; Hanson, B.; Howard, B.; Hall Jamieson, K.; Kiermer, V.; Marcus, E.; Kline Pope, B.; Schekman, R.; et al. Transparency in authors’ contributions and responsibilities to promote integrity in scientific publication. *Proc. Natl. Acad. Sci. USA* **2018**, *115*, 2557–2560. [CrossRef] [PubMed]
54. Berg, J. Transparent author credit. *Science* **2018**, *359*, 961. [CrossRef]
55. Pacific, T. Medicine and CRediT. 2018. Available online: <http://www.councilscienceeditors.org/wp-content/uploads/3.3-Pacific.pdf> (accessed on 20 January 2019).
56. ICMJE. Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals. 2018. Available online: <http://www.icmje.org/icmje-recommendations.pdf> (accessed on 20 January 2019).
57. Macrina, F. *Scientific Integrity*, 3rd ed.; ASM Press: Washington, DC, USA, 2005; pp. 88–89. ISBN 9781555816476.
58. Venuti, L. (Ed.) *The Translation Studies Reader*; Routledge: London, UK, 2010; ISBN 0-203-75486-7.
59. Munday, J. (Ed.) *The Routledge Companion to Translation Studies*; Routledge: London, UK, 2009; ISBN 978-0-203-87945-0.
60. Munday, J. *Introducing Translation Studies. Theories and Applications*, 4th ed.; Routledge: London, UK, 2016; ISBN 978-1-315-69186-2.
61. Matarese, V. CRediT and me: Academia’s imperfect project to standardize contributions to research articles, and one language professional’s attempts to set it straight. Presented at the 14th Annual Meeting of Mediterranean Editors and Translators (METM19), Girona, Spain, 4–6 October 2018; Available online: <https://www.metmeetings.org/en/credit-and-me:1100> (accessed on 20 January 2019).
62. Altkins, H. Author credit: PLOS and CRediT update. 2016. Available online: <https://blogs.plos.org/plos/2016/07/author-credit-plos-and-credit-update/> (accessed on 20 January 2019).
63. O’Connell, A. Implementing CRediT: An interview with Cell Press’s Gabriel Harp. *Sci. Ed.* **2017**, *39*, 55–56. Available online: <https://www.csescienceeditor.org/article/implementing-credit-interview-cell-press-gabriel-harp/> (accessed on 20 January 2019).
64. Koller, J. Using CRediT to capture author contributions in Editorial Manager. 2018. Available online: <https://wkauthorservices.editage.com/resources/author-resource-review/2018/may-2018.html> (accessed on 20 January 2019).
65. Marušić, A.; Bates, T.; Anić, A.; Marušić, M. How the structure of contribution disclosure statements affects validity of authorship: A randomized study in a general medical journal. *Curr. Med. Res. Opin.* **2006**, *22*, 1035–1044. [CrossRef] [PubMed]
66. Ivaniš, A.; Hren, D.; Sambunjak, D.; Marusić, M.; Marusić, A. Quantification of authors’ contributions and eligibility for authorship: Randomized study in a general medical journal. *J. Gen. Intern. Med.* **2008**, *23*, 1303. [CrossRef] [PubMed]
67. Gertel, A.; Winchester, C.; Woolley, K.; Yarker, Y. The development and uptake of the Joint Position Statement on the role of professional medical writers. *Eur. Sci. Ed.* **2018**, *44*, 83–84.

