

Implementing Quantitative Declarations of Authorship Contribution: A Call to Action

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ABSTRACT

Problems due to limitations of the status quo in authorship declaration across scientific fields are accumulating at an accelerating pace. Here we highlight the importance of having a mechanism to capture quantitative author contribution. That can be achieved using a range of Intellectual Activities (IAs) as recommended by International Committee for Medical Journal Editors (ICMJE), Contributor Roles Taxonomy (CRediT), or Quantitative Uniform Authorship Declaration (QUAD). Eventually, this quantitative assessment can be used to evaluate the impact of the author using the Author Performance Index (API) to avoid any superfluous credit assignment. Irrespective of the field and the online submission tool of a journal, this approach will enable the scientific community to devise a new paradigm of an objective and precise evaluation of the impact of an author in scientific communications. Not unlike climate change, adapting is inevitable, and the sooner we act the more trouble we stave off.

Keywords: Intellectual contribution, Intellectual activity, Unfair authorship, Multi-authored paper, Online submission, Declaration of author contribution.

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INTRODUCTION

Authorship on the byline has remained the standard means of declaring who contributed to scientific publications.^[1-5] In addition, logistical contributions which also play vital roles in the production of a publication have traditionally been declared in the “acknowledgment” section of a paper along with the fund or grant providers. Due to the changes in the types of contributions manifested in collaborative research or team science^[6,7] adoption of a shift of diverse credit assignment from authors to contributors has been proposed.^[8-11] Furthermore, assigning authorship without any intellectual contribution continues to grow.^[3,11,12-19,20] The increasing concern of unfair authorship assignment parallels the ever-growing number of Multi-Authored Papers (MAP) involving collaborative research^[21-32] as well as team research.^[6,7]

Nevertheless, declaration of contribution such as those recommended by the International Committee for Medical Journal Editors (ICMJE)^[33] and proposed by Contributor Roles Taxonomy (CRediT)^[11] are among the commonly used sources to declare author contributions for Intellectual Activities (IA) involved in the production of a paper. Notably, ICMJE

recommendations include four categories of IA while CRediT lists 11 types of contributions (but not limited) of which at least nine are intellectual in nature. In addition to those, a tool defined as Quantitative Uniform Authorship Declaration (QUAD)^[34] offers a list of four IAs which are similar to what is recommended by ICMJE.

Under the mounting pressure to find a solution of fair share of credits as author or contributors, the quantitative approach could be implemented by the journal publishers through their online submission system. Declaration of contribution to those IAs can be captured quantitatively by a mathematical tool called the relative Intellectual Contribution (IC^r).^[35] The importance of quantitative declaration of intellectual activities, hence calculating the IC^r will be useful to (i) list the authors in the bylines, and (ii) measure the impact of an individual as an author more quantitatively by using both T-index which calculates an adjusted or modified *h*-index according to the IC^r^[35] and Author Performance Index (API).^[36]

This paper proposes a mechanism to adopt a quantitative approach and explains how it would help to evaluate the impact of an author more precisely in scientific communication.

A brief introduction to ICMJE recommendations, CRediT, QUAD, and IC^r

After its initial inception in 1978 as Uniform Requirements for Manuscripts for Biomedical journal, the ICMJE recommendations



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went beyond standardizing manuscript format and preparation across journals. In its latest version of 2019, four criteria were recommended to assign authorship in Biomedical journals, namely: (i) substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (ii) drafting the work or revising it critically for important intellectual content; AND (iii) final approval of the version to be published; AND (iv) 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. Any individual must meet all four criteria to become eligible as an author of a paper.^[33]

The Contributor Roles Taxonomy (CRediT) provides diverse classes of roles that are needed to publish research output. The CRediT classification covers roles and contributions beyond those that have been used to assign authorship. Following this taxonomy all contributors, whether their contribution is intellectual or logistical in nature, can be listed formally either as authors or named in acknowledgements.^[11]

The QUAD system, proposed in 2003, expands on these categorizations by allowing the useful quantification of the contribution in four categories of IA namely, conception and design, data collection, data analysis and conclusions, and manuscript preparation. Percent contribution to each IA is assigned for each author to calculate the total contribution (or credit share). Positions of the authors in the list may follow a descending order of total contribution across all four categories. In case two or more authors have equal contributions, the listing could be made alphabetically.^[34] An example of quantitative author contribution according to the QUAD system is given in Table 1.

Calculating IC^r, proposed in 2017, provides a more flexible quantitative approach than QUAD to define IA involved in the production of a paper. According to this approach, contributions are not restricted to any defined IAs but are up to the authors to decide based on the nature of the work they want to publish.

To calculate IC^r, each IA is also assigned with a Weighing Factor (WF) depending on its importance to produce the paper. Finally a percent contribution of each author in each IA is assigned to calculate IC^r.^[35] An example of assigning quantitative contribution of authors for a manuscript is shown in the Table 2.

Mechanism to incorporate declaration of quantitative contribution

Most of the online submission tools involve a few steps that lead to a final submission. This includes information of the article (e.g., title, abstract, keywords), author details (names, affiliation, emails), uploading files, list of reviewers, and disclaimers. To adopt the proposed mechanism to capture quantitative author contribution, a publisher or a journal can incorporate the required information as described below.

The declaration of quantitative contribution can be captured at any of the stages of the article submission: initial submission, submission of the revised version, or when finalizing the accepted manuscript. Incorporation of a quantitative tool such as IC^r in the existing online submission tool will need (i) a list of IAs that are involved in the production of a paper (such as from ICJME, QUAD, or CRediT), (ii) a weighing factor for each IA, and (iii) percent contribution of each author for each IA.

IAs involved in the production of a paper can be captured during the step of collecting article information. The online submission tool of a journal may provide the option to choose or define IAs. Authors may be given the option either to choose ICJME criteria, CRediT roles and contributions, or QUAD specific IAs. Authors may also give open-ended option to define IAs involved in the production of their paper (Figure 1, Step 1).

Upon completion of defining the IAs, the system may allow them to assign a Weight Factor (WF) for each IA (Figure 1 step 2). The algorithm to assign author-defined IA and WF should be designed in a way that the sum of WFs of all IA equals 100%.

Authors will be given the option to choose IAs that are involved in the production of the paper according to either ICJME, QUAD,

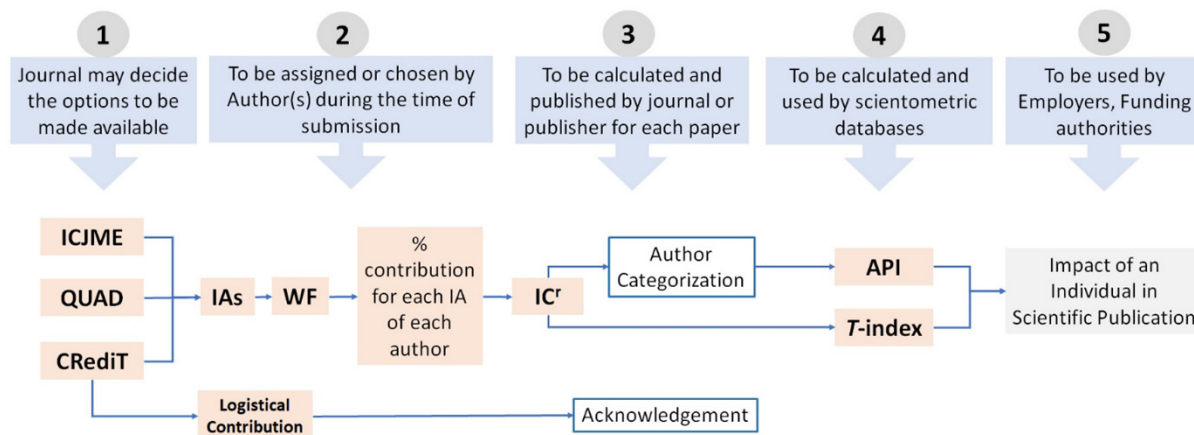


Figure 1: Mechanism to adopt a quantitative approach to measure contribution and impact of an author.

or CRediT (Step 1). Depending on the convenience and interests, any group of authors involved in the production of a paper may choose from either ICMJE recommended criteria, list of roles and contribution from CRediT, or QUAD (Step 2). Authors will then be given an opportunity to assign a Weighing Factor (WF) for each IA and % contribution (or its decimal value) for each IA of

each author (Step 2). Quantitative intellectual contribution of an individual can then be calculated algorithmically by the online submission tool based on the Relative Intellectual Contribution (IC^r) equation (Step 3). Once IC^r is made available with the published paper, scientometric databases can use it to calculate the impact of an author precisely such as using T-index which is a multiplication of IC^r and *h*-index (Step 4). If the authors are given the option to identify primary author, principal author, or co-author at any point during the manuscript submission and such a categorization is made available, the scientometric databases can also use Author Performance Index (API) to reveal the performance of an author (Step 5).

The author will then assign the quantitative contribution of each author (either in the form of a percentage or its decimal value) for each IA (Figure 1, Step 2). Preferably the corresponding author can take the lead to assign the quantitative contribution of all authors. The sum of contributions of all authors for each IA should equal 100%. (Table 2).

Table 1: An example of calculating quantitative author contribution using QUAD for the current manuscript.

Intellectual Activities (IA)	Percent Contribution	
	MTR	JVV
Conception and design	0.60	0.40
Data collection	NA	NA
Data analysis and conclusions	NA	NA
Manuscript preparation	0.50	0.50
Author's total contribution or Credit Share	1.10	0.90

MTR: Mohammad Tariqur Rahman; JVJ: Justus V Verhagen.

Table 2: An example of calculating quantitative author contribution and calculating IC^r for the current manuscript.

Intellectual Activities (IA)	WFn*	IC _a	
		MTR	JVV
Formulation of the initial concept/idea.	0.25	0.60	0.40
Literature review to support the different stages of paper preparation.	0.30	0.65	0.35
Writing the manuscript (from initial writing until the submission).	0.30	0.55	0.45
Revision of the manuscript according to reviewer's comments.	0.15	0.50	0.50
Author's relative intellectual contribution [IC ^r].		0.585	0.415

IC_a is the decimal value of the contribution of an author for each IA.

Also note that ΣIC_a for each IA, and ΣIC^r for all authors are equal to 1.

*WFn is assigned based on a consensus process of the authors of this manuscript. •IC_a can be assigned during the submission of the final version of the accepted manuscript.

IC^r = Σ(IC_a × W_n) where, IC_a = % IC (in decimal value) for each Intellectual Activity (IA); W_n = weighing factor (WF) for each IA.

Table 3: An example of calculating API of different authors who published the same number of papers (e.g., 200) in their publishing careers of 25 years.

Author	P ^P	P ^T	P ^P /P ^T	P ^T -P ^P	Y ^C	Y ^F	Y ^C -Y ^F	(P ^T -P ^P)/(Y ^C -Y ^F)	Log P ^P	API
Author 1	25	200	0.125	175	2020	1995	25	0.005	1.398	0.007
Author 2	75	200	0.375	125	2020	1995	25	0.015	1.875	0.028
Author 3	125	200	0.625	75	2020	1995	25	0.025	2.097	0.052
Author 5	175	200	0.875	25	2020	1995	25	0.035	2.243	0.079
Author 6	200	200	1	0	2020	1995	25	0.040	2.301	0.092

$$API = \left[\frac{P^P}{P^T} \right] \div (Y^C - Y^F) \times \text{Log } P^P$$

were, P^P = Σ # of papers as primary and principal author; P^T = Σ # of papers as author (including primary, principal and coauthor); Y^F = Year of publication of the first paper being counted, i.e., 1995; Y^C = Current year of publication (the year when IC^r of an author is calculated), i.e., 2020

Note: All four variables in the equation will vary from one author to another. However, for the sake of calculation the number of papers as P^P for all authors are only shown different.

Once adopted, such quantitative contribution can be made available for each paper such as the IC^r of each author to produce the paper. Eventually the IC^r may be used by the journal to algorithmically categorize the authors as primary, principal, or co-authors^[36] (Figure 1, Step 3).

To measure the contribution of an individual as an author, their impact on the scientific field could also be calculated using T-index^[35] that quantifies an *h*-index^[37,38] weighed by the IC^r of an author in a published paper. Both the API (Table 3) and T-index may be calculated and stored by scientometric databases such as Web of Science (Clarivate), Scopus, and ORCID for further use such as by employers and funding agencies to evaluate the impact of an individual as an author of scientific publications (Figure 1, Step 4).

DISCUSSION

Unfair assignment of authorship^[1,8,9,39-43] and superfluous authorship credit counting based on citation dependent metrics^[23,44-51] are two major ongoing concerns in scientific communications.

While unfair authorship assignment can at least partially be tackled by declarations of author contribution,^[11,33,52] the impact of authorship can be measured quantitatively using the *h*-index and altmetrics^[37,53-55]

Major journals require declaration of author contribution either in the open-ended format or in a journal specific format following either ICMJE guidelines or CRediT. However, a declaration of author contribution in a quantitative manner is yet to be adopted. It can be noted that 70% of the respondents (*n*=370) who participated in an online survey recommended to declare author contribution in a quantitative manner.^[36]

Quantitative author contribution eventually can also help to minimize the superfluous authorship credit counting based on using the citation dependent metrics more fairly according to the quantitative contribution to the paper or by calculating API.^[35,36]

Declarations of quantitative intellectual contribution can be captured at any stage during the submission. However, it might be more practical to capture quantitative contribution prior to finalizing the accepted submission or during the submission of the revised version. This is mainly because revision of the manuscript, according to the inputs from the reviewers and editor(s), could be considered as an IA, hence can be added for the calculation of quantitative contribution such as IC^r.

This will allow identification of major contributions of the author in the production of a paper, consistent with current standards.^[56] In addition, the quantitative contribution may be further used to quantify the performance (contribution) of an individual in scientific publications using the API.^[36] This also allows each discipline to flexibly implement their idiosyncratic authorship culture.^[57,58]

These quantifications will allow clear and explicit deliberation among authors, avoiding conflict,^[59] as well as public declaration of contributions for each publication, avoiding unethical authorship practices such as guest, ghost, and honorary authorship, additional advantages arise when these data are combined across articles.

We suggest these to be established based on both journals' databases, as well as by proposed mandatory declarations in progress reports to all international funding agencies.

With these practical suggestions in hand, we urge the scientific communities and relevant stakeholders such as publishers to adopt a quantitative tool to more accurately capture the contributions of an author. The proposed approach might serve as a starting point or template from which to find universally acceptable solutions.

We believe both the journal publishers and international funding agencies can play key-roles in this process. This will inevitably allow the employers to recruit and promote the deserving candidates based on deeper insight into their merits. This will also be an important tool for funding agencies, as it is in their (and tax-payers') interest to understand whom they fund, and they have the leverage to require such. Nonetheless, this will require a world-wide concerted strategic effort that also includes editors and researchers.

CONCLUSION

Here we provide several practical approaches for diverse fields of science to broadly adopt means to quantify authors' contributions to publications. Further, stakeholders like publishers and funding agencies are encouraged to work together to implement these relatively simple steps to resolve several important flaws in the current anachronistic scientific byline.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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AUTHOR CONTRIBUTIONS

MTR conceptualized the content. Both MTR and JV prepared and finalized the manuscript.

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