The State of Authorship

Maximizing Impact with the Time and Money You Spend

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ABSTRACT

The scholarly communication process is shifting. With the ever-increasing number of published papers, it is important to ensure that your paper will stand out and be cited. It is also important to spend your time and money wisely in the pursuit of publishing success. With many steps required to reach the ultimate goal of a successful, well-cited publication, what are the costs to researchers in terms of time and money? Where are the opportunities to improve an article's chances of being cited? **A deeper understanding of the work and cost that goes into crafting and publishing an article, along with greater information regarding factors influencing citations, will allow authors to better allocate their valuable resources when communicating their research and maximize the impact of the published article.** Toward that end, this paper reviews the costs—in money and time—involved in publishing a manuscript and highlights the factors that affect subsequent citation of the published paper.

By recent estimates, there are at least 28,000 journals in the areas of science, technology, and medicine alone, and the number of journals is growing by the hundreds each year.[1]

INTRODUCTION

Scholarly communication, and specifically the publication of research results in peer-reviewed journals, is vital to the sharing of knowledge worldwide. Its importance ranges from having the power to transform lives and alter national policy to driving the career advancement of those who carry out research, and even to simply helping satisfy our curiosity about the world around us. Scholarly communication is also a broad endeavor, and includes a number of channels. Research can be communicated to colleagues, journalists, and the public through informal conversations, slides and presentations, newspaper articles, and even on social media or blogs. However, the gold standard for communicating research remains formal publication in a peer-reviewed scholarly journal.

By recent estimates, there are at least 28,000 journals in the areas of science, technology, and medicine alone, and the number of journals is growing by the hundreds each year.[1] And while the scholarly journal has existed for over 350 years in more or less its current form,[2] the publishing industry is undergoing a seismic shift in its business model, made possible by the emergence of the internet as a tool for the dissemination of information. Traditionally, journals were free for authors, and publishers covered their costs by selling subscriptions to libraries and other institutions that purchase

access on behalf of individual researchers. However, a new model began to emerge in 2002 after the public release of the Budapest Open Access Initiative, a set of publishing principles envisioning freely accessible research publications.[3] Under these principles, an open access publisher allows for any reader to freely "read, download, copy, distribute, print, search, or link to the full texts" of published articles "without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself."[4] In such cases, subscription fees do not exist, and the costs of publication now have to be borne directly by the publisher or the author. Several of the first publishers to foray into the realm of open access covered their costs by assessing a fee (termed an Article Processing Charge or APC) to authors whose work was accepted for publication.[3] The use of APCs is still quite common (see below), and a number of traditional journals have begun to operate as "hybrids," offering a paid open access option alongside the traditional subscription-based model. While there are clear benefits to open access, it is also important to note that this shift creates new considerations for authors related to direct monetary costs inherent in publishing their work.

In addition to monetary costs, the production of a research manuscript involves heavy investments of time on the part of its authors. While some is known about the amount of time that elapses between submission and acceptance (or final publication) of a manuscript,[5] it is important to note that the process of communicating research includes many steps, both before and after the submission-to-acceptance period (**Figure 1**). The early stages of drafting a manuscript and its figures, evaluating the strength of the work with feedback from colleagues, and choosing the right journal also involve effort. In today's "big heap" world, efforts to share and enhance an article after publication (e.g., by sharing on social media or linking datasets and lay summaries) are also increasingly common, but unmeasured.

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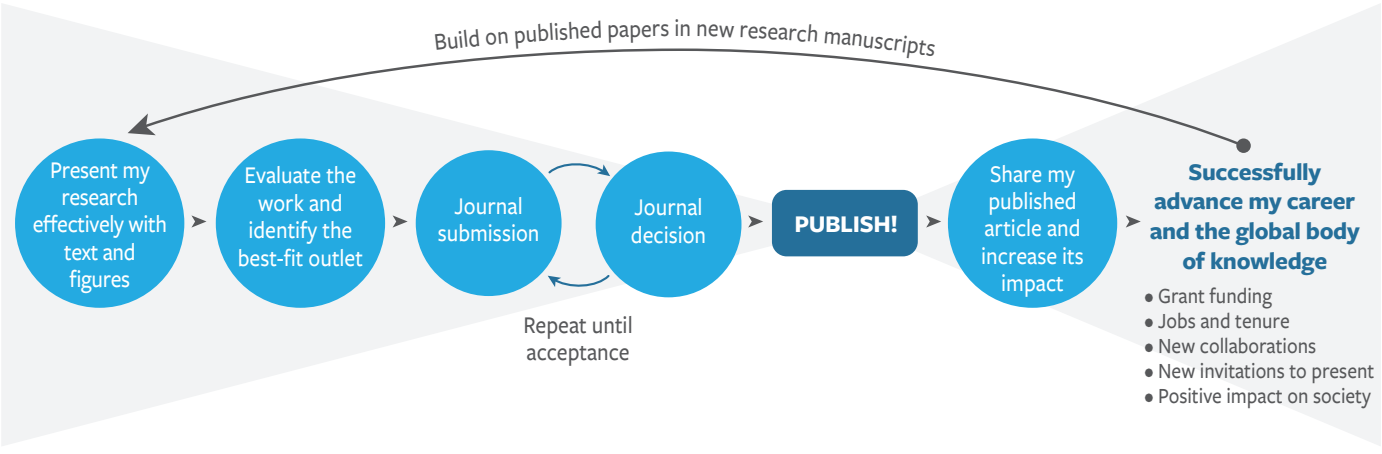
Despite the importance of scholarly communication, the overall process is laden with inefficiencies and costs. And while citation of one's work is critical for career success, it can be difficult to know how to give each manuscript the best chance of being cited frequently, thereby maximizing its impact. Below, we specifically identify the steps to publishing a paper that involve time and monetary cost. Using published studies and some new survey data, we also provide estimates of time and money spent where possible. Finally, we discuss factors that affect the number of citations a published paper receives, identifying some potential steps that authors can take to improve the impact of their work. Together, this information provides insight into how researchers can best spend their limited time and resources in the publishing process so that they can focus on making discoveries and advancing their careers.

TIME

Researchers naturally spend the bulk of their time in the lab, the library, or the field, collecting new data and observations. But when n the work of conducting experiments and analyzing the results is complete, the next step in the process is to communicate those findings to the rest of the scientific community. Anyone who has published a research paper knows that this process also involves a lot of time, spent both

FIGURE 1



directly in preparing and revising the paper and in waiting for decisions and feedback from journal editors and reviewers. There are a number of steps in the process of creating, submitting, and publishing a manuscript—how much time is spent at these various stages? **Figure 2** outlines many of the steps involved in publishing a paper and what we know about the time that is spent at each point along the way, both from our survey results and from prior studies.

Pre-submission. Each of the thousands of journals defines the scope of the articles it accepts, and each journal has its own expectations for their broad appeal and novelty. In addition, each journal may have its own requirements with respect to the form a manuscript should take, including the overall length, the number and types of figures, the ethical declarations required, and the formatting of references to previously published research. Producing a manuscript that meets all of these requirements takes time and effort, and authors may face difficult decisions when choosing which details and findings to include or exclude in order to satisfy scope and length requirements. Importantly, most journals will only consider articles that have not been previously published and that are not under consideration for publication elsewhere. While this system makes good sense for the integrity of scholarly communication, it nevertheless requires authors to select a single target journal at a time and tailor their manuscript specifically to the requirements of that journal.

In our **survey of 132 researchers across several fields of study** (see Methods for more information about the survey), respondents reported that they spent a median of 2.1 days on the initial preparation of a manuscript before first submitting their work to a journal. Early results indicate that this initial preparation time varies by field, with engineering and mathematics papers requiring additional time to write, but more data are needed to confirm this observation (**Figure 2**). In addition to writing the manuscript text, figures are an important part of conveying research results. While some researchers may create figures as part of drafting their manuscript, many begin creating figures while still performing research, especially if they choose to publicly present preliminary findings at a conference or other venue. At this time, little quantitative information is available regarding time spent preparing figures in particular, but from our discussions with researchers, this is a frequent pain point that likely extends the total preparation time considerably.

After submission but before publication. Upon submission, a sequence of events is set into place wherein the journal evaluates the submitted manuscript and conveys

FIGURE 2

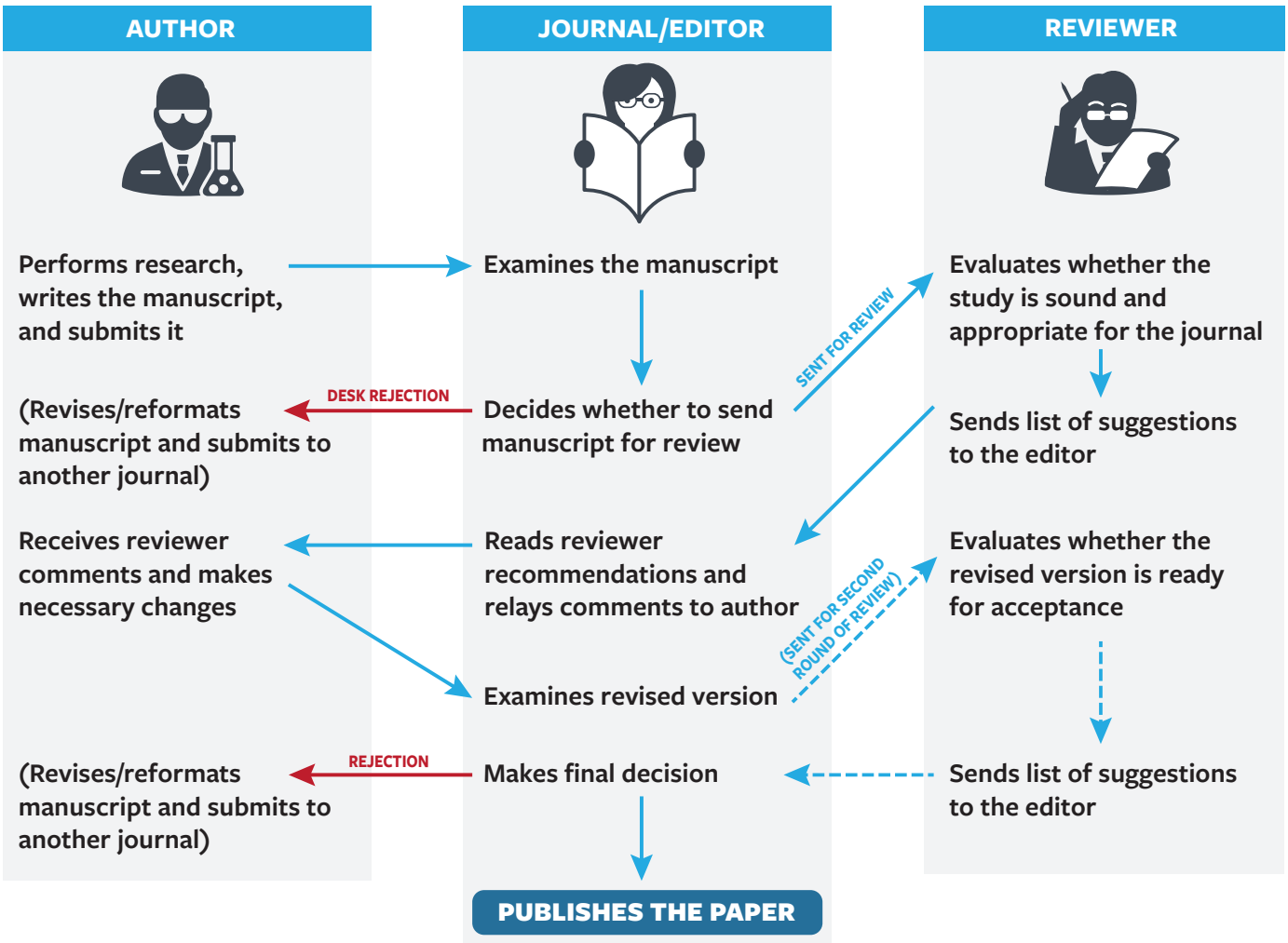
Area of Study	n	Writing Time	Journal Submission (mean)	Total Reject Time (median)	Research Time (median)	Rewriting Time (median)	Submitted to Accepted	Accepted to Published	Total (days)
Chemistry	26	1.9	1.35	3.0	14	0.3	130.0	127.2	262.4
Engineering	18	3.3	1.56	13.6	7	0.4	145.2	130.9	293.3
Biomedicine	14	1.9	1.43	10.7	7	0.4	141.5	146.7	301.2
Physics	26	2.1	1.17	5.0	7	0.3	151.6	174.1	333.1
Earth Science	20	2.5	1.25	7.5	7	0.8	167.7	181.4	360.0
Mathematics	16	3.5	1.40	24.0	10.5	0.4	232.1	155.5	415.5
Social Science	12	1.9	1.83	25.0	28	1.5	159.8	241.4	429.5
Overall	132	2.1	1.39	10.9	7	0.4	188.1	175.9	377.4

feedback and decisions to the authors. This lengthy process typically includes several people and requires a lot of communication (see **Figure 3**). Initially, the manuscript is reviewed by an editor at the journal who makes an initial decision to send the paper for review or to reject it as being out of scope or otherwise unsuitable for the journal (commonly termed a "desk rejection"). Prior research shows that approximately 21% of submissions are rejected without being sent for review,[6] and in many cases, this type of rejection can be quite rapid. Our survey respondents who had recently been rejected without review (n = 32) reported a median of 7.5 days for receiving a desk rejection (**Figure 2**).

Once a paper has been sent for peer review, authors wait for the journal to assign peer reviewers, for the reviewers to evaluate the manuscript, and for the editor to communicate the comments and issue a suggestion for rejection, acceptance, or resubmission after improving the manuscript. Despite a reported median time of 5 hours spent on a single peer review[1] reviewers and editors are busy researchers, and therefore, the time elapsed before a first decision is on the order of months. One survey of academics found that they reported an average of 80 days for their most recent peer review experience,[6] and another study of neuroscientists found an average of 122 days under review.[7] This timeline roughly matches the amount of time that authors feel is reasonable for the peer review process,[6] although things may move considerably slower in high-impact journals.[8] Altogether, a study by Björk and Solomon revealed a median time of 188 days spent between submission and acceptance.[5] The overall time is skewed slightly by longer timelines in the field of mathematics, but fields such as biomedicine, engineering, chemistry, and physics still saw delays of between 130 and 152 days.[5] The same study found an overall median time of 175 days between acceptance and final publication, with social sciences skewing the data (242 days); biomedicine, engineering, and chemistry had publication delays of 125 to 175 days.[5]

The journal loop. Authors of articles rejected for publication after submission to a journal must then identify additional journals that are appropriate for their work and repeat the process of manuscript preparation and submission. Much of the work to write the paper has likely been completed before the initial

FIGURE 3



submission, so this step may only involve any reformatting work necessary to meet the requirements of a new journal. However, authors often do further work to strengthen the presentation of their manuscript or to include additional experimental results in response to reviewer feedback from a previous submission. This additional investment of time does appear to pay off, as resubmitted manuscripts have been found to receive significantly more citations than articles published in their first-intent journal.[9] These results highlight the benefit of thorough peer review, even if a paper is not accepted; changes made in response to peer reviewers' critiques have the potential to improve the quality of a manuscript and allow it to make a greater overall impact.

In our survey, authors reported submitting their papers to an **average of 1.4 journals before acceptance**. These findings are in line with Kravitz and Baker's study of neuroscience papers (2.1 journal submissions on average)[7] and by estimations of acceptance at a manuscript's first journal, which fall around 50% to 75%.[6,9] Likewise, in a large-scale survey of over 2,500 of our customers done for an earlier study, approximately 80% of respondents reported submitting to an average of 1 to 2 journals, in general, when they publish.[10] Survey respondents from the present study reported needing a median of 10 hours to revise and reformat for a new journal, not including time needed to select a new target journal.

COST

Beyond time spent bringing a manuscript through the publication process, there is the potential for monetary fees to be involved. These fees range from fixed prices for submission or publication to extras like fees for color figures, expedited review, or even substantial copyediting.[11] As stated above, the shift toward open access has introduced the concept of the article process charge (APC), but even traditional journals sometimes carry page charges or other fees. Note that we are dealing strictly with costs direct to authors and their grants in this paper, but the costs of library subscriptions (which can be considerable[12]) should not be forgotten.

Pre-submission costs. Before submission to a journal, the costs borne by researchers are largely centered on the time spent writing a manuscript, soliciting and incorporating feedback, and selecting a journal. However, services are available for several pre-submission steps, including language editing, figure preparation, and journal recommendation, from AJE and a number of other providers. These early-stage charges are completely voluntary and largely reflect the eagerness of some researchers to save their own time and that of their co-authors.

Submission fees. Some journals charge a fee (usually nominal) upon submission of a manuscript. Such fees are rare, however, with only 1% of science journals in a recent study of nearly 2,000 journals listing a submission fee (median amount of $67.50).[13] Still, researchers should be aware of the possibility of submission fees and check journal websites for details.

Publication fees and page charges. Traditionally, journals needed to print copies of the papers they accepted, leading some publishers to levy charges per page (approximately 17% of science journals; page charges in social science journals are exceedingly rare).[13] Others opted to limit charges to manuscripts that exceeded a preset length limit (approximately 7% of science journals).[13] While they vary slightly by field, these charges land around $100 per page.[13]

Journals under the open access model almost invariably exist online only; therefore, printing charges are not relevant and the use of page limits is rare. Instead, many open access journals request a one-time publication fee for accepted manuscripts, the APC. This charge helps cover the costs related to receiving and reviewing submissions, preparing the final version, and hosting the final version online (among many other expenses). Before describing the typical charge, it is important to note that not all open access journals charge fees to authors. Instead, many are designed to run on funding from an outside source, whether the institution where the journal is published or even large funding organizations, as was the case for the journal *eLife* during its first three years.[14] One careful study of journals in the Directory of Open Access Journals (DOAJ) found that only 26% of journals indexed in the DOAJ self-report charging an APC.[3] Even if this number is a low estimate, it is unlikely that more than half of open access journals actually charge APCs. A very recent study of the DOAJ showed that 61% of journals with APCs were published by commercial entities.[15]

When taking a closer look at the charges levied by open access journals, Solomon and Björk found that the average price for journals charging an APC was $906 when comparing across journals (and a remarkably similar $904 when factoring in the number of articles published in the various journals), with a range of $8 to $3,900.[3] With a few

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examples of journals charging higher amounts (e.g., $5,200 for *Nature Communications*),[16] this estimate may be somewhat low, but such outliers are rare compared to the over 9,000 journals in the DOAJ.[17] Indeed, when limiting the APC analysis to established journals in the international cross-disciplinary index Scopus, the average APC is $1,418,[17,18] right around the current charges for large open access "megajournals" like *PLOS ONE* and *Scientific Reports*. It is important to note that any comprehensive study of APCs is complicated by variations across journals at a given publisher, article types at a given journal, and even the license type for a given article.[11,15] Some journals that operate under a traditional publishing model also offer authors immediate open access for their article in exchange for a surcharge. As of 2012, at least 4,381 journals used a hybrid model, with a majority charging at least $3,000 for open access publication.[19] Despite the proportion of journals with a hybrid option, uptake has remained fairly low, at around 1-2%, perhaps because of the relatively high cost to authors.[19,20]

Color figure fees. As described above for page charges, printing hard copies was once an important consideration for every scholarly journal. Printing paper copies entails added expenses when authors want to use color in their figures, as doing so requires an array of ink colors instead of just black. To offset this additional expense, and potentially disincentivize the use of color, many journals feature fees related to color. While once more common, a large percentage of journals still have this type of fee (53% of science journals and 33% of social sciences journals), including many that charge for color figures in print while allowing color images online.[13] A small survey of publisher color charges in 2013 found an average of around £300,[21] which is $444 per figure at today's exchange rate. Despite the fees, the proportion of color figures has gone up substantially in certain journals in recent years.[22] Color can help convey messages more clearly and may make other researchers more likely to share published figures in their talks, and these advantages may be worth the additional cost. Overall, online-only open access journals tend to make liberal use of color because of the freedom of the electronic medium.

Comparison of open access and traditional journal fees. While not every subscription-based journal charges fees, the practice is sufficiently common to warrant a comparison to the flat APC. Looking at over 175,000 manuscripts that AJE has received in recent years, we find an average of 4,748 words per paper. While the exact number of typeset pages this would represent will vary from journal to journal,[23-25] various estimates from publishers indicate that a paper of this average length will encompass at least 5 pages in the final typeset version. Based on these numbers, **Table 1** provides a comparison of the costs of publishing a standard-length manuscript in an open access journal charging an APC and a traditional journal with page and color figure charges. Overall, including one color figure brings the cost similar to the average APC across all journals in the DOAJ, and including two color figures brings the cost to the range of the average APC for journals in Scopus.

Citation counts can serve as a proxy for the overall quality and impact of a paper given that it quantifies the influence that work has had on the thinking and research efforts of other investigators.

IMPACT

Importance of tracking citations. Citations represent the number of times the findings from a given published work are formally referenced in subsequent publications. Citation counts can serve as a proxy for the overall quality and impact of a paper given that it quantifies the influence that work has had on the thinking and research efforts of other investigators. Citations generally suggest that researchers consider the results of

TABLE 1

Page charges ($101.58/page)[13]		Color charges ($444/figure)[21]		TOTAL COST
		1 figure	$444	$951.90
5 pages	$ 507.90	2 figures	$888	$1,395.90
		3 figures	$1,332	$1,839.90
			Average APC (all journals)[3]	$906.00
			Average APC (journals in Scopus)[18]	$1,418.17

a paper important and useful enough to call attention to and/or incorporate into their own research. As such, publication of highly cited papers is considered an important indicator of productivity and thought leadership within a field and is often a key component in determining career success. Furthermore, frequent citation of a researcher's published work establishes a credible track record of success, a positive indicator of future productivity that can result in favorable decisions by funders and administrators with respect to grants and career advancement.[26]

Factors influencing citations. Ultimately, the strength of the research in a paper is the critical factor dictating its success. Clear presentation of research results, through well written text and effective figures, also enables readers to better understand the important conclusions and incorporate them into their own research and writing. However, while the research essence and presentation of the paper defines its potential to be cited, there are a number of factors that have been shown to influence citation counts, both related to the manuscript itself and the authors. An understanding of these factors helps highlight steps that authors can take to maximize the impact of their paper. Certain factors lie outside of an author's control (e.g., authors with surnames near the beginning of the alphabet see a slight citation boost),[27] but being able to identify these factors provides a clearer view of the scholarly communication process and the potential impact of a specific manuscript.

Furthermore, frequent citation of a researcher's published work establishes a credible track record of success...

Factors related to the authors and their research program. Publishing experience plays an important role in determining citation potential, particularly for researchers in early career stages. In particular, the number of prior publications is a reliable indicator of the number of citations for a researcher's next publication, although the effect tapers off quickly within the first 5 to 10 publications.[28] This effect likely exists as early-career investigators learn how to improve the quality and presentation of their work in general and how best to frame their results so that readers can fully grasp the implications and apply the findings to their own work. The publication process itself also plays a role because each subsequent paper published boosts the researcher's profile in the field. Additional interactions with journal reviewers and editors mean more opportunities to get expert feedback, anticipate criticism, and better address potential shortcomings in subsequent work. Recognition within one's research field can also increase citation potential; for example, biomedical researchers who are appointed as Howard Hughes Medical Institute Investigators see a citation boost, and this boost is stronger if they were cited at relatively low frequency before their appointment.[29] It is worth noting, however, that such predictors are effective on a large scale; highly cited authors still occasionally produce papers that go completely uncited.[30]

An author's research field also has a strong effect on the number of citations his or her paper may receive. Some fields, such as molecular biology and immunology, are more active than others in terms of number of publications per year,[31] generating greater opportunity to be cited. Other fields such as mathematics move more slowly and therefore generate fewer citations over time.[31] In addition, some fields have different standards and conventions with respect to the number

TABLE 2

Journal Citations Per Document (from SCImago) (%)

AOS	Min	10	20	30	40	50	60	70	80	90	Max
Chemistry	0	0.35	0.71	1.28	1.73	2.17	2.59	3.32	4.00	5.67	43.29
Engineering	0	0.18	0.37	0.65	0.96	1.36	1.85	2.47	3.17	4.10	27.36
Biomedicine	0	0.14	0.49	0.95	1.48	2.08	2.66	3.33	4.00	5.54	109.78
Physics	0	0.39	0.67	1.11	1.54	1.91	2.19	2.72	3.49	4.49	45.11
Earth Science	0	0.25	0.52	0.96	1.36	1.87	2.41	2.95	3.57	4.92	15.88
Mathematics	0	0.30	0.46	0.62	0.83	1.08	1.36	1.71	2.12	3.03	16.92
Social Science	0	0.07	0.18	0.33	0.52	0.74	1.07	1.46	2.04	2.94	18.32
Overall	**0**	**0.10**	**0.23**	**0.46**	**0.79**	**1.28**	**1.88**	**2.57**	**3.45**	**4.81**	**109.78**

of previous works to be cited per paper, further skewing the overall citation volume. This discrepancy by field has led to the creation of new citation measures that attempt to normalize citation counts so that they can be compared across fields. One prominent example is the Source Normalized Impact per Paper (SNIP), derived from the Scopus database.[32] However, the use of such metrics is not universal, and raw citation counts are still more commonly reported.

Factors related to the choice of journal. Final publication venue, and particularly the average citation count of other papers within the journal where a paper is published, plays a very important role in driving citation success. In fact, the average citation rate for a journal was found in a prior study to be the top quantitative indicator of citation success for new articles.[33] This effect can probably be attributed to the more demanding criteria for acceptance into these higher profile journals as well as their larger readership (generating increased awareness). Journals with high citation rates may also impart a certain level of trust in the work they publish among readers due to the prestige of the journal itself (subjective prestige of a journal was also a positive predictor of citation success).[33]

Acceptance to a highly cited journal is not a guaranteed path to success, however, and is not the norm for most papers and authors. In fact, half of all papers are published in journals with an average of just 1.28 citations per article, and over 90 percent are published in journals where the typical article receives fewer than five citations (**Table 2**). Even within top-tier journals, several studies have shown that citation distributions are often heavily skewed, with a small percentage of papers receiving the bulk of citations that make up the journal's average.[34-37] Furthermore, a recent study of predictors of lack of citations used keyword analysis to suggest that uncited papers are frequently poor subject matches for the journals in which they were published.[30] To reach the right audience for an article, it is therefore important to find a strong journal fit for the topic and to select keywords that will be meaningful to the readership of that journal. Articles that do not fit the scope of the journal or that use unfamiliar keywords or terminology (relative to the typical articles for that journal) will have a lower chance of discovery by the right audience regardless of the overall prestige of the journal itself.

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Factors related to the manuscript. Several aspects of the research article itself affect its potential to be cited. For example, a well-written review often garners higher levels of citations than primary research, and randomized trials and systematic reviews yield more citations than prospective or case-control medical studies.[38,39] Even when comparing among research articles, however, several specific elements have been shown to contribute to citation success, starting with the set of authors. There is a positive relationship between the number of authors on a paper and the number of citations it receives,[40] and collaborations among authors from multiple countries increases the average impact by 1.6 citations.[41] These results may be explained by the greater awareness generated by having more researchers involved with a paper who expose the work to their social networks. In particular, authors from different countries likely have less overlap in their researcher networks, leading to greater reach for the article. Research in publications with greater numbers of authors may also benefit from the availability of more resources and varied intellectual input, strengthening the study itself. Finally, with each additional author comes the potential for self-citation, although self-citations are often associated with a concomitant increase in external citations.[42]

Other factors, including longer reference lists[43,44] and increased page counts,[30] have been shown to positively affect citations. Longer articles may simply have more material that can be cited, and authors of other works may receive notifications when they are cited, drawing attention to the newly published work as well as creating the potential for reciprocation.[44] The length of the title of a manuscript, a critical component that draws in readers, has alternately been shown to either positively and negatively impact an article's citations. When a title is too short, it may not impart enough information to entice readers or enough keywords to appear in search results. Lengthy titles, however, may be ignored by readers who have difficulty discerning the focus of the article. Altogether, a title of intermediate length (perhaps 12-15 words) that includes critical keywords is likely to garner the greatest amount of attention among potential readers.

Early determinants of citation success. There are some early indicators of an article's eventual citation count, including social media attention garnered on Twitter, Facebook, blogs, researcher-specific networks such as Mendeley, ResearchGate or academia.edu, and mainstream media.[45,46] Usage data (e.g., views and downloads) soon after initial publication may also serve as an early indicator of citation success.[39]

...effective communication is a critical component towards making all the work that came before it worthwhile.

One study successfully predicted the subsequent citation counts of medical articles within three weeks of publication by administering a standardized rating system that measured "newsworthiness" and clinical relevance.[47] Importantly, social media activity correlates but does not necessarily directly result in citations,[48] although articles that are discussed immediately upon publication do appear to be cited frequently over time.

Challenges related to determining impact through citations. While citations are the primary goal and success measurement for most researchers, there are issues with equating citations and impact. First and foremost, citations do not encompass the greater societal impact of research. No citations are generated when research is used by doctors to save lives, by engineers to build safer bridges, or by educators to effectively share knowledge with students, but this type of validation is arguably of greater importance to the world than citations. Secondly, all citations are treated equally, whereas there are differences in the sentiment behind a citation. Was the citation based solely on using a previously described method? Was it pointing out a fundamental research result that enabled the new research paper? Or was it meant to highlight earlier work that the new paper refutes?

Citations are also a long-term measure, taking years or decades to accumulate to levels that allow for proper assessment of an article's impact. As citation levels are often judged within a window of a few years, this process ignores the potential of so-called "sleeping beauty" papers that generate considerable numbers of citations only after an more extended period.[49] The race to generate citations quickly also leads to efforts to game the system. Finally, citations are based solely on the coverage of the database considered. For this reason, the citation counts for a single article vary when analyzed using different services like Google Scholar, Scopus, and Web of Science.[50]

CONCLUSIONS

Although some have pointed out that the basic functions of a journal (registration, archiving, dissemination, and certification or validation) can be decoupled[51] publication in a scholarly journal and subsequent citation by peers is still the criterion for success for the vast majority of researchers. Success in communicating research leads to both career advancement and societal impact (see **Figure 1**). The researcher herself sees progression toward hiring and tenure as well as new opportunities to collaborate, present work, and join editorial boards. The broader community benefits from expansion of the collective understanding of our world, and society itself may be improved through advancements in medicine, technology, and policy. Taking the time to communicate your work effectively is worth the investment. Based on what we now know about the efforts involved in creating a manuscript and the factors affecting its subsequent success, what are the most important things to keep in mind?

Craft your manuscript carefully from the start. One thing stands out from the available data regarding the timeline for publishing a paper: the vast majority of time is spent waiting for reviewers and journal representatives to provide feedback. While authors spend around two days writing a manuscript, and perhaps a few weeks or months doing new experiments and analyses in response to reviewer feedback, they typically wait 26 weeks between submission and acceptance, and sometimes an additional 25 weeks between acceptance and publication (**Figure 2**). The hours spent writing a manuscript are quite few compared with time spent performing research or waiting for publication, but those hours are extremely precious. A little extra effort to polish the first manuscript draft or create engaging figures could help avoid an additional submission (and the extra 26 weeks that accompany it). While an extra submission step may not add direct monetary costs, your time is worth money, too. Saving effort also ensures that valuable grant funding can go toward performing research rather than cycle after cycle of attempts to get journals to accept a manuscript.

Target the right audience, before and after publication. Another common theme stands out when investigating the factors that affect article citation: a manuscript must find the right audience. Good fit starts with the journal selected; find a journal that publishes articles with topics and keywords similar to the most important concepts and terms in your paper. It is not enough to simply choose

popular keywords if they do not fit the journal you have selected or a journal with a high citation rate if it doesn't typically publish on your topic. Other positive indicators of citation success, such as long reference lists and optimal titles, also likely relate to finding an appropriate audience (in this case, authors who research similar topics and readers who can easily get a sense of your article's main thesis, respectively). In addition, don't neglect to help drive awareness of your paper after it has been published. Take the time to make sure that the article is being shared with potentially interested readers through channels like social media, presentations, and email. There is also potential to enhance the published article by sharing underlying datasets, summaries, or new information related to the work.

Ultimately, maximizing impact potential requires authors to invest substantial time and resources to ensure findings are presented clearly, in an easily digestible format, and to the right audience.

Ultimately, maximizing impact potential requires authors to invest substantial time and resources to ensure findings are presented clearly, in an easily digestible format, and to the right audience. As with the effort involved to conduct research itself, publication requires patience, commitment, and expertise to achieve success. However, as the final step of the research process, effective communication is a critical component towards making all the work that came before it worthwhile.

METHODS

Publication time investment survey. To estimate the amounts of time devoted to each stage of the scholarly manuscript preparation and publication process, surveys were sent to corresponding authors of randomly selected papers across various fields of study published from 2012-2014. Randomization was performed using the SCImago Journal & Country Rank website (www.scimagojr.com), which makes available information on number of publications, number of citable documents, and average citations per document for over 21,000 scholarly journals contained within the Scopus citation index. To keep the analysis manageable, the journal subject categories used by Scopus were grouped into broader disciplines as follows: Chemistry (including the categories Chemistry, Chemical Engineering, and Materials Science), Engineering (Engineering; Computer Science; Energy), Biomedicine (Health Professions; Nursing; Agricultural & Biological Sciences; Veterinary; Medicine; Dentistry; Biochemistry, Genetics & Molecular Biology; Immunology & Microbiology; Neuroscience; Pharmacology & Toxicology), Physics (Physics & Astronomy), Earth Science (Earth & Planetary Sciences; Environmental Science), Mathematics (Mathematics; Decision Sciences), and Social Science (Social Sciences; Psychology).

Journals were randomly selected from each of the above disciplines in a weighted fashion to account for differences in publication volume among journals, and the corresponding authors of randomly selected articles from each of these journals were contacted via email and asked to take the survey. The corresponding authors contacted were limited to only those whose articles were published in English and for whom an email address was available through the article's page on the journal website. The survey is still open (and we may provide new updates later), but at the time of this writing, 2,494 authors have been contacted, and 132 surveys have been completed (5.3% response rate).

The survey consisted of four main questions and two follow-up questions presented only to authors who indicate they submitted to more than one journal during the process of publishing their manuscript. Responses from partially completed surveys are included in the final results for those questions were a response was provided. The survey questions and follow-ups are listed below.

1. *How many hours were needed to write and format the original version of your manuscript before it was submitted to the first journal you considered?*

2. *Including the journal where your article was published, to how many journals in total did you submit your manuscript?*

3. *How many additional hours in total were required to re-write or re-format the manuscript for submission to any additional journals or to respond to requests for revision from journal editors or reviewers?*

4. *How many weeks in total were required to perform any additional research required by journal editors or reviewers for acceptance for publication?*

5. (*Follow-up question*) *For all journals where your manuscript was declined BEFORE peer review (if any), what was the average time in days between submission of the manuscript and notification of the journal's decision?*

6. (*Follow-up question*) *For all journals where your manuscript was peer reviewed but NOT accepted (if any), what was the average time in days between submission of the manuscript and notification of the journal's decision?*

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