

PLOS ONE: BACKGROUND, FUTURE DEVELOPMENT, AND ARTICLE-LEVEL METRICS

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Abstract

PLoS ONE, a peer-reviewed Open Access academic journal published by the Public Library of Science, was founded in 2006 with the intent of reevaluating many of the aspects of the scholarly journal. As a result, *PLoS ONE* has taken elements of the traditional publishing model for scholarly journals and separated them into those functions that are most effectively carried out before publication (for example, peer review in order to evaluate whether the article deserves to join the scientific literature) and those that can most effectively be carried out after publication (for example, how impactful the article was once it joined the literature). With this basic premise in place, and using the online tools that are now available, the journal has grown to the extent that in 2009 it will become one of the largest journals in the world (by publication volume). This article overviews the development of the journal to date – how it differs from most other journals and how it engages with its core audiences. In March 2009, the journal (along with other PLoS titles) began a program to place ‘article-level metrics’ on each publication, and this article outlines how this has been achieved, as well as plans for further development. In conclusion, this article looks forward to the future developments of this transformational journal.

Keywords: PLoS ONE; Article-Level Metrics; Public Library of Science; Open Access.

1. Introduction

The Public Library of Science (PLoS) began its publishing program with the intention of proving that highly selective, quality journals could be published under an Open Access model; to this end, *PLoS Biology* launched in 2003, was followed by

PLoS Medicine in 2004 [1]. Both journals quickly established themselves as premier titles in their field and remain as such. In this way, PLoS proved that Open Access publishing was compatible with the very best science and the very highest standards of professional publications. PLoS then moved on to build its publishing portfolio with the launch of four “community-run journals” – *PLoS Pathogens*, *PLoS Genetics*, *PLoS Computational Biology* (all launched in 2005), and *PLoS Neglected Tropical Diseases* (launched in 2007) [1]. In contrast to *PLoS Biology* and *PLoS Medicine*, which are run by professional in-house editors, the community journals operate very much like the majority of traditional journals – they are run entirely by the academic community, with an Editor in Chief, Associate Editors, and an editorial board with broad expertise who make editorial decisions and follow rigorous peer review. As was the case with the two original titles, these community journals also established themselves as high-quality publication venues and may help provide a sustainable Open Access model for more traditional journals. As a result of this evolution, *PLoS ONE* was conceived and launched.

An Open Access scholarly journal capable of encompassing all of science, providing an efficient publication venue for all scientifically sound articles that is able to exploit the full potential of the online medium, has long been the vision of Harold Varmus, Michael Eisen, and Patrick Brown, the original founders of PLoS. To meet this vision, in December 2006 *PLoS ONE* [2] was launched with the long-term goal of establishing a fresh and innovative publication venue for every scientific discipline. While the majority of online research journals do little more than reproduce the features and services of their print versions, *PLoS ONE* is an attempt to exploit the potential of the Internet in the context of scholarly communication and Web 2.0 functionality.

In the two and a half years since its launch, *PLoS ONE* has grown to become the largest PLoS title and is well on its way to fulfilling the original vision of the founders, as well as contributing to a transformation in the way in which academic journals are published. In 2007, the journal published 1,231 articles; in 2008 it published 2,722 articles. At current rates of growth, the journal is on track to publish over 4,300 articles in 2009 and assuming this growth continues at the same rate, in 2010 *PLoS ONE* could be publishing around 1% of all the articles listed in PubMed for that year (PubMed lists 803,00 published articles for 2008 [3]).

As with all journals published by PLoS, *PLoS ONE* is fully Open Access, employing a publication-fee model and making use of a Creative Commons Attribution License for all published content, with the intent that the dissemination, reach, and re-use of published articles should be maximized. The peer review process in *PLoS ONE* focuses on scientific rigor and research integrity, but does not select content based on possible “impact” (or other subjective values such as “interest”, “broad appeal”; “advance in the field,” or “likelihood to receive citations”). This

critical feature of peer review in *PLoS ONE* means that any research article that appropriately reports on correctly performed science can be published. In effect, any scientific research article which would be accepted for publication by any other rigorously peer reviewed journal, would also be acceptable for publication in *PLoS ONE*.

PLoS ONE is an “online-only” journal (as are all PLoS titles) and has always been published on the open-source Ambra/Topaz platform (a semantically enabled web publishing platform). In July 2007, the journal was launched with the ability to make comments and notes on articles and added the ability to rate articles (on a five-point scale under three criteria: Insight; Reliability; and Style). In September 2007, *PLoS ONE* added the ability to leave “trackbacks” on articles (reciprocal links that indicate where an article has been linked from on the internet) and in August 2008, it moved from a weekly publication schedule to a daily one, publishing articles as soon as they were available in their final form.

Clearly, *PLoS ONE* is a new type of publication that does not conform to many of the norms of a traditional academic journal. At the time of writing (March 2009), *PLoS ONE* had published over 5,000 articles, written by over 30,000 contributing authors and reviewed by over 10,000 peer reviewers. Therefore, it is clear from these numbers that the broader academic community supports the approach of the journal. This success has no doubt been due in part to the strength of the PLoS brand (which in turn is the result of the success of the journals that preceded PLoS ONE), however, *PLoS ONE* is now becoming firmly established in its own right.

2. Publication Philosophy of *PLoS ONE*

Traditionally, filtering and assessment of potential research impact are undertaken during the peer review and editorial acceptance process. With the aid of peer reviews, journals make subjective decisions as to whether or not each submission meets the standards required for their title (standards which may be ill defined, and which often relate to things such as ‘potential impact’ or ‘significant advance’). Even if they are technically sound, articles that fail to meet that standard are rejected and, as a result, are often submitted to successive journals before being accepted and then published many months or even years after their first submission. Authors (and the academic reward system in which they operate) perpetuate this cycle by attempting to get their research published in certain highly regarded journals with the result that publication is delayed while a suitable journal is found, and the ‘review burden’ on the academic community is multiplied by the fresh review of each new re-submission. By focusing the peer review process on

scientific rigor and research integrity; seeking alternate ways to assess research output; and by explicitly avoiding the more subjective elements of editorial decision-making, *PLoS ONE* has the potential to substantially improve the speed and efficiency of the communication of research results, which in turn will accelerate research itself.

Until recently, publication in a specific journal provided almost the only way for a reader to easily and quickly filter content for probable relevance or impact in their field (effectively, the reader makes an assumption that acceptance by a specific journal represents a predictive measure as to the eventual impact of the research published within it). In this situation, the opinion of a small number of individuals (perhaps 2 peer reviewers and one editor) determines whether a paper is published in a specific journal. By extension, the opinion of those people (who act on the paper in advance of publication, and without the benefit of evaluation over time by the wider community) exerts a disproportionate influence on what is read by the community (and with what preconceptions).

'Post-publication' evaluation of research impact can be made once citations have accrued to an article, but this can take many months or years to be realized and in addition, citations are typically only reported at the journal (not the article) level via measures such as the Impact Factor of the journal in which the article was published. However, the online medium provides a myriad of new opportunities for sorting, assessing, searching, and filtering content that may be equal or superior to evaluation via the journal in which an article is published. As a result, and in order to better facilitate these new possibilities, *PLoS ONE* takes the traditional functions of a journal and consciously separates them into those functions that are most effectively carried out before publication (for example, peer review in order to evaluate whether the article deserves to join the scientific literature) and those that can most effectively be carried out after publication (for example, how impactful was that article once it joined the literature).

As a result of the philosophy outlined above, *PLoS ONE* is defined by several key factors that make it unique in the industry:

- 1) It has a scope which encompasses all scientific disciplines (although it is mostly centered on the life and biomedical sciences, as these are the areas in which *PLoS* is currently the strongest, due to their historical origins).
- 2) It does not select content based on subjective determinations of "impact". Instead, it is prepared to publish all "good" science (which is determined via objective peer review) and as a result publishes work that presents major advances, as well as incremental or descriptive science. It is also important to note that *PLoS ONE* publishes work where the results may be negative or inconclusive (something that is particularly important in the field of clinical trials where a desire to publish only positive results can distort the medical

literature, but something that is also important in order to prevent later investigators wasting time repeating experiments that have already been shown to be ineffective).

- 3) Because of the publication-fee business model (in which publication costs scale very closely to publication volumes, and each new publication pays for its own costs); because the journal is not rejecting otherwise publishable papers merely to maintain a high level of “impact” (as might be done at a journal that is concerned with maintaining an Impact Factor); and because the journal is online-only, *PLoS ONE* has no need for a limited page budget. Therefore, it is capable of publishing all the content which passes its peer review process, and as a result, publication volumes scale with submission volumes (assuming a constant quality of submitted articles).
- 4) *PLoS ONE* embraces user interaction, frank feedback, community involvement, and Web 2.0 innovations. As a result, it has the potential to inspire open and vibrant discourse around published articles (although it is certainly the case that use of these tools has not yet reached a critical level of use or acceptance).
- 5) Finally, *PLoS ONE* regards itself as a service provider to academia and uses the community to make decisions in as fair and unbiased a manner as possible. Decisions on individual manuscripts are made by academic editors who are organized in a non-hierarchical manner, and there is a clear appeal process for disputed decisions.

It is important to note that the “traditional” editorial publication process has great value; it has served academia well for many years and will continue to serve academia in the future. It is also more than capable of adopting some of the features that *PLoS ONE* is developing (indeed, many of the features employed at *PLoS ONE* were not necessarily pioneered there, and most are in use by all PLoS journals). However, *PLoS ONE* is an attempt to see whether it is possible to publish journal articles in a manner that provides value to academia in different, and hopefully more effective, ways than the “traditional” publication model.

3. Organization and Workflow

PLoS ONE is designed to provide an efficient, fast, and “hassle-free” publication experience, with minimum intervention by the publisher or its staff.

The journal currently makes use of an online peer review system provided by eJournal Press (Allen Track). All submissions pass through an initial Quality Check (QC) to ensure that submissions meet various requirements relating to

items such as full disclosure of “competing interests”, appropriate oversight of human and animal research, full disclosure of funding sources, appropriate deposition in discipline-specific databases, appropriate registration of clinical trials, technical quality of the files, and so forth. In total, the QC checklist includes over 20 different checks and is one of the most comprehensive in the industry. For whatever reason, some articles will never make it past this stage, and when required, *PLoS ONE* does follow up on potential misconducts using the guidelines laid down by the Committee on Publication Ethics (of which PLoS is a member).

Once a manuscript passes QC it is assigned to an Academic Editor or to a Section Editor (who is responsible for assigning an Academic Editor), and the editorial evaluation of the manuscript begins. Academic Editors are responsible for finding peer reviewers, evaluating their reports, and rendering a final decision on the manuscript. Through this process, in-house administrative staff are on hand to respond to queries, solve problems, and chase late reviewers for their reports. Summary information on the performance of the peer review process is supplied at the journal website [4].

At the time of writing (March 2009) *PLoS ONE* is receiving over 500 submissions per month and, on average, authors are receiving a first decision in under 30 days (from passing QC). Authors are invariably required to revise and resubmit their work, and the manuscript is then re-evaluated in light of those revisions. Once the paper is ultimately accepted (which happens for approximately 71% of all submissions [5]) it passes on to production. Before moving into production, papers are given a further round of “check for completeness” and authors are required to proof their article at this stage so that files can pass through the production workflow as rapidly as possible. *PLoS ONE* accepts RTF, Word, and LaTeX submissions, and the typesetting is conducted in China by the Charlesworth group. Articles appear online within approximately 30 days of acceptance; they are published on a daily schedule (as and when they become available) and their full text is simultaneously posted to PubMed Central.

Full text content is indexed at PubMed, MEDLINE, PubMed Central, Scopus, Google Scholar, the Chemical Abstracts Service (CAS), EMBASE, AGRICOLA, Zoological Records, and RefAware, as well as being searchable via the Web of Knowledge. As with all PLoS journals, in addition to the formal archive at PubMed Central, *PLoS ONE* is also archived via LOCKSS (Lots of Copies Keep Stuff Safe) [6] and a further archiving arrangement is being pursued with the Royal Dutch Library.

4. Adding Value After Publication

PLOS and *PLoS ONE* has developed a number of features which add value to articles once they have been published. For example, the journal employs several features that might be considered as “Web 2.0”. Most obviously, the journal allows registered (non-anonymous) users to leave notes directly on portions of the text, comments on the entire article, and to make “star ratings” on the content itself. Notes and comments form discussion threads and users are encouraged to engage in debate via this functionality. In addition, any user can suggest a correction to the article, and those corrections are also handled via the commenting functionality

Other than PLoS, few major publishers offer this degree of flexibility in allowing users to leave feedback on specific articles (exceptions include the BMJ and the journals of BioMed Central), and although it is fair to say that there has been steady use of these features, their use is not yet widespread or frequent as compared to, for example, commenting activity on scientific blogs or other news media. In 2008, raw data on commenting activity was provided to a number of independent investigators. In general, these investigators found that “feedback” activity was occurring on approximately 18% [7]- 23% [8] of all *PLoS ONE* articles, and this rose to 39% if you include “PLoS-generated” comments. Forty percent of all comments were left by the authors themselves and approximately 30% of all (non-author) comments were categorized as interpretation or criticism from readers. Approximately 11% were requests for clarification and a further 11% added new information or citations to the paper. It was also observed that there was not yet a great deal of meaningful “back-and-forth” debate taking place on a typical paper [9]. Overall, these analyses provided encouraging signs that although commenting is not as widespread as was originally hoped for, it is certainly not non-existent and does provide meaningful ‘added value’ to many journal articles.

PLoS ONE employs a two-level taxonomic structure when determining what topics a paper falls into. This is “traditional” in the sense that most publishers employ a similar classification methodology. However, with a journal the size and scope of *PLoS ONE* it has become evident that the structure (which is designed to be used by readers, editors, and authors) does not adequately meet the needs of the journal and is not necessarily the best way to navigate the content. Therefore, PLoS plans to develop a tagging system for articles, which may combine both closed-vocabulary tags and user-generated ‘folksonomy’ (collaborative input) tags. Once implemented, this will provide another example of functionality being applied “post-publication” more appropriately than “pre-publication” and will allow communities to determine their own groupings of relevant articles (as opposed to making that decision on their behalf, as is done in most other journals).

Yet, another example of *PLoS ONE*'s philosophy of separating pre-publication actions from post-publication actions comes in the form of Collections [10]. In a traditional journal, special issues (or supplements) are often published; these usually consist of a single issue of the journal and represent an aggregation of content around a single theme. The drawbacks with special issues are that they are fixed on a certain date (the publication date of that issue); they contain articles which only appear in that single special issue (as they have a bibliographic reference that is attached to the special issue); and they cannot be enhanced or expanded in the future. The equivalent functionality at *PLoS ONE* (a "Collection") views articles as items that can be tagged and re-presented in new and dynamic ways. Because inclusion in a *PLoS ONE* Collection is simply a "tag" on the journal platform, any given article can reside in more than one Collection; each Collection can grow over time as new articles are added; Collections can include articles from any other PLoS journal; and they can be created at short notice. *PLoS ONE* uses these collections to highlight areas of interest for the journal, for the output of conferences or symposia, or as a vehicle for large research collaborations to collect their content in one place. In all cases, articles are published as part of the normal output of *PLoS ONE* (and are subject to the same acceptance criteria as any other article), and therefore, the citation reference is always unique no matter how many Collections an article appears in.

All of the above features are made possible by the Ambra/Topaz publishing platform, and at the time of publication, all PLoS journals will be on this platform. Therefore, although this article deals specifically with *PLoS ONE*, PLoS is exploring the value and applications of post-publication interactivity in the context of its entire portfolio.

5. Article-Level Metrics

PLoS believes that the journal in which an article is published should not be the primary mechanism to determine whether that article will have any worth. Instead, PLoS feels that each article should be evaluated based solely on its own contribution to the literature (and not on some halo effect due to being published in the company of other high-quality articles).

The most well known example of a journal-level bibliometric measure is the Impact Factor (as calculated by Thomson Reuter's Web of Science). While of some utility as a predictive measure of the average impact of a journal, the Impact Factor has been widely misused to the extent that the careers and grants of many academics are influenced by the Impact Factor of the journals they have published in,

and some academics are strongly discouraged from publishing in certain journals unless they have an Impact Factor. Moreover, because of the widespread adoption of the Impact Factor and the fact that a journal with an Impact Factor is liable to enjoy more subscriptions and receive more high-quality submissions as a result, journals and journal publishers have an incentive to promote the Impact Factor due to the potential content- and finance-related benefits that follow. Hence, the system is perpetuated by a combination of academia's adoption of a poor measure and the industry's support for that measure because of the commercial benefits it brings.

Although the Impact Factor is widely adopted within academia it is well understood that measurements of this type, applied at the journal level, are far from ideal when attempting to evaluate the scientific contribution of individual articles, or by inference, individual academics (there is a wealth of literature on this topic, see [11] for a well informed critique of citation statistics; and [12] for a recent review of Impact Factor issues). Certainly, the Impact Factor is embedded in academic culture and currently remains dominant in research assessment, however, the online publishing medium and the advantages inherent in Open Access content provide tremendous potential for the development of alternative measures of research impact and influence.

As one of the few journals that explicitly does not select content based on perceived or anticipated "impact", *PLoS ONE* is an ideal testbed for the development and implementation of viable measures that work at the article level to indicate the "impact" of the article itself (as opposed to the journal in which the article is published). In addition, with a large database of articles (growing at a rate of more than 300 per month) the journal is in possession of a considerable corpus of peer-reviewed material to analyze from this respect. Moreover, interaction with the *PLoS ONE* editorial board and market research amongst the research community reinforces the view that the time is right to introduce and develop new and innovative metrics which can be applied at the article level.

With this background in mind, PLoS is rolling out a program to provide a suite of "article-level metrics" for every article in each of its seven titles - a program which started at the end of March 2009. The aim for every article is to provide information relating to online usage, citation activity, blog and media coverage, commenting activity, social bookmarking, 'star ratings' and "best of" picks as selected by academic experts, as well as other measures yet to be determined. It is hoped that the combination of these metrics, which will be openly available for scrutiny and analysis, will lead to new ways to filter and evaluate individual articles, eventually resulting in new ways for users to find relevant content and new standards to measure the "impact" of research (and hence individuals, departments, institutions, and journals).

This paper provides a brief introduction to the concept of article-level metrics and highlights the approach that PLoS is taking to the problem. It is certainly not the case that PLoS has invented the concept of article-level metrics, or that others have not proposed similar measures in the past. Indeed, some journals already provide some article-level metrics (such as citation counts for journals on the HighWire platform [13], or downloads for articles in the Journal of Vision [14] and Frontiers in Neuroscience [15]). However, where this development is unique and may be considered ground-breaking, is in the breadth of different measures being proposed and provided; the large corpus of high-quality content that the measures are being applied to (over 10,000 PLoS articles at time of writing); the commitment to future development; and the fact that a major publisher is publicly exposing this wide range of measures on all of its articles in an attempt to openly develop new ways to evaluate and filter scientific output.

Finally, the tools and data that PLoS are (initially) providing are not particularly sophisticated. Therefore, as PLoS builds these datasets and extends their analysis, they hope to collaborate with others to determine the most appropriate way to compile, interpret and present them.

5.1. Phased Rollout

The development of article-level metrics at PLoS can be considered to have two distinct phases – “data acquisition and presentation” followed by “data manipulation and re-use.” The initial phase was launched in late March 2009 (the time at which this article was written) [16, 17, 18] and PLoS expects to make significant inroads into the second phase from late 2009 onwards.

5.2. Data Acquisition and Presentation (March 2009)

Before being able to do interesting or sophisticated analyses on its data, PLoS first needs to acquire that data (where it is held by external data providers), as well as to develop new ways to measure the data that is output by its own platform. Therefore, PLoS will attempt to develop as many data sources as possible and compile them in a consistent and reusable fashion. As a general rule, a service will need to have an API (an internet protocol allowing users to query remote databases or websites for their underlying data) that can resolve down to the article level for PLoS to be able to use its data in the most effective manner.

At the end of March 2009, with the 0.9.2 upgrade of the Topaz publishing platform [16], PLoS implemented the first article-level metrics for all Topaz-hosted content (all titles except *PLoS Biology*, which will migrate to this platform, and gain these features, with the Topaz 0.9.3 upgrade in May 2009). This phase can be seen

as a period of data gathering, before attempting to manipulate, evaluate, and draw conclusions from that data. With this in mind, the program was launched with the following metrics:

Citation Activity in the Scholarly Literature: This is a well established metric, and one that most people agree can be viewed as an accurate indicator of the worth of an article. Citation data is displayed from Scopus and PubMed Central (specifically a numerical value for the number of citations as recorded at each service). Clicking each link takes the reader to a landing page at each service listing the citing articles. At present, the citation counts are independent of each other (i.e., they are not de-duplicated)

Blog Coverage: This is closely related to media coverage and indicates how “newsworthy” or “interesting” an article might be for a readership that is wider than normal. There are a small number of services that attempt to search the internet and index blog postings on specific scientific papers, and PLoS has been able to work with Postgenomic, Nature Blogs, and Bloglines. The number of blog posts aggregated by each service is displayed as a numerical value, which links to a landing page at each service (that then lists the blog posts and points users to the relevant postings). By attempting to compile these blog posts in this way, PLoS is acting on the assumption that from the reader’s point of view, it is preferable to use the article as the starting point when seeking all discussions that have happened concerning that article. It is worthwhile to notice that at the time of writing, Postgenomic is by far the most comprehensive service of the three. As with other data, the blog coverage is not de-duplicated between each service.

Trackback Data: Trackbacks are another way to capture information on how an article has been “linked to” via the internet (when a web page links to a PLoS article and has constructed that link in the correct format, a “trackback” link is automatically created at PLoS, pointing back to the ‘citing’ web page). Trackbacks are typically used for blog posts and, to date, the adoption of trackbacks by PLoS users has been minimal (although it is hoped that future upgrades will make the functionality more user-friendly and powerful).

Comments and Notes: This is functionality that has always been present on the Topaz platform, and represents a way to have conversations about articles; to gain an indication of what other users feel about those articles; and to correct errors in articles. Therefore, an understanding of the commenting and notation activity of any article is an indication of the interest it has generated in the community.

Social Bookmarking: In the wider world, individuals use social bookmarking services, such as Delicious, to record their own bookmarks, to show others what they are reading, and to utilize “the wisdom of the crowd” to find new sources of in-

formation. In academia these services are also commonly used, although in addition to their social bookmarking utility, their users also use them as “reference management” tools to record the literature that they are finding useful. Although it is clearly not the same activity, it may prove reasonable to draw an analogy between citing an article (when someone values an article enough to cite it in their own publications) and bookmarking an article (when someone values an article enough to save it in a publicly viewable location for future reference). At launch, PLoS is displaying data from CiteULike and Connotea and at present, it appears that CiteULike is by far the most comprehensive of the two services. PLoS provides a count of how many people have bookmarked the paper at each service. This data is provided in the form of a link to a landing page at each service, which then displays who the others are that have bookmarked the paper.

Numerical Ratings: This is one of the most common Web 2.0 tools and is used by multiple services in the outside world to gather user feedback on the worth of a product or service. Therefore, it seems obvious that allowing users the ability to leave this type of feedback would be another useful metric when evaluating articles. Unfortunately, to date, the use of this functionality has been very limited on the *PLoS ONE* site. Where it is used, it is often the case that a single user will indiscriminately rate an article with five stars. It is hoped (but not expected) that the increased prominence of article-level metrics will encourage worthwhile use of this measure.

The image shows a screenshot of a PLoS ONE article page for "The Evolution of Mammalian Gene Families". The page features a blue header with the PLoS ONE logo and navigation links. The article title is prominently displayed, followed by a navigation bar with tabs for "Article", "Related Content", and "Comments: 8". Below the title, there are several sections: "Related Articles on the Web" with links to Google Scholar and PubMed; "Cited in" with a link to Scopus (27) and PubMed Central (12); "Bookmarked in" with links to Connotea (1) and CiteULike (2); and "Related Blog Posts" with a link to Postgenomic (4). On the right side, there is a sidebar with "Average Rating" (0 User Ratings), "Related Content" (Evolutionary Biology, Genetics and Genomics), and "Share this Article" (Bookmark, Email, etc.). The page also includes a search bar, login options, and a trackback URL at the bottom.

Figure 1. Example page of Article-Level Metrics on PLoS ONE (March 2009).

Examples of articles which exhibit many of the metrics noted above include Order in Spontaneous Behavior by Maye et al [19], and The Evolution of Mammalian Gene Families by Demuth et al [20]. Figure 1 provides a screenshot of how the data is presented (currently the data resides under the second tab of every article page).

5.3. Future Developments (late 2009)

Usage Statistics: The largest missing piece from the initial launch was the inclusion of usage statistics and as a result, this is the next thing that PLoS will focus on, with the intent to provide COUNTER compliant download statistics at the article level. There has been some work done by COUNTER to propose standards for data of this type [21], and PLoS will aim to adhere to any industry standards that are developed. In addition, PLoS expects that the data will allow users to view download behavior over time. Once this functionality is live (anticipated to be the first half of 2009), the PLoS journals will join a very small group of academic journals which are being this transparent with their usage data (other examples being “Journal of Vision” [14] and “Frontiers in Neuroscience” [15]).

Additional Sources: Provided suitable APIs are in place, then through the course of 2009 PLoS hopes to also include citation data from CrossRef, expert evaluation data from Faculty 1000, additional blog aggregators, and additional Social Bookmarking services such as Mendeley.

It is hoped that by launching this program, PLoS will gain feedback as to which measures are valued, will gain an understanding of which sources are trustworthy, and will encourage partners to come forward with ideas on how to use, manipulate, re-use, and analyze the data. As a result of this feedback, the functionality for the second phase of “data manipulation and re-use” will be specified during 2009 and implemented during 2010 (and beyond).

It is expected that PLoS will develop ways to present consolidated (deduplicated) data from overlapping services; the ability to compare articles against others in the PLoS corpus of content using any given metric; and the ability to search and sort results using each metric. In addition, PLoS is open to the possibility of making use of some yet-to-be-developed measure for “article impact” (in the event that it is proposed and adopted by the Academy). Finally, PLoS would like to include Google Scholar data (which is available to users without cost), but this is dependent on developments at Google Scholar itself.

5.4. Drawbacks of Article Level Metrics

Any measurement system of this type has inherent flaws relating to the ability to

“game” each individual measure; the lack of confidence in being able to compare one measure against another between different publishers; disagreements as to the utility of each metric; and the lack of confidence that all relevant data points are being picked up for each metric.

In addition, these developments are likely to stimulate a renewed debate as to whether or not measurements of this type are actually helpful or necessary. Although the academic community appears to have accepted the Impact Factor, there is likely to be a reluctance to further outsource the quantification of academic worth to yet more numerical measures. Related to this is the fact that it will be very important that the community interprets these measures correctly. It would be a great disappointment if academia were to replace one badly interpreted metric (the impact factor) with an alternate badly interpreted one!

It is also important to recognize that some things are very difficult to quantify. For example, measures related to “authority” (of the author, or the work) are very hard to quantify and understand [22]. Other examples are the difficulties that exist when trying to measure the effects of clinical articles on practice, or in measuring the effect that an article has had on changing public policy – such articles might get very few citations, although they may generate considerable media coverage. Therefore, it is clear that the simple measures initially adopted by PLoS may not be adequate for certain concepts or certain article types, and that more work will be needed to gain a more complete picture for any given article.

PLoS fully accepts that it publishes just seven titles among a worldwide output of almost 24,000 [23]. Above all, PLoS is firmly of the belief that the best way to tackle this problem will be for publishers to adopt accepted standards, for the academic community to provide input and buy-in, and for the resulting datasets to be delivered in an open and transparent manner. Only in this way is academia likely to develop new tools and ultimately adopt new practices in this area of research assessment. Whatever measures PLoS might develop, it is unlikely to get them all right and so PLoS hopes that this program will inspire others to pursue this problem, and looks forward to being at the forefront of new developments in collaboration with academia and other publishers.

Finally, there is clearly no substitute for actually reading articles and forming a critical opinion, as to their contribution and value. However, in an era in which at least 1.3 million articles [23, 24] are published every year, it is clear that appropriate computational tools are also needed to help the reader navigate the literature and make informed decisions as to which articles to read.

6. Engaging the Community

PLoS has several stakeholder groups, each of which is engaged via a variety of channels. In every case, PLoS is looking to expand knowledge of its communities and to seek input from those groups in order to help improve its service levels.

PLoS ONE in particular is extremely pro-active in interactions with its (current and future) authors, reviewers, readers, editorial board, and other members of the general public. In most cases, this engagement is conducted using free, or highly cost-effective online tools. Specifically, *PLoS ONE* engages its communities via the following PLoS-wide, or *PLoS ONE*-specific, channels:

Blogs: *PLoS ONE* operates *everyONE* (<http://everyone.plos.org>), a “community blog” intended for authors, readers and supporters of the journal. This blog runs on the Wordpress platform and generates a significant amount of traffic. It is used as the primary communication vehicle for the community, and individuals are encouraged to go there to find out what is happening at the journal. In addition, PLoS itself has a blog that it uses for announcements of wider PLoS interest.

Discussion Forums: *PLoS ONE* operates a private discussion forum for its editorial board (which consists of almost 800 academic editors). This forum runs on the CollectiveX service and allows the editorial board to engage in private debates and explore issues of interest to the journal in a user friendly online environment.

Online Discussion Expert: Possibly unique among academic publishers, *PLoS ONE* employs an “online discussion expert,” Bora Zivkovic, who is charged with engaging the blogosphere and promoting PLoS activities through that channel. Zivkovic also writes about PLoS on ‘A Blog Around the Clock’ (<http://scienceblogs.com/clock/>), his private blog, which is one of the most well respected science blogs in the world.

Social Media: PLoS has a vibrant “plos.org” Facebook group of almost 4,000, and this group is used on a daily basis by a large proportion of those registrants. PLoS operates a Twitter stream (<http://twitter.com/plos>) and posts regularly to a following of over 800 (in addition, several other PLoS staff twitter regularly). *PLoS ONE* also operates a FriendFeed room (<http://friendfeed.com/rooms/plosone>), into which it feeds its current content, its blog output, and the PLoS Twitter stream. Engagement by the “online discussion expert” ensures that the content is regularly discussed and refreshed.

User Feedback: *PLoS ONE* conducts regular online surveys to its author and reader base and uses their feedback to adapt policies. PLoS also conducts online focus groups with groups of individuals.

Blogosphere Engagement: Unlike many media outlets, in addition to seeking cov-

erage in the mainstream news media, PLoS cultivates the blogosphere. Bloggers are given equal membership (as compared to traditional journalists) to the PLoS press list and PLoS' online discussion expert is an active blogger in his own right.

7. Conclusion

PLoS ONE demonstrates the utility of a suite of new tools, new philosophies, and new attitudes, which may yet indicate the future direction of the academic journal. Allied to this, PLoS has demonstrated that it is feasible and realistic to provide metrics at the article level for all of its titles.

PLoS views article-level metrics as a topic of fundamental significance to the publishing process and will be actively developing these measures going forward. Any publisher who shares the view that the article itself is more important than the journal in which it is published, could replicate these measures, and PLoS would be happy to share its methodology. Assuming the Academy finds these measures of use, then it is felt that standards should be developed and adopted that would carefully define each metric, in order to allow cross-platform comparisons and open-analysis of data sets. As such, PLoS hopes to be involved in the development of these standards, along with other interested parties.

PLoS ONE is built very much on the notion that it is a service provider for the academic community and that article publication is the start of a process of academic engagement, not the end. Therefore, it is expected that the journal will continue to seek new ways to improve the service it provides to the academic community; to provide pre- and post-publication tools that add value; to enhance the organization of its content; to facilitate data mining; and to improve the ability of each user to filter content in the most appropriate way for their own use.

Finally, as PLoS moves forward, it will continue to explore how all open content can be used, combined and re-used, both from its own journals and beyond.

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References

- [1] <http://www.plos.org/about/faq.html#plosjournals>.
- [2] <http://www.plosone.org>.

- [3] <http://www.ncbi.nlm.nih.gov/sites/entrez>.
- [4] <http://www.plosone.org/static/review.action>.
- [5] <http://www.plosone.org/static/review.action>.
- [6] http://www.lockss.org/lockss/Public_Library_of_Science.
- [7] ADIE, E. "Commenting on scientific articles (PLoS edition)", writing in the *Nascent blog*, February 11th, 2009 (http://blogs.nature.com/wp/nascent/2009/02/commenting_on_scientific_artic.html).
- [8] NEYLON, C. "Can post publication peer review work? The PLoS ONE report card", writing in the *Science In The Open blog*, August 27th, 2008 (<http://blog.openwetware.org/scienceintheopen/2008/08/27/can-post-publication-peer-review-work-the-plos-one-report-card/>).
- [9] SINGH, D. "Peering into PLoS ONE Comment Stats", writing in the *bbgm blog*, August 27th, 2008 (<http://mndoci.com/blog/2008/08/27/peering-into-plos-one-comment-stats/>).
- [10] <http://www.plosone.org/article/browseVolume.action>.
- [11] ADLER, R., EWING, J. and TAYLOR, P. "Citation Statistics: A report from the International Mathematical Union (IMU) in cooperation with the International Council of Industrial and Applied Mathematics (ICIAM) and the Institute of Mathematical Statistics (IMS)", June 2008 (<http://www.mathunion.org/fileadmin/IMU/Report/CitationStatistics.pdf>).
- [12] BRUMBACK, R.A., "Impact Factor Wars: Episode V_The Empire Strikes Back" *Journal of Child Neurology*, Vol 24, No 3, pp 260-262, March 2009.
- [13] <http://highwire.stanford.edu/>.
- [14] WATSON, A.B., "Measuring demand for online articles at the Journal of Vision", *Journal of Vision*, Vol 7, No 7, pp 1-3, May 2007 (<http://journalofvision.org/7/7/i/>).
- [15] <http://frontiersin.org/evaluationsystem/>.
- [16] CAVE, R. "PLoS Journals upgrade to Topaz 0.9.2", writing in the *PLoS blog*, March 26th, 2008 (<http://www.plos.org/cms/node/459>).
- [17] PATTERSON, M. "Article redesign on PLoS Journals", writing in the *PLoS blog*, March 31st, 2008 (<http://www.plos.org/cms/node/460>).
- [18] BINFIELD, P. "Newly Launched Features on our Online Platform" writing in the *everyONE blog*, March 31st, 2008 (<http://everyone.plos.org/2009/03/31/newly-launched-features-on-our-online-platform/>)
- [19] <http://www.plosone.org/article/related/info%3Adoi%2F10.1371%2Fjournal.pone.0000443>.
- [20] <http://www.plosone.org/article/related/info%3Adoi%2F10.1371%2Fjournal.pone.0000085>.
- [21] BRODY, T., GEDYE, R., MACINTYRE, R., NEEDHAM, P., PENTZ, E., RUMSEY, S. and SHEPHERD, P., "Publisher and Institutional Repository Us-

age Statistics (PIRUS): Developing a global standard to enable the recording, reporting and consolidation of online usage statistics for individual journal articles hosted by institutional repositories, publishers and other entities”, Final Report, Jan 2009 (<http://www.jisc.ac.uk/whatwedo/programmes/pals3/pirus.aspx>).

- [22] JENSEN, M. “The New Metrics of Scholarly Authority”, *The Chronicle of Higher Education*, Vol 53, Iss 41, pp B6, June 15th, 2007.
- [23] BJÖRK, B., ROOSR, A. and LAURI, M. “Global annual volume of peer reviewed scholarly articles and the share available via different open access options”, Proc. *ELPUB2008. Open Scholarship: Authority, Community, and Sustainability in the Age of Web 2.0 - the 12th International Conference on Electronic Publishing*. ISBN 978-0-7727-6315-0, 2008, pp. 178-186 (http://elpub.scix.net/cgi-bin/works/Show?178_elpub2008).
- [24] U.K. Parliament. “Appendix 46. Memorandum from Reed Elsevier”, *Select Committee on Science and Technology* (2004). *Scientific publications: free for all? Tenth Report of Session 2003-04. Volume 2. Oral and written evidence*. London: Parliament. (<http://www.publications.parliament.uk/pa/cm200304/cmselect/cmsctech/399/399we57.htm>).

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