A DIGITAL MOB IN THE IVORY TOWER? CONTEXT COLLAPSE IN SCHOLARLY COMMUNICATION ONLINE

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Abstract: What are the effects of digital media on scholarly communication, both internal and external, and how do scholars react to the problem of context collapse, the situation that arises when internal communication among peers is suddenly put under public scrutiny? We approach this question by reviewing and contrasting the different functions of scholarly publishing and science communication for the academic community through a series of cases, and then discussing the relative reluctance of scholars to engage with new social media channels, such as blogs and Twitter, before this background. We close by describing different definitions of scholarly impact, and the role of novel approaches to evaluation that involve not just the academic community, but a wide variety of stakeholders.

1. Introduction

Around the 30th of June 2014 an intense debate erupted on the Internet about a psychological experiment conducted by three researchers at Facebook, the University of California, and Cornell University. The scientists aimed to test the hypothesis that emotions are contagious, that is, that happiness and sadness can spread from one person to the next by exposure. This phenomenon was previously known from laboratory settings, but it had never been studied in a computer-mediated setting and on a large sample of subjects before. In the experiment, conducted in early 2012, close to 700,000 Facebook users were randomly selected and their News Feed was adjusted to filter out specific posts with positive and negative emotion words, posts that the users would normally have been exposed to. Subsequently the emotional content of the subjects' posts in the following period was studied. The study found that users exposed to less negative emotive content would also post fewer negative status updates, and that those exposed to fewer positive emotions would in turn post fewer negative status updates, though the observed effect size was

small. No content was added to the News Feed of any users, and the percentage of posts filtered out in this fashion from the News Feed was very small.

The results of the study were published in *Proceedings of the National Academy of Sciences* (PNAS), a very reputable journal, as an open access article (Kramer, Guillory & Hancock 2014). Ironically, the openness of the article and the fact that it was digitally available may have considerably spurred the furor that erupted a month after the publication of the original article, when the piece was picked up first by *The Atlantic*, *Forbes*, *Venture Beat*, *The Independent*, *The New York Times*, *The Wall Street Journal* and *The Financial Times*, and then by a number of scholars and privacy activists. The British parliament considered an official inquiry to investigate whether users rights had been breached in the course of the study. The first author, Adam Kramer, published a response via Facebook in which he noted that it had not been the aim of the study to cause anxiety among users and surmised that the company had made numerous improvements since the experiment had been first conducted (Kramer 2014). Facebook's chief operating officer, Sheryl Sandberg, remarked in a statement to *The Wall Street Journal* that the study "had been poorly communicated" (Krishna 2014).

The controversy surrounding the study touched a wide range of issues, from research ethics to privacy to the representation of scientific research in the media. Scientific controversies followed by mediated disputes are hardly new (cf. Nerlich & Halliday 2007; Saguy & Almeling 2008). Yet, one aspect of the research was largely overlooked in the debate following its publication, namely that it reached a very large and heterogeneous audience by being published in an open access publication, and that this apparently contributed to its controversial reception, which, in turn, was in part a result of the configuration of the discourse: scientists (i) with access to a huge trove of user data, (ii) reporting on analyzing that data, (iii) influencing the behavior of their test subjects without their knowledge, and (iv) doing so in the privileged environment of an academic journal. It is ironic that the very fact that this research was openly published led to a significant backlash, yet it also demonstrated the tensions embedded in the exclusivity of academic discourse.

2. Scholarly Discourse and Science Communication: Convergence and Diversification

Let us approach these tensions by examining the relationship of scholarly communication and the Internet. The great proliferation of

digital technology in Western countries in the past two decades has dramatically altered access to information, making it significantly cheaper, faster, and more varied, with far-reaching implications for science and scholarship (Borgman 2007). High hopes exist with regards to the ability of new technologies to improve science, and yet not all of these have been fulfilled so far. One reason for this is the opposition between what is technologically possible and what furthers or conflicts with the vested interests of established actors in the ecosystem of scholarly communication.

The differentiation of *internal communication* (scholarly discourse) and *external communication* (science communication) has been blurred considerably in recent years, both by societal forces pressing for more transparency in publicly funded research and by the advent of digital media. Scandals involving the falsification of research results and unethical practices in science are unlikely to have strengthened the public's faith in science. Perhaps even more importantly, an increasing democratization of information and knowledge more generally has spurred the demand for constant interaction of science with other societal actors. How science is assessed by government, the media, the business world, and NGOs, plays an increasingly important role, both in forms of direct assessment and evaluation, but also in the competition for societal recognition and acceptance. Public outrage over research that is considered unethical or unnecessary arguably has a growing impact, and scientists must work to gain and sustain the public's trust. Enlisting public support is a key objective in approaches such as crowd science and virtual citizen science, which also aim to change not only scholarly communication, but the fashion in which research itself is conducted.

Science communication and scholarly discourse historically play very different roles. While science is inconceivable without scholarly discourse, science communication is a relatively recent invention, born out of the need to legitimize big science projects in the postwar period of the 20th century. In the following we will discuss science communication in the mass media and how it has been impacted by the shift towards digital communication.

Furthermore, we focus on the role of social media for new regimes of evaluating scientific impact, and that these new regimes are set to serve as important indices of scientific legitimacy in the future. We argue that social media has an important role to play in the future because it enables the seamless evaluation of all forms of scholarly output by a diverse community of stakeholders, and that the need to engage such a community is the plausible outcome of a democratization of knowledge, a configuration of conspiring technological and social change that Christine

Borgman refers to as a "co-evolution of technology and behavior" (2008:4).We begin by discussing the increasing codependence of science and media from a perpetrated ideal state of scientific independence to one of growing reliance of science on public legitimization through the media. We furthermore focus on the legitimatory role of social media in particular, its popularity adding to the pressure to "open" science up, a trend that historically reaches back much further. Finally, we examine alternative regimes of evaluating scientific impact, so-called *altmetrics*, which offer new ways of evaluating how scholarly output is received. We argue that, in the long run, scholarly communication is likely to follow certain broader trends initiated by shifts in the configuration of genres and actors, to both *diversify* and *consolidate* its form. We discuss the evolution of digital scholarly communication and its impact on three levels, namely:

(1) the distinction between formal and informal communication;
(2) the distinction between front stage and back stage in knowledge production;
(3) the distinction between different forms of impact (allocated by experts vs. allocated by the broader public).

We furthermore identify aspects of scholarly communication that are functionally stable and contrast them with aspects which are subject to change and diversification.

3. The Digital Evolution of Scholarly Communication

While initially a novel and exotic phenomenon, Computer-Mediated Communication between individuals has since its inception become a thoroughly mundane mode of communication, fully integrated with both face-to-face communication and the mass media (Baron 2008). We live in increasingly mediatized environments, in which communication through an array of digital devices which are constantly connected to the Internet is the norm (Deuze 2012). While there are significant discrepancies in its distributions, the spread of digital media is no longer restricted to Western countries, but is firmly established in emerging economies and has achieved a critical size even in poorer countries (International Telecommunications Union 2014). Roughly one third of the world's population have some degree of access to the Internet, and growth with regards to general access, but also with respect to usage intensity, is robust.

It has been widely argued that the Internet facilitates open debate among equals, reducing the technical and organizational barriers that otherwise inhibit the open flow of knowledge and ideas (Shirky 2008). Among other areas, this also extends to science, and accordingly arguments have been made for the increased integration of social media into the established modes of academic discourse, with the aim of reshaping expert communication in order to make it more open and pluralistic (Weinberger 2012). It is not purely due to technological innovation that this situation arises: there is also a political focus on achieving "a democratization of science" (Wilkins 2008:411) through more open dissemination of scholarly research. From demanding access to scholarly research results (*open access*) to opening the entire research process to public scrutiny (*open science*), the notion that science should be a more participatory endeavor is taking hold, though it remains to be seen whether this is merely a short-term fad or a more sustained development. This push for more democratization is not restricted to publishing, but seeks to encompass all stages of the research process. Open science aims to make research increasingly transparent under the banner of public stakeholdership in science. Rather than merely making the fruits of scholarly research available to the public, citizens are increasingly regarded as active stakeholders in the scientific process.

This pressure is accompanied by both a diversification and magnification with regards to the role of the media for science. Whereas mass media has an important role as an intermediary in the dissemination of scientific concepts and popularization of scientific fields, the role of social media is more complex, as it serves to blur the boundary between different, previously seemingly neatly divided modes of scholarly discourse and between different, previously clearly delineated stakeholder roles.

4. Formal and Informal Functions of Scholarly Discourse

Academic research is founded on communication. Meadows (1998) points out the defining role of early journals not just for the dissemination of scholarly knowledge, but for the constitution of science as such, pointing its historical origins. Scholarly communication can at the onset be defined as being associated both with a particular goal and with a specific professional community (Borgman & Furner 2005). Beyond both of these areas, the exchange of information and the transmission of knowledge obviously also take place in a variety of settings and among numerous actors.

Borgman (2007) differentiates between three core functions of scholarly communication: (i) *legitimization*, (ii) *dissemination*, and (iii) *access*, *preservation* and *curation*. The second and third aspects have been profoundly impacted by digitization. Research is disseminated more rapidly through digital publishing than was previously the case, and has the potential of reaching broader audiences, both scholarly and public. A combination of well-established, traditional and novel means are used to promote publications, such as disseminating review copies, but also tweeting about one's research (Bar-Ilan et al. 2012; Mahrt, Weller & Peters 2014). Digital archiving and curation has also sought to keep pace with technological developments, with an ever growing number of repositories and digital archives to insure the long-term availability of content. Measures such as the introduction of persistent identifiers (DOI for publications, ORCID for authors) have been taken to standardize access and make retrieving, saving and citing easier for authors. Legitimization is established in a number of ways: through publication in prestigious journals, by means of quantitative indicators such as the journal impact factor, and via citation numbers of articles. The latter have recently been joined by a large number of additional quantitative indicators in conjunction with the so-called *altmetrics* movement, which aims to assess impact coming from a number of sources, such as downloads, Facebook likes, Twitter retweets, Mendeley saves and other sources. Legitimization may well be the distinctive feature of scholarly communication. Borgman (2007:76) notes that "self-publishing is an oxymoron in the scholarly world" – dissemination of content without licensing through peer-review means nothing in terms of academic achievement. What is more, the combination of different strata of legitimization is crucial: publishers, libraries, and the media all have a role to play. As different forms of communication converge, with a greater variety of actors engaging with one another, "research in general and science in particular are less isolated from society" (Borgman 2007:83). Greater convergence of different academic fields and of applied and basic research are affected in this way, as are science and society more broadly.

For centuries the distinction between formal and informal scholarly communication was medially underpinned by the one being ephemeral, while the other was permanent. This is no longer an issue, as virtually all digital content can be considered permanent and the importance of other indicators of scientific quality has therefore been increased accordingly. The style and presentation of a scholarly work identify it as such, as does peer review, the most crucial component. The core criteria distinguishing scholarly communication from other kinds of discourse is that value

judgments by third parties – reviewers, evaluators, advisors – are made to license knowledge as established, and accordingly much of the processes of licensing is central to scholarly communication in terms of the time, energy, and money allocated to it.

Formal scholarly communication is conducted in a variety of well-established formats, such as monographs, journal articles, book chapters in edited collections, and conference papers. While a range of genres and subgenres exist, there are also significant differences. Whereas papers in conference proceedings have little significance in the humanities, they are of high prestige in computer science, partly due to the field's long history of distributing publications electronically. In the life sciences, but also in the behavioral and social sciences, journal articles are the most prestigious form of publishing, though there are considerable differences with regards to the allocation of prestige. While some fields strongly follow quantitative measures such as Thompson Reuters journal impact factor, others allocate prestige more strongly through 'soft' factors, such as the reputation of the editors, the editorial board, or the publisher.

The formal characteristics of publications differ strongly from one field to another, in terms of style, length and integration of empirical data. Some fields are also considerably more uniform than others in terms of how they organize and present their research. The age of the respective formats also differ, with conference papers being a fairly recent innovation whereas scholarly monographs follow a long tradition. The tandem role of technology and the evolution of formats, driven by cultural change and the increasing professionalization of science, also becomes quite apparent in this context. In addition to differences in fields and their adoption of new technology notwithstanding, scholarly texts have changed with their mode of distribution, from monographs which were delivered in long form for economic reasons to conference papers which have become more prevalent as proceedings can be delivered electronically.

The previous two decades have seen a considerable market concentration in academic publishing, and it seems very likely that this trend will continue. While differences in this area too are significant, technological shifts towards digital publishing mean that smaller private publishers and university presses are under great pressure to remain competitive. While the number of academic publications overall continues to grow, large corporate actors are controlling ever larger market shares (Jinha 2010). These companies are also able to publish digital content in the appropriate quality through their publication platforms, making them much more likely to persevere in the future than smaller competitors who may not survive the transition to a fully digital scholarly ecosystem

(Houghton 2010). The technological changes have by now long reached all publishers, whether in the sciences or the humanities. Both journals and monographs are by now published digitally, with many areas already fully or significantly reliant on digital texts for all aspects of scholarly knowledge exchange. It is clear that in these contexts, rather than having any material aspect, the terms 'book' and 'journal' are simply metaphors, but this does not impede their salience. Scholarly communication seems set to become fully digital in the course of the next few years, both as a result of policy initiatives, economic pressure, and usage practices that facilitate this change. This development is a notable contrast to (for example) literary publishing, where the dynamics are quite different, and readers are considerably less utilitarian in their expectations.

5. The Lasting Importance of Peer Review

The cornerstone of scholarly communication is peer review. It is hard to overstate its universal importance, and easy to underrate it in relation to technological or economic aspects of academic publishing. As we will argue in the course of this chapter, scholarship has proven to be very adaptable when it comes to certain aspects of scholarly communication, but resistant to change in others. Peer review is one such point where we observe a large degree of stability in practices, even though there have been calls to innovate peer review through alternative or variant procedures (van Rooyen et al. 1999). Peer review plays such as crucial role in formal scholarly communication because it licenses the quality of the research and certifies it as scientific content. This is crucial for the accumulation of scholarly credit, on which junior academics rely in order to achieve tenure and promotion. As competition in science continues to grow, so does the pressure to collect as many tokens of scholarly quality as possible. The more competitive a field is, the more likely it is that only those junior researchers with a strong and unwavering focus on certified forms of knowledge dissemination in the shape of formal publications will succeed, while competitors will fall behind (Merton 1968).

While the economics and the technology underpinning scholarly publication have changed dramatically in the course of the last decades, this is not the case with regards to the scholarly value system, which has remained stable. The core aim of researchers is to acquire status and build a reputation, to which the production of certified knowledge makes a major contribution. The certification process, as described above, is under discussion in respect to its potential for optimization, but the underlying idea that knowledge must be certified by other (more senior) researchers is

alive and well. The accumulation of social capital in the scholarly community is the key prerequisite for tenure and promotion, and carries further secondary rewards, such as funding and public visibility. Scholars compete for scarce resources when they apply for grants or professorships, and in this process the certification of quality by peers is crucial. The pressure to acquire a high level of certification is greatest where the competition is strongest and where the value attached to standardized forms of certification is most significant, such as in the hard sciences, with well-established large scale journals and high impact factors. This situation of sustained competition affects the way in which scientists communicate, because it forces them to plan communication strategically and regard its product as their capital. Creating a publishing record becomes paramount, particularly to junior scholars.

A central role in the context of accruing social capital is that of *invisible colleges* (Crane 1969), that is, communities of scholars that work together, cite one another and progress together in terms of career development, without being formally affiliated, part of the same institution, or geographically proximate to each other. The existence of invisible colleges in particular contributes to the importance of informal digital communication, as it seems likely that communication patterns in email, Twitter, and other channels will reveal invisible colleges to a degree.

Informal scholarly communication has traditionally played a considerably less noticeable role than formal communication. Preprints have been circulated since the beginning of the system of journal publishing, and the importance of personal correspondence was established long before this system was put into place, and before credit and reward became paramount as a result of the professionalization of science. This professionalization went hand in hand with the formalization of its genres, an observation that we will return to later. The rise of digital communication has made informal genres of scholarly discourse much more visible than was previously the case. Mailing lists, message boards, scholarly blogging and social media all play an increasingly important role in informal scholarly discourse, but this role is so far unrelated to the certification of knowledge that translates into scholarly credit which we have described. Informal communication is hard to evaluate because it does not serve the licensing function of formal scholarly communication as it generally lacks peer review. This hardly diminishes its role, as the result of several surveys shows (see below). Scholars regardless of age and discipline strongly rely on different tools for informal scholarly communication, be it email to discuss research with colleagues, mailing

lists to exchange news regarding job vacancies, conference calls and research projects, or blogs to publicize their research or share ideas. Mediated informal scholarly communication plays an important role and can be assumed to have increased significantly, considering the wide array of channels that can be used to conduct it (cf. Barjak 2006; Gruzd, Staves & Wilk 2012; Levine, Boehm & Christensen 2013; Lupton 2014). This is unlikely to have impinged on face-to-face interaction, rather it seems likely that scholars simply communicate more in general, and more visibly. But while the significance of informal scholarly communication to scholars is undiminished, it does not yet play any formal role in acquiring status, at least not one that would be easily observable. While scholars doubtlessly benefit from connecting to peers and sharing information, these benefits are less immediate than those derived from social capital gained through formal publishing. It is still a requirement for researchers to publish formally – their informal communication is merely a valuable extra that has added benefits for them.

Informal scholarly communication in social media arguably plays a role in addition to formal publishing, but it shows absolutely no tendencies to displace publishing in scholarly journals, monographs or conference papers (Bader, Fritz & Gloning 2012; Levine, Boehm & Christensen 2013; Pscheida, Albrecht, Herbst, Minet & Köhler 2013). Whereas informal discourse has a role to disseminate, discuss, reference and curate the output of scholarship, it does not infringe on that primary output, but merely frames it. The fact that informal scholarly communication is increasingly recorded and sometimes also public (as is the case with blogs and Twitter) opens it up as a resource for the study of scholarly communication more broadly (Mortensen & Walker 2002; Mauranen 2013).

6. Front Stage and Back Stage in Academia

Both formal and informal scholarly communication have become much more publicly visible than was previously the case, with far-reaching consequences. As scholarly communication is conducted digitally and increasingly also open access, the work of scientists is increasingly publically scrutinized, to the extent that it also draws more attention from the media and the general public (Borgman 2007; Evans & Reimer 2009). Previously research results could be assumed to be read first and foremost by other scientists, though it has been shown that much published research is never read by anyone at all apart from its author and the reviewer.

The push for more openness has significant implications for the *front stage/back stage* distinction that characterizes science. Sociologists of science argue that belonging to a particular epistemic culture is constituted by specific codes, practices and beliefs that form the basis of the scientific community (Knorr-Cetina 1999). But membership is inherently exclusionary: only by barring others from joining the club can the club be upheld. This poses problems when the codes which index group membership are exchanged under a degree of public scrutiny, at least to the extent that it is less clear who has access to what is being exchanged and what potential exists for misrepresentation. The case cited at the beginning of this chapter attests to this problem of *context collapse* (Marwick & Boyd 2010). In the case of the Facebook study, a published article was scrutinized first by the press and then by bloggers, activists and scholars. But since the article was online, many responses, both in the press and by bloggers, did not merely discuss the study abstractly, but linked directly to the source. The author, Adam Kramer, wrote a response on his Facebook page that he later referred to as an official response. What this and similar examples underpin is the loss of a definitive separation between audiences and discussants. The availability of the research results enables a much broader scrutiny than would have been the case under different circumstances.

7. Science, the Media, and the Public

In a classic essay on the sociology of science, Robert K. Merton (1973) notes how the relationship of science and society has shifted multiple times in its development from the 17th to the 20thcentury. He recalls how the entrenchment of modern science from the early struggles of the natural philosophers to attain legitimacy eventually led to the post-war scientist to regard himself "as independent of society" and to see science as "a self-validating enterprise which was in society but not of it" (Merton 1973:268). Arguably the relationship of science with the broader public has changed significantly in Western societies in recent decades as a result of social change. The "frontal assault on the autonomy of science"(1973:268) that Merton described in the 1970s has given way to much more pragmatic regimes of science policy. This viewpoint that sees science *in* society, rather than distinct from it, is captured by the concept of the triple helix of science, government and industry (Etzkowitz & Leydesdorff 2000). Science is hardly seen as independent of society anymore by most sociologists of science, but rather as both constitutive to and a product of the post-industrial knowledge society.

Shifts in science policy and the ascendency of the mass media have both had a combined influence on this development. Weingart (1998) thoroughly criticizes the traditional dichotomous view of science and the general public, in which the mass media acts as intermediate between the two. As he points out, in such a view science possesses an implicit monopoly on factual knowledge, while the public relies only on meager common sense. In this view the media acts as science's "translator and propagandist" (Weingart 1998:870), seeking to win the public's support. The relationship is one of extreme asymmetry: science establishes facts and disseminates them to the public, with journalists taking on the role of mediators. Media and science are alike, Weingart points out, in that media creates its own reality and actively sets an agenda. He further argues that while interaction between science and the public is nothing new "[n]ovelty is in the form and intensity which emanates from a closer connection between science and its social environment as well as the new role of the media in observing this connection" (1998:872).

In descriptions of science and the public as sociotechnical systems, both are frequently treated as discrete and opposed forces, with scientists seen as rational and informed by logic, and the public as irrational, emotional and inherently unpredictable (Cook, Pieri & Robbins 2004). Cook et al. provide a detailed study of how the public is characterized by scientists in a series of interviews with academics and find that it is both regarded as passive, fearful, incapable of grasping risk, and as in need of education. Not only is there an inherent rift between experts and laypersons in such a model, there is also a power imbalance between the two parties: whereas scientists articulate demands towards the public and are disappointed if they are not met, the public lacks understanding of complex scientific issues and must be educated (Jacoby & Gonzales 1991). In practice, however, the perception of the actual situation is markedly at odds with this characterization. Science and the public are both much more diversified and fuzzy than their neat rhetorical separation would make us believe, and their relationship has a much less hierarchical character than in the bygone era of big science. Scholars in the twenty-first century are engaged in a constant competition not only for the acceptance and endorsement of their colleagues in peer review, grant applications, and tenure proceedings, but they also struggle for public recognition in the mass media and, increasingly, in digital media.

Meanwhile, the relationship between science and journalism is frequently characterized as being strained by tensions as a result of the asymmetry in power and authority. Dornan (1990:48) accuses the media of "prescriptive agitations" and Colson (2011:892) refers to "a kind of

contempt displayed by scientists towards the media", while scientists are seen as arrogant by journalists. This differs from the situation inside science, due to its hierarchical organization. As Leah Lievrouw (1990:9) points out, "scientists as a subculture share very similar values about their work and can persuade one another of the value of their research based on a reasonably consistent set of standards and conventions". At the same time, science journalism has historically played an important role in reinforcing the authority of science as pristine, pure and at once superior to and outside of popular culture (cf. Fürsich & Lester 1996, who speak of a paradox situation). Lievrouw (1990) equates informal communication with face to face communication, highlighting the medial distinction between the two that prevailed up the 1990s. It is helpful to distinguish different aspects of scholarly communication and different stages in its evolution. It is also helpful to differentiate between micro and macro level communication (discourse among individual scholars vs. systemic change), and between a procedural view (often taken by science studies and the studies of the sociology of knowledge) and a view focused on the products of scholarly discourse (often taken in information science and bibliometrics).

Lievrouw (1990) further describes scholarly communication as a three-stage process in which knowledge is first *conceptualized*, then *documented*, and finally *popularized*. Mass media plays an important part in the third step of this process, but is traditionally excluded from the first two. The conceptualization of new knowledge occurs informally in hallway conversation and laboratory meetings, in notes and through email. The second stage, documentation, is concerned with bringing knowledge into a form that allows presentation. Finally, in the third stage scientific research is popularized. That is, communicated to a broader public. Importantly, the process of popularizing in research is in essence a process of assimilation in which compatible material is integrated into an already established theme. One example here is that of cold fusion research in the United States, an issue that received much attention because of its compatibility with public concerns. Hot fusion was regarded as dangerous and dirty, while cold fusion promised to be cheaper, safer and more efficient, and to offer the same advantages as traditional energy sources. Popularization is not merely a random effort. Rather, it is necessary to enlist support in the form of funding (which enables future research) public interest (which, among other things, helps to recruit junior researchers), political support (which can result in boost in attention and prestige), and other gains which cannot be obtained through internal communication. Work in the sociology of science has pointed to this

interdependence of scientific communities and the role of consensus to establish scientific findings as facts, to be presented to the public.

8. From Dissemination to (More) Participation?

The relation of science and the media has been impacted considerably by the advent of social media, which enables a much broader participation in the scholarly process than is the case in traditional broadcasting or print formats. What Weingart (1998) calls the *science-media-coupling* in the 1990s could have been circumvented by a complex interdependence of science with a variety of actors who communicate through digital media and conduct what in political communication is referred to as a *permanent campaign* (Larsson 2014), an environment in which political actors are constantly vying for attention. While the mass media discussed by Lievrouw (1990) and Weingart (1998) is a social system of actors, digital media rather presents an infrastructure for communication and interaction that connects both established actors and systems of actors, and lends a stage to new ones. The technical infrastructure represents a powerful enabler of both old and new actors which facilitates a diversification of participants.

Weingart (1998) uses the term *medialization* to describe the media's impact on science. A similar set of effects can be applied to the impact of digital media on science, which partly overlaps with the characteristics of broadcast media and partly differs, as a result of the technicity of digital media. In online platforms, the individual is arguably the most salient category of representation. Self-representation permeates all levels of social media use. In science, countless indicators exist to measure and represent the impact of a scholar in a growing number of services and platforms.

Bucchi (1996) describes innovative forces in science communication beyond the canonical dissemination and mediation approach. In the classical model, scientific facts are mediated by professional communicators (usually journalists) to a lay audience. Not only are all three parties distinct from one another, they also have different capabilities and are assigned different roles: while the scientific content emanates from science, it is considered too complex and difficult for laypersons to assess. In the prominent metaphorical use, mediators must translate complex scientific knowledge to the public, necessarily 'dumbing down' the scientific facts. Both scientists and journalists play an active role, while the public remains a passive recipient. As Bucchi critically notes, the blame for 'miscommunication' is usually assigned to journalists for

misrepresenting and to the public for misunderstanding scientific research, whereas scientists themselves are relatively unscrutinized. He aptly points out that rather than just concerning how scientists enter the media, there is increasing incursion of the public into science. In the same vein, Colson (2011) presents the result of a study on the relationship of science journalism and science blogging that highlights the tensions that arise as a result of a technological shift. Her study reveals that science journalists are skeptical of academics who blog, and that academics in turn see blogging as a way of circumventing the mass media − a step that is seen as an opportunity by Hermida (2010:80), who argues that "science journalism must continue to evolve and must now look beyond the print model and its inherent limitations". Shanahan (2011) describes scholarly blogs as "boundary layers" that create new writer-reader interactions. In contrast to traditional science journalism, the distance between writer and reader is greatly reduced in blogging. Whereas the science journalist takes on the role of translator or guide, science bloggers are forced to more directly interact with audiences. They are motivated by engaging in discussion and participating in debates about the topics they raise in their blogs (Puschmann & Mahrt 2012; Shema, Bar-Ilan & Thelwall 2012).

It is worth pointing out that enlisting the public is by no means a novel phenomenon in scholarly communication. Bucchi (1996) describes the kind of constitutive boundary work that takes place to constitutionalize new fields to the public at large. Examples from the 19th century, a period in which modern science had to establish its authority, illustrate how actively engaging laypersons played a considerable role in the motives of scientists such as Helmholtz. Whereas 19th century mediatization ultimately aimed to disseminate results to the public so as to enlist its support for scientific endeavors, proponents of open science see social media as an instrument for the co-production of knowledge. This dynamic challenges the traditional role configuration of expert and layperson, posing potential threats to the organizational structure of science.

9. Adoption of Social Media in Science

In spite of many calls for more integration of social media into science to fill the demand of making science "more open", reactions have been mixed. The internet arguably plays an increasingly important role in how academics present themselves both to peers and to broader publics. The convergence of all forms of digital technology and their proliferation into all spheres of life has spurred this development. Over time, the attitude towards social media in science has become more integrative, for example

Priem, Piwowar and Hemminger (2012:2) contend that "these tools do not create new types of scholarly practice so much as they facilitate existing practice". In a similar vein, Colson (2011:890) cites biochemist and blogger Daniel Brown: "science bloggers run the gamut of career levels, from lay people with a strong interest in science to teachers, graduate students, postdocs, and an increasing number of principal investigators".

Borgman and Furner (2005:4) describe the process of scholarly communication as becoming ever-more integrated: "The cycle of scholarly activities is blending into a continuous, looping flow, as people discuss, write, share, and seek information through networked information systems." They list the countless devices that can be used to access and disseminate digital information, and the numerous formats and data types they support. These formats are in turn increasingly dynamic in being available for constant updating and editing, rather than remaining static. The authors highlight the particular role of bibliometrics for the ongoing assessment of science in the context of growing integration and an increasingly utilitarian view of academia. This applies particularly to the social life of scholarly publications (Brown & Duguid 1995, in Borgman & Furner 2005). Anderson (1997:27) highlights the role of communication technology for science, finding that scholars who communicate more are also more productive. As a result of the increased mobility and connectivity brought about by the Internet, she goes on to argue that "the potential for greater inclusiveness in the invisible college brought about by scholars' use of computer mediated communication necessitates a global examination of the behaviors and attitudes of scholars regarding CMC", also noting that particularly informal communication is a strong predictor of membership in an invisible college.

Barjak (2006) finds similar results pointing to the relation of productivity and use of digital technology in informal scholarly discourse. Views diverge on whether the digitization of scholarly discourse changes science and scholarship as such, or whether it only affects work practices, rather than affording more fundamental epistemological changes as well. Interestingly, publication activity correlates positively with all forms of Internet usage. In Barjak's words, "the more productive scientists are, the more they use the Internet for all the investigated purposes (social communication, information retrieval and dissemination)" (2006:1363).

Following up on these results, Lupton (2014) conducted a study among an international and interdisciplinary sample of 711 academics about their use of social media. This enabled her to gain insights into the strategic ways in which some scholars use social media and the benefits they have experienced for their academic work. According to Lupton, benefits

included connecting and establishing networks not only with peers, but also with stakeholder groups outside of universities, promoting openness and sharing of information, publicizing and development of research, and giving and receiving support. On the other hand, Lupton also found that while the majority of the respondents were very positive about using social media, they also expressed a range of concerns. These included issues of privacy and the blurring of boundaries between personal and professional use, the risk of jeopardizing their career through injudicious use of social media, lack of credibility, the quality of the content they posted, time pressures, social media use becoming an obligation, becoming a target of attack, too much self-promotion by others, possible plagiarism of their ideas, and the commercialization of content and copyright issues. These findings exemplify the pressure of outside forces on academia as a result of the diversification of relevant science policy actors. They also point to the versatility of social media for purposes going far beyond knowledge dissemination per se. Seeing social media through the lens of knowledge dissemination misses the point that they increasingly play a role for informal networking and relationship management among many academics.

In a similar vein, Bell (2012) explores the use of science blogs for the dissemination of scholarly knowledge, focusing in particular on how science bloggers regard their own role and the relation to their audience. Drawing on Brake's (2007) research on how bloggers conceptualize their audiences, she notes the long history of criticism towards science in his approach to communication, which systematically excludes the public. Importantly, Bell notes how the values of social media – interactivity and openness – clash with values associated with the scientific career path. She also points out that bloggers form cliques online in ways very similar to the invisible colleges recognized by Crane (1969). Additionally, many of the motives of scholarly bloggers that she notes fit with those described by Kjellberg in her study of early scholarly bloggers (2009).

Blogs as a form of personal publishing highlight the diversification of channels available to present and discuss scholarly knowledge (Kirkup 2010; Kjellberg 2009). As emphasized by Amsen's (2008) small interview study with five scholarly bloggers, blogs are used widely by individuals at the intersection of science and science communication. The bloggers she interviews argue that blogs are value to present ideas, for debate, to connect to others and to present both their field and science more broadly. However, there is a distinct tendency to associate blogging with the popularization of science, rather than with presenting original ideas. One blogger states that he doesn't want to risk getting scooped (Amsen

2008:10) and there are risks associated with disclosing potential confidential information. At the same time, she refers to blogs as "a playpen for new ideas" (p. 13), in line with the findings in other studies.

Bell (2012) finds similar motivations in her interview study of bloggers in neuroscience and psychology. Her respondents note the freedom of expression that their blog afforded them, allowing them both to publish things not fitting neatly into formal publishing regimes but also personalizing their communication to reflect their interests and viewpoints more broadly, rather than sticking to a particular subject matter in science. She also notes a tension between bloggers oriented more towards science and those identifying more closely with journalism (Bell 2012:259). The resulting conflict is one that points to the diversification of roles that follows a diversification of tools and information sources.

To summarize, the adoption of social media in academia has, in those places where it has succeeded, relied on a combination of curiosity and enjoyment of experimentation, on the belief that reaching broader audiences will have career benefits, and on the view that new forms of scholarly communication have long-term potential. However, there has been very little pressure to integrate social media into scholarly workflows and, accordingly, adoption has been limited. A key issue is the allocation of time: secondary communicative activities outside formal scholarly communication are conducted on top of established practices, posing challenges to the time budget.

10. Public Evaluation and "Flavors" of Impact

Scholarly communication has been widely studied from an outcome perspective as a proxy for the impact of science. *Bibliometrics*, a subfield of information science, is concerned with studying citation behavior and with utilizing citations as an indicator of different types of scholarly behavior. Using citation data, the productivity of individual researchers and their relative influence can be studied, the interaction between fields and nationalities can be scrutinized, as can the evolution of an area of research over time and (more broadly) the trajectory of science as a whole (Evans 2008).

Several forces converge when it comes to assessing the impact of scholarly communication, namely (i) the availability of more scholarly content in both digital and open form, (ii) the availability of social media tools that can be used to both disseminate the content further and record some sort of interaction, and (iii) a push for more openness and public scrutiny of science by society in general. The evaluation via publication

indicators is not restricted to individuals, but also extends to departments, universities and countries which are compared to determine scientific performance on a European and global scale. As Borgman and Furner (2005) point out: a major problem of link analysis is that it is not necessarily clear what the predicate denotes, i.e. in what context a given author cites a particular work. These issues are magnified studying indicators such as tweets, likes, shares, etc., for which both the reader community and the context of link creation remain largely opaque.

A core contention associated with the development described above is that it may lead to a unilateral focus on the impact of publications (and ultimately authors) over other forms of licensing quality (e.g. through the reputation of journals or institutions, availability of content), while diversifying this measure away from citations to other, faster measures (downloads, clicks, etc.). The possible risk associated with this is that popularity (public impact) in the broadest sense could trump quality (scientific impact). Whereas impact in any form was previously cumbersome and difficult to measure by comparison, this is increasingly simplified by various tools. It seems plausible that the speed and ease with which social media can serve to associate reference from individuals to scholarly works will advance the significance of social media instruments to point to scholarly works. While citations are still the gold standard, other forms of impact assessment are likely to gain relevance simply by being readily available. There is also reason to believe that while increased metrification will probably lead to more transparency, it may also result in more control. The style in which Priem, Pimowar and Hemminger (2012:1) describe *altmetrics* betrays a degree of mistrust in current scholarly practices, as made immediately clear by their claim that altmetrics will contribute to "exposing and fixing scholarly processes once hidden and ephemeral".

The abovementioned studies have to date largely focused on the usage perspective of scholars, namely the adoption of and attitudes towards social media. Increasingly, the potential of social media for the evaluation of scientific impact also plays a relevant role. Impact assessments are important for the assignment of funding and in the tenure process, thus significantly influencing career development. But seeing the impact of science through the lens of traditional impact metrics comes with a number of limitations. To quote Priem et al. (2012) again, "citations measure impact only on that minority of an article's audience with the means and inclination to cite it in the literature, leaving out clinicians, the general public, and even most scientists". Given the increasing pressure to improve the return on investment in science form the public perspective,

wide dissemination and impact of research seems crucial. Whereas previously a unilateral definition of impact as either a high impact factor of the publication or silent agreement among experts regarding the high prestige of a particular journal or press, was sufficient, it seems likely that this will shift towards more holistic measures of impact, as tools to provide such measures are more widely used by scholars.

Priem et al.'s (2012:13) main point is that different social media measurements of impact fall into four discreet clusters or *flavors* of impact, which identify separate audiences and usage practices and vary depending on how and by whom the research is used: work that is cited; work that is saved and shared; popular hits; and expert picks. Important dimensions in the context of impact measurement are the availability of measures and the democratization of how to "make" impact. Whereas previously only slow citation measures would leave any kind of visible dent, now many more indicators are available. Some of these, such as the statistics reported by Mendeley (saves to a bibliography) or SSRN (downloads) are arguably closer to citations in terms of signaling engagement, while others (e.g. abstract views, likes on Facebook, tweets mentioning the source) are perhaps less of a signal of engagement.

The diversification of these impact measures is important because it does not constitute a singular effect on how the output of a stable process will be presented. Rather, it is likely to result in a feedback to the practice itself, and this effect goes hand in hand with institutional changes that have shaped scholarly communication in past years, namely the need for greater measurable impact in the context of scientific evaluation, which influences the allocation of funding, the awarding of tenure, and the success of promotion processes.

11. Conclusions

In this chapter we have argued that the form and function of scholarly communications is defined by the individual needs of stakeholders, the organizational and cultural shaping of science as a community of practice and of the specific disciplines that comprise scholarship, and, finally, by changes in technology. These changes conspire to create a new type of medial setting in which scientists can address a range of stakeholders, rather than having to choose between clearly defined audiences. At the same time, the need to communicate in rigorously defined forms in traditional scholarly communication remains unchanged as a result of how scholarship is licensed by peers. But increasingly in addition to these genres, a wide variety of other formats are also used to promote research

and reach out to further audiences. This also creates challenges for academics who are faced with the anger of context collapse.

We believe that in the long term, this will lead to more convergence between formal and informal communication, and between formats that target specific audiences. We furthermore believe that the emphasis of communication will shift from popularization to dissemination and evaluation, generating legitimacy for scientific research, rather than 'educating the public'. Such a shift marks a long-term departure from a neat conceptual separation between science and the public at large, a shift driven both by robust societal forces and technological innovation.

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